관리번호

사본번호

서울제물포터널 민간투자사업 건설공사

구 조 계 산 서

[국회대로지하차도 및 상부공원화(1단계-중첩구간) [변경] 실시설계]

- 1구간 - [토목분야] 2/3권

2021. 04.

서울터널주식회사

관 리 번 호

사 본 번 호

국회대로지하차도 및 상부공원화(1단계-중첩구간) (변경)실시설계

구 조 계 산 서

[II]

2021. 04.

서울특별시

목 차

I 권

제 1장 지하차도 1-1

1.1 접속슬래브 1-3

1.2 U1~U3(STA.0+285.0) 1-11

1.3 U4~U5(STA.0+325.0) 1-97

1.4 U6(STA.0+345.0) 1-181

1.5 U7(STA.0+365.0) 1-265

1.6 U8(STA.0+385.0) 1-359

1.7 U9~U10(STA.0+425.0) 1-465

1.8 U11(STA.0+445.0) 1-563

1.9 U12(STA.0+465.0) 1-373

1.10 U13(STA.0+485.0) 1-885

1.11 B1(STA.0+510.0) 1-1101

1.12 B2(STA.0+540.0) 1-1281

1.13 B3(STA.0+580.0) 1-1471

1.14 B4(STA.0+620.0) 1-1667

1.15 B5(STA.0+660.0) 1841

II 권

제 1장 지하차도 2-1

1.16 B6(STA.0+679, 본선) 2-3

1.17 B6-1(STA.0+700, 본선) 2-163

1.18 B6-1(STA.0+700.0, 램프) 2-347

1.19 B7(STA.0+740.0, 본선) 2-471

1.20 B7(STA.0+740.0, 램프) 2-655

1.21 B8(STA.0+780.0, 본선) 2-657

1.22 B8(STA.0+780.0, 램프) 2-959

1.23 차량용 피난연결통로 2-1081

1.24 대인용 피난연결통로 2-1191

1.25 개구부 보강거더 2-1355

1.26 부반력 앵커 2-1383

1.27 풍도슬래브 및 브라켓 2-1481

II 권

제 2장 집수정 2-1607

2.1 집수정 단면 2-1609

2.2 점검통로 단면 A-A 2-1805

2.3 점검통로 단면 C-C 2-1921

2.4 점검통로 단면 D-D 2-1949

2.5 점검통로 단면 E-E 2-2067

2.6 점검통로 단면 F-F 2-2095

2.7 보강거더 #1,#2 2-2123

2.8 보강거더 #3,#4 2-2135

2.9 보강거더 #5,#6 2-2147

2.10 집수정 마감벽 2-2159

2.11 집수정 점검통로 마감벽 #1 2-2203

2.12 집수정 점검통로 마감벽 #2 2-2237

2.13 집수정 점검통로 마감벽 #3 2-2271

2.14 내부계단 및 월류벽 2-2301

III권

제 3장 가시설공

3-1 1차시공가시설 3-1

3-1.1 TYPE-01(STA.0+224.0 ~ 0+324.0) 3-3

3-1.2 TYPE-02(STA.0+324.0 ~ 0+362.0) 3-33

3-1.3 TYPE-03(STA.0+362.0 ~ 0+382.0) 3-91

3-1.4 TYPE-04(STA.0+382.0 ~ 0+443.5) 3-143

3-1.5 TYPE-05(STA.0+443.5 ~ 0+463.0) 3-197

3-1.6 TYPE-06(STA.0+463.0 ~ 0+484.5) 3-251

3-1.7 TYPE-07(STA.0+484.5 ~ 0+509.5) 3-315

3-1.8 TYPE-08(STA.0+509.5 ~ 0+539.5) 3-375

3-1.9 TYPE-09(STA.0+539.5 ~ 0+560.0) 3-451

3-1.10 TYPE-10(STA.0+560.0 ~ 0+580.0) 3-527

3-1.11 TYPE-11(STA.0+580.0 ~ 0+600.0) 3-607

3-1.12 TYPE-12~12-1(STA.0+600.0 ~ 0+619.0) 3-689

3-1.13 TYPE-13(STA.0+619.0 ~ 0+625.0) 3-869

3-1.14 TYPE-13-1(STA.0+625.0 ~ 0+632.2) 3-963

3-1.15 TYPE-13-2(STA.0+632.2 ~ 0+644.5) 3-1041

3-1.16 TYPE-14(STA.0+644.5 ~ 0+657.5) 3-1137

3-1.17 TYPE-15(STA.0+657.5 ~ 0+683.5) 3-1229

3-1.18 TYPE-16(STA.0+683.5 ~ 0+701.0) 3-1335

3-1.19 TYPE-17(STA.0+701.0 ~ 0+720.0) 3-1469

3-1.20 TYPE-18(좌,우)(STA.0+720.0 ~ 0+737.0) 3-1577

3-1.21 TYPE-19(STA.0+737.0 ~ 0+751.5) 3-1797

3-1.22 TYPE-20(STA.0+751.5 ~ 0+769.5) 3-1917

3-1.23 TYPE-21(STA.0+769.5 ~ 0+780.15) 3-2037

3-1.24 TYPE-21(갱문-사버팀보) 3-2163

3-1.25 TYPE-막이벽 3-2297

Ⅲ권

제 3장 가시설공 3-2361

3-2 2차시공가시설 3-2361

3-2.1 TYPE-16(STA.0+683.5 ~ 0+701.0) 3-2363

3-2.2 TYPE-17(STA.0+701.0 ~ 0+720.0) 3-2389

3-2.3 TYPE-18(STA.0+720.0 ~ 0+737.7) 3-2437

3-2.4 TYPE-19(STA.0+737.7 ~ 0+751.5) 3-2479

3-2.5 TYPE-20(STA.0+751.5 ~ 0+769.5) 3-2521

3-2.6 TYPE-21(STA.0+769.5 ~ 0+780.150) 3-2563

3-3 광역상수관 매달기 3-2605

3-3.1 A.상수관매달기(지간4.0m) 3-2607

3-3.2 A.상수관매달기(지간4.5m) 3-2615

3-3.3 B.상수관매달기(곡관보호공) 3-2623

제 4장 수리계산서 3-2631

4.1 집수정 용량 계산서 3-2633

4.2 초기우수처리시설 용량 계산서 3-2641

제1장 지하차도

1.1 접속슬래브
1.2 U1~U3(STA.0+285.0)
1.3 U4~U5(STA.0+325.0)
1.4 U6(STA.0+345.0)
1.5 U7(STA.0+365.0)
1.6 U8(STA.0+385.0)
1.7 U9~U10(STA.0+425.0)
1.8 U11(STA.0+445.0)
1.9 U12(STA.0+465.0)
1.10 U13(STA.0+485.0)
1.11 B1(STA.0+510.0)
1.12 B2(STA.0+540.0)
1.13 B3(STA.0+580.0)
1.14 B4(STA.0+620.0)
1.15 B5(STA.0+660.0)
1.16 B6(STA.0+679.0, 본선)
1.17 B6-1(STA.0+700.0, 본선)
1.18 B6-1(STA.0+700.0, 램프)
1.19 B7(STA.0+740.0, 본선)
1.20 B7(STA.0+740.0, 램프)
1.21 B8(STA.0+780.0, 본선)
1.22 B8(STA.0+780.0, 램프)
1.23 차량용 피난연결통로
1.24 대인용 피난연결통로
1.25 개구부 보강거더
1.26 부반력 앵커
1.27 풍도슬래브 및 브라켓
1.28 지하차도 입구 마감벽

1.16 B6(STA.0+679.0)
- 본 선 -

국회대로 지하차도

STA.0+679.000 (내진)

목 차

1. 설계조건

2. 단면가정

3. 설계지진력 산정

4. 하중재하도

5. 하중조합

6. 단면력도

7. 기능수행수준 부재력집계

8. 붕괴방지수준 부재력집계

1. 설계조건

1.1 적용하중

1) 단위중량

① 철근 콘크리트 : r_c = 25.0 kN/m^3

② 무근 콘크리트 : r_c = 23.5 kN/m^3

③ Ascon Pav. : r_{asp} = 23.0 kN/m^3

④ 토사(지하수위 이상) : r_s = 19.0 kN/m^3

토사(지하수위 이하) : r_{sub} = 10.0 kN/m^3

⑤ 보호몰탈 : r_m = 21.0 kN/m^3

2) 활하중

⊙ 노면활하중(DB-24 기준)에 대한 등가 등분포하중

$D / B_o \geq 0.5$ 인 경우		
토 피 (D, m)	노면의 활하중 P_{vl} (kN/m^2)	비고
1.0	39.0	· 토피의 중간 값은 노면 활하중 상위의 값을 적용
1.5	25.0	
2.0	18.0	
2.5	14.0	
3.0	11.0	
3.5 이상	10.0	
$D / B_o < 0.5$ 인 경우		
토 피 (D, m)	노면의 활하중 P_{vl} (kN/m^2)	비고
0.1	17.0	· D/B_o 의 중간 값은 P_{vl} x D 의 상위 값을 적용 · D/B_o 노면 활하중(P_{vl})은 표의 값을 D로 나누어 구한다.
0.2	27.0	
0.3	33.0	
0.4 이상	36.0	

주1) D : 토피고(m)

2) B_o : ≧10m 이상의 토피에 대한 노면 활하중은 10.0으로 한다.

3) 수 압 (장기실지하수위 : GL - 1 m)

⊙ 정수압 : $F = r_w \times h$

4) 토 압

① 정지 토압계수 : $K_o = 1 - \sin \phi$ [ø : 흙의 내부마찰각(°)]

② 설계토압 : $Wq = K_o \times r_s \times h$ (kN/m^2)

5) 지진하중 (응답변위법)

① 붕괴방지수준, 기능수행수준 모두 수행

② 하중형태 : 지반변위에 의한 하중, 주면전단력, 구체 관성력

1.2 탄성계수 ☞ 2012년도 콘크리트구조설계기준

1) 콘크리트

① 설계기준강도 (f_{ck}) = 27 MPa

② 탄성계수 (E_c) = $8{,}500\times(fcu)^{1/3}$, [fcu = fck+4 = 31 MPa]

= 26,702 MPa = 26,702,000 kN/m^2

2) 철 근 (SD40)

① 항복강도 (f_y) = 400 MPa

② 탄성계수 (E_s) = 200,000 MPa = 200,000,000 kN/m^2

1.3 강도감소계수 ☞ 2007년도 개정 콘크리트구조설계기준 p61 (3.3.3)

1) 휨모멘트와 축력을 받는 부재

① 인장지배 단면 : ø = 0.85

2) 전단력과 비틀림모멘트를 받는 부재 : ø = 0.75

1.4 설계피복

단위 : mm

구 분	상부슬래브	하부슬래브	중간슬래브	외측벽체	기둥	거더
상면(벽체외측)	100	80	80	100	90	135
하면(벽체내측)	80	100	80	80	90	90

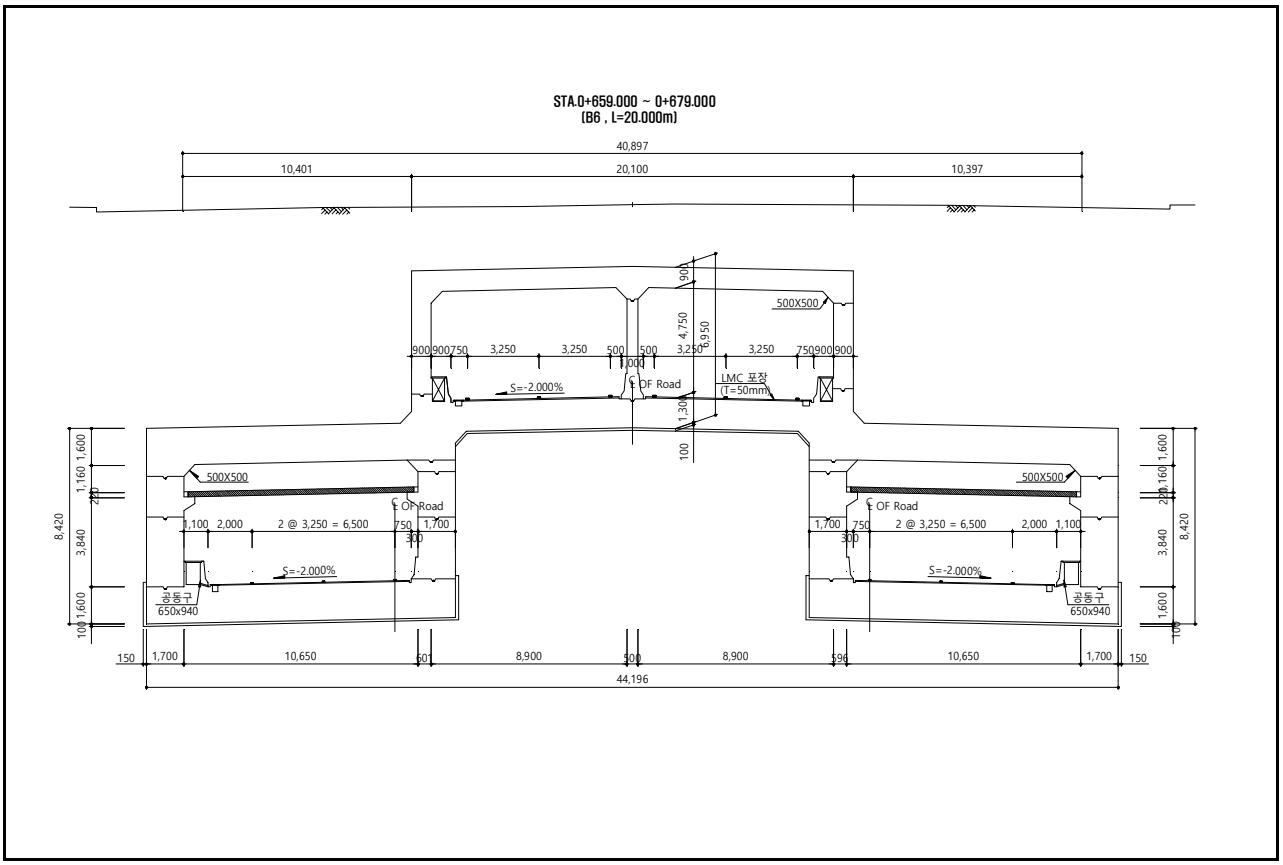
1.5 참고문헌

① 콘크리트설계기준(한국콘크리트학회, 2012) ② 구조물기초설계기준(국토해양부, 2014)

③ 도시철도내진설계기준(국토교통부, 2013)

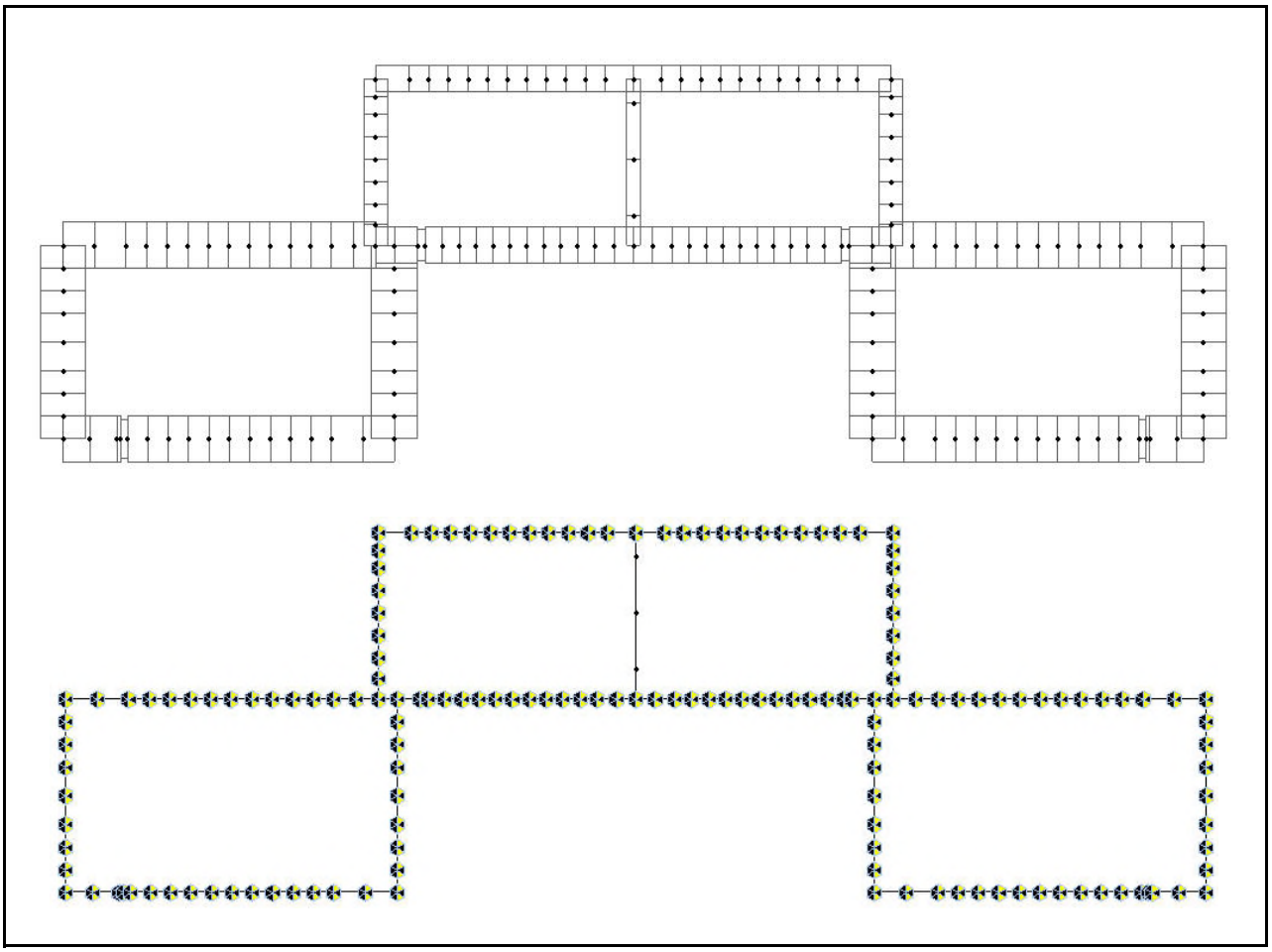
2. 단면가정

2.1 해석단면



2.2 해석모델링

1) 해석모델



2) 지진시 지반반력계수

(1) 동적 지반물성치

* 계산식

- Vo (초기 전단파 속도) : **지반조사 보고서 참고**
- Vs (해당 지층의 전단파 속도) = 0.8 × Vo (m/sec , 기능수행수준)
  = 0.5 × Vo (m/sec , 붕괴방지수준)
- G_D (동적전단탄성계수) = γ_t / g × Vs^2 (kN/m^2) (g = 9.81 m/s^2)
- E_D (동적탄성계수) = 2 ×(1 + υ)× G_D (kN/m^2)

구 분	H	γ_t (kN/m^3)	V_o (m/sec)	υ	기능수행수준			붕괴방지수준		
					V_s (m/sec)	G_D (kN/m^2)	E_D (kN/cm^2)	V_s (m/sec)	G_D (kN/m^2)	E_D (kN/cm^2)
매립층	1.600	18.000	156.000	0.440	125	28,578	82,305	78	11,163	32,150
퇴적층(자갈층)	10.200	19.000	289.000	0.431	231	103,529	296,299	145	40,441	115,742
풍화토	2.700	20.000	424.000	0.408	339	234,570	660,549	212	91,629	258,027
풍화암	3.500	21.000	631.000	0.387	505	545,493	1,513,197	316	213,083	591,093
연 암	12.000	23.000	1216.000	0.280	973	2,218,738	5,679,968	608	866,694	2,218,738
경 암	0.000	26.000	2059.000	0.243	1,647	7,191,128	17,877,144	1,030	2,809,034	6,983,259

단, 지반조사보고서 참조

(2) 지진시 지반반력계수 (기능수행수준, 붕괴방지수준)

* 연직방향 지반반력계수

- B_V = (슬래브의 재하환산폭) = √(V×V) , B_H = (벽체의 재하환산폭) = √(H×H)
  = 20.300 m = 44.200 m = 12.670 m
- $K_{ho(vo)} = 1/0.3 \cdot E_D$

* 연직방향 환산 지반반력계수(압축방향)

- $K_V = K_{vo} (B_V/0.3)^{-3/4}$, $K_H = K_{ho} (B_H/0.3)^{-3/4}$

* 본선 수평방향 지반반력계수(전단방향)

- $K_{SV} = \lambda \times k_V = 1/3 \times k_V$, $K_{SH} = \lambda \times k_H = 1/3 \times k_H$

구 분	기능수행수준					붕괴방지수준				
	$K_{ho(vo)}$ (kN/m^3)	K_V (kN/m^3)	K_H (kN/m^3)	K_{SV} (kN/m^3)	K_{SH} (kN/m^3)	$K_{ho(vo)}$ (kN/m^3)	K_V (kN/m^3)	K_H (kN/m^3)	K_{SV} (kN/m^3)	K_{SH} (kN/m^3)
매립층	274,349	11,628	16,560	3,876	5,520	107,168	2,534	6,469	845	2,156
퇴적층(자갈층)	987,663	41,863	59,617	13,954	19,872	385,806	16,353	23,288	5,451	7,763
풍화토	2,201,831	93,326	132,905	31,109	44,302	860,090	36,455	51,916	12,152	17,305
풍화암	5,043,990	213,793	304,462	71,264	101,487	1,970,308	83,513	118,930	27,838	39,643
연 암	18,933,228	802,497	1,142,834	267,499	380,945	7,395,792	313,476	446,420	104,492	148,807
보통암	15,536,147	658,510	937,782	219,503	312,594	6,068,807	257,230	366,321	85,743	122,107
경 암	59,590,479	2,525,782	3,596,958	841,927	1,198,986	23,277,531	986,633	1,405,062	328,878	468,354

* 램프 수평방향 지반반력계수(전단방향)

- $K_{SV} = \lambda \times k_V = 1/3 \times k_V$, $K_{SH} = \lambda \times k_H = 1/3 \times k_H$

구 분	기능수행수준					붕괴방지수준				
	$K_{ho(vo)}$ (kN/m^3)	K_V (kN/m^3)	K_H (kN/m^3)	K_{SV} (kN/m^3)	K_{SH} (kN/m^3)	$K_{ho(vo)}$ (kN/m^3)	K_V (kN/m^3)	K_H (kN/m^3)	K_{SV} (kN/m^3)	K_{SH} (kN/m^3)
매립층	274,349	10,288	26,352	3,429	8,784	107,168	4,019	10,294	1,340	3,431
퇴적층(자갈층)	987,663	37,038	94,866	12,346	31,622	385,806	14,468	37,057	4,823	12,352
풍화토	2,201,831	82,571	211,488	27,524	70,496	860,090	32,254	82,613	10,751	27,538
풍화암	5,043,990	189,155	484,481	63,052	161,494	1,970,308	73,888	189,250	24,629	63,083

연 암	18,933,228	710,014	1,818,559	236,671	606,186	7,395,792	277,349	710,374	92,450	236,791
보통암	15,536,147	582,621	1,492,265	194,207	497,422	6,068,807	227,586	582,916	75,862	194,305
경 암	59,590,479	2,234,701	5,723,735	744,900	1,907,912	23,277,531	872,930	2,235,834	290,977	745,278

(3) 구간별 지반반력계수

*** 기능수행수준**

[상부슬래브 지진시 지반반력계수 , **퇴적층(자갈층)** , **퇴적층(자갈층)**]

토층	K_V (kN/m^3)	K_{SV} (kN/m^3)	간격1 (m)	간격2 (m)	연직 지반반력계수 (kN/m)	수평 지반반력계수 (kN/m)	해당절점
퇴적층(자갈층)	41,863	13,954	0.450	1.250	35,583	11,861	139 163
퇴적층(자갈층)	41,863	13,954	1.250	0.730	41,444	13,815	140 162
퇴적층(자갈층)	41,863	13,954	0.730	0.730	30,560	10,187	141 to149 153 to 161
퇴적층(자갈층)	41,863	13,954	0.730	1.050	37,258	12,419	150 152
퇴적층(자갈층)	41,863	13,954	1.050	1.050	43,956	14,652	151
퇴적층(자갈층)	37,038	12,346	0.850	1.175	37,501	12,500	63 121
퇴적층(자갈층)	37,038	12,346	1.175	1.175	43,520	14,507	64 120
퇴적층(자갈층)	37,038	12,346	1.175	0.765	35,927	11,976	65 119
퇴적층(자갈층)	37,038	12,346	0.765	0.765	28,334	9,445	66 to 74 110 to 118
퇴적층(자갈층)	37,038	12,346	0.765	0.825	29,445	9,815	75 109
퇴적층(자갈층)	37,038	12,346	0.825	0.825	30,557	10,186	76 108
퇴적층(자갈층)	37,038	12,346	0.825	0.450	23,612	7,871	77 107

[하부슬래브 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암**]

토층	K_V (kN/m^3)	K_{SV} (kN/m^3)	간격1 (m)	간격2 (m)	연직 지반반력계수 (kN/m)	수평 지반반력계수 (kN/m)	해당절점
풍화암	189,155	63,052	0.850	1.000	174,968	58,323	1 34
풍화암	189,155	63,052	1.000	1.000	189,155	63,052	2 33
풍화암	189,155	63,052	1.000	0.150	108,764	36,255	3 32
풍화암	189,155	63,052	0.150	0.250	37,831	12,610	4 31
풍화암	189,155	63,052	0.250	0.760	95,523	31,841	5 30
풍화암	189,155	63,052	0.760	0.760	143,757	47,919	6 to 14 21 to 29
풍화암	189,155	63,052	0.760	1.175	183,007	61,002	15 20
풍화암	189,155	63,052	1.175	1.175	222,257	74,086	16 19
풍화암	189,155	63,052	1.175	0.850	191,519	63,840	17 18
퇴적층(자갈층)	41,863	13,954	0.850	0.300	24,071	8,024	79 105
퇴적층(자갈층)	41,863	13,954	0.300	0.630	19,466	6,489	80 104
퇴적층(자갈층)	41,863	13,954	0.630	0.630	26,374	8,791	81to89 95to103
퇴적층(자갈층)	41,863	13,954	0.630	0.725	28,362	9,454	90 94
퇴적층(자갈층)	41,863	13,954	0.725	0.725	30,350	10,117	91 92 93

[좌측벽체 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암**]

토층	K_H (kN/m^3)	K_{SH} (kN/m^3)	간격1 (m)	간격2 (m)	수평 지반 반력계수 (kN/m)	전단 지반 반력계수 (kN/m)	해당절점
퇴적층(자갈층)	59,617	19,872	0.450	0.625	32,044	10,681	139
퇴적층(자갈층)	59,617	19,872	0.625	0.625	37,260	12,420	136
퇴적층(자갈층)	59,617	19,872	0.625	0.788	42,104	14,035	134
퇴적층(자갈층)	59,617	19,872	0.788	0.788	46,948	15,649	132

퇴적층(자갈층)	59,617	19,872	0.788	0.788	46,948	15,649	129
퇴적층(자갈층)	59,617	19,872	0.788	0.788	46,948	15,649	127
퇴적층(자갈층)	59,617	19,872	0.788	0.725	45,085	15,028	125
퇴적층(자갈층)	59,617	19,872	0.725	0.725	43,222	14,407	122
퇴적층(자갈층)	59,617	19,872	0.725	0.650	40,986	13,662	77
퇴적층(자갈층)	94,866	31,622	0.700	0.800	71,150	23,717	63
퇴적층(자갈층)	94,866	31,622	0.800	0.800	75,893	25,298	59
퇴적층(자갈층)	94,866	31,622	0.800	0.800	75,893	25,298	55
풍화토	211,488	70,496	0.800	1.010	191,397	63,799	51
풍화토	211,488	70,496	0.575	1.010	167,605	55,868	47
풍화암	484,481	161,494	1.010	0.800	438,455	146,152	43
풍화암	484,481	161,494	0.800	0.800	387,585	129,195	39
풍화암	484,481	161,494	0.800	0.800	387,585	129,195	35
풍화암	484,481	161,494	0.800	0.700	363,361	121,120	1
퇴적층(자갈층)	94,866	31,622	0.650	0.800	68,778	22,926	106
퇴적층(자갈층)	94,866	31,622	0.800	0.800	75,893	25,298	61
퇴적층(자갈층)	94,866	31,622	0.800	0.800	75,893	25,298	57
풍화토	211,488	70,496	0.800	1.010	191,397	63,799	53
풍화토	211,488	70,496	1.010	1.010	213,603	71,201	49
풍화암	484,481	161,494	1.010	0.800	438,455	146,152	45
풍화암	484,481	161,494	0.800	0.800	387,585	129,195	41
풍화암	484,481	161,494	0.800	0.800	387,585	129,195	37
풍화암	484,481	161,494	0.800	0.700	363,361	121,120	18

[우측벽체 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암**]

토층	K_H (kN/m^3)	K_{SH} (kN/m^3)	간격1 (m)	간격2 (m)	수평 지반 반력계수 (kN/m)	전단 지반 반력계수 (kN/m)	해당절점
퇴적층(자갈층)	59,617	19,872	0.450	0.625	32,044	10,681	163
퇴적층(자갈층)	59,617	19,872	0.625	0.625	37,260	12,420	137
퇴적층(자갈층)	59,617	19,872	0.625	0.788	42,104	14,035	135
퇴적층(자갈층)	59,617	19,872	0.788	0.788	46,948	15,649	133
퇴적층(자갈층)	59,617	19,872	0.788	0.788	46,948	15,649	130
퇴적층(자갈층)	59,617	19,872	0.788	0.788	46,948	15,649	128
퇴적층(자갈층)	59,617	19,872	0.788	0.725	45,085	15,028	126
퇴적층(자갈층)	59,617	19,872	0.725	0.725	43,222	14,407	123
퇴적층(자갈층)	59,617	19,872	0.725	0.650	40,986	13,662	107
퇴적층(자갈층)	94,866	31,622	0.700	0.800	71,150	23,717	121
퇴적층(자갈층)	94,866	31,622	0.800	0.800	75,893	25,298	62
퇴적층(자갈층)	94,866	31,622	0.800	0.800	75,893	25,298	58
풍화토	211,488	70,496	0.800	1.010	191,397	63,799	54
풍화토	211,488	70,496	1.010	1.010	213,603	71,201	50
풍화암	484,481	161,494	1.010	0.800	438,455	146,152	46
풍화암	484,481	161,494	0.800	0.800	387,585	129,195	42
풍화암	484,481	161,494	0.800	0.800	387,585	129,195	38
풍화암	484,481	161,494	0.800	0.700	363,361	121,120	34
퇴적층(자갈층)	94,866	31,622	0.650	0.800	68,778	22,926	78
퇴적층(자갈층)	94,866	31,622	0.800	0.800	75,893	25,298	60
퇴적층(자갈층)	94,866	31,622	0.800	0.800	75,893	25,298	56

풍화토	211,488	70,496	0.800	1.010	191,397	63,799	52
풍화토	211,488	70,496	1.010	1.010	213,603	71,201	48
풍화암	484,481	161,494	1.010	0.800	438,455	146,152	44
풍화암	484,481	161,494	0.800	0.800	387,585	129,195	40
풍화암	484,481	161,494	0.800	0.800	387,585	129,195	36
풍화암	484,481	161,494	0.800	0.700	363,361	121,120	17

*** 붕괴방지수준**

[상부슬래브 지진시 지반반력계수 , **퇴적층(자갈층)** , **퇴적층(자갈층)**]

토층	K_V (kN/m^3)	K_{SV} (kN/m^3)	간격1 (m)	간격2 (m)	연직 지반반력계수 (kN/m)	수평 지반반력계수 (kN/m)	해당절점
퇴적층(자갈층)	16,353	5,451	0.450	1.250	13,900	4,633	139 163
퇴적층(자갈층)	16,353	5,451	1.250	0.730	16,189	5,396	140 162
퇴적층(자갈층)	16,353	5,451	0.730	0.730	11,937	3,979	141 to149 153 to 161
퇴적층(자갈층)	16,353	5,451	0.730	1.050	14,554	4,851	150 152
퇴적층(자갈층)	16,353	5,451	1.050	1.050	17,170	5,723	151
퇴적층(자갈층)	14,468	4,823	0.850	1.175	14,649	4,883	63 121
퇴적층(자갈층)	14,468	4,823	1.175	1.175	17,000	5,667	64 120
퇴적층(자갈층)	14,468	4,823	1.175	0.765	14,034	4,678	65 119
퇴적층(자갈층)	14,468	4,823	0.765	0.765	11,068	3,689	66 to 74 110 to 118
퇴적층(자갈층)	14,468	4,823	0.765	0.825	11,502	3,834	75 109
퇴적층(자갈층)	14,468	4,823	0.825	0.825	11,936	3,979	76 108
퇴적층(자갈층)	14,468	4,823	0.825	0.450	9,223	3,074	77 107

[하부슬래브 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암**]

토층	K_V (kN/m^3)	K_{SV} (kN/m^3)	간격1 (m)	간격2 (m)	연직 지반반력계수 (kN/m)	수평 지반반력계수 (kN/m)	해당절점
풍화암	73,888	24,629	0.850	1.000	68,347	22,782	1 34
풍화암	73,888	24,629	1.000	1.000	73,888	24,629	2 33
풍화암	73,888	24,629	1.000	0.150	42,486	14,162	3 32
풍화암	73,888	24,629	0.150	0.250	14,778	4,926	4 31
풍화암	73,888	24,629	0.250	0.760	37,314	12,438	5 30
풍화암	73,888	24,629	0.760	0.760	56,155	18,718	6 to 14 21 to 29
풍화암	73,888	24,629	0.760	1.175	71,487	23,829	15 20
풍화암	73,888	24,629	1.175	1.175	86,819	28,940	16 19
풍화암	73,888	24,629	1.175	0.850	74,812	24,937	17 18
퇴적층(자갈층)	16,353	5,451	0.850	0.300	9,403	3,134	79 105
퇴적층(자갈층)	16,353	5,451	0.300	0.630	7,604	2,535	80 104
퇴적층(자갈층)	16,353	5,451	0.630	0.630	10,302	3,434	81to89 95to103
퇴적층(자갈층)	16,353	5,451	0.630	0.725	11,079	3,693	90 94
퇴적층(자갈층)	16,353	5,451	0.725	0.725	11,856	3,952	91 92 93

[좌측벽체 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암**]

토층	K_H (kN/m^3)	K_{SH} (kN/m^3)	간격1 (m)	간격2 (m)	수평 지반 반력계수 (kN/m)	전단 지반 반력계수 (kN/m)	해당절점
퇴적층(자갈층)	23,288	7,763	0.450	0.625	12,517	4,172	139
퇴적층(자갈층)	23,288	7,763	0.625	0.625	14,555	4,852	136
퇴적층(자갈층)	23,288	7,763	0.625	0.788	16,447	5,482	134

퇴적층(자갈층)	23,288	7,763	0.788	0.788	18,339	6,113	132
퇴적층(자갈층)	23,288	7,763	0.788	0.788	18,339	6,113	129
퇴적층(자갈층)	23,288	7,763	0.788	0.788	18,339	6,113	127
퇴적층(자갈층)	23,288	7,763	0.788	0.725	17,611	5,870	125
퇴적층(자갈층)	23,288	7,763	0.725	0.725	16,884	5,628	122
퇴적층(자갈층)	23,288	7,763	0.725	0.650	16,010	5,337	77
퇴적층(자갈층)	37,057	12,352	0.700	0.800	27,793	9,264	63
퇴적층(자갈층)	37,057	12,352	0.800	0.800	29,646	9,882	59
퇴적층(자갈층)	37,057	12,352	0.800	0.800	29,646	9,882	55
풍화토	82,613	27,538	0.800	1.010	74,764	24,921	51
풍화토	82,613	27,538	0.575	1.010	65,471	21,824	47
풍화암	189,250	63,083	1.010	0.800	171,272	57,091	43
풍화암	189,250	63,083	0.800	0.800	151,400	50,467	39
풍화암	189,250	63,083	0.800	0.800	151,400	50,467	35
풍화암	189,250	63,083	0.800	0.700	141,938	47,313	1
퇴적층(자갈층)	37,057	12,352	0.650	0.800	26,866	8,955	106
퇴적층(자갈층)	37,057	12,352	0.800	0.800	29,646	9,882	61
퇴적층(자갈층)	37,057	12,352	0.800	0.800	29,646	9,882	57
풍화토	82,613	27,538	0.800	1.010	74,764	24,921	53
풍화토	82,613	27,538	1.010	1.010	83,439	27,813	49
풍화암	189,250	63,083	1.010	0.800	171,272	57,091	45
풍화암	189,250	63,083	0.800	0.800	151,400	50,467	41
풍화암	189,250	63,083	0.800	0.800	151,400	50,467	37
풍화암	189,250	63,083	0.800	0.700	141,938	47,313	18

[우측벽체 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암**]

토층	K_H (kN/m^3)	K_{SH} (kN/m^3)	간격1 (m)	간격2 (m)	수평 지반 반력계수 (kN/m)	전단 지반 반력계수 (kN/m)	해당절점
퇴적층(자갈층)	23,288	7,763	0.450	0.625	12,517	4,172	163
퇴적층(자갈층)	23,288	7,763	0.625	0.625	14,555	4,852	137
퇴적층(자갈층)	23,288	7,763	0.625	0.788	16,447	5,482	135
퇴적층(자갈층)	23,288	7,763	0.788	0.788	18,339	6,113	133
퇴적층(자갈층)	23,288	7,763	0.788	0.788	18,339	6,113	130
퇴적층(자갈층)	23,288	7,763	0.788	0.788	18,339	6,113	128
퇴적층(자갈층)	23,288	7,763	0.788	0.725	17,611	5,870	126
퇴적층(자갈층)	23,288	7,763	0.725	0.725	16,884	5,628	123
퇴적층(자갈층)	23,288	7,763	0.725	0.650	16,010	5,337	107
퇴적층(자갈층)	37,057	12,352	0.700	0.800	27,793	9,264	121
퇴적층(자갈층)	37,057	12,352	0.800	0.800	29,646	9,882	62
퇴적층(자갈층)	37,057	12,352	0.800	0.800	29,646	9,882	58
풍화토	82,613	27,538	0.800	1.010	74,764	24,921	54
풍화토	82,613	27,538	1.010	1.010	83,439	27,813	50
풍화암	189,250	63,083	1.010	0.800	171,272	57,091	46
풍화암	189,250	63,083	0.800	0.800	151,400	50,467	42
풍화암	189,250	63,083	0.800	0.800	151,400	50,467	38
풍화암	189,250	63,083	0.800	0.700	141,938	47,313	34
퇴적층(자갈층)	37,057	12,352	0.650	0.800	26,866	8,955	78
퇴적층(자갈층)	37,057	12,352	0.800	0.800	29,646	9,882	60

퇴적층(자갈층)	37,057	12,352	0.800	0.800	29,646	9,882	56
풍화토	82,613	27,538	0.800	1.010	74,764	24,921	52
풍화토	82,613	27,538	1.010	1.010	83,439	27,813	48
풍화암	189,250	63,083	1.010	0.800	171,272	57,091	44
풍화암	189,250	63,083	0.800	0.800	151,400	50,467	40
풍화암	189,250	63,083	0.800	0.800	151,400	50,467	36
풍화암	189,250	63,083	0.800	0.700	141,938	47,313	17

3. 설계지진력 산정

1) 설계응답스펙트럼

① 지표면 가속도계수(A)

* 내진성능목표

재 현 주 기	50년	100년	200년	500년	1000년	5000년
기능수행수준	II 등급	I 등급	특등급			
붕괴방지수준				II 등급	I 등급	특등급

* 위험도 계수

재 현 주 기	50년	100년	200년	500년	1000년	5000년
위험도계수(I)	0.40	0.57	0.73	1.00	1.40	2.00

* 기반면, 지표면 : S_B

지 반 종 류		상부 30m에 대한 평균 지반 특성		
		전단파속도 V_{S30}(m.sec)	표준관입시험 N(타격수)	비배수전단강도 (kPa)
S_A	경암지반	1500초과	–	–
S_B	보통암지반	760 ~ 1500		
S_C	매우 조밀한 토사지반 또는 연암지반	360 ~ 760	50초과	100초과
S_D	단단한 토사지반	180 ~ 360	15 ~ 50	50 ~ 100
S_E	연약한 토사지반	180미만	15미만	50미만
S_F	부지 고유의 특성평가가 요구되는 지반			

* 지진계수

지진 구역	지반 종류	지진계수		비고	지진 구역	지반 종류	지진계수		비고
		Ca	Cv				Ca	Cv	
I	S_A	0.09	0.09	기반면, 지표면	II	S_A	0.05	0.05	
	S_B	0.11	0.11			S_B	0.07	0.07	
	S_C	0.13	0.18			S_C	0.08	0.11	
	S_D	0.16	0.23			S_D	0.11	0.16	
	S_E	0.22	0.37			S_E	0.17	0.23	

* 지표면 가속도계수(A)

- 기능수행수준

기반면 : A = I x Ca = 0.57 x 0.09 = 0.051

지표면1 : A = I x Ca = 0.57 x 0.16 = 0.091 ← 토층

지표면2 : A = I x Ca = 0.57 x 0.11 = 0.063 ← 암층

- 붕괴방지수준

기반면 : A = I x Ca = 1.40 x 0.09 = 0.126

지표면1 : A = I x Ca = 1.40 x 0.16 = 0.224 ← 토층

지표면2 : A = I x Ca = 1.40 x 0.11 = 0.154 ← 암층

② 지표면 응답 가속도(Sa)

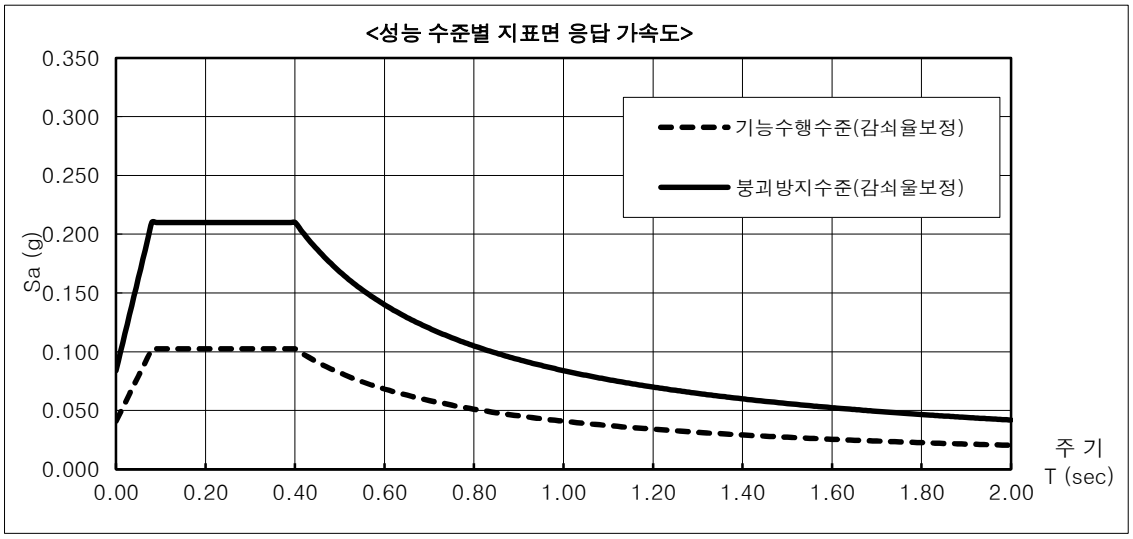
* T'_s = Cv/2.5xCa = 0.400 * T_o = 0.2xT's = 0.080

* 감쇠율에 대한 보정, C_D

C_D = 1.5/(40h+1)+0.5 = 0.800 , 감쇠율, h = 0.1 (기능수행수준)

C_D = 1.5/(40h+1)+0.5 = 0.667 , 감쇠율, h = 0.2 (붕괴방지수준)

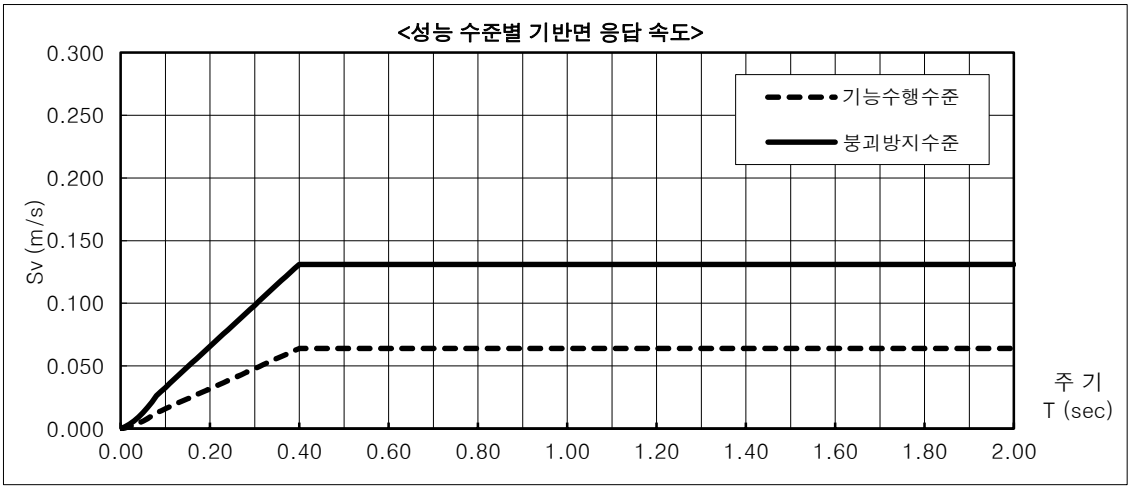
* 성능수준별 지표면 응답 가속도



- $S_{a(at\ T=0)}$ = A x C_D = 0.051 x 0.800 = 0.041 g (기능수행수준)
  = A x C_D = 0.126 x 0.667 = 0.084 g (붕괴방지수준)
- $S_{a(at\ T=0.40)}$ = 2.5 x A x C_D = 2.5 x 0.051 x 0.800 = 0.103 g (기능수행수준)
  = 2.5 x A x C_D = 2.5 x 0.126 x 0.667 = 0.210 g (붕괴방지수준)

③ 기반면 응답 속도(Sv)

* Sv = T/2π×Sa (m/s^2)



- g = 9.81 m/s^2
- $S_{v(at\ T=0.40)}$ = T / 2π x Sa = 0.40 / 2π x 0.103 x g = 0.064 m/s (기능수행수준)
  = T / 2π x Sa = 0.40 / 2π x 0.210 x g = 0.131 m/s (붕괴방지수준)

2) 지반변위

① 표층지반의 특성값 : $T_G = \sum 4Hi / Vsi$

* 기능수행수준

Hi(m)	지반종류	N치	Vsi(m/sec)	T_G(4Hi/Vsi)
1.600	매립층	-	156	0.041
10.200	퇴적층(자갈층)	-	289	0.141
2.700	풍화토	-	424	0.025
3.500	풍화암	-	631	0.022
12.000	연 암	-	1216	0.039
0.000	보통암	-	1050	0.000
0.000	경 암	-	2059	0.000
0.000	0.00	-	0	0.000
30.000	T_G (지반의 특성값, sec)			0.268

* Ts (지반의 고유주기, sec)

= 1.25 × T_G = 1.25 × 0.268 = 0.34 sec

* $S_{a,atT=Ts}$ = 0.103 g = 1.007 m/s²

* $S_{v,at\ T=Ts}$ = 0.054 m/s

* 붕괴방지수준

Hi(m)	지반종류	N치	Vsi(m/sec)	T_G(4Hi/Vsi)
1.600	매립층	-	156	0.041
10.200	퇴적층(자갈층)	-	289	0.141
2.700	풍화토	-	424	0.025
3.500	풍화암	-	631	0.022
12.000	연 암	-	1216	0.039
0.000	보통암	-	1050	0.000
0.000	경 암	-	2059	0.000
0.000	0	-	0	0.000
30.000	T_G (지반의 특성값, sec)			0.268

* Ts (지반의 고유주기, sec)

= 1.25 × T_G = 1.25 × 0.268 = 0.34 sec

* $S_{a,atT=Ts}$ = 0.210 g = 2.061 m/s²

* $S_{v,at\ T=Ts}$ = 0.112 m/s

② 지반변위 (2중코사인)

$U_{h1} = 2 / \pi^2 \cdot Sv \cdot T_s \cdot \cos(\omega_0 \cdot x_1 / v_{sod1})$ 제 1층에서의 변위

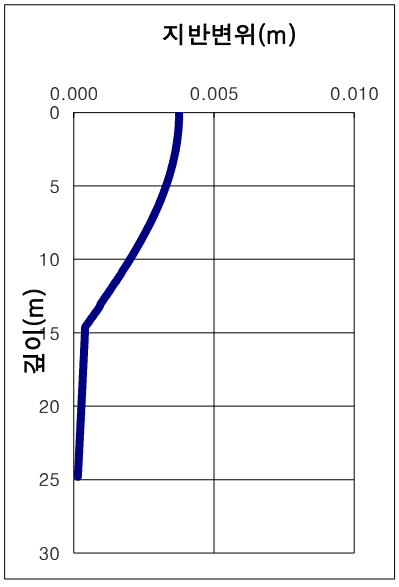
$$U_{h2(x)} = \frac{2}{\pi^2} S_v T_G \cos\left(\frac{\omega_0 H_1}{v_{s0d1}}\right) \cdot \left(\cos\frac{w_0 x_2}{v_{s0d2}} - \frac{\sin\frac{w_0 x_2}{v_{s0d2}}}{\tan\frac{w_0 H_2}{v_{s0d2}}} \right)$$ 제 2층에서의 변위

H_s = 10.30 m, H_1 = 14.5 m, H_2 = 15.5 m, γ_1 = 19.1, γ_2 = 22.5

V_{s0d1} = 300 m/s V_{s0d2} = 1084 m/s α = 0.23

ω_0 = 30.220 ⟶ 0.000 *O.K!!*

* 기능수행수준



기반면 깊이

H = 10.300 m

Sv = 0.054 m/s

Ts = 0.34 sec

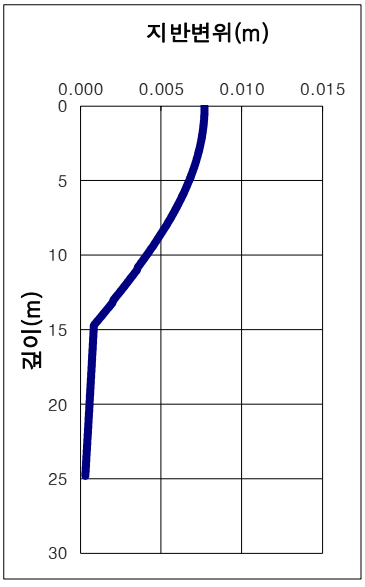
$U(Z_U)$=U(Z=4.450m)

= 0.003381 m

$U(Z_B)$=J(Z=10.300m

= 0.000339 m

* 붕괴방지수준



기반면 깊이

H = 10.300 m

Sv = 0.112 m/s

Ts = 0.34 sec

$U(Z_U)$=U(Z=4.450m)

= 0.006923 m

$U(Z_B)$=J(Z=17.120m

= 0.000693 m

3) 지진하중

① 지반변위하중

* **상부슬래브에 작용하는 지반변위하중**

$P_{상부} = K_{SV,기능} \times U(Z_U) = 13,954 \times 0.003381 = \mathbf{47.173}$ kN/m^2 (기능수행수준)

$= K_{SV,붕괴} \times U(Z_U) = 5,451 \times 0.006923 = \mathbf{37.735}$ kN/m^2 (붕괴방지수준)

* **측벽에 작용하는 지반변위하중**

$P(Z) = K_H \times [\ U(Z) - U(Z_B)\ ]$

1) 기능수행수준 좌측벽체

구분	해당절점	Z (m)	U(Z) (m)	$U(Z_B)$ (m)	$U(Z)-U(Z_B)$ (m)	K_H (kN/m^3)	P(Z) (kN/m^2)
기능수행수준	139	4.450	0.003381	0.000339	0.003042	59,617	181.355
	136	5.075	0.003271	0.000339	0.002933	59,617	174.835
	134	5.700	0.003149	0.000339	0.002810	59,617	167.539
	132	6.488	0.002977	0.000339	0.002638	59,617	157.287
	129	7.275	0.002786	0.000339	0.002448	59,617	145.916
	127	8.063	0.002578	0.000339	0.002239	59,617	133.496
	125	8.850	0.002353	0.000339	0.002015	59,617	120.107
	122	9.575	0.002133	0.000339	0.001795	59,617	106.995
	77	10.300	0.001902	0.000339	0.001563	59,617	93.203
	63	10.300	0.001902	0.000339	0.001563	94,866	148.312
	59	11.100	0.001635	0.000339	0.001296	94,866	122.980
	55	11.900	0.001357	0.000339	0.001019	94,866	96.638
	51	12.700	0.001071	0.000339	0.000732	211,488	154.843
	47	13.710	0.000699	0.000339	0.000361	211,488	76.286
	43	14.720	0.000398	0.000339	0.000060	484,481	28.848
	39	15.520	0.000378	0.000339	0.000040	484,481	19.322
	35	16.320	0.000359	0.000339	0.000020	484,481	9.704
	1	17.120	0.000339	0.000339	0.000000	484,481	0.000
	106	10.300	0.001902	0.000339	0.001563	94,866	148.312
	61	11.100	0.001635	0.000339	0.001296	94,866	122.980
	57	11.900	0.001357	0.000339	0.001019	94,866	96.638
	53	12.700	0.001071	0.000339	0.000732	211,488	154.843
	49	13.710	0.000699	0.000339	0.000361	211,488	76.286
	45	14.720	0.000398	0.000339	0.000060	484,481	28.848
	41	15.520	0.000378	0.000339	0.000040	484,481	19.322
	37	16.320	0.000359	0.000339	0.000020	484,481	9.704
	18	17.120	0.000339	0.000339	0.000000	484,481	0.000

2) 기능수행수준 우측벽체

구분	해당절점	Z	U(Z)	$U(Z_B)$	$U(Z)-U(Z_B)$	K_H	P(Z)
		(m)	(m)	(m)	(m)	(kN/m^3)	(kN/m^2)
기능수행수준	163	4.450	0.003381	0.000339	0.003042	59,617	181.355
	137	5.075	0.003271	0.000339	0.002933	59,617	174.835
	135	5.700	0.003149	0.000339	0.002810	59,617	167.539
	133	6.488	0.002977	0.000339	0.002638	59,617	157.287
	130	7.275	0.002786	0.000339	0.002448	59,617	145.916
	128	8.063	0.002578	0.000339	0.002239	59,617	133.496
	126	8.850	0.002353	0.000339	0.002015	59,617	120.107
	123	9.575	0.002133	0.000339	0.001795	59,617	106.995
	107	10.300	0.001902	0.000339	0.001563	59,617	93.203
	121	10.300	0.001902	0.000339	0.001563	94,866	148.312
	62	11.100	0.001635	0.000339	0.001296	94,866	122.980
	58	11.900	0.001357	0.000339	0.001019	94,866	96.638
	54	12.700	0.001071	0.000339	0.000732	211,488	154.843
	50	13.710	0.000699	0.000339	0.000361	211,488	76.286
	46	14.720	0.000398	0.000339	0.000060	484,481	28.848
	42	15.520	0.000378	0.000339	0.000040	484,481	19.322
	38	16.320	0.000359	0.000339	0.000020	484,481	9.704
	34	17.120	0.000339	0.000339	0.000000	484,481	0.000
	78	10.300	0.001902	0.000339	0.001563	94,866	148.312
	60	11.100	0.001635	0.000339	0.001296	94,866	122.980
	56	11.900	0.001357	0.000339	0.001019	94,866	96.638
	52	12.700	0.001071	0.000339	0.000732	211,488	154.843
	48	13.710	0.000699	0.000339	0.000361	211,488	76.286
	44	14.720	0.000398	0.000339	0.000060	484,481	28.848
	40	15.520	0.000378	0.000339	0.000040	484,481	19.322
	36	16.320	0.000359	0.000339	0.000020	484,481	9.704
	17	17.120	0.000339	0.000339	0.000000	484,481	0.000

3) 붕괴방지수준 좌측벽체

구분	해당절점	Z	U(Z)	$U(Z_B)$	$U(Z)-U(Z_B)$	K_H	P(Z)
		(m)	(m)	(m)	(m)	(kN/m^3)	(kN/m^2)
붕괴방지수준	139	4.450	0.006923	0.000693	0.006229	23,288	145.071
	136	5.075	0.006699	0.000693	0.006006	23,288	139.855
	134	5.700	0.006448	0.000693	0.005755	23,288	134.018
	132	6.488	0.006096	0.000693	0.005403	23,288	125.818
	129	7.275	0.005705	0.000693	0.005012	23,288	116.722
	127	8.063	0.005279	0.000693	0.004586	23,288	106.787
	125	8.850	0.004819	0.000693	0.004126	23,288	96.076
	122	9.575	0.004369	0.000693	0.003675	23,288	85.588
	77	10.300	0.003895	0.000693	0.003201	23,288	74.556
	63	10.300	0.003895	0.000693	0.003201	37,057	118.638
	59	11.100	0.003348	0.000693	0.002655	37,057	98.374
	55	11.900	0.002779	0.000693	0.002086	37,057	77.303
	51	12.700	0.002193	0.000693	0.001499	82,613	123.863
	47	13.710	0.001432	0.000693	0.000739	82,613	61.023
	43	14.720	0.000815	0.000693	0.000122	189,250	23.076
	39	15.520	0.000775	0.000693	0.000082	189,250	15.456
	35	16.320	0.000734	0.000693	0.000041	189,250	7.763
	1	17.120	0.000693	0.000693	0.000000	189,250	0.000
	106	10.300	0.003895	0.000693	0.003201	37,057	118.638
	61	11.100	0.003348	0.000693	0.002655	37,057	98.374
	57	11.900	0.002779	0.000693	0.002086	37,057	77.303
	53	12.700	0.002193	0.000693	0.001499	82,613	123.863
	49	13.710	0.001432	0.000693	0.000739	82,613	61.023
	45	14.720	0.000815	0.000693	0.000122	189,250	23.076
	41	15.520	0.000775	0.000693	0.000082	189,250	15.456
	37	16.320	0.000734	0.000693	0.000041	189,250	7.763
	18	17.120	0.000693	0.000693	0.000000	189,250	0.000

4) 붕괴방지수준 우측벽체

구분	해당절점	Z	U(Z)	$U(Z_B)$	$U(Z)-U(Z_B)$	K_H	P(Z)
		(m)	(m)	(m)	(m)	(kN/m^3)	(kN/m^2)
붕괴방지수준	163	4.450	0.006923	0.000693	0.006229	23,288	145.071
	137	5.075	0.006699	0.000693	0.006006	23,288	139.855
	135	5.700	0.006448	0.000693	0.005755	23,288	134.018
	133	6.488	0.006096	0.000693	0.005403	23,288	125.818
	130	7.275	0.005705	0.000693	0.005012	23,288	116.722
	128	8.063	0.005279	0.000693	0.004586	23,288	106.787
	126	8.850	0.004819	0.000693	0.004126	23,288	96.076
	123	9.575	0.004369	0.000693	0.003675	23,288	85.588
	107	10.300	0.003895	0.000693	0.003201	23,288	74.556
	121	10.300	0.003895	0.000693	0.003201	37,057	118.638
	62	11.100	0.003348	0.000693	0.002655	37,057	98.374
	58	11.900	0.002779	0.000693	0.002086	37,057	77.303
	54	12.700	0.002193	0.000693	0.001499	82,613	123.863
	50	13.710	0.001432	0.000693	0.000739	82,613	61.023
	46	14.720	0.000815	0.000693	0.000122	189,250	23.076
	42	15.520	0.000775	0.000693	0.000082	189,250	15.456
	38	16.320	0.000734	0.000693	0.000041	189,250	7.763
	34	17.120	0.000693	0.000693	0.000000	189,250	0.000
	78	10.300	0.003895	0.000693	0.003201	37,057	118.638
	60	11.100	0.003348	0.000693	0.002655	37,057	98.374
	56	11.900	0.002779	0.000693	0.002086	37,057	77.303
	52	12.700	0.002193	0.000693	0.001499	82,613	123.863
	48	13.710	0.001432	0.000693	0.000739	82,613	61.023
	44	14.720	0.000815	0.000693	0.000122	189,250	23.076
	40	15.520	0.000775	0.000693	0.000082	189,250	15.456
	36	16.320	0.000734	0.000693	0.000041	189,250	7.763
	17	17.120	0.000693	0.000693	0.000000	189,250	0.000

② 주면전단력

(1) 램프

* 기능수행수준

$\tau_u = 2*G_{D,TOP}/(\pi^2)\cdot Sv\cdot T_G\cdot w_0 / v_{sod1}\sin(w_0x_u/v_{s0d1}) = 17.016$ kN/m^2

$$\tau_B = \frac{2G_D}{\pi^2}\cdot S_v\cdot T_G\cdot\frac{w_0}{v_{s0d2}}\cdot\cos\left(\frac{w_0H_1}{v_{sod1}}\right)\cdot\left(\sin\frac{w_0x_2}{v_{s0d2}}+\frac{\cos w_0x_2/v_{s0d2}}{\tan w_0H_2/v_{s0d2}}\right) = 13.716 \text{ kN/m}^2$$

$\tau_W = (\tau_u + \tau_B)/2 = 15.366$ kN/m^2

* 붕괴방지수준

$\tau_u = 2*G_{D,TOP}/(\pi^2)\cdot Sv\cdot T_G\cdot w_0 / v_{sod1}\sin(w_0x_u/v_{s0d1}) = 13.611$ kN/m^2

$$\tau_B = \frac{2G_D}{\pi^2}\cdot S_v\cdot T_G\cdot\frac{w_0}{v_{s0d2}}\cdot\cos\left(\frac{w_0H_1}{v_{sod1}}\right)\cdot\left(\sin\frac{w_0x_2}{v_{s0d2}}+\frac{\cos w_0x_2/v_{s0d2}}{\tan w_0H_2/v_{s0d2}}\right) = 10.972 \text{ kN/m}^2$$

$\tau_W = (\tau_u + \tau_B)/2 = 12.292$ kN/m^2

(2) 본선

* 기능수행수준

$\tau_u = 2*G_{D,TOP}/(\pi^2)\cdot Sv\cdot T_G\cdot w_0 / v_{sod1}\sin(w_0x_u/v_{s0d1}) = 17.016$ kN/m^2

$$\tau_B = \frac{2G_D}{\pi^2}\cdot S_v\cdot T_G\cdot\frac{w_0}{v_{s0d2}}\cdot\cos\left(\frac{w_0H_1}{v_{sod1}}\right)\cdot\left(\sin\frac{w_0x_2}{v_{s0d2}}+\frac{\cos w_0x_2/v_{s0d2}}{\tan w_0H_2/v_{s0d2}}\right) = 2.603 \text{ kN/m}^2$$

$\tau_W = (\tau_u + \tau_B)/2 = 9.809$ kN/m^2

* 붕괴방지수준

$\tau_u = 2*G_{D,TOP}/(\pi^2)\cdot Sv\cdot T_G\cdot w_0 / v_{sod1}\sin(w_0x_u/v_{s0d1}) = 13.611$ kN/m^2

$$\tau_B = \frac{2G_D}{\pi^2}\cdot S_v\cdot T_G\cdot\frac{w_0}{v_{s0d2}}\cdot\cos\left(\frac{w_0H_1}{v_{sod1}}\right)\cdot\left(\sin\frac{w_0x_2}{v_{s0d2}}+\frac{\cos w_0x_2/v_{s0d2}}{\tan w_0H_2/v_{s0d2}}\right) = 2.082 \text{ kN/m}^2$$

$\tau_W = (\tau_u + \tau_B)/2 = 7.847$ kN/m^2

③ 관성력

* 기능수행수준 γ_c = 25.0 kN/m^3

- 상부슬래브(본선) 관성력 (Vi = 0.900 m^3/m^2 : 단위면적당 부피 , Z = 4.450 m)

f_u = mi × ai = wi × K_{Hi} = Vi × γ_con × A × (1 − 0.015·Z)

= 0.900 × 25.0 × 0.091 × 0.933 = 1.915 kN/m^2 (기능수행수준)

= 0.900 × 25.0 × 0.224 × 0.933 = 4.704 kN/m^2 (붕괴방지수준)

- 상부슬래브(램프) 관성력 (Vi = 1.600 m^3/m^2 : 단위면적당 부피 , Z = 9.940 m)

f_m = mi × ai = wi × K_{Hi} = Vi × γ_con × A × (1 − 0.015·Z)

= 1.600 × 25.0 × 0.091 × 0.851 = 3.104 kN/m^2 (기능수행수준)

= 1.600 × 25.0 × 0.224 × 0.851 = 7.624 kN/m^2 (붕괴방지수준)

- 하부슬래브(본선) 관성력 (Vi = 1.300 m^3/m^2 : 단위면적당 부피 , Z = 10.300 m)

fu = mi × ai = wi × K_{Hi} = Vi × γ_con × A × (1 − 0.015·Z)

= 1.300 × 25.0 × 0.091 × 0.846 = 2.506 kN/m^2 (기능수행수준)

= 1.300 × 25.0 × 0.224 × 0.846 = 6.155 kN/m^2 (붕괴방지수준)

- 하부슬래브(램프) 관성력 (Vi = 1.600 m^3/m^2 : 단위면적당 부피 , Z = 17.120 m)

f_B = mi × ai = wi × K_{Hi} = Vi × γ_con × A × (1 − 0.015·Z)

= 1.600 × 25.0 × 0.063 × 0.743 = 1.864 kN/m^2 (기능수행수준)

= 1.600 × 25.0 × 0.154 × 0.743 = 4.578 kN/m^2 (붕괴방지수준)

- 좌측벽체 관성력

구분	해당절점	Z	Vi	ɣ_con	A (가속도계수)		1-0.015·Z	$f_{u(Z)기능}$	$f_{u(Z)붕괴}$
		(m)	(m^3/m^2)	(kN/m^3)	기능수행	붕괴방지	(m)	(kN/m^2)	(kN/m^2)
본선	139	4.450	0.900	25.0	0.091	0.224	0.933	1.915	4.704
	136	5.075	0.900	25.0	0.091	0.224	0.924	1.896	4.656
	134	5.700	0.900	25.0	0.091	0.224	0.915	1.877	4.609
	132	6.488	0.900	25.0	0.091	0.224	0.903	1.852	4.550
	129	7.275	0.900	25.0	0.091	0.224	0.891	1.828	4.490
	127	8.063	0.900	25.0	0.091	0.224	0.879	1.804	4.430
	125	8.850	0.900	25.0	0.091	0.224	0.867	1.780	4.371
	122	9.575	0.900	25.0	0.091	0.224	0.856	1.757	4.316
	77	10.300	0.900	25.0	0.091	0.224	0.846	1.735	4.261
램프	63	10.300	1.700	25.0	0.091	0.224	0.846	3.277	8.049
	59	11.100	1.700	25.0	0.091	0.224	0.834	3.231	7.935
	55	11.900	1.700	25.0	0.091	0.224	0.822	3.184	7.821
	51	12.700	1.700	25.0	0.091	0.224	0.810	3.138	7.706
	47	13.710	1.700	25.0	0.091	0.224	0.794	3.079	7.562
	43	14.720	1.700	25.0	0.063	0.154	0.779	2.076	5.100
	39	15.520	1.700	25.0	0.063	0.154	0.767	2.044	5.021
	35	16.320	1.700	25.0	0.063	0.154	0.755	2.012	4.943
	1	17.120	1.700	25.0	0.063	0.154	0.743	1.980	4.864
	106	10.300	1.700	25.0	0.091	0.224	0.846	3.277	8.049
	61	11.100	1.700	25.0	0.091	0.224	0.834	3.231	7.935
	57	11.900	1.700	25.0	0.091	0.224	0.822	3.184	7.821
	53	12.700	1.700	25.0	0.091	0.224	0.810	3.138	7.706
	49	13.710	1.700	25.0	0.091	0.224	0.794	3.079	7.562
	45	14.720	1.700	25.0	0.063	0.154	0.779	2.076	5.100
	41	15.520	1.700	25.0	0.063	0.154	0.767	2.044	5.021
	37	16.320	1.700	25.0	0.063	0.154	0.755	2.012	4.943
	18	17.120	1.700	25.0	0.063	0.154	0.743	1.980	4.864

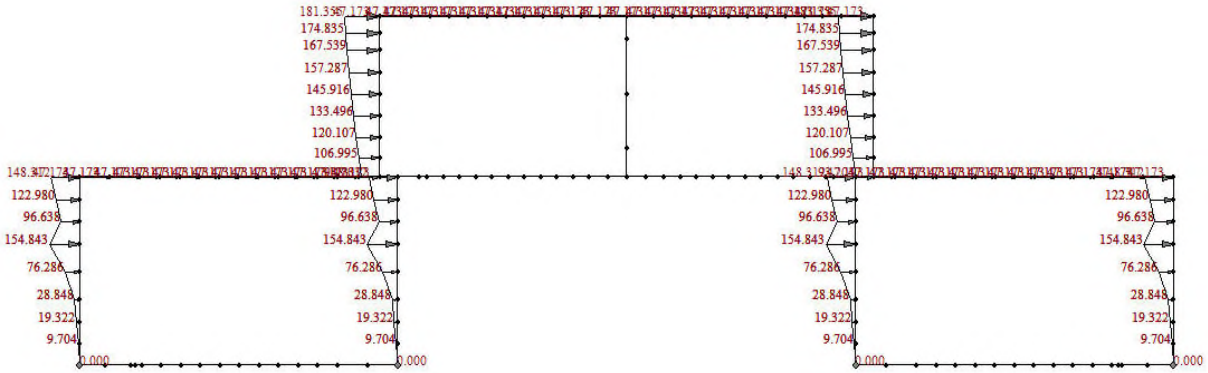
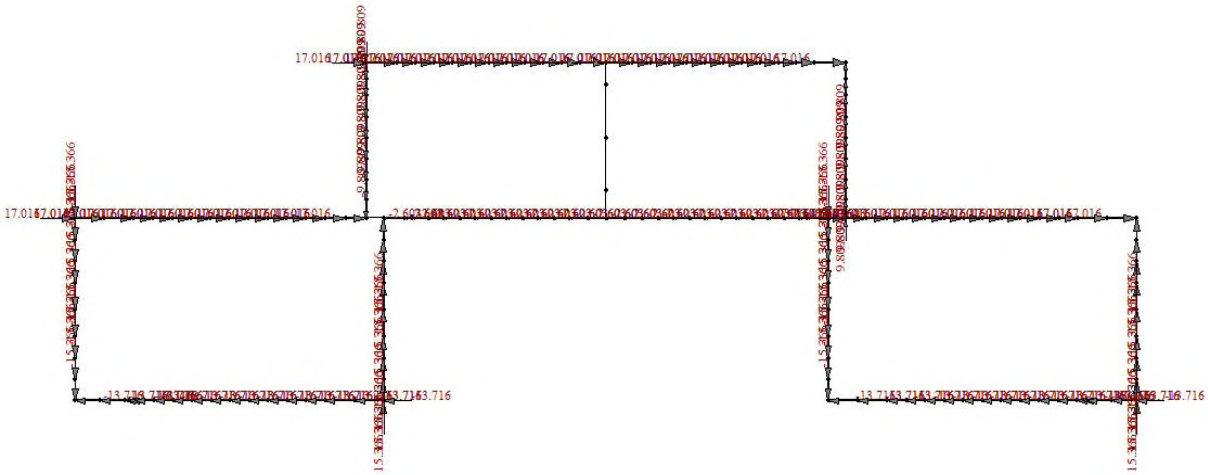
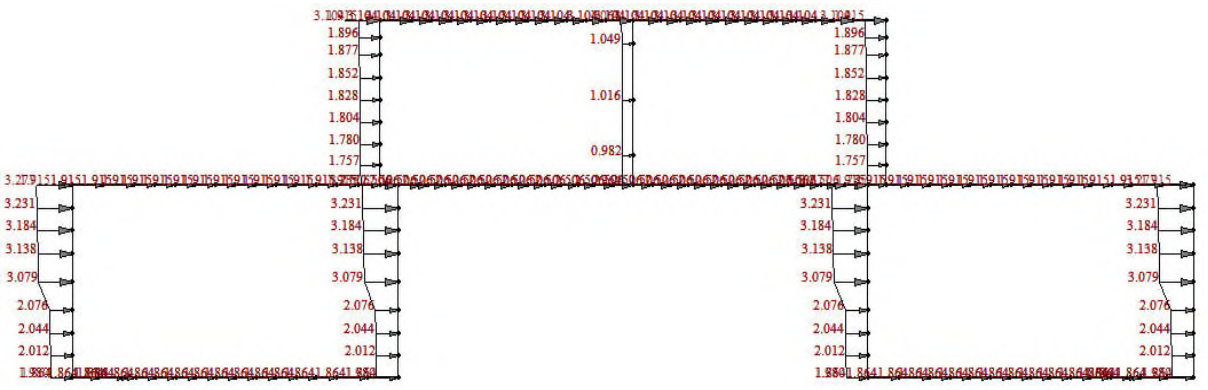
- 우측벽체 관성력

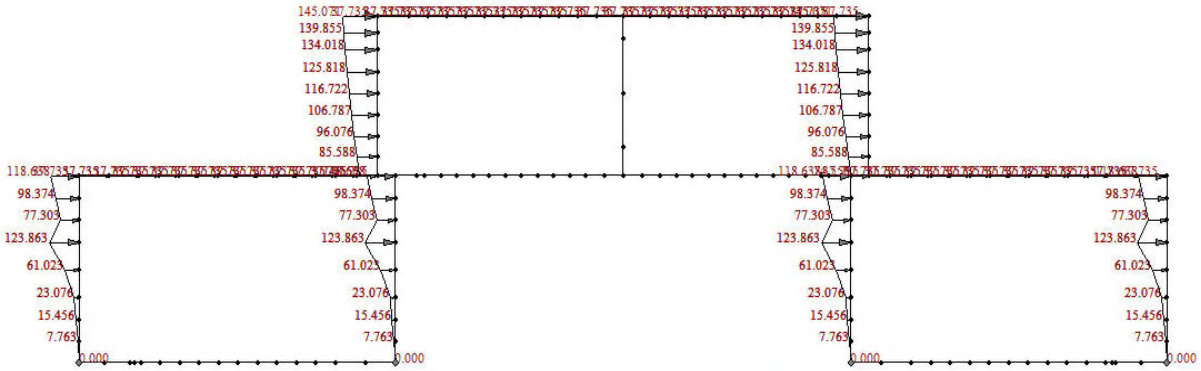
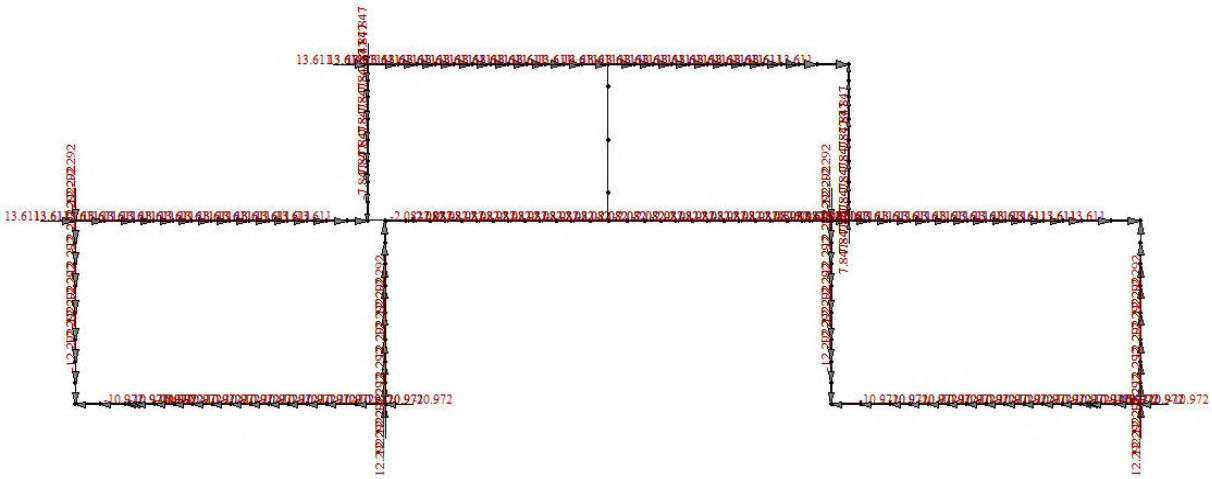
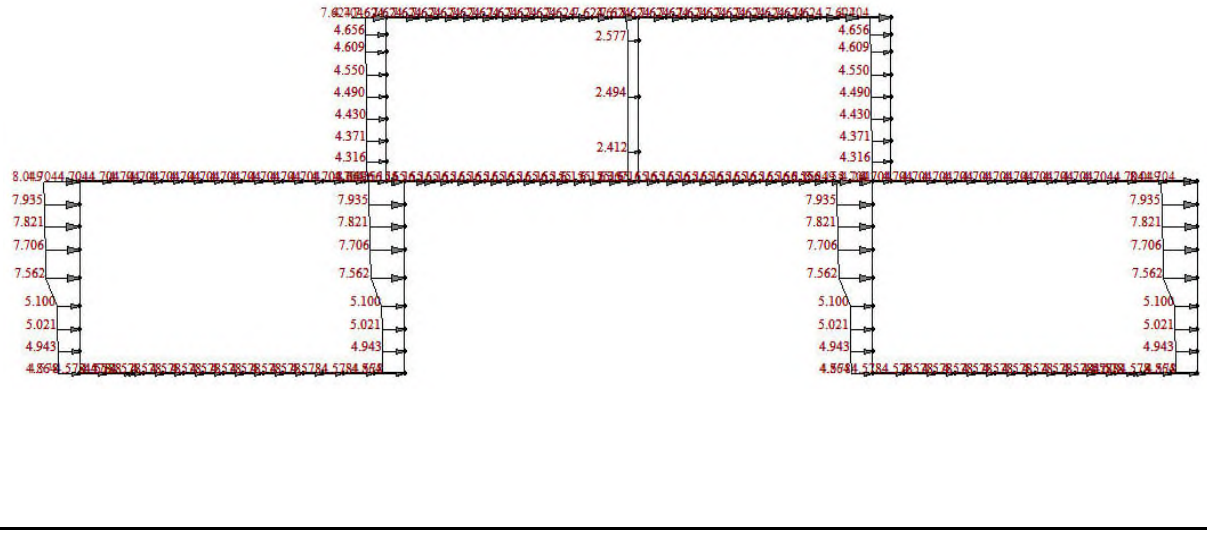
구분	해당절점	Z	Vi	ɣ_con	A (가속도계수)		1-0.015·Z	$f_{u(Z)기능}$	$f_{u(Z)붕괴}$
		(m)	(m^3/m^2)	(kN/m^3)	기능수행	붕괴방지	(m)	(kN/m^2)	(kN/m^2)
본선	163	4.450	0.900	25.0	0.091	0.224	0.933	1.915	4.704
	137	5.075	0.900	25.0	0.091	0.224	0.924	1.896	4.656
	135	5.700	0.900	25.0	0.091	0.224	0.915	1.877	4.609
	133	6.488	0.900	25.0	0.091	0.224	0.903	1.852	4.550
	130	7.275	0.900	25.0	0.091	0.224	0.891	1.828	4.490
	128	8.063	0.900	25.0	0.091	0.224	0.879	1.804	4.430
	126	8.850	0.900	25.0	0.091	0.224	0.867	1.780	4.371
	123	9.575	0.900	25.0	0.091	0.224	0.856	1.757	4.316
	107	10.300	0.900	25.0	0.091	0.224	0.846	1.735	4.261
램프	121	10.300	1.700	25.0	0.091	0.224	0.846	3.277	8.049
	62	11.100	1.700	25.0	0.091	0.224	0.834	3.231	7.935
	58	11.900	1.700	25.0	0.091	0.224	0.822	3.184	7.821
	54	12.700	1.700	25.0	0.091	0.224	0.810	3.138	7.706
	50	13.710	1.700	25.0	0.091	0.224	0.794	3.079	7.562
	46	14.720	1.700	25.0	0.063	0.154	0.779	2.076	5.100
	42	15.520	1.700	25.0	0.063	0.154	0.767	2.044	5.021
	38	16.320	1.700	25.0	0.063	0.154	0.755	2.012	4.943
	34	17.120	1.700	25.0	0.063	0.154	0.743	1.980	4.864
	78	10.300	1.700	25.0	0.091	0.224	0.846	3.277	8.049
	60	11.100	1.700	25.0	0.091	0.224	0.834	3.231	7.935
	56	11.900	1.700	25.0	0.091	0.224	0.822	3.184	7.821
	52	12.700	1.700	25.0	0.091	0.224	0.810	3.138	7.706
	48	13.710	1.700	25.0	0.091	0.224	0.794	3.079	7.562
	44	14.720	1.700	25.0	0.063	0.154	0.779	2.076	5.100
	40	15.520	1.700	25.0	0.063	0.154	0.767	2.044	5.021
	36	16.320	1.700	25.0	0.063	0.154	0.755	2.012	4.943
	17	17.120	1.700	25.0	0.063	0.154	0.743	1.980	4.864

- 본선 중앙벽체 관성력

구분	해당절점	Z	Vi	ɣ_con	A (가속도계수)		1-0.015·Z	$f_{u(Z)기능}$	$f_{u(Z)붕괴}$
		(m)	(m^3/m^2)	(kN/m^3)	기능수행	붕괴방지	(m)	(kN/m^2)	(kN/m^2)
중앙벽체	151	4.450	0.500	25.0	0.091	0.224	0.933	1.064	2.613
	138	5.300	0.500	25.0	0.091	0.224	0.921	1.049	2.577
	131	7.275	0.500	25.0	0.091	0.224	0.891	1.016	2.494
	124	9.250	0.500	25.0	0.091	0.224	0.861	0.982	2.412
	92	10.300	0.500	25.0	0.091	0.224	0.846	0.964	2.367

4. 하중 재하도

구분	기능수행수준
지반변위하중	
주면전단력	
관성력	

구분	붕괴방지수준
지반변위하중	
주면전단력	
관성력	

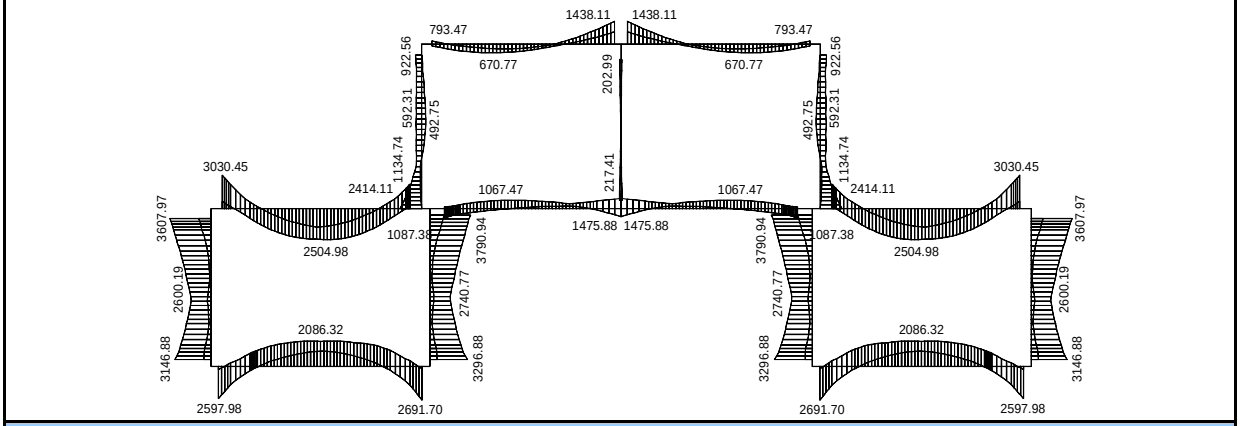
5. 하중조합

1) 콘크리트구조기준(2012)

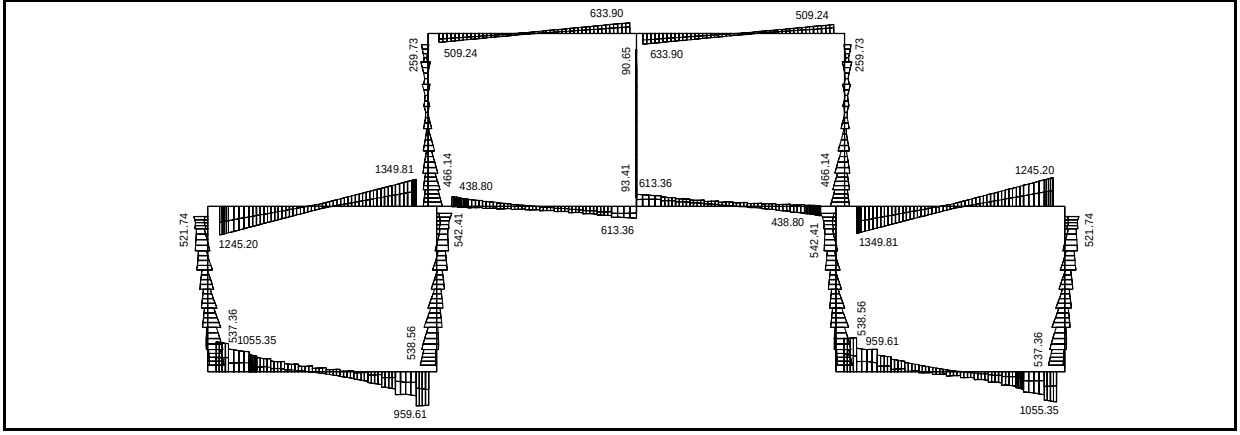
하중조합		고정하중	활하중						토압				수압		지진하중	비고
		자중	연직하중			수평하중			연직하중		수평하중		연직 수압	수평 수압		
			만재하	편재하		만재하	편재하		지하수無	지하수有	지하수無	지하수有				
				좌측	우측		좌측	우측								
		LC01	LC02	LC03	LC04	LC05	LC06	LC07	LC8	LC9	LC10	LC11	LC12	LC13	LC15	
기능수행수준	E1COMB01	1.200	1.000			1.000			1.200		1.000				1.400	
	E1COMB02	1.200		1.000			1.000		1.200		1.000				1.400	
	E1COMB03	1.200			1.000			1.000	1.200		1.000				1.400	
	E1COMB04	1.200	1.000			0.500			1.200		0.500				1.400	
	E1COMB05	1.200		1.000			0.500		1.200		0.500				1.400	
	E1COMB06	1.200			1.000			0.500	1.200		0.500				1.400	
	E1COMB07	0.900							0.900		1.000				1.400	
	E1COMB08	0.900							0.900		0.500				1.400	
	E1COMB09	1.200	1.000			1.000				1.200		1.000	1.200	1.000	1.400	
	E1COMB10	1.200		1.000			1.000			1.200		1.000	1.200	1.000	1.400	
	E1COMB11	1.200			1.000			1.000		1.200		1.000	1.200	1.000	1.400	
	E1COMB12	1.200	1.000			0.500				1.200		0.500	1.200	0.500	1.400	
	E1COMB13	1.200		1.000			0.500			1.200		0.500	1.200	0.500	1.400	
	E1COMB14	1.200			1.000			0.500		1.200		0.500	1.200	0.500	1.400	
	E1COMB15	0.900								0.900		1.000	0.900	1.000	1.400	
	E1COMB16	0.900								0.900		0.500	0.900	0.500	1.400	
붕괴방지수준	E2COMB01	1.200	1.000			1.000			1.200		1.000				1.000	
	E2COMB02	1.200		1.000			1.000		1.200		1.000				1.000	
	E2COMB03	1.200			1.000			1.000	1.200		1.000				1.000	
	E2COMB04	1.200	1.000			0.500			1.200		0.500				1.000	
	E2COMB05	1.200		1.000			0.500		1.200		0.500				1.000	
	E2COMB06	1.200			1.000			0.500	1.200		0.500				1.000	
	E2COMB07	0.900							0.900		1.000				1.000	
	E2COMB08	0.900							0.900		0.500				1.000	
	E2COMB09	1.200	1.000			1.000				1.200		1.000	1.200	1.000	1.000	
	E2COMB10	1.200		1.000			1.000			1.200		1.000	1.200	1.000	1.000	
	E2COMB11	1.200			1.000			1.000		1.200		1.000	1.200	1.000	1.000	
	E2COMB12	1.200	1.000			0.500				1.200		0.500	1.200	0.500	1.000	
	E2COMB13	1.200		1.000			0.500			1.200		0.500	1.200	0.500	1.000	
	E2COMB14	1.200			1.000			0.500		1.200		0.500	1.200	0.500	1.000	
	E2COMB15	0.900								0.900		1.000	0.900	1.000	1.000	
	E2COMB16	0.900								0.900		0.500	0.900	0.500	1.000	

6. 단면력도

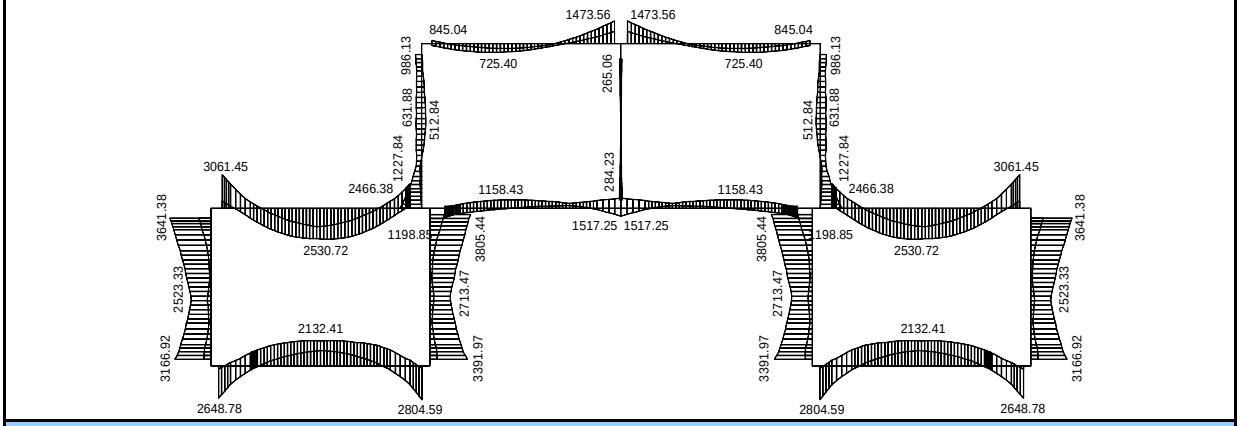
기능수행수준 – 모멘트도(B.M.D)



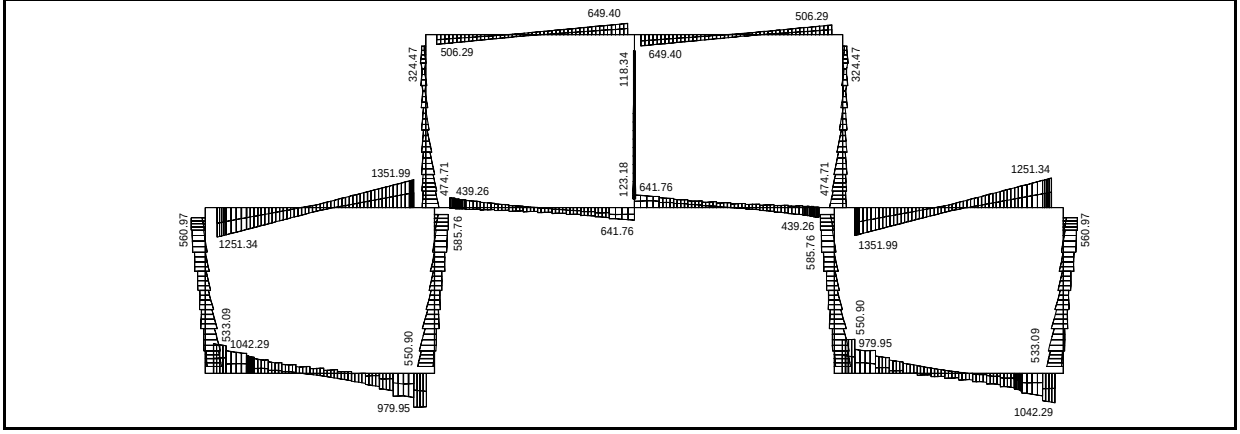
기능수행수준 – 전단력도(S.F.D)



붕괴방지수준 – 모멘트도(B.M.D)



붕괴방지수준 – 전단력도(S.F.D)



7. 기능수행수준 부재력 집계

7.1 기능수행수준 부재력 집계

7.1.1 슬래브

구 분		부재	절점	계 수 하 중			사 용 하 중
				M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
상 부 슬래브	램프벽체부	65	I[63]	3030.450	-	1245.200	-
	램프중앙부	72	3/4	2504.980	-	-	-
	램프접합부	78	J[77]	2414.110	-	1349.810	-
	본선접합부	143	I[139]	793.470	-	509.240	-
	본선중앙부	146	3/4	670.770	-	-	-
	중앙벽체부	154	J[151]	1438.110	-	633.900	-
하 부 슬래브	램프벽체부	1	I[1]	2597.980	-	1055.350	-
	램프중앙부	9	2/4	2086.320	-	-	-
	램프접합부	16	J[17]	2691.700	-	959.610	-
	본선접합부	80	J[79]	1087.380	-	438.800	-
	본선중앙부	86	I[84]	1067.470	-	-	-
	중앙벽체부	93	J[92]	1475.880	-	613.360	-
	램프측구	4	J[5]	1066.890	-	1055.350	-
	본선측구	81	J[80]	1131.710	-	438.800	-

7.1.2 벽체: 램프

구 분			부재	절점	계 수 하 중			사 용 하 중
					M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
외측 벽체	상단	M_{max}	61	J[63]	3607.970	1020.020	521.740	
		P_{max}	61	I[59]	863.780	1934.450	521.740	
	중앙 부모멘트	M_{max}	45	I[43]	2600.190	1316.220	-	
		P_{max}	45	I[43]	528.650	2002.310	-	
	하단	M_{max}	33	I[1]	3146.880	1378.000	537.360	
		P_{max}	33	I[1]	3146.880	2150.590	537.360	
내측 벽체	상단	M_{max}	62	J[78]	3790.940	2151.470	542.410	
		P_{max}	62	I[60]	3406.420	2174.270	542.410	
	중앙 부모멘트	M_{max}	46	I[44]	2740.770	2356.550	-	
		P_{max}	46	I[44]	2740.770	2356.550	-	
	하단	M_{max}	34	I[17]	3296.880	2569.100	538.560	
		P_{max}	34	I[17]	3296.880	2569.100	538.560	

7.1.3 벽체 :본선

구 분			부재	절점	계 수 하 중			사 용 하 중
					M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
외측 벽체	상단	M_{max}	923	289	922.560	289.160	259.730	
		P_{max}	22	696	21.870	695.720	259.730	
	중앙	M_{max}	493	360	492.750	359.530	-	
		P_{max}	113	722	112.570	721.820	-	
	중앙 부모멘트	M_{max}	592	413	592.310	413.080	-	
		P_{max}	38	731	38.200	731.220	-	
	하단	M_{max}	1135	490	1134.740	489.920	466.140	
		P_{max}	241	758	240.880	758.050	466.140	
중앙부 벽체	상단	M_{max}	203	1483	202.990	1482.570	90.650	
		P_{max}	190	1495	189.840	1495.070	90.650	
	중앙	M_{max}	190	1495	189.840	1495.070	-	
		P_{max}	14	1524	13.600	1524.120	-	
	하단	M_{max}	217	1569	217.410	1568.620	93.410	
		P_{max}	217	1569	217.410	1568.620	93.410	

8. 붕괴방지수준 부재력 집계

8.1 붕괴방지수준 부재력 집계

8.1.1 슬래브

구 분		부재	절점	계 수 하 중			사 용 하 중
				M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
상 부 슬래브	램프벽체부	65	I[63]	3061.450	-	1251.340	-
	램프중앙부	72	3/4	2530.720	-	-	-
	램프접합부	78	J[77]	2466.380	-	1351.990	-
	본선접합부	143	I[139]	845.040	-	506.290	-
	본선중앙부	146	3/4	725.400	-	-	-
	중앙벽체부	154	J[151]	1473.560	-	649.400	-
하 부 슬래브	램프벽체부	1	I[1]	2648.780	-	1042.290	-
	램프중앙부	9	I[9]	2132.410	-	-	-
	램프접합부	16	J[17]	2804.590	-	979.950	-
	본선접합부	80	J[79]	1198.850	-	439.260	-
	본선중앙부	86	I[84]	1158.430	-	-	-
	중앙벽체부	93	J[92]	1517.250	-	641.760	-
	램프측구	4	J[5]	1177.040	-	1042.290	-
	본선측구	81	J[80]	1243.040	-	439.260	-

8.1.2 벽체 : 램프

구 분			부재	절점	계 수 하 중			사 용 하 중
					M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
외 측 벽체	상단	M_{max}	61	J[63]	3641.380	1025.950	560.970	
		P_{max}	61	I[59]	815.400	1935.900	560.970	
	중앙 부모멘트	M_{max}	45	I[43]	2523.330	1281.390	-	
		P_{max}	45	I[43]	605.520	2037.150	-	
	하단	M_{max}	33	I[1]	3166.920	1427.450	533.090	
		P_{max}	33	I[1]	971.860	2101.140	533.090	
내측 벽체	상단	M_{max}	62	J[78]	3805.440	2107.310	585.760	
		P_{max}	62	I[60]	3435.870	2137.490	585.760	
	중앙 부모멘트	M_{max}	46	I[44]	2713.470	2359.060	-	
		P_{max}	46	I[44]	2713.470	2359.060	-	
	하단	M_{max}	34	I[17]	3391.970	2547.110	550.900	
		P_{max}	34	I[17]	3391.970	2547.110	550.900	

8.1.3 벽체 : 본선

구 분			부재	절점	계 수 하 중			사 용 하 중
					M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
외측 벽체	상단	M_{max}	968	294	968.130	293.550	324.470	
		P_{max}	27	695	27.230	695.010	324.470	
	중앙	M_{max}	513	349	512.840	349.140	-	
		P_{max}	104	737	104.110	736.850	-	
	중앙 부모멘트	M_{max}	632	392	631.880	392.420	-	
		P_{max}	78	752	77.770	751.870	-	
	하단	M_{max}	1228	453	1227.840	453.310	474.710	
		P_{max}	334	795	333.980	794.670	474.710	
중앙부 벽체	상단	M_{max}	265	1483	265.060	1482.560	118.340	
		P_{max}	248	1495	248.090	1495.070	118.340	
	중앙	M_{max}	248	1495	248.090	1495.070	-	
		P_{max}	19	1524	19.300	1524.120	-	
	하단	M_{max}	284	1569	284.230	1568.620	123.180	
		P_{max}	284	1569	284.230	1568.620	123.180	

국회대로 지하차도

STA.0+679.000

목 차

1. 설계조건
2. 단면가정
3. 부력 검토
4. 해석모델링
5. 지반 반력계수
6. 하중계산
7. 하중재하도
8. 하중조합
9. 단면력도
10. 전산해석결과
11. 단면력 정리
12. 단면설계
13. 우각부 검토
14. 배력철근 검토
15. 처짐검토
16. 지지력검토
17. 신축이음부 검토
18. 주철근조립도

1. 설계조건

1.1 구조형식 : 철근 콘크리트 BOX 구조물

1.2 지반조건

기 초 형 식	계 산 토 피	지 하 수 위	지 지 층	E_O(지반반력계수)	비 고
직접 기초	H = 9.500 m	GL -1.000m	풍화암	50MPa	지반조사보고서 참고

(실제토피 H = 9.477 m)

1.3 재료 중량

철근 콘크리트	25.00 kN/m^3	역청포장	23.00 kN/m^3
Mortar	21.50 kN/m^3	지 하 수	10.00 kN/m^3

1.4 사용재료의 강도

콘크리트	설계강도(fck)	27 MPa	
	탄성계수(Ec)	$E_c = 8{,}500 \times \sqrt[3]{(fck + 4)} =$ 26702 MPa	
철 근	설계강도(fy)	400 MPa	
	탄성계수(Es)	2.0E+05 MPa	

1.5 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 = 19.00 kN/m^3
- 수 중 = 10.00 kN/m^3

1.6 노면활하중 (DB-24 적용) = 10.000 kN/m^2

1.7 토 사

지 층 분 류	단위중량(kN/m^3)		내부마찰각(Ø)	정지토압(K_0)	비 고
	지하수위 이상	지하수위 이하			
뒷채움흙	19.00	10.00	30.0	0.500	Ko=1-sin Ø

1.8 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력설계법 : 사용성검토 (처짐, 균열, 우각부보강 등)

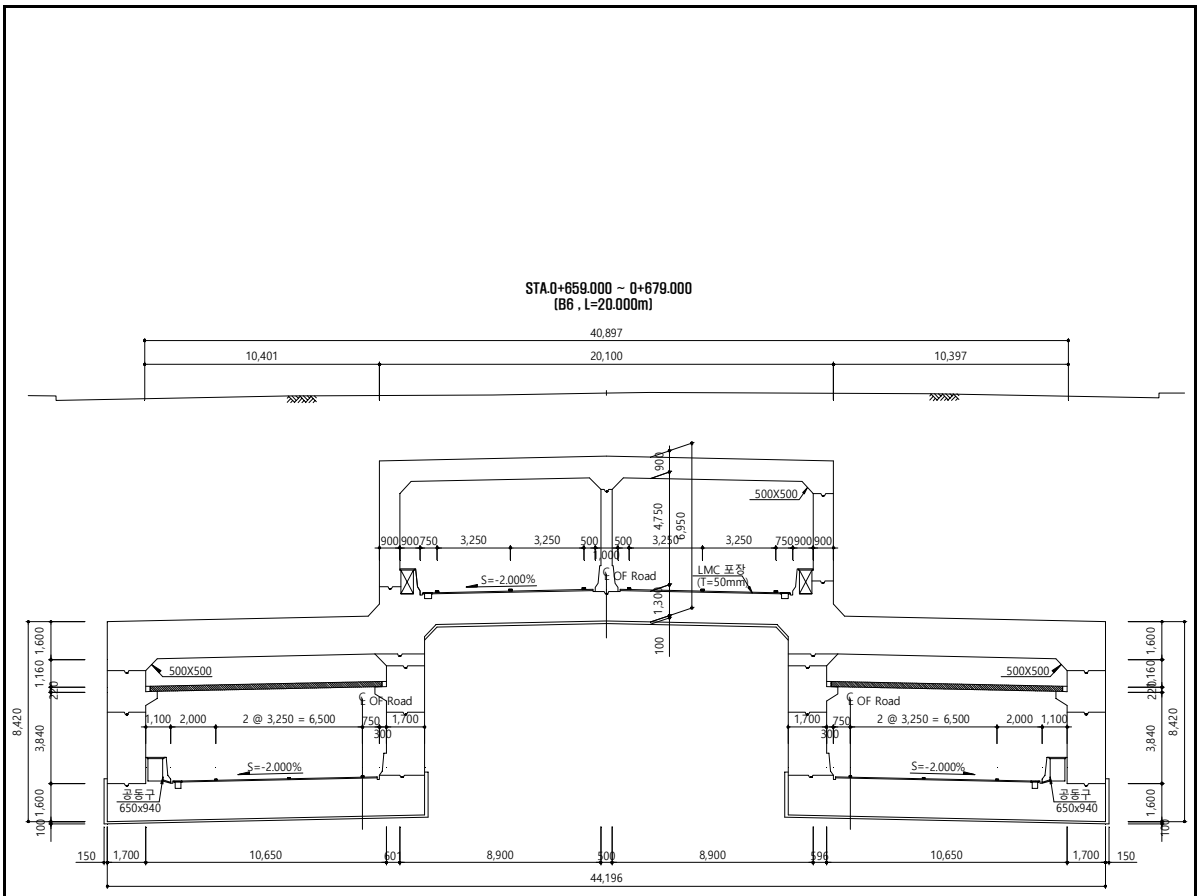
1.9 사용프로그램

- MIDAS Civil 2009

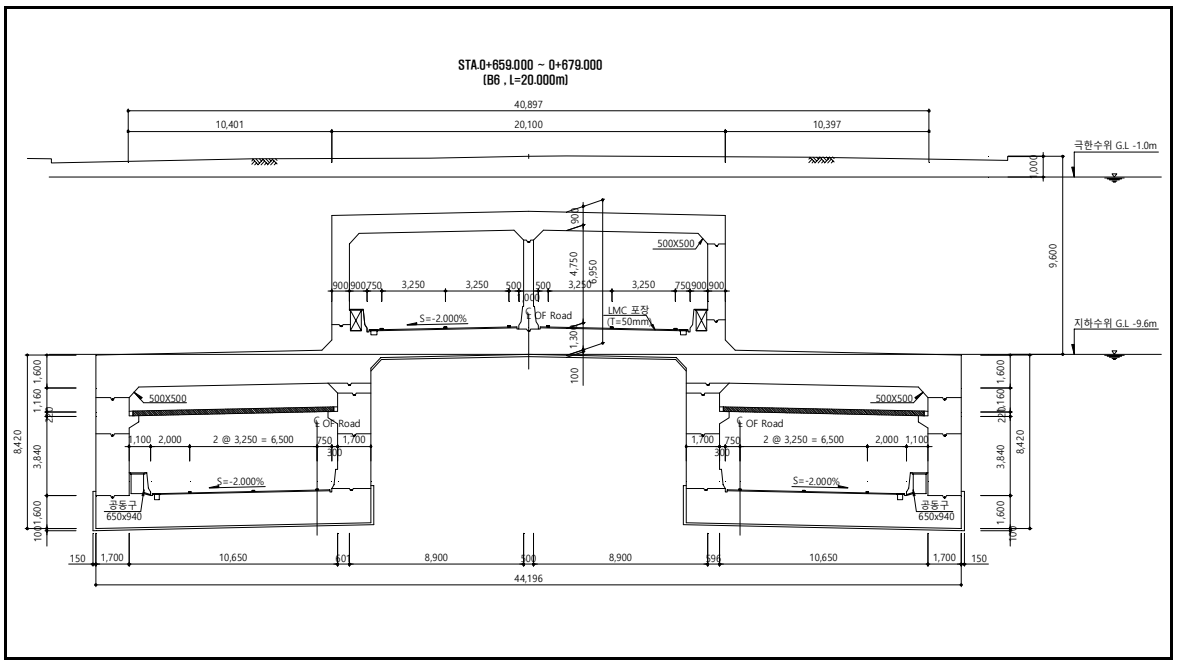
1.10 참고문헌

- 콘크리트구조기준 : 국토해양부(2012)
- 도시철도 내진설계기준 : 국토교통부(2013)

2. 단면가정


STA.0+659.000 ~ 0+679.000
(B6 , L=20.000m)
40,897
10,401
20,100
10,397
900
4,750
6,950
500X500
900 900 750 3,250 3,250 500 500 3,250 3,250 750 900 900
1,000
S=-2.000%
℄ OF Road
LMC 포장
(t=50mm)
1,310
100
500X500
500X500
℄ OF Road
℄ OF Road
1,100 2,000 2 @ 3,250 = 6,500 750 1,700
1,700 750 2 @ 3,250 = 6,500 2,000 1,100
300
300
S=-2.000%
S=-2.000%
8,420
1,600
1,160
200
3,840
1,600
100
8,420
1,600
200
1,160
3,840
1,600
100
횡단구
650x940
횡단구
650x940
150 1,700 10,650 601 8,900 500 8,900 596 10,650 1,700 150
44,196

3. 부력 검토



3.1 부력 검토 결과 : 램프

구 분	작용력(kN/m)	저항력(kN/m)	비 고
시 공 중	281.000	2,742.389	지하수위를 5.64m 이하로 유지
완공후 (지하수위 G.L -9.6m)	2,555.270	10,480.493	F.S = 4.102 > 1.200 ------ O.K
완공후 (극한수위 G.L-1.0m)	6,356.470	10,627.307	F.S = 1.672 > 1.050 ------ O.K

3.2 시공중 부력 검토(상부슬래브 폐합전 단면 검토)

3.2.1 굴착고 : 17.920 m

3.2.2 부력 작용폭 : 44.200 m

3.2.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × Hw × 28.100 m = 281.000 Hw kN/m

= 10.000 × Hw × 16.100 m = 161.000 Hw kN/m

= 442.000 Hw

여기서, U : 부력 (kN/m)

μ : 단위 부력 (kN/m^2)

r_w : 물의 단위 중량 (kN/m^3)

Hw : 지하수위로부터 구조물 바닥슬래브 하면까지의 높이 (m)

B : 부력이 작용하는 구조물의 폭 (m)

3.2.4 작용력

$R = W_1 + W_2 + F$ = 2742.389 + 0.000 + 0.000 = 2742.389 kN/m

여기서, W_1 : 구체자중 (kN/m)

W_2 : 상재하중 (kN/m)

F : 주면마찰력 (kN/m) ⇒ 구조물 벽체와 주변뒷채움 흙과의 접촉불확실성을 고려하여 무시한다.

(1) W_1 (램프 구체자중)

① 램프 하부슬래브

(1.300 × 28.100)× 25.000 = 913.250 kN/m

② 풍도슬래브

(0.220 × 21.300)× 25.000 = 117.150 kN/m

③ 벽 체

외측벽체

(1.700 × 5.220)× 4 EA × 25.000 = 887.400 kN/m

접합부 벽체-하단

(0.000 × 0.000)× 4 EA × 25.000 = 0.000 kN/m

접합부 벽체-중간

(0.000 × 0.000)× 4 EA × 25.000 = 0.000 kN/m

④ 방호벽

중앙부 방호벽

(0.050 + 0.130)× 1/2 × 0.750 × 25.00 × 2 EA = 3.375 kN/m

(0.130 + 0.250)× 1/2 × 0.175 × 25.00 × 2 EA = 1.663 kN/m

(0.250 + 0.000)× 1/2 × 0.125 × 25.00 × 2 EA = 0.781 kN/m

공동구 방호벽

(0.100 + 0.180)× 1/2 × 0.750 × 25.00 × 2 EA = 5.250 kN/m

(0.180 + 0.300)× 1/2 × 0.175 × 25.00 × 2 EA = 2.100 kN/m

(0.300 + 0.000)× 1/2 × 0.125 × 25.00 × 2 EA = 0.938 kN/m

소 계 = 1931.907 kN/m

(2) W2 (본선 구체자중)

① 본선 하부슬래브

(1.300 × 16.100)× 25.000 = 523.250 kN/m

② 풍도슬래브

(0.220 × 0.000)× 25.000 = 0.000 kN/m

③ 벽 체

외측벽체

(0.900 × 4.750)× 2 EA × 25.000 = 213.750 kN/m

중간 벽체

(0.500 × 4.750)× 1 EA × 25.000 = 59.375 kN/m

접합부 벽체-중간

(0.000 × 0.000)× 2 EA × 25.000 = 0.000 kN/m

④ 방호벽

중앙부 방호벽

(0.050 + 0.130)× 1/2 × 0.750 × 25.00 × 2 EA = 3.375 kN/m

(0.130 + 0.250)× 1/2 × 0.175 × 25.00 × 2 EA = 1.663 kN/m

(0.250 + 0.000)× 1/2 × 0.125 × 25.00 × 2 EA = 0.781 kN/m

공동구 방호벽

(0.100 + 0.180)× 1/2 × 0.750 × 25.00 × 2 EA = 5.250 kN/m

(0.180 + 0.300)× 1/2 × 0.175 × 25.00 × 2 EA = 2.100 kN/m

(0.300 + 0.000)× 1/2 × 0.125 × 25.00 × 2 EA = 0.938 kN/m

소 계 = 810.482 kN/m

TOTAL = 2742.389 kN/m

(2) W_2 (상재하중) : 없음

(3) F (주면마찰력) : 없음

3.2.5 안정검토

$$F_s = \frac{R}{U} = \frac{2742.389}{442.000\ Hw} \geq 1.1 \Rightarrow H \leq 5.640\ m$$

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 5.640m이하로 유지.

3.3 완공후 부력 검토 (지하 수위 : G.L-9.6m)

3.3.1 굴착고 : 17.920 m

3.3.2 부력 작용폭 : 44.200 m

3.3.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 8.320 × 28.100 = 2337.920 KN/m

10.000 × 1.350 × 16.100 = 217.350 KN/m

= 2555.270 KN/m

3.3.4 저항력

$R = W_1 + W_2 + F$ = 4189.889 + 5978.545 + 312.059 = 10480.493 KN/m

(1) W_1 (램프 구체자중)

① 시공중부력검토 구체자중 = 1931.907 KN/m

② 램프 상부 슬래브

(1.600 × 24.100)× 25.000 = 964.000 kN/m

③ 헌치

(0.500 × 0.500)× 1/2 × 6 EA × 25.000 = 18.750 kN/m

소 계 = 2914.657 kN/m

(2) W2 (본선 구체자중)

① 시공중부력검토 구체자중 = 810.482 KN/m

② 본선 상부 슬래브

(0.900 × 20.100)× 25.000 = 452.250 kN/m

③ 헌치

(0.500 × 0.500)× 1/2 × 4 EA × 25.000 = 12.500 kN/m

④ 풍도 브라켓

(0.300 + 0.600)× 1/2 × 0.500 × 25.00 × 0 EA = 0.000 kN/m

소 계 = 1275.232 kN/m

TOTAL = 4189.889 kN/m

(3) W3 (상재하중)

① 아스팔트(램프)

(0.450 × 24.100)× 23.000 = 249.435 kN/m

② 상재토(램프)

지하수위 이상

되메움토 : (9.050 × 24.100)× 19.000 = 4143.995 kN/m

지하수위 이하

되메움토 : (0.000 × 24.100)× 20.000 = 0.000 kN/m

③ 상재토(본선)

지하수위 이상

되메움토 : (4.000 × 20.100)× 19.000 = 1527.600 kN/m

지하수위 이하

되메움토 : (0.000 × 20.100)× 20.000 = 0.000 kN/m

④ 수목하중 = 10.000 kN/m

⑤ 방수몰탈

(0.050 × 44.200)× 21.500 = 47.515 kN/m

TOTAL = 5978.545 kN/m

(3) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로 적용

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi = 1 - \sin 30$ = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 9.500 m

지하수위 이하 구간(H_2) = 0.000 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

$= 2 \times 0.0 \times 0.000 + 0.500 \times (19.0 \times 9.500^2 + 10.0 \times 0.000^2 + 2 \times 19.0 \times 9.500 \times 0.000) \times \tan 20^\circ = 312.059$ kN/m

3.3.5 안정검토

$$F_s = \frac{R}{U} = \frac{10480.493}{2555.270} = 4.102 \geq 1.050 \quad \therefore \text{O.K}$$

3.4 완공후 부력 검토 (극한수위 : G.L - 1.000 m)

3.4.1 굴착고 : 17.920 m

3.4.2 부력 작용폭 : 44.200 m

3.4.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 16.920 × 28.100 = 4754.520 KN/m

10.000 × 9.950 × 16.100 = 1601.950 KN/m

= 6356.470 KN/m

3.4.4 저항력

$R = W_1 + W_2 + F$ = 4189.889 + 6243.695 + 193.723 = 10627.307 KN/m

(1) W_1 (구체자중)

① 실수위시부력검토 구체자중 = 4189.889 KN/m

TOTAL = 4189.889 kN/m

(2) W_2 (상재하중)

① 아스팔트(램프)

(0.450 × 24.100)× 23.000 = 249.435 kN/m

② 상재토(램프)

지하수위 이상

되메움토 : (0.550 × 24.100)× 19.000 = 251.845 kN/m

지하수위 이하

되메움토 : (8.500 × 24.100)× 20.000 = 4097.000 kN/m

③ 상재토(본선)

지하수위 이상

되메움토 : (1.000 × 20.100)× 19.000 = 381.900 kN/m

지하수위 이하

되메움토 : (3.000 × 20.100)× 20.000 = 1206.000 kN/m

④ 수목하중 = 10.000 kN/m

⑤ 방수몰탈

(0.050 × 44.200)× 21.500 = 47.515 kN/m

TOTAL = 6243.695 kN/m

(3) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi = 1 - \sin$ = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 1.000 m

지하수위 이하 구간(H_2) = 8.500 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

= 2 × 30.0 × 0.000 + 0.500 ×(19.0 × 1.000 ² + 10.0 × 8.500 ²

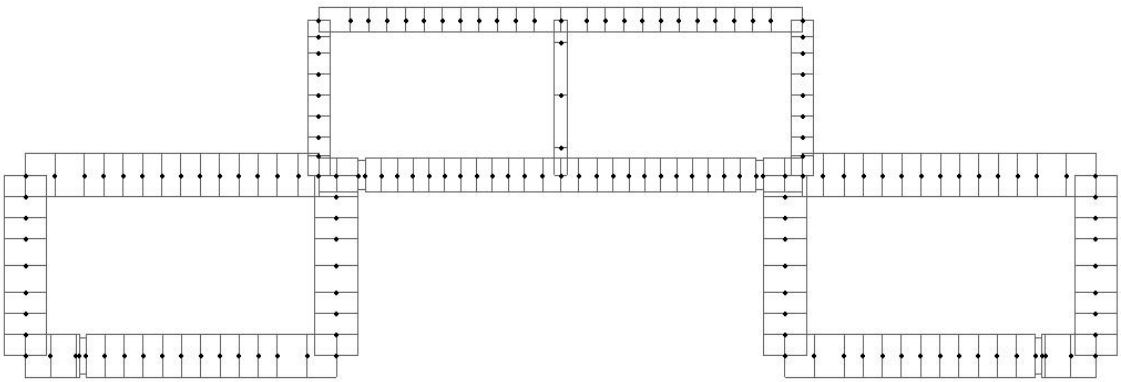
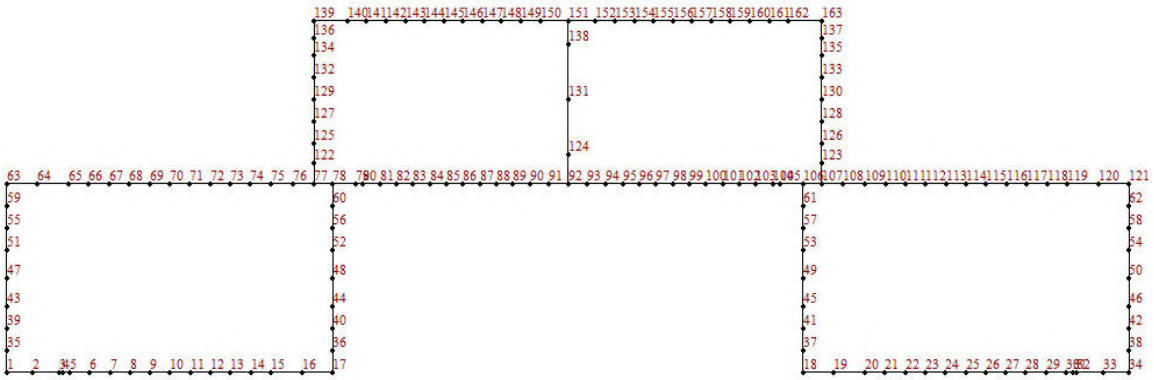
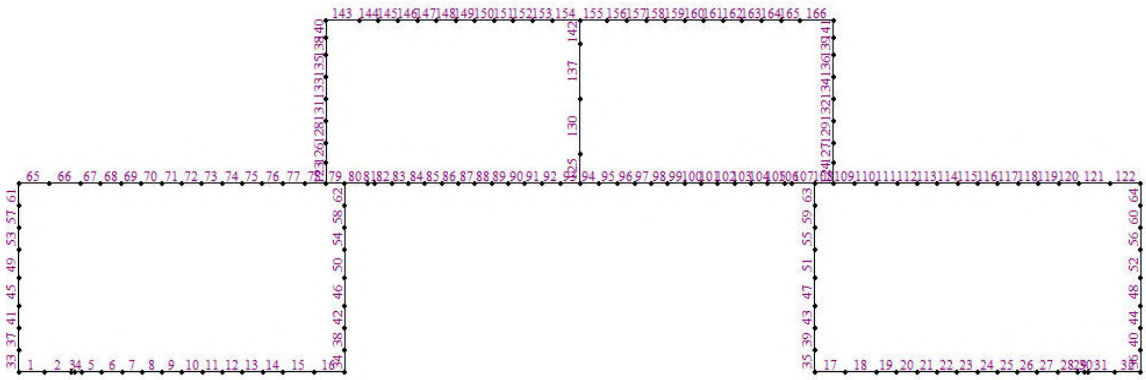
+ 2 × 19.0 × 1.000 × 8.500)× tan 20° = 193.723 kN/m

3.4.5 안정검토

$$F_s = \frac{R}{U} = \frac{10627.307}{6356.470} = 1.672 \geq 1.050$$ ∴ O.K

4. 해석모델링

4.1 Modeling

모델링

절점번호

부재번호


4.2 단면제원

구 분		부재폭 (m)	부재두께(m)	단면적 (m2)	단면2차 모멘트(m4)	비 고
슬래브	1	1.000	1.600	1.600	0.3413333	램프 상부슬래브
	2	1.000	0.900	0.900	0.0607500	본선 상부슬래브
	3	1.000	1.600	1.600	0.3413333	램프 하부슬래브
	4	1.000	1.300	1.300	0.1830833	본선 하부슬래브
벽체	1	1.000	1.700	1.700	0.4094167	램프 벽체
	2	1.000	0.900	0.900	0.0607500	본선 외측벽체
	3	1.000	0.500	0.500	0.0104167	본선 중앙벽체

4.3 강역산정

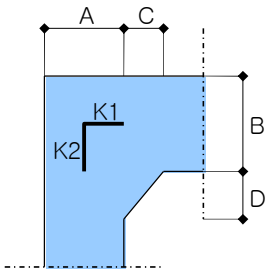
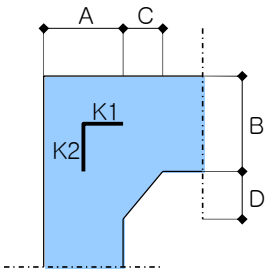
1) 강역설정기준(콘크리트구조기준, 2012)

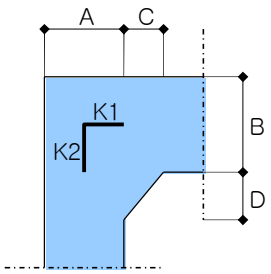
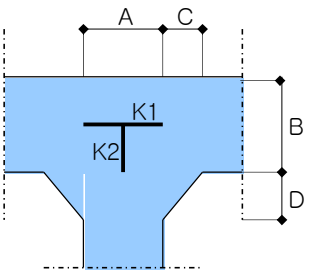
CASE 1 : 부재단부가 다른 부재와 접합할 때는 부재단에서 부재두께의 1/4 안쪽점에서 절점까지

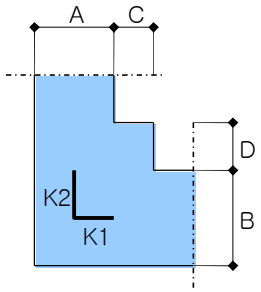
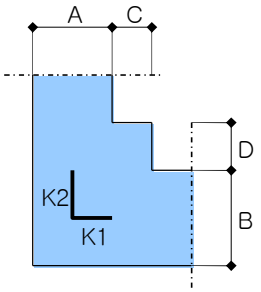
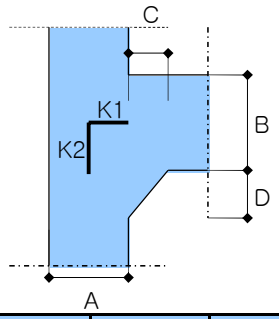
CASE 2 : 부재가 그 축선에 대해 25° 이상 60° 미만인 경사진 헌치를 갖는 경우에는 부재두께가 1.5배가 되는 점에서 부터 절점까지

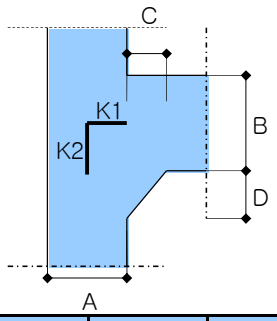
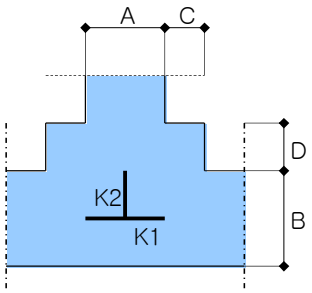
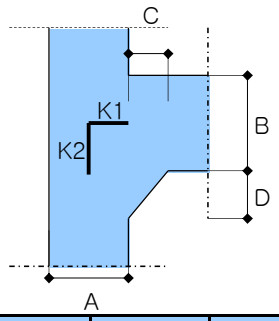
CASE 3 : 헌치의 경사가 60° 이상의 경우는 헌치의 시점에서 부재두께의 1/4 안쪽 점에서부터 절점까지

2) 강역설정

구분	(단부)			(접합부)		
상부슬래브 램프						
	구분	치수	단위	구분	치수	단위
	A	1.700	m	A	1.700	m
	B	1.600	m	B	1.600	m
	C	0.500	m	C	0.500	m
	D	0.500	m	D	0.500	m
	Θ1	45.000	°	Θ1	45.000	°
	Θ2	45.000	°	Θ2	45.000	°
	K1	0.550	m	K1	0.550	m
	K2	0.450	m	K2	0.450	m

구분	(단부)			(중앙부)		
상부슬래브 본선						
	구분	치수	단위	구분	치수	단위
	A	0.900	m	A	0.500	m
	B	0.900	m	B	0.900	m
	C	0.500	m	C	0.500	m
	D	0.500	m	D	0.500	m
	Θ1	45.000	°	Θ1	45.000	°
	Θ2	45.000	°	Θ2	45.000	°
	K1	0.500	m	K1	0.300	m
	K2	0.500	m	K2	0.700	m

구분	(외측 단부)			(내측 단부)			(접합부)		
하부슬래브 램프									
구분	치수	단위	구분	치수	단위	구분	치수	단위
A	1.700	m	A	1.700	m	A	1.700	m
B	1.600	m	B	1.600	m	B	1.300	m
C		m	C		m	C	0.500	m
D		m	D		m	D	0.500	m
Θ1		°	Θ1		°	Θ1	45.000	°
Θ2		°	Θ2		°	Θ2	45.000	°
K1	0.450	m	K1	0.450	m	K1	0.700	m
K2	0.375	m	K2	0.375	m	K2	0.300	m

구분	(단부)			(중앙부)			(단부)		
하부슬래브 본선									
구분	치수	단위	구분	치수	단위	구분	치수	단위
A	1.300	m	A	0.500	m	A	1.700	m
B	0.900	m	B	1.300	m	B	1.300	m
C	0.500	m	C		m	C	0.500	m
D	0.500	m	D		m	D	0.500	m
Θ1	45.000	°	Θ1		°	Θ1	45.000	°
Θ2	45.000	°	Θ2		°	Θ2	45.000	°
K1	0.700	m	K1		m	K1	0.700	m
K2	0.300	m	K2	0.525	m	K2	0.300	m

5. 지반 반력계수

5.1 연직 지반반력 계수 : 램프

$Kv = Kv_0 (Bv / 0.3)^{(-3/4)}$

여기서, Kv : 연직방향 지반반력계수 (kN/㎥)

Kv_0 : 토질시험결과에 의해 구한 지반반력계수 = (1 / 0.3)·α·E_0

α , E_0 : 지반반력계수의 추정에 쓰이는 계수 및 지반변형계수 (kN/㎡)로서,

아래의 E_0 와 α의 관계참조

다음의 시험방법에 의한 변형계수 E_0 (kN/㎡)	α	
	평상시	지진시
지름 30cm의 강체원판에 의한 평판재하시험을 반복시킨 곡선에서 구한 변형계수의 1/2	1	2
보링공내에서 측정한 변형계수	4	8
공시체의 1축 또는 3축압축시험에서 구한 변형계수	4	8
표준관입시험의 N값에서 E_0=2800N 으로 추정한 변형계수	1	2

- Bv : 하중 작용 방향에 직교하는 기초의 환산재하폭 (m) = √(Av)
- Av : 연직방향의 재하면적(㎡)
- E_0 = 300000 kN/㎡

Kv_0 = 1/0.3 x α x E_0 = 1/0.3 x 4 x 300000 = 4000000 kN/㎥

Bv = √(Av) = √(28.10 × 28.10) = 28.10 m

Kv = Kv_0 x (Bv / 0.3) $^{-3/4}$

= 4000000 x (28.10 / 0.3) $^{-3/4}$ = 132,853 kN/㎥

구 분	지 반 반 력 계 수 (kN/㎡)			절 점
1	(0.8500 + 1.0000) / 2 × 132,853	=	122,889	1 34
2	(1.0000 + 1.0000) / 2 × 132,853	=	132,853	2 33
3	(1.0000 + 0.1500) / 2 × 132,853	=	76,390	3 32
4	(0.1500 + 0.2500) / 2 × 132,853	=	26,571	4 31
5	(0.2500 + 0.7600) / 2 × 132,853	=	67,091	5 30
6	(0.7600 + 0.7600) / 2 × 132,853	=	100,968	6 to 14 21 to 29
7	(0.7600 + 1.1750) / 2 × 132,853	=	128,535	15 20
8	(1.1750 + 1.1750) / 2 × 132,853	=	156,102	16 19
9	(1.1750 + 0.8500) / 2 × 132,853	=	134,514	17 18

5.2 연직 지반반력 계수 : 본선

$Kv = Kv_0 (Bv / 0.3)^{(-3/4)}$

여기서, Kv : 연직방향 지반반력계수 (kN/㎥)

Kv_0 : 토질시험결과에 의해 구한 지반반력계수 = $(1 / 0.3) \cdot \alpha \cdot E_0$

α , E_0 : 지반반력계수의 추정에 쓰이는 계수 및 지반변형계수 (kN/㎡)로서,

아래의 E_0 와 α의 관계참조

다음의 시험방법에 의한 변형계수 E_0 (kN/㎡)	α	
	평상시	지진시
지름 30cm의 강체원판에 의한 평판재하시험을 반복시킨 곡선에서 구한 변형계수의 1/2	1	2
보링공내에서 측정한 변형계수	4	8
공시체의 1축 또는 3축압축시험에서 구한 변형계수	4	8
표준관입시험의 N값에서 E_0=2800N 으로 추정한 변형계수	1	2

- Bv : 하중 작용 방향에 직교하는 기초의 환산재하폭 (m) = √(Av)
- Av : 연직방향의 재하면적(㎡)
- E_0 = 28000 kN/㎡

Kv_0 = 1/0.3 x α x E_0 = 1/0.3 x 4 x 28000 = 373333 kN/㎥

Bv = √(Av) = √(16.10 × 16.10) = 16.10 m

Kv = Kv_0 x (Bv / 0.3) $^{-3/4}$

= 373333 x (16.10 / 0.3) $^{-3/4}$ = 18,829 kN/㎥

구 분	지 반 반 력 계 수 (kN/㎡)			절 점
1	(0.8500 + 0.3000) / 2 × 18,829	=	10,826	79 105
2	(0.3000 + 0.6300) / 2 × 18,829	=	8,755	80 104
3	(0.6300 + 0.6300) / 2 × 18,829	=	11,862	81to89 95to103
4	(0.6300 + 0.7250) / 2 × 18,829	=	12,756	90 94
5	(0.7250 + 0.7250) / 2 × 18,829	=	13,651	91 92 93

5.3 수평 지반반력 계수 : 절점에 수평방향 무한강성 적용

6. 하중계산

6.1 구체자중 ····· LC01

· PROGRAM 내에서 자동계산

6.2 활하중 ····· LC02~07

(1) 노면 활하중

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m²)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

D/B0 < 0.5		
D/B0	Pvl × D, kN/m2	비 고
0.1	17.000	* D/B0의 중간 값은, Pvl × D의 상위값을 적용 *D/B0 중노면활하중(Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

D/B_0 = 9.500 / 12.050 = 0.788

노면활하중 Pvl = 10.000 kN/㎡

노면활하중에 의한 측압 (hl) = 10.000 × 0.500 = 5 kN/㎡

① 상부 슬래브에 작용하는 하중 (W_{L1}) ∴ W_{L1} = **10.000** kN/m^2

② 측벽에 작용하는 하중 (W_{L2})

W_{L2} = 10.000 × 0.500 ∴ W_{L2} = **5.000** kN/m^2

6.3 토압 (연직하중 – 지하수가 없을 경우) ····· LC8

① 상부슬래브 : 본선

· ASPHALT 포장하중	:	0.000	×	23.00	=	0.000 kN/m^2
· 수목하중	:				=	10.000 kN/m^2
· 토 사	:	3.950	×	19.00	=	75.050 kN/m^2
· 방수 Mortar	:	0.050	×	21.50	=	1.075 kN/m^2
				∴ Total W_{D4} =		**86.125** kN/m^2

② 상부슬래브 : 램프(도로부)

· ASPHALT 포장하중	:	0.450	×	23.00	=	10.350 kN/m^2
· 토 사	:	9.000	×	19.00	=	171.000 kN/m^2
· 방수 Mortar	:	0.050	×	21.50	=	1.075 kN/m^2
				∴ Total W_{D4} =		**182.425** kN/m^2

6.4 토압 (연직하중 - 지하수가 있는 경우 : GL -1.000 m) ····· LC9

① 상부슬래브 : 본선

· ASPHALT 포장하중	:	0.000	×	23.00	=	0.000	kN/m^2
· 수목하중	:				=	10.000	kN/m^2
· 흙 (지하수위 이상)	:	1.000	×	19.00	=	19.000	kN/m^2
· 흙 (지하수위 이하)	:	2.950	×	10.00	=	29.500	kN/m^2
· 방수 Mortar	:	0.050	×	21.50	=	1.075	kN/m^2
			∴ Total W_{D5} =			**59.575**	kN/m^2

② 상부슬래브 : 도로부

· ASPHALT 포장하중	:	0.450	×	23.00	=	10.350	kN/m^2
· 흙 (지하수위 이상)	:	0.550	×	19.00	=	10.450	kN/m^2
· 흙 (지하수위 이하)	:	8.450	×	10.00	=	84.500	kN/m^2
· 방수 Mortar	:	0.050	×	21.50	=	1.075	kN/m^2
			∴ Total W_{D5} =			**106.375**	kN/m^2

6.5 토압 (수평하중 - 지하수가 없을경우) ····· LC10

토압 (수평토압)

· W_{h1} = 0.500 × [0.00 × 19.00 + (4.00 + 0.90 / 2) × 19.0]
= **42.275** kN/m^2

· W_{h2} = 42.275 + 0.500 × [5.850 x 19.0] = **97.850** kN/m^2

· W_{h3} = 97.850 + 0.500 × [6.820 x 19.0] = **162.640** kN/m^2

6.6토압 (수평하중 - 지하수가 있을경우) ····· LC11

토압 (수평토압)

· W_{h1} = 0.500 × [1.00 × 19.00 + (3.00 + 0.90 / 2) × 10.0]
= **26.750** kN/m^2

· W_{h2} = 26.750 + 0.500 × [5.700 x 10.0] = **55.250** kN/m^2

· W_{h3} = 55.250 + 0.500 × [6.820 x 10.0] = **89.350** kN/m^2

6.7 지하수압 (연직하중) ····· LC12

① 상부슬래브 : 본선

· W_{w1} = (3.00 + 0.00 - 0.00) × 10.0 = **30.000** kN/m^2

② 상부슬래브 : 램프(도로부)

· W_{w2} = (8.50 + 0.00 - 0.00) × 10.0 = **85.000** kN/m^2

② 본선(화단부), 하부슬래브에 작용하는 하중 (W_{w2}) : 양수압

· W_{w3} = (4.00 + 6.950 - 1.00) × 10.0 = **99.500** kN/m^2

④ 램프(도로부), 하부슬래브에 작용하는 하중 (W_{w2}) : 양수압

· W_{w4} = (9.50 + 8.420 - 1.00) × 10.0 = **169.200** kN/m^2

6.8 지하수압 (수평하중) ····· LC13

① 측벽에 작용하는 하중 (W_{W3}, W_{W4})

- W_{w1} = (4.00 − 1.00 + 0.90 / 2) × 10.0 = **34.500** kN/m^2
- W_{w2} = 34.500 + (5.700) x 10.0 = **91.500** kN/m^2
- W_{w3} = 91.500 + (6.820) x 10.0 = **159.700** kN/m^2

6.9 건조수축 : − 15℃ (상부슬래브만 재하) ····· LC14

건조수축률 ε = 0.00015

온도선팽창계수 α = 0.00001

6.10 부등침하 : ····· LC15

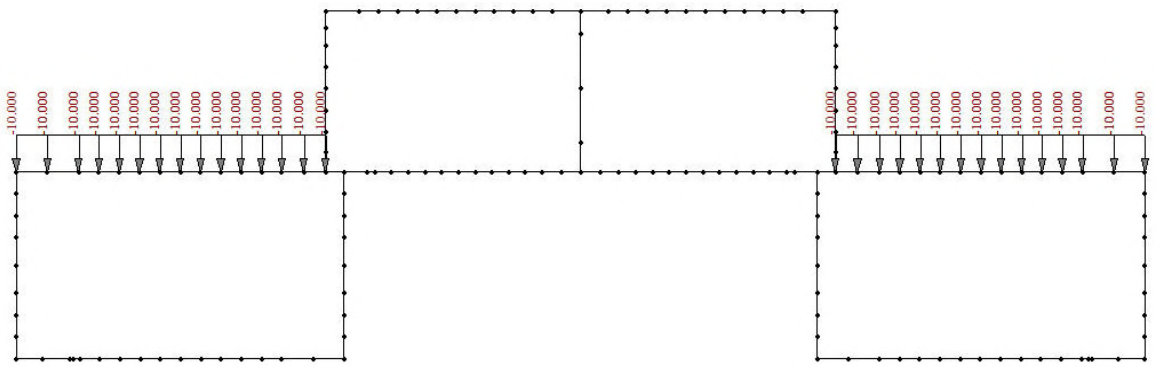
부등 침하량 차이 δ = 3.47mm 지반조사보고서 참조

7. 하중재하도

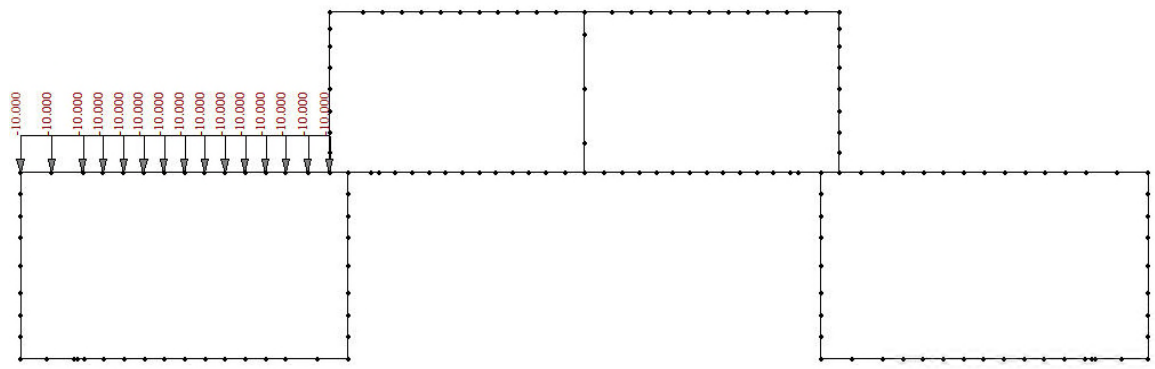
LC1. 고정하중(자중)

프로그램내에서 자동 계산

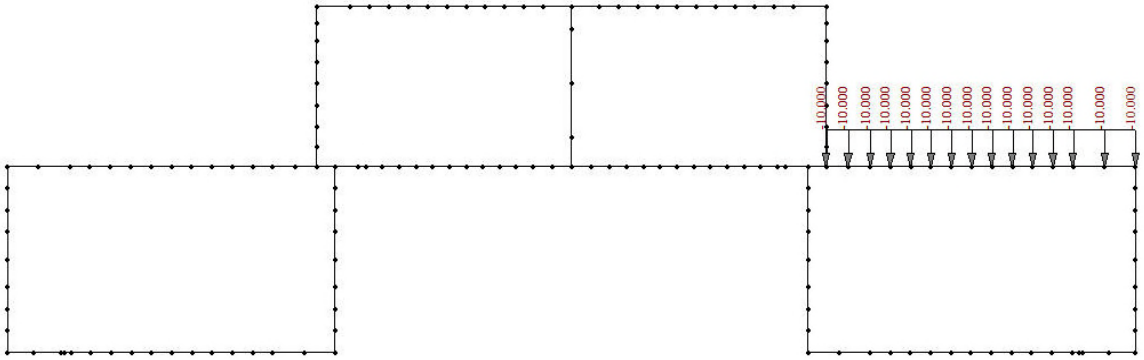
LC2. 활하중(연직하중 만재하시)



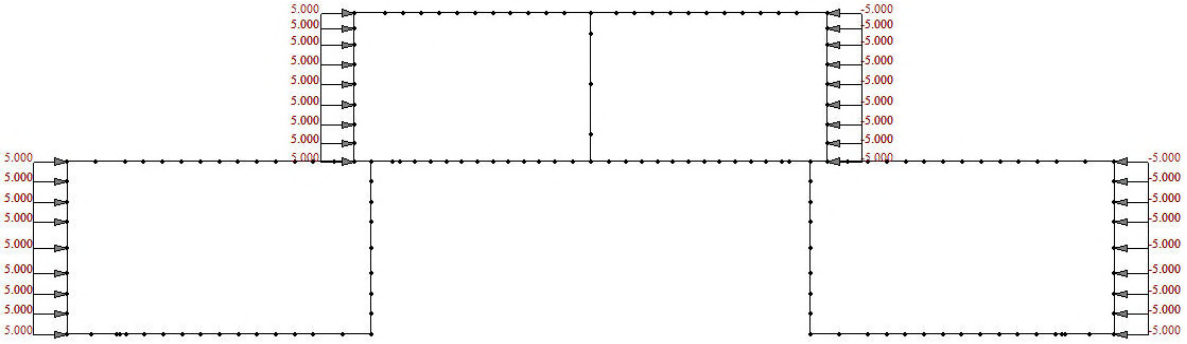
LC3. 활하중(연직하중 좌측편재하시)



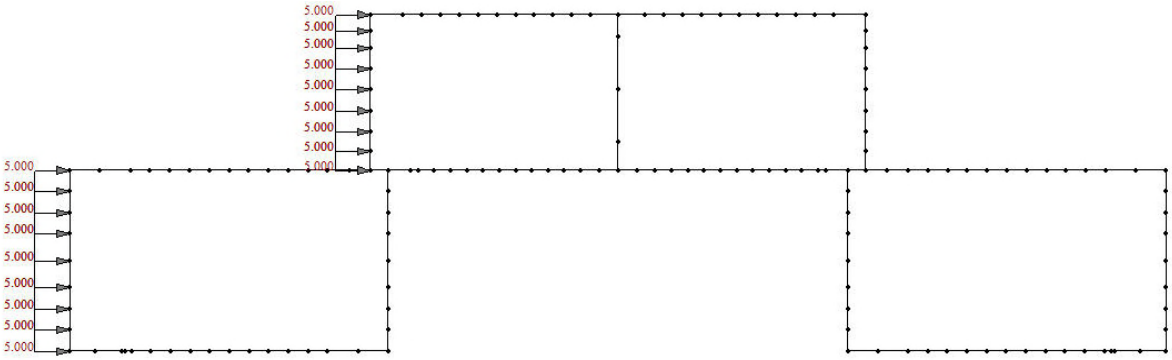
LC4. 활하중(연직하중 우측편재하시)



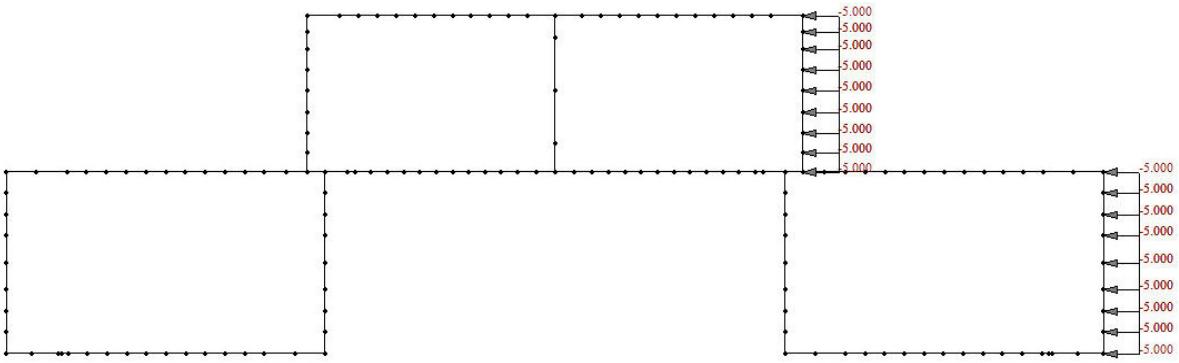
LC5. 활하중(수평하중 만재하시)



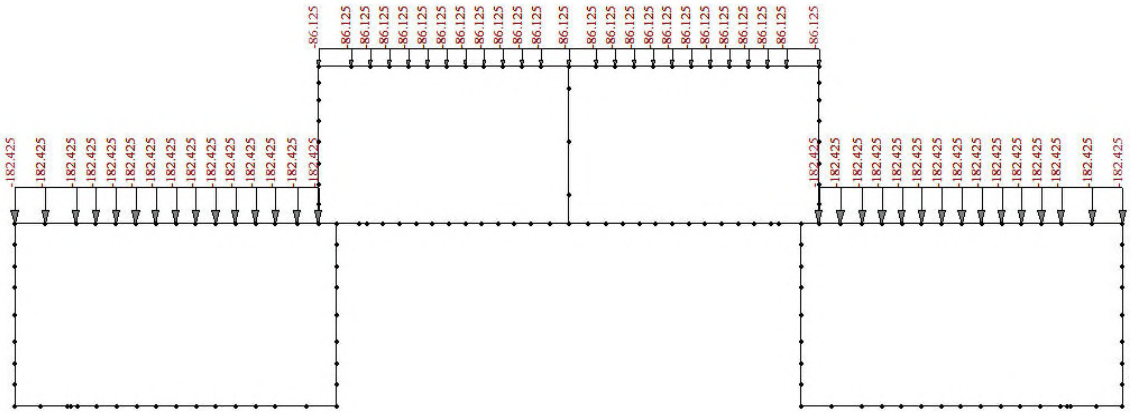
LC6. 활하중(수평하중 좌측편재하시)



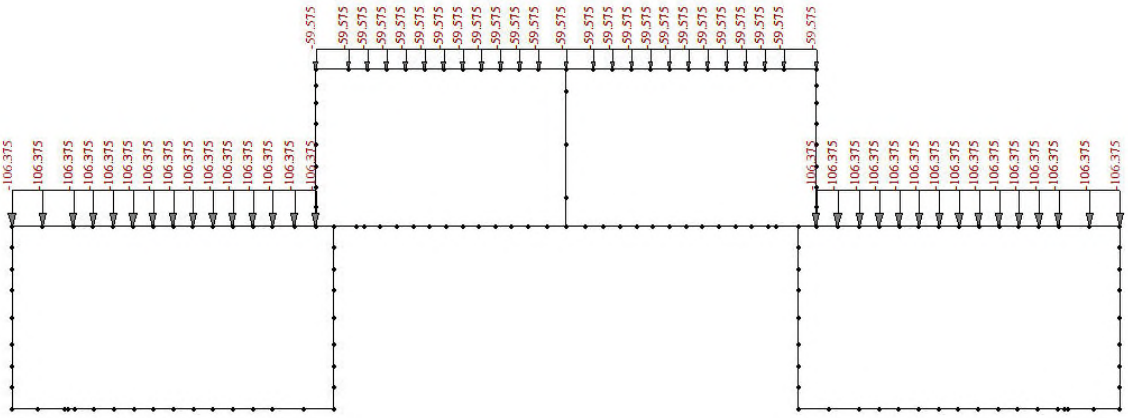
LC7. 활하중(수평하중 우측편재하시)



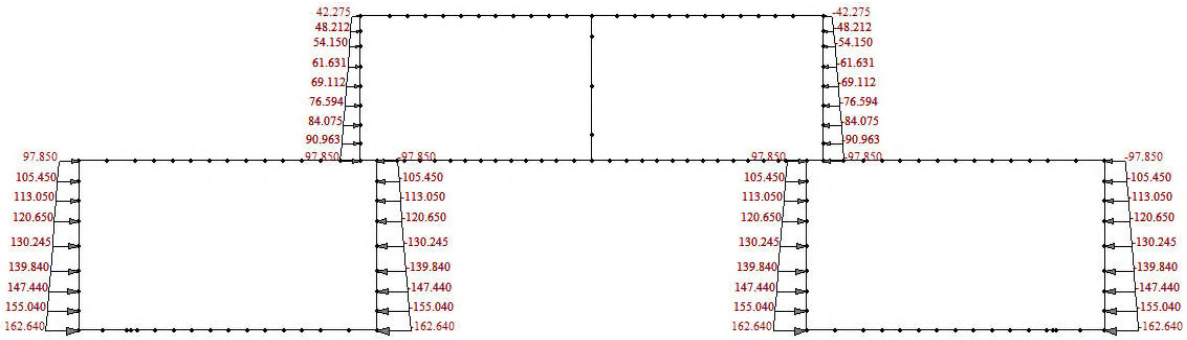
LC8. 토압(연직하중 지하수無)



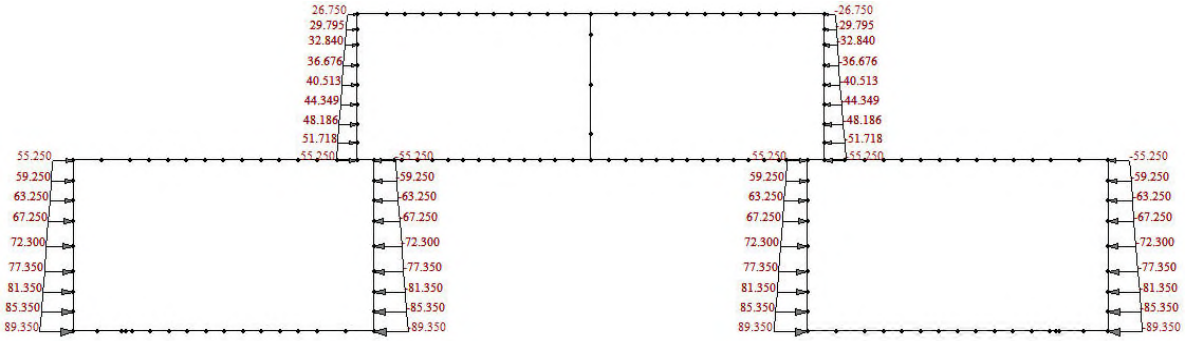
LC9. 토압(연직하중 지하수有)



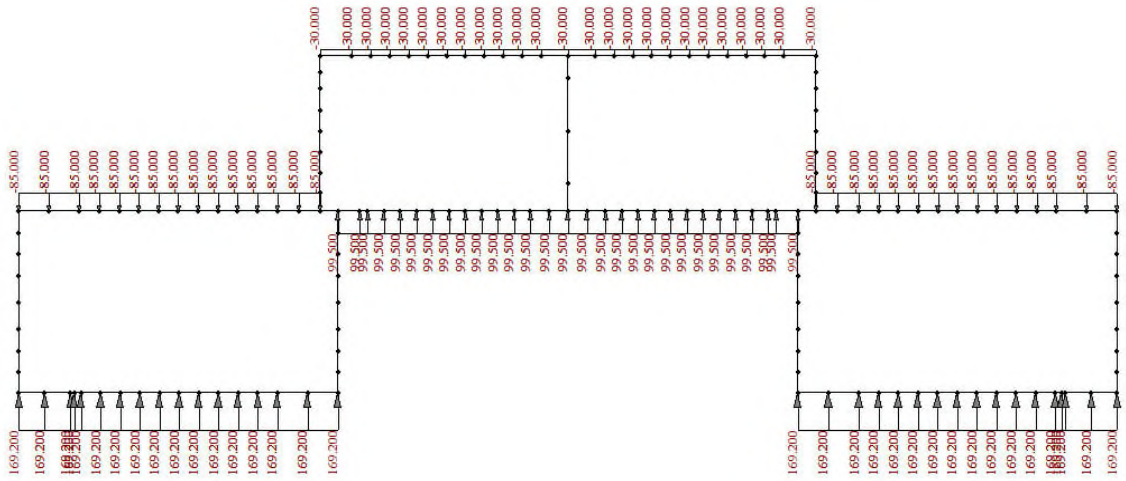
LC10. 토압(수평하중 지하수無)



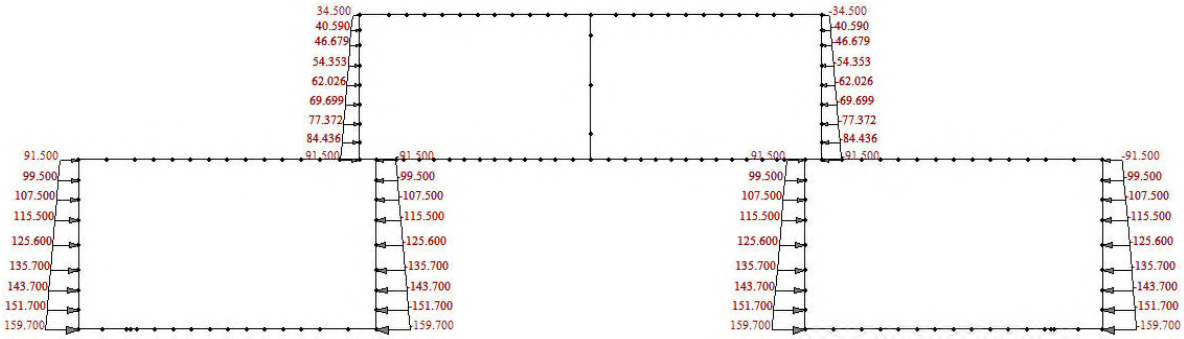
LC11. 토압(수평하중 지하수有)



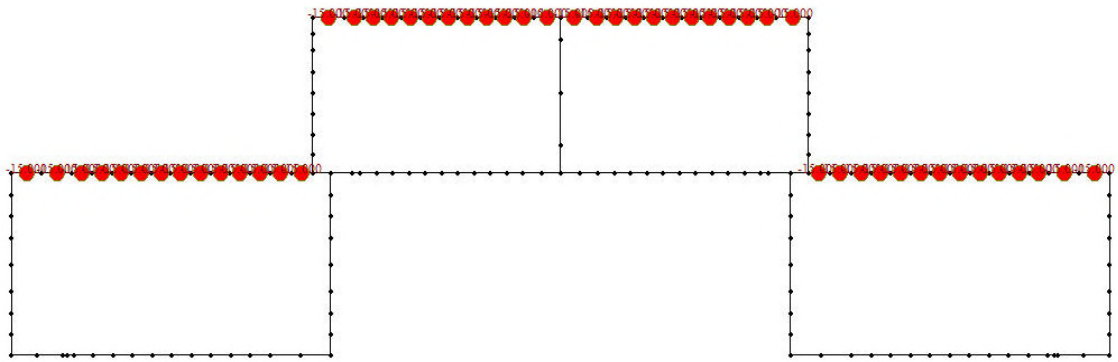
LC12. 수압(연직하중)



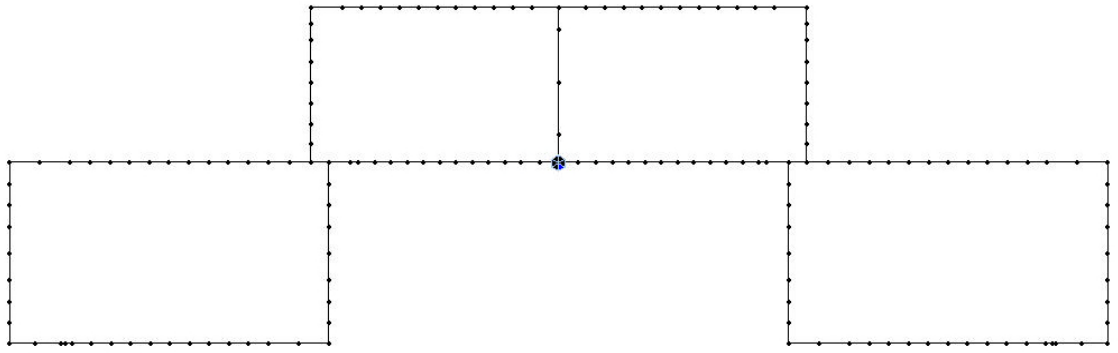
LC13. 수압(수평하중)



LC14. 건조수축하중



LC15. 부등침하



8. 하중조합

α_H : 토피의 두께에 따른 연직방향 하중 Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, $\alpha_H = 1.0$

h > 2.0 m 에 대해서, $\alpha_H = 1.05 - 0.025h \geq 0.875$

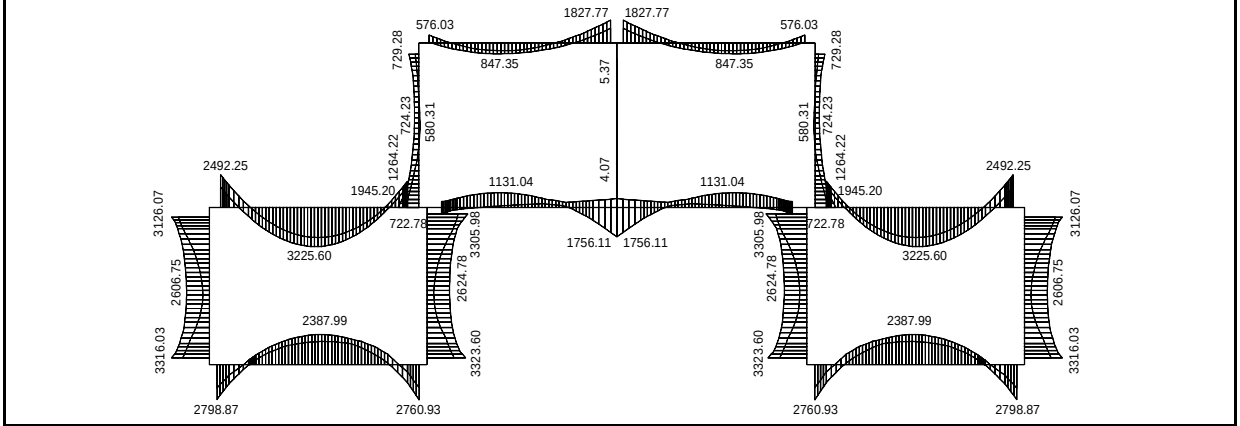
적용토피 = 3.000 m $\alpha_H = 1.05 - 0.025 \times 3.00$

$= 0.975 \geq 0.875 \quad \therefore \alpha_H = 0.975$

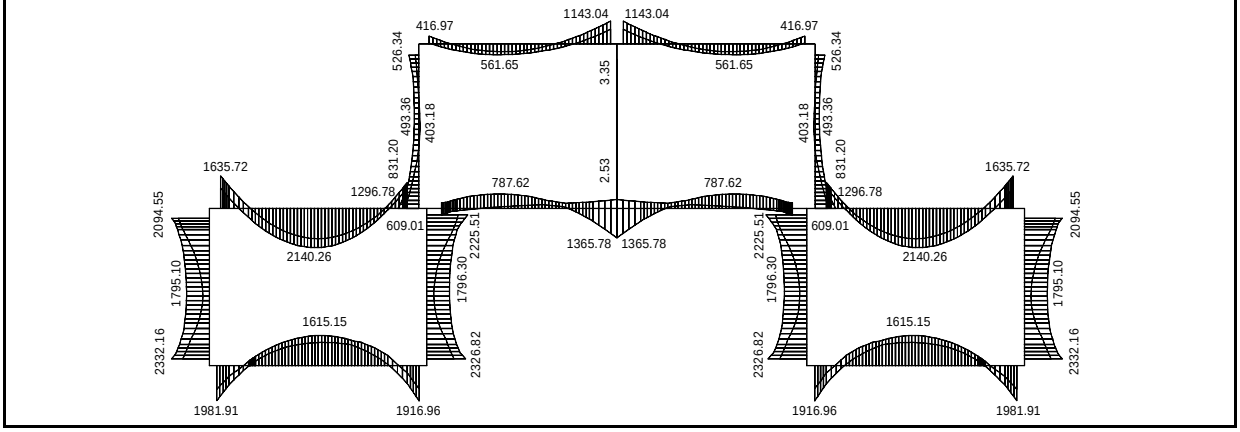
하중조합		고정하중	활하중						토압				수압		건조수축	부등침하	비고
		자중	연직하중			수평하중			연직하중		수평하중		연직수압	수평수압			
			만재하	편재하		만재하	편재하		지하수無	지하수有	지하수無	지하수有					
				좌측	우측		좌측	우측									
		LC01	LC02	LC03	LC04	LC05	LC06	LC07	LC8	LC9	LC10	LC11	LC12	LC13	LC14	LC15	
극한하중조합	UCOMB01	1.20	1.60			1.60			1.56		1.60				1.20	1.20	
	UCOMB02	1.20		1.60			1.60		1.56		1.60				1.20	1.20	
	UCOMB03	1.20			1.60			1.60	1.56		1.60				1.20	1.20	
	UCOMB04	1.20	1.60			1.60				1.56		1.60	1.56	1.60	1.20	1.20	
	UCOMB05	1.20		1.60			1.60			1.56		1.60	1.56	1.60	1.20	1.20	
	UCOMB06	1.20			1.60			1.60		1.56		1.60	1.56	1.60	1.20	1.20	
	UCOMB07	1.20	1.60			0.80			1.56		0.80				1.20	1.20	
	UCOMB08	1.20		1.60			0.80		1.56		0.80				1.20	1.20	
	UCOMB09	1.20			1.60			0.80	1.56		0.80				1.20	1.20	
	UCOMB10	1.20	1.60			0.80				1.56		0.80	1.56	0.80	1.20	1.20	
	UCOMB11	1.20		1.60			0.80			1.56		0.80	1.56	0.80	1.20	1.20	
	UCOMB12	1.20			1.60			0.80		1.56		0.80	1.56	0.80	1.20	1.20	
	UCOMB13	0.90							1.60		1.60						
	UCOMB14	0.90								1.60		1.60	1.60	1.60			
	UCOMB15	0.90							1.60		1.60						
	UCOMB16	0.90								1.60		1.60	1.60	1.60			
사용하중조합	WCOMB01	1.00	1.00			1.00			1.00		1.00				1.00	1.00	
	WCOMB02	1.00		1.00			1.00		1.00		1.00				1.00	1.00	
	WCOMB03	1.00			1.00			1.00	1.00		1.00				1.00	1.00	
	WCOMB04	1.00	1.00			1.00				1.00		1.00	1.00	1.00	1.00	1.00	
	WCOMB05	1.00		1.00			1.00			1.00		1.00	1.00	1.00	1.00	1.00	
	WCOMB06	1.00			1.00			1.00		1.00		1.00	1.00	1.00	1.00	1.00	
	WCOMB07	1.00	1.00			0.50			1.00		0.50				1.00	1.00	
	WCOMB08	1.00		1.00			0.50		1.00		0.50				1.00	1.00	
	WCOMB09	1.00			1.00			0.50	1.00		0.50				1.00	1.00	
	WCOMB10	1.00	1.00			0.50				1.00		0.50	1.00	0.50	1.00	1.00	
	WCOMB11	1.00		1.00			0.50			1.00		0.50	1.00	0.50	1.00	1.00	
	WCOMB12	1.00			1.00			0.50		1.00		0.50	1.00	0.50	1.00	1.00	
	WCOMB13	1.00							1.00		1.00						
	WCOMB14	1.00								1.00		1.00	1.00	1.00			
	WCOMB15	1.00							1.00		1.00						
	WCOMB16	1.00								1.00		1.00	1.00	1.00			

9. 단면력도

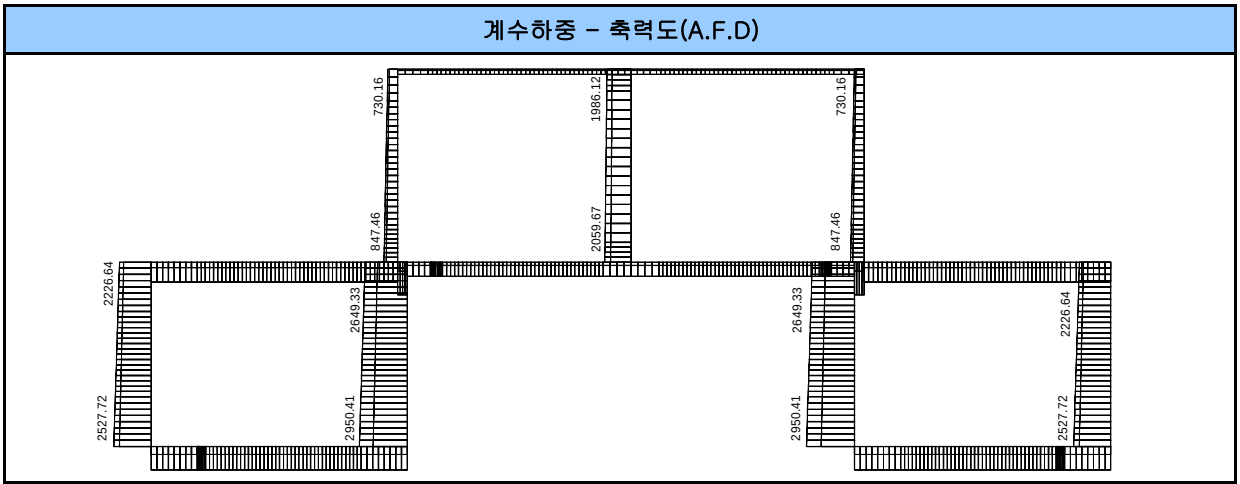
계수하중 – 모멘트도(B.M.D)



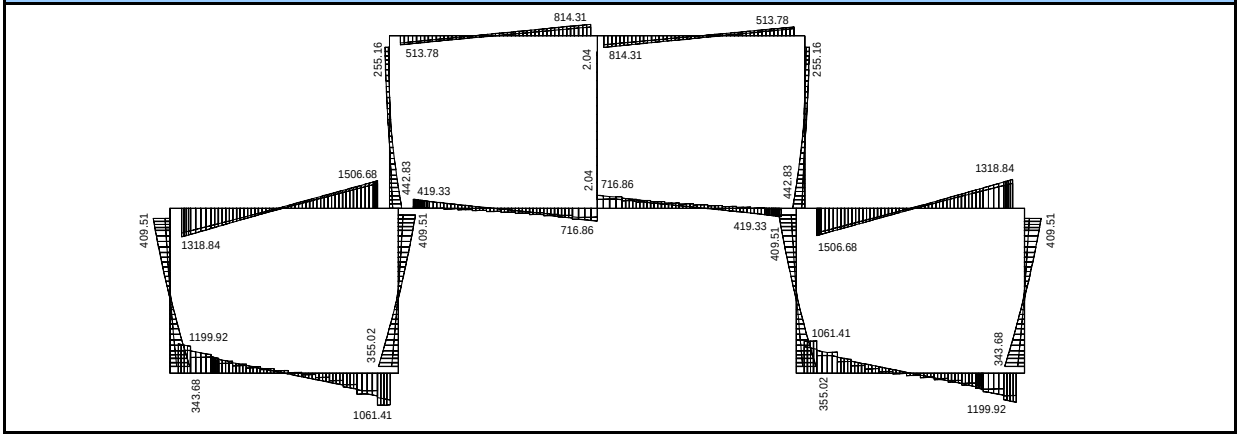
사용하중 – 모멘트도(B.M.D)



계수하중 – 축력도(A.F.D)



계수하중 – 전단력(S.F.D)



10. 전산 해석 결과

10.1 부재력 집계표(부재력도 및 전산 OUTPUT DATA 참조)

※ 상부슬래브

구 분	위 치	상시				지진시			적용하중					
		계수하중			사용하중	MAX(기능수행수준, 붕괴방지수준)			계수하중			사용하중	모멘트	전단
		모멘트	축력	전단력	모멘트	모멘트	축력	전단력	모멘트	축력	전단력	모멘트		
		Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)	Mu(ko.m)	Pu(kN)	Su(kN)	Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)		
상 부 슬래브	램프벽체부	2492.250		1318.840	1635.720	3061.450		1251.340	3061.450	-	1318.840	1635.720	지진시	상시
	램프중앙부	3225.600		0.000	2140.260	2530.720		0.000	3225.600	-	0.000	2140.260	상시	상시
	램프접합부	1945.200		1506.680	1296.780	2466.380		1351.990	2466.380	-	1506.680	1296.780	지진시	상시
	본선접합부	576.030		513.780	416.970	845.040		509.240	845.040	-	513.780	416.970	지진시	상시
	본선중앙부	847.350		0.000	561.650	725.400		0.000	847.350	-	0.000	561.650	상시	상시
	중앙벽체부	1827.770		814.310	1143.040	1473.560		649.400	1827.770	-	814.310	1143.040	상시	상시

※ 하부슬래브

구 분	위 치	상시				지진시			적용하중					
		계수하중			사용하중	MAX(기능수행수준, 붕괴방지수준)			계수하중			사용하중	모멘트	전단
		모멘트	축력	전단력	모멘트	모멘트	축력	전단력	모멘트	축력	전단력	모멘트		
		Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)	Mu(kN.m)	Pu(kN)	Su(kN)	Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)		
하 부 슬래브	램프벽체부	2798.870	-	1199.920	1981.910	2648.780	-	1055.350	2798.870	-	1199.920	1981.910	상시	상시
	램프중앙부	2387.990	-	0.000	1615.150	2132.410	-	0.000	2387.990	-	0.000	1615.150	상시	상시
	램프접합부	2760.930	-	1061.410	1916.960	2804.590	-	979.950	2804.590	-	1061.410	1916.960	지진시	상시
	본선접합부	722.780	-	419.330	609.010	1198.850	-	439.260	1198.850	-	439.260	609.010	지진시	지진시
	본선중앙부	1131.040	-	0.000	787.620	1158.430	-	0.000	1158.430	-	0.000	787.620	지진시	상시
	중앙벽체부	1756.110	-	716.860	1365.780	1517.250	-	641.760	1756.110	-	716.860	1365.780	상시	상시
	램프측구	545.250	-	1199.920	379.710	1177.040	-	1055.350	1177.040	-	1199.920	379.710	지진시	상시
	본선측구	833.430	-	419.330	704.550	1243.040	-	439.260	1243.040	-	439.260	704.550	지진시	지진시

※ 벽체 : 램 프

구 분	위 치		상시				지진시			적용하중					
			계수하중			사용하중	MAX(기능수행수준, 붕괴방지수준)			계수하중			사용하중	모멘트	전단
			모멘트	축력	전단력	모멘트	모멘트	축력	전단력	모멘트	축력	전단력	모멘트		
			Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)	Mu(kN.m)	Pu(kN)	Su(kN)	Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)		
외측 벽체	상단부	Mmax	3126.070	2055.080	409.510	2094.550	3641.380	1025.950	560.970	3641.380	1025.950	560.970	2094.550	지진시	지진시
		Pmax	2768.660	2226.640	409.510	2094.550	863.780	1935.900	560.970	2768.660	2226.640	560.970	2094.550	상시	지진시
	중앙부(-)	Mmax	2606.750	2328.330	0.000	1795.100	2600.190	1316.220	0.000	2606.750	2328.330	0.000	1795.100	상시	상시
		Pmax	1887.440	2407.690	0.000	1795.100	605.520	2037.150	0.000	1887.440	2407.690	0.000	1795.100	상시	상시
	하단부	Mmax	3316.030	2527.530	343.680	2332.160	3166.920	1427.450	537.360	3316.030	2527.530	537.360	2332.160	상시	지진시
		Pmax	3315.610	2527.720	343.680	2332.160	3146.880	2150.590	537.360	3315.610	2527.720	537.360	2332.160	상시	지진시
내측 벽체	상단부	Mmax	3305.980	2214.920	409.510	2225.510	3805.440	2151.470	585.760	3805.440	2151.470	585.760	2225.510	지진시	지진시
		Pmax	2799.830	2649.330	409.510	2225.510	3435.870	2174.270	585.760	2799.830	2649.330	585.760	2225.510	상시	지진시
	중앙부(-)	Mmax	2624.780	2830.380	0.000	1796.300	2740.770	2359.060	0.000	2740.770	2359.060	0.000	1796.300	지진시	상시
		Pmax	2624.780	2830.380	0.000	1796.300	2740.770	2359.060	0.000	2624.780	2830.380	0.000	1796.300	상시	상시
	하단부	Mmax	3323.600	2769.420	355.020	2326.820	3391.970	2569.100	550.900	3391.970	2569.100	550.900	2326.820	지진시	지진시
		Pmax	3143.180	2950.410	355.020	2326.820	3391.970	2569.100	550.900	3143.180	2950.410	550.900	2326.820	상시	지진시

※ 벽체 : 본 선

구 분	위 치		상시				지진시			적용하중					
			계수하중			사용하중	붕괴방지수준			계수하중			사용하중	모멘트	전단
			모멘트	축력	전단력	모멘트	모멘트	축력	전단력	모멘트	축력	전단력	모멘트		
			Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)	Mu(kN.m)	Pu(kN)	Su(kN)	Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)		
외측 벽체	상단부	Mmax	729.280	717.750	255.160	526.340	968.130	293.550	324.470	968.130	293.550	324.470	526.340	지진시	지진시
		Pmax	687.140	730.160	255.160	526.340	27.230	695.720	324.470	687.140	730.160	324.470	526.340	상시	지진시
	중앙부(+)	Mmax	580.310	738.310	0.000	403.180	512.840	359.530	0.000	580.310	738.310	0.000	403.180	상시	상시
		Pmax	274.920	773.850	0.000	403.180	112.570	736.850	0.000	274.920	773.850	0.000	403.180	상시	상시
	중앙부(-)	Mmax	724.230	759.160	0.000	493.360	631.880	413.080	0.000	724.230	759.160	0.000	493.360	상시	상시
		Pmax	307.410	789.490	0.000	493.360	77.770	751.870	0.000	307.410	789.490	0.000	493.360	상시	상시
	하단부	Mmax	1264.220	844.850	442.830	831.200	1227.840	489.920	474.710	1264.220	844.850	474.710	831.200	상시	지진시
		Pmax	1186.910	847.460	442.830	831.200	333.980	794.670	474.710	1186.910	847.460	474.710	831.200	상시	지진시
중앙부 벽체	상단부	Mmax	5.370	1877.600	2.040	3.350	265.060	1482.570	118.340	265.060	1482.570	118.340	3.350	지진시	지진시
		Pmax	0.001	1986.120	2.040	3.350	248.090	1495.070	118.340	0.001	1986.120	118.340	3.350	상시	지진시
	중앙부(+)	Mmax	5.070	1890.110	0.000	3.160	248.090	1495.070	0.000	248.090	1495.070	0.000	3.160	지진시	상시
		Pmax	0.001	2015.170	0.000	3.160	19.300	1524.120	0.000	0.001	2015.170	0.000	3.160	상시	상시
	하단부	Mmax	4.070	1963.660	2.040	2.530	284.230	1568.620	123.180	284.230	1568.620	123.180	2.530	지진시	지진시
		Pmax	0.001	2059.670	2.040	2.530	284.230	1568.620	123.180	0.001	2059.670	123.180	2.530	상시	지진시

11. 단면 설계 정리

※ 상부슬래브

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
상부슬래브	램프 벽체부	2492.25	1635.72	-	3061.45	3061.45	1318.84	3480.76	2165.88	1.00	1.767 1.667	0.100	H32@250 + H32@250	H16@150 - 2EA	1.14	264.83	125.00
	램프 중앙부	3225.60	2140.26	-	2530.72	3225.60		4053.99		1.00	1.600 1.520	0.080	H32@250 + H32@250 H25@250		1.26	393.23	125.00
	램프 접합부	1945.20	1296.78	-	2466.38	2466.38	1506.68	3480.76	2165.88	1.00	1.767 1.667	0.100	H32@250 + H32@250	H16@150 - 2EA	1.41	388.93	125.00
	본선 접합부	576.03	416.97	-	845.04	845.04	513.78	1283.60		1.00	1.067 0.967	0.100	H25@250 + H25@250		1.52	468.34	125.00
	본선 중앙부	847.35	561.65	-	725.40	847.35		1081.46		1.00	0.900 0.820	0.080	H25@250 + H25@250		1.28	404.87	125.00
	중앙 벽체부	1827.77	1143.04	-	1473.56	1827.77	814.31	2134.16	1114.30	1.00	1.067 0.967	0.100	H29@250 + H29@250 H25@250	H16@150 - 2EA	1.17	189.78	125.00

※ 하부슬래브

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
하부슬래브	램프 벽체부	2798.87	1981.91		2648.78	2798.87	1199.92	3120.73	2165.88	1.00	1.600 1.500	0.100	H32@250 + H32@250	H16@150 - 2EA	1.11	141.46	125.00
	램프 중앙부	2387.99	1615.15		2132.41	2387.99		3163.93		1.00	1.600 1.520	0.080	H32@250 + H32@250		1.32	422.96	125.00
	램프 접합부	2760.93	1916.96		2804.59	2804.59	1061.41	3120.73	2165.88	1.00	1.600 1.500	0.100	H32@250 + H32@250	H16@150 - 2EA	1.11	153.37	125.00
	본선 접합부	722.78	609.01		1198.85	1198.85	439.26	1605.18		1.00	1.300 1.200	0.100	H25@250 + H25@250		1.34	565.37	125.00
	본선 중앙부	1131.04	787.62		1158.43	1158.43		1632.75		1.00	1.300 1.220	0.080	H25@250 + H25@250		1.41	447.97	125.00
	중앙 벽체부	1756.11	1365.78		1517.25	1756.11	716.86	2472.66		1.00	1.300 1.200	0.100	H32@250 + H32@250	H16@150 - 2EA	1.41	194.78	125.00
	램프측구	545.25	379.71		1177.04	1177.04	1199.92	2580.67	1804.90	1.00	1.330 1.250	0.080	H32@250 + H32@250	H16@150 - 2EA	2.19	1620.17	125.00
	본선측구	833.43	704.55		1243.04	1243.04	439.26	1704.02		1.00	1.100 1.020	0.080	H29@250 + H29@250		1.37	556.89	125.00

※ 벽체 : 램프

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
외측 벽체	상단부 Mmax	3126.07	2094.55	1025.95	3641.38	3641.38	560.97	#NAME?		1.00	1.867 / 1.767	0.100	H32@250 + H32@250		#NAME?	183.75	125.00
	상단부 Pmax	2768.66	2094.55	2226.64	863.78	2768.66	560.97	#NAME?		1.00	1.867 / 1.767	0.100	H32@250 + H32@250		#NAME?	183.75	125.00
	중앙부(-) Mmax	2606.75	1795.10	2328.33	2600.19	2606.75		#NAME?		1.00	1.700 / 1.600	0.100	H32@250 + H32@250		#NAME?	204.75	125.00
	중앙부(-) Pmax	1887.44	1795.10	2407.69	605.52	1887.44		#NAME?		1.00	1.700 / 1.600	0.100	H32@250 + H32@250		#NAME?	204.75	125.00
	하단부 Mmax	3316.03	2332.16	2527.53	3166.92	3316.03	537.36	#NAME?		1.00	1.700 / 1.600	0.100	H32@250 + H32@250 / H19@250		#NAME?	156.51	125.00
	하단부 Pmax	3315.61	2332.16	2527.72	3146.88	3315.61	537.36	#NAME?		1.00	1.700 / 1.600	0.100	H32@250 + H32@250 / H19@250		#NAME?	156.51	125.00

※ 벽체 : 램프

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
내측벽체	상단부 Mmax	3305.98	2225.51	2151.47	3805.44	3805.44	585.76	#NAME?		1.00	1.867 1.767	0.100	H32@250 + H32@250		#NAME?	160.58	125.00
	상단부 Pmax	2799.83	2225.51	2649.33	3435.87	2799.83	585.76	#NAME?		1.00	1.867 1.767	0.100	H32@250 + H32@250		#NAME?	160.58	125.00
	중앙부(-) Mmax	2624.78	1796.30	2359.06	2740.77	2740.77		#NAME?		1.00	1.700 1.600	0.100	H32@250 + H32@250		#NAME?	204.47	125.00
	중앙부(-) Pmax	2624.78	1796.30	2830.38	2740.77	2624.78		#NAME?		1.00	1.700 1.600	0.100	H32@250 + H32@250		#NAME?	204.47	125.00
	하단부 Mmax	3323.60	2326.82	2569.10	3391.97	3391.97	550.90	#NAME?		1.00	1.700 1.600	0.100	H32@250 + H32@250 H19@250		#NAME?	157.36	125.00
	하단부 Pmax	3143.18	2326.82	2950.41	3391.97	3143.18	550.90	#NAME?		1.00	1.700 1.600	0.100	H32@250 + H32@250 H19@250		#NAME?	157.36	125.00

※ 벽체 : 본선

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
외측벽체	상단부 Mmax	729.28	526.34	293.55	968.13	968.13	324.47	#NAME?		1.00	1.067 / 0.967	0.100	H25@250 + H25@250		#NAME?	325.51	125.00
	상단부 Pmax	687.14	526.34	730.16	27.23	687.14	324.47	#NAME?		1.00	1.067 / 0.967	0.100	H25@250 + H25@250		#NAME?	325.51	125.00
	중앙부(+) Mmax	580.31	403.18	738.31	512.84	580.31		#NAME?		1.00	0.900 / 0.820	0.080	H19@250 + H19@250		#NAME?	284.01	125.00
	중앙부(+) Pmax	274.92	403.18	773.85	112.57	274.92		#NAME?		1.00	0.900 / 0.820	0.080	H19@250 + H19@250		#NAME?	284.01	125.00
	중앙부(-) Mmax	724.23	493.36	759.16	631.88	724.23		#NAME?		1.00	0.900 / 0.800	0.100	H25@250 + H25@250		#NAME?	258.68	125.00
	중앙부(-) Pmax	307.41	493.36	789.49	77.77	307.41		#NAME?		1.00	0.900 / 0.800	0.100	H25@250 + H25@250		#NAME?	258.68	125.00
	하단부 Mmax	1264.22	831.20	844.85	1227.84	1264.22	474.71	#NAME?		1.00	0.900 / 0.800	0.100	H29@250 + H29@250		#NAME?	142.27	125.00
	하단부 Pmax	1186.91	831.20	847.46	333.98	1186.91	474.71	#NAME?		1.00	0.900 / 0.800	0.100	H29@250 + H29@250		#NAME?	142.27	125.00
중앙부벽체	상단부 Mmax	5.37	3.35	1482.57	265.06	265.06	118.34	#NAME?		1.00	0.667 / 0.587	0.080	H16@250 + H16@250		#NAME?	21995.29	125.00
	상단부 Pmax	0.00	3.35	1986.12	248.09	0.00	118.34	#NAME?		1.00	0.667 / 0.587	0.080	H16@250 + H16@250		#NAME?	21995.29	125.00
	중앙부(+) Mmax	5.07	3.16	1495.07	248.09	248.09		#NAME?		1.00	0.500 / 0.420	0.080	H16@250 + H16@250		#NAME?	16525.67	125.00
	중앙부(+) Pmax	0.00	3.16	2015.17	19.30	0.00		#NAME?		1.00	0.500 / 0.420	0.080	H16@250 + H16@250		#NAME?	16525.67	125.00
	하단부 Mmax	4.07	2.53	1568.62	284.23	284.23	123.18	#NAME?		1.00	0.500 / 0.420	0.080	H16@250 + H16@250		#NAME?	20638.82	125.00
	하단부 Pmax	0.00	2.53	2059.67	284.23	0.00	123.18	#NAME?		1.00	0.500 / 1.620	0.080	H16@250 + H16@250		#NAME?	20638.82	125.00

12. 단면설계

12.1 상부슬래브 단면검토

12.1.1 램프벽체부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1766.667	1666.667	1500.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
3061.450	1318.840	1635.720	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 96.984 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 566666.667 As - 3061450000 = 0

∴ Required As = 5564.458 ㎟ [p = 0.00334]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 36625.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 5833.333 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 5412.659 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 5833.333 ㎟

4/3·Req As ⇒ MIN As = 7419.277 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

∴ USE As =	1단	H	32	@	250	=	3176.800	㎟	[4	EA/M]
		H	32	@	250	=	3176.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	6353.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 114.099 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1666.667 - 114.099) / 114.099

= 0.0408

· ε_t = 0.0408 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 3480.764 kN.m > Mu = 3061.450 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 974.279 kN < Vu = 1318.840 kN

· 1/2·Øv·Vc = 487.140 kN < Vu = 1318.840 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 600 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 114.854 ㎟ [소요 전단철근]

· Required Av = 114.854 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 974.279 kN + 1191.600 kN

= 2165.879 kN > Vu = 1318.840 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00381

· k = - np + √((np)^2 + 2np) = 0.206

· j = 1 - k / 3 = 0.931

· x = k·d = 343.118 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 6.142 MPa

· fs = Mo / (As·(D - x/3)) = 165.850 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 165.850 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 264.827 mm

· s_2 = 300·(210 / fst) = 379.862 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 264.827 mn > 125.000 mm ∴ **O.K**

12.1.2 램프중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1600.000	1495.815	1495.815
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
3225.600	0.000	2140.260	104.185	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 114.961 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 508577.099 As - 3225600000 = 0

∴ Required As = 6595.863 ㎟ [p = 0.00441]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 32870.535 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 5235.352 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 4857.802 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 5235.352 ㎟

4/3·Req As ⇒ MIN As = 8794.484 ㎟

∴ Pmin<P<Pmax CASE ⇒ As=Req.As 이상배근

	1단	H	32	@	250	=	3176.800	㎟	[4	EA/M]
∴ USE As =		H	32	@	250	=	3176.800	㎟	[4	EA/M]
	2단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	8380.400	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 135.248 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1495.815 - 135.248) / 135.248

= 0.0302

· ε_t = 0.0302 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 4053.987 kN.m > Mu = 3225.600 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 971.560 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 485.780 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00560

· k = - np + √((np)^2 + 2np) = 0.244

· j = 1 - k / 3 = 0.919

· x = k·d = 364.349 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.548 MPa

· fs = Mo / (As·(D - x/3)) = 185.823 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 189.795 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 32 / 2 = 64.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 393.229 mm

· s_2 = 300·(280 / fst = 442.583 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 393.229 mn > 125.000 mm ∴ **O.K**

12.1.3 램프접합부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1766.667	1666.667	1500.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
2466.380	1506.680	1296.780	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 77.669 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 566666.667 As - 2466380000 = 0

∴ Required As = 4456.270 ㎟ [p = 0.00267]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 36625.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 5833.333 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 5412.659 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 5833.333 ㎟

4/3·Req As ⇒ MIN As = 5941.693 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	32	@	250	=	3176.800	㎟	[4	EA/M]
∴ USE As =		H	32	@	250	=	3176.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	6353.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 91.376 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1666.667 - 91.376) / 91.376

= 0.0517

· ε_t = 0.0517 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 3480.764 kN.m > Mu = 2466.380 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 974.279 kN < Vu = 1506.680 kN

· 1/2·Øv·Vc = 487.140 kN < Vu = 1506.680 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 600 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 177.467 ㎟ [소요 전단철근]

· Required Av = 177.467 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 974.279 kN + 1191.600 kN

= 2165.879 kN > Vu = 1506.680 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00381

· k = - np + √((np)^2 + 2np) = 0.206

· j = 1 - k / 3 = 0.931

· x = k·d = 343.118 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.869 MPa

· fs = Mo / (As·(D - x/3)) = 131.484 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 131.484 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 388.933 mm

· s_2 = 300·(210 / fst) = 479.146 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 388.933 mn > 125.000 mm ∴ **O.K**

12.1.4 본선접합부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1066.667	966.667	800.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
845.040	513.780	416.970	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 45.902 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 328666.667 As - 845040000 = 0

∴ Required As = 2633.645 ㎟ [p = 0.00272]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 21242.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3383.333 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 3139.342 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3383.333 ㎟

4/3·Req As ⇒ MIN As = 3511.527 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴ USE As =		H	25	@	250	=	2026.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	4053.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 54.003 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (966.667 - 54.003) / 54.003

= 0.0507

· ε_t = 0.0507 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 1283.597 kN.m > Mu = 845.040 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 519.615 kN > Vu = 513.780 kN

· 1/2·Øv·Vc = 259.808 kN < Vu = 513.780 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00419

· k = - np + √((np)^2 + 2np) = 0.215

· j = 1 - k / 3 = 0.928

· x = k·d = 207.557 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.477 MPa

· fs = Mo / (As·(D - x/3)) = 114.614 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 114.614 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 468.337 mm

· s_2 = 300·(210 / fst) = 549.670 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 468.337 mn > 125.000 mm ∴ **O.K**

12.1.5 본선중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	900.000	820.000	820.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
847.350	0.000	561.650	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 54.803 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 278800.000 As - 847350000 = 0

∴ Required As = 3144.349 ㎟ [p = 0.00383]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 18019.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 2870.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2663.028 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 2870.000 ㎟

4/3·Req As ⇒ MIN As = 4192.466 ㎟

∴ Pmin<P<Pmax CASE ⇒ As=Req.As 이상배근

	1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴ USE As =		H	25	@	250	=	2026.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	4053.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 64.475 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (820.000 - 64.475) / 64.475

= 0.0352

· ε_t = 0.0352 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 1081.457 kN.m > Mu = 847.350 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 532.606 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 266.303 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00494

· k = - np + √((np)^2 + 2np) = 0.231

· j = 1 - k / 3 = 0.923

· x = k·d = 189.203 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.843 MPa

· fs = Mo / (As·(D - x/3)) = 183.049 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 183.049 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 25 / 2 = 67.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 404.866 mm

· s_2 = 300·(280 / fst = 458.893 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 404.866 mn > 125.000 mm ∴ **O.K**

12.1.6 중앙벽체부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1066.667	938.383	771.716
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
1827.770	814.310	1143.040	128.284	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 105.814 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 319050.256 As - 1827770000 = 0

∴ Required As = 6071.078 ㎟ [p = 0.00647]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20620.969 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3284.341 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 3047.489 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3284.341 ㎟

4/3·Req As ⇒ MIN As = 8094.770 ㎟

∴ Pmin<P<Pmax CASE ⇒ As=Req.As 이상배근

		1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]
∴	USE As	=	H	29	@	250	=	2569.600	㎟	[4 EA/M]
		2단	H	25	@	250	=	2026.800	㎟	[4 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	7166.000	㎟	∴ **O.K**

▣ 휨모멘트 검토

· c = a / β1 = 124.487 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (938.383 - 124.487) / 124.487

= 0.0196

· ε_t = 0.0196 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 2134.161 kN.m > Mu = 1827.770 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 501.245 kN < Vu = 814.310 kN

· 1/2·Øv·Vc = 250.623 kN < Vu = 814.310 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 385.9 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 202.837 ㎟ [소요 전단철근]

· Required Av = 202.837 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 501.245 kN + 613.052 kN

= 1114.297 kN > Vu = 814.310 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00764

· k = - np + √((np)^2 + 2np) = 0.278

· j = 1 - k / 3 = 0.907

· x = k·d = 260.738 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 10.297 MPa

· fs = Mo / (As·(D - x/3)) = 187.333 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 195.152 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 29 / 2 = 85.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 189.781 mm

· s_2 = 300·(210 / fst) = 322.825 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 189.781 mn > 125.000 mm ∴ **O.K**

12.2 하부슬래브 단면검토

12.2.1 램프벽체부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1600.000	1500.000	1500.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
2798.870	1199.920	1981.910	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 98.912 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 510000.000 As - 2798870000 = 0

∴ Required As = 5675.093 ㎟ [p = 0.00378]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 32962.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 5250.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 4871.393 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 5250.000 ㎟

4/3·Req As ⇒ MIN As = 7566.790 ㎟

∴ Pmin<P<Pmax CASE ⇒ As=Req.As 이상배근

∴ USE As =	1단	H	32	@	250	=	3176.800	㎟	[4	EA/M]
		H	32	@	250	=	3176.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	6353.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 116.367 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1500.000 - 116.367) / 116.367

= 0.0357

· ε_t = 0.0357 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 3120.726 kN.m > Mu = 2798.870 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 974.279 kN < Vu = 1199.920 kN

· 1/2·Øv·Vc = 487.140 kN < Vu = 1199.920 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 600 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 75.214 ㎟ [소요 전단철근]

· Required Av = 75.214 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 974.279 kN + 1191.600 kN

= 2165.879 kN > Vu = 1199.920 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00424

· k = - np + √((np)^2 + 2np) = 0.216

· j = 1 - k / 3 = 0.928

· x = k·d = 323.497 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.801 MPa

· fs = Mo / (As·(D - x/3)) = 224.064 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 224.064 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 141.462 mm

· s_2 = 300·(210 / fst) = 281.169 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 141.462 mn > 125.000 mm ∴ **O.K**

12.2.2 램프중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1600.000	1520.000	1520.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
2387.990	0.000	1615.150	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 82.790 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 516800.000 As - 2387990000 = 0

∴ Required As = 4750.086 ㎟ [p = 0.00313]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 33402.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 5320.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 4936.345 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 5320.000 ㎟

4/3·Req As ⇒ MIN As = 6333.448 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	32	@	250	=	3176.800	㎟	[4	EA/M]
∴ USE As =		H	32	@	250	=	3176.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	6353.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 97.400 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1520.000 - 97.400) / 97.400

= 0.0438

· ε_t = 0.0438 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 3163.931 kN.m > Mu = 2387.990 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 987.269 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 493.635 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00418

· k = - np + √((np)^2 + 2np) = 0.214

· j = 1 - k / 3 = 0.929

· x = k·d = 325.907 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.023 MPa

· fs = Mo / (As·(D - x/3)) = 180.117 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 180.117 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 32 / 2 = 64.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 422.956 mm

· s_2 = 300·(280 / fst = 466.364 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 422.956 mn > 125.000 mm ∴ **O.K**

12.2.3 램프접합부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1600.000	1500.000	1500.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
2804.590	1061.410	1916.960	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 99.122 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 510000.000 As - 2804590000 = 0

∴ Required As = 5687.101 ㎟ [p = 0.00379]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 32962.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 5250.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 4871.393 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 5250.000 ㎟

4/3·Req As ⇒ MIN As = 7582.801 ㎟

∴ Pmin<P<Pmax CASE ⇒ As=Req.As 이상배근

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴	USE As	=	H	32	@	250	=	3176.800	㎟	[4 EA/M]
		2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	∴ **O.K**

▣ 휨모멘트 검토

· c = a / β1 = 116.614 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1500.000 - 116.614) / 116.614

= 0.0356

· ε_t = 0.0356 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 3120.726 kN.m > Mu = 2804.590 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 974.279 kN < Vu = 1061.410 kN

· 1/2·Øv·Vc = 487.140 kN < Vu = 1061.410 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 600 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 29.044 ㎟ [소요 전단철근]

· Required Av = 29.044 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 974.279 kN + 1191.600 kN

= 2165.879 kN > Vu = 1061.410 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00424

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.216

· j = 1 - k / 3 = 0.928

· x = k·d = 323.497 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.513 MPa

· fs = Mo / (As·(D - x/3)) = 216.721 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 216.721 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 153.370 mm

· s_2 = 300·(210 / fst) = 290.696 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 153.370 mn > 125.000 mm ∴ **O.K**

12.2.4 본선접합부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1300.000	1200.000	1200.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
1198.850	439.260	609.010	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 52.355 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 408000.000 As - 1198850000 = 0

∴ Required As = 3003.887 ㎟ [p = 0.0025]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 26370.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 4200.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 3897.114 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 4200.000 ㎟

4/3·Req As ⇒ MIN As = 4005.182 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴ USE As =		H	25	@	250	=	2026.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	4053.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 61.595 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1200.000 - 61.595) / 61.595

= 0.0554

· ε_t = 0.0554 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 1605.182 kN.m > Mu = 1198.850 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 779.423 kN > Vu = 439.260 kN

· 1/2·Øv·Vc = 389.712 kN < Vu = 439.260 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00338

· k = - np + √((np)^2 + 2np) = 0.195

· j = 1 - k / 3 = 0.935

· x = k·d = 234.124 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.637 MPa

· fs = Mo / (As·(D - x/3)) = 133.908 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 133.908 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 565.370 mm

· s_2 = 300·(280 / fst = 627.296 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 565.370 mn > 125.000 mm ∴ **O.K**

12.2.5 본선중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1300.000	1220.000	1220.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
1158.430	0.000	787.620	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 49.687 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 414800.000 As - 1158430000 = 0

∴ Required As = 2850.796 ㎟ [p = 0.00234]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 26809.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 4270.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 3962.066 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 4270.000 ㎟

4/3·Req As ⇒ MIN As = 3801.061 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴ USE As =		H	25	@	250	=	2026.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	4053.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 58.455 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1220.000 - 58.455) / 58.455

= 0.0596

· ε_t = 0.0596 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 1632.747 kN.m > Mu = 1158.430 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 792.413 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 396.207 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00332

· k = - np + √((np)^2 + 2np) = 0.194

· j = 1 - k / 3 = 0.935

· x = k·d = 236.277 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.842 MPa

· fs = Mo / (As·(D - x/3)) = 170.254 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 170.254 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 25 / 2 = 67.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 447.974 mm

· s_2 = 300·(280 / fst = 493.379 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 447.974 mn > 125.000 mm ∴ **O.K**

12.2.6 중앙벽체부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1300.000	1200.000	1200.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
1756.110	716.860	1365.780	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 77.523 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 408000.000 As - 1756110000 = 0

∴ Required As = 4447.862 ㎟ [p = 0.00371]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 26370.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 4200.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 3897.114 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 4200.000 ㎟

4/3·Req As ⇒ MIN As = 5930.483 ㎟

∴ Pmin<P<Pmax CASE ⇒ As=Req.As 이상배근

	1단	H	32	@	250	=	3176.800	㎟	[4	EA/M]
∴ USE As =		H	32	@	250	=	3176.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	6353.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 91.203 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1200.000 - 91.203) / 91.203

= 0.0365

· ε_t = 0.0365 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 2472.659 kN.m > Mu = 1756.110 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 779.423 kN > Vu = 716.860 kN

· 1/2·Øv·Vc = 389.712 kN < Vu = 716.860 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00529

· k = - np + √((np)^2 + 2np) = 0.238

· j = 1 - k / 3 = 0.921

· x = k·d = 285.250 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.667 MPa

· fs = Mo / (As·(D - x/3)) = 194.550 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 194.550 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 194.780 mm

· s_2 = 300·(210 / fst) = 323.824 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 194.780 mn > 125.000 mm ∴ **O.K**

12.2.7 램프측구

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1330.000	1250.000	1250.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
1177.040	1199.920	379.710	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 49.240 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 425000.000 As - 1177040000 = 0

∴ Required As = 2825.150 ㎟ [p = 0.00226]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 27468.750 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 4375.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 4059.494 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 4375.000 ㎟

4/3·Req As ⇒ MIN As = 3766.867 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	32	@	250	=	3176.800	㎟	[4	EA/M]
∴ USE As =		H	32	@	250	=	3176.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	6353.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 57.930 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1250.000 - 57.930) / 57.930

= 0.0617

· ε_t = 0.0617 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 2580.67 kN.m > Mu = 1177.040 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 811.899 kN < Vu = 1199.920 kN

· 1/2·Øv·Vc = 405.950 kN < Vu = 1199.920 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 600 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 155.208 ㎟ [소요 전단철근]

· Required Av = 155.208 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 811.899 kN + 993.000 kN

= 1804.899 kN > Vu = 1199.920 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00508

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.234

· j = 1 - k / 3 = 0.922

· x = k·d = 291.926 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 2.257 MPa

· fs = Mo / (As·(D - x/3)) = 51.846 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 51.846 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 32 / 2 = 64.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 1865.210 mm

· s_2 = 300·(280 / fst = 1620.168 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 1620.168 mn > 125.000 mm ∴ **O.K**

12.2.8 본선측구

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1100.000	1020.000	1020.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
1243.040	439.260	704.550	80.000	0.85	0.80

· a = As·fy/(0.85·fck·B) = 0.017 As = 64.512 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 346800.000 As - 1243040000 = 0

∴ Required As = 3701.364 ㎟ [p = 0.00363]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 22414.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3570.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 3312.547 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3570.000 ㎟

4/3·Req As ⇒ MIN As = 4935.151 ㎟

∴ Pmin<P<Pmax CASE ⇒ As=Req.As 이상배근

	1단	H	29	@	250	=	2569.600	㎟	[4	EA/M]
∴ USE As =		H	29	@	250	=	2569.600	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	5139.200	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 75.896 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (1020.000 - 75.896) / 75.896

= 0.0373

· ε_t = 0.0373 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 1704.019 kN.m > Mu = 1243.040 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 706.677 kN > Vu = 439.260 kN

· 1/2·Øv·Vc = 353.339 kN < Vu = 439.260 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00504

· k = - np + √((np)^2 + 2np) = 0.233

· j = 1 - k / 3 = 0.922

· x = k·d = 237.306 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 6.311 MPa

· fs = Mo / (As·(D - x/3)) = 145.705 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 145.705 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 29 / 2 = 65.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 556.885 mm

· s_2 = 300·(280 / fst = 576.508 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 556.885 mn > 125.000 mm ∴ **O.K**

12.3 램프-벽체 단면검토

12.3.1 외측 벽체 상단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	3641.380	560.970	1025.950	2094.550
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1866.667	1766.667	100.000	80.000	1600.000
e (mm)	β1	Øf	Øv		
3549.276	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0048] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 1060.000 mm

· a = β1·c = 901.000 mm

· Cck = 0.85·fck·B·H = 42840000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 906.598 mm

· d" = X - H + d = 806.598 mm

· Cc = 0.85·fck·a·b = 20677.950 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2541.440 kN

· Pb = Cc + Cs - Ts = 19105.378 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 13439.426 kN.m

· eb = Mb / Pb = 703.437 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ # ∴ ####

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 4355.874 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1766.667 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1025.950 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 3641.380 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 1080.029 kN > Vu = 560.970 kN

· 1/2·Øv·Vc = 540.015 kN < Vu = 560.970 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00360

· k = - np + √((np)^2 + 2np) = 0.201

· j = 1 - k / 3 = 0.933

· x = k·d = 355.100 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.157 MPa

· fs = Mo / (As·(D - x/3)) = 200.002 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 200.002 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 183.746 mm

· s_2 = 300·(210 / fst) = 314.997 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 183.746 mm > 125.000 mm ∴ **O.K**

12.3.2 외측 벽체 상단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	2768.660	560.970	2226.640	2094.550
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1866.667	1766.667	100.000	80.000	1600.000
e (mm)	β1	Øf	Øv		
1243.425	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0048] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 1060.000 mm

· a = β1·c = 901.000 mm

· Cck = 0.85·fck·B·H = 42840000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 906.598 mm

· d" = X - H + d = 806.598 mm

· Cc = 0.85·fck·a·b = 20677.950 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2541.440 kN

· Pb = Cc + Cs - Ts = 19105.378 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 13439.426 kN.m

· eb = Mb / Pb = 703.437 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 2050.023 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1766.667 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2226.640 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 2768.660 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1127.776 kN > Vu = 560.970 kN

· 1/2·Øv·Vc = 563.888 kN > Vu = 560.970 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00360

· k = - np + √((np)^2 + 2np) = 0.201

· j = 1 - k / 3 = 0.933

· x = k·d = 355.100 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.157 MPa

· fs = Mo / (As·(D - x/3)) = 200.002 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 200.002 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 183.746 mm

· s_2 = 300·(210 / fst) = 314.997 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 183.746 mm > 125.000 mm ∴ **O.K**

12.3.3 외측 벽체 중앙부(-) Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	2606.750	0.000	2328.330	1795.100
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1700.000	1600.000	100.000	80.000	1600.000
e (mm)	β1	Øf	Øv		
1119.579	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0052] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 960.000 mm

· a = β1·c = 816.000 mm

· Cck = 0.85·fck·B·H = 39015000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 823.825 mm

· d" = X - H + d = 723.825 mm

· Cc = 0.85·fck·a·b = 18727.200 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2541.440 kN

· Pb = Cc + Cs - Ts = 17154.628 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 11378.553 kN.m

· eb = Mb / Pb = 663.293 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1843.404 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1600.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2328.330 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 2606.750 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1140.897 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 570.449 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00397

· k = - np + √((np)^2 + 2np) = 0.210

· j = 1 - k / 3 = 0.930

· x = k·d = 336.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.181 MPa

· fs = Mo / (As·(D - x/3)) = 189.874 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 189.874 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 204.749 mm

· s_2 = 300·(210 / fst) = 331.799 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 204.749 mm > 125.000 mm ∴ **O.K**

12.3.4 외측 벽체 중앙부(-) Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	1887.440	0.000	2407.690	1795.100
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1700.000	1600.000	100.000	80.000	1600.000
e (mm)	β1	Øf	Øv		
783.922	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0052] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 960.000 mm

· a = β1·c = 816.000 mm

· Cck = 0.85·fck·B·H = 39015000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 823.825 mm

· d" = X - H + d = 723.825 mm

· Cc = 0.85·fck·a·b = 18727.200 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2541.440 kN

· Pb = Cc + Cs - Ts = 17154.628 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 11378.553 kN.m

· eb = Mb / Pb = 663.293 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1507.747 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1600.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2407.690 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 1887.440 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1144.363 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 572.182 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00397

· k = - np + √((np)^2 + 2np) = 0.210

· j = 1 - k / 3 = 0.930

· x = k·d = 336.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.181 MPa

· fs = Mo / (As·(D - x/3)) = 189.874 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 189.874 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 204.749 mm

· s_2 = 300·(210 / fst) = 331.799 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 204.749 mm > 125.000 mm ∴ **O.K**

12.3.5 외측 벽체 하단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	3316.030	537.360	2527.530	2332.160
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1700.000	1584.719	115.281	80.000	1584.719
e (mm)	β1	Øf	Øv		
1311.965	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	7499.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0059] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 950.832 mm

· a = β1·c = 808.207 mm

· Cck = 0.85·fck·B·H = 39015000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 817.181 mm

· d" = X - H + d = 701.900 mm

· Cc = 0.85·fck·a·b = 18548.351 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2999.840 kN

· Pb = Cc + Cs - Ts = 16517.379 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 11762.800 kN.m

· eb = Mb / Pb = 712.147 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 2013.865 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1584.719 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2527.530 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 3316.030 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1138.616 kN > Vu = 537.360 kN

· 1/2·Øv·Vc = 569.308 kN > Vu = 537.360 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00473

· k = - np + √((np)^2 + 2np) = 0.226

· j = 1 - k / 3 = 0.925

· x = k·d = 358.147 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.888 MPa

· fs = Mo / (As·(D - x/3)) = 212.218 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 214.862 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 156.514 mm

· s_2 = 300·(210 / fst) = 293.211 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 156.514 mn > 125.000 mm ∴ **O.K**

12.3.6 외측 벽체 하단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	3315.610	537.360	2527.720	2332.160
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1700.000	1584.719	115.281	80.000	1584.719
e (mm)	β1	Øf	Øv		
1311.700	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	7499.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0059] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 950.832 mm

· a = β1·c = 808.207 mm

· Cck = 0.85·fck·B·H = 39015000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 817.181 mm

· d" = X - H + d = 701.900 mm

· Cc = 0.85·fck·a·b = 18548.351 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2999.840 kN

· Pb = Cc + Cs - Ts = 16517.379 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 11762.800 kN.m

· eb = Mb / Pb = 712.147 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 2013.600 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1584.719 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2527.720 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 3315.610 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1138.624 kN > Vu = 537.360 kN

· 1/2·Øv·Vc = 569.312 kN > Vu = 537.360 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00473

· k = - np + √((np)^2 + 2np) = 0.226

· j = 1 - k / 3 = 0.925

· x = k·d = 358.147 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.888 MPa

· fs = Mo / (As·(D - x/3)) = 212.218 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 214.862 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 156.514 mm

· s_2 = 300·(210 / fst) = 293.211 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 156.514 mn > 125.000 mm ∴ **O.K**

12.3.7 내측 벽체 상단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	3805.440	585.760	2151.470	2225.510
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1866.667	1766.667	100.000	80.000	1600.000
e (mm)	β1	Øf	Øv		
1768.763	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0048] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 1060.000 mm

· a = β1·c = 901.000 mm

· Cck = 0.85·fck·B·H = 42840000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 906.598 mm

· d" = X - H + d = 806.598 mm

· Cc = 0.85·fck·a·b = 20677.950 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2541.440 kN

· Pb = Cc + Cs - Ts = 19105.378 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 13439.426 kN.m

· eb = Mb / Pb = 703.437 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 2575.361 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1766.667 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2151.470 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 3805.440 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 1124.787 kN > Vu = 585.760 kN

· 1/2·Øv·Vc = 562.394 kN < Vu = 585.760 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00360

· k = - np + √((np)^2 + 2np) = 0.201

· j = 1 - k / 3 = 0.933

· x = k·d = 355.100 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.605 MPa

· fs = Mo / (As·(D - x/3)) = 212.507 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 212.507 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 160.576 mm

· s_2 = 300·(210 / fst) = 296.461 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 160.576 mm > 125.000 mm ∴ **O.K**

12.3.8 내측 벽체 상단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	2799.830	585.760	2649.330	2225.510
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1866.667	1766.667	100.000	80.000	1600.000
e (mm)	β1	Øf	Øv		
1056.807	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0048] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 1060.000 mm

· a = β1·c = 901.000 mm

· Cck = 0.85·fck·B·H = 42840000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 906.598 mm

· d" = X - H + d = 806.598 mm

· Cc = 0.85·fck·a·b = 20677.950 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2541.440 kN

· Pb = Cc + Cs - Ts = 19105.378 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 13439.426 kN.m

· eb = Mb / Pb = 703.437 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1863.405 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1766.667 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2649.330 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 2799.830 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 1144.585 kN > Vu = 585.760 kN

· 1/2·Øv·Vc = 572.293 kN < Vu = 585.760 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00360

· k = - np + √((np)^2 + 2np) = 0.201

· j = 1 - k / 3 = 0.933

· x = k·d = 355.100 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.605 MPa

· fs = Mo / (As·(D - x/3)) = 212.507 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 212.507 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 160.576 mm

· s_2 = 300·(210 / fst) = 296.461 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 160.576 mm > 125.000 mm ∴ **O.K**

12.3.9 내측 벽체 중앙부(-) Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	2740.770	0.000	2359.060	1796.300
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1700.000	1600.000	100.000	80.000	1600.000
e (mm)	β1	Øf	Øv		
1161.806	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0052] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 960.000 mm

· a = β1·c = 816.000 mm

· Cck = 0.85·fck·B·H = 39015000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 823.825 mm

· d" = X - H + d = 723.825 mm

· Cc = 0.85·fck·a·b = 18727.200 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2541.440 kN

· Pb = Cc + Cs - Ts = 17154.628 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 11378.553 kN.m

· eb = Mb / Pb = 663.293 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ # ∴ ####

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1885.631 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1600.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2359.060 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 2740.770 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1142.239 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 571.120 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00397

· k = - np + √((np)^2 + 2np) = 0.210

· j = 1 - k / 3 = 0.930

· x = k·d = 336.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.186 MPa

· fs = Mo / (As·(D - x/3)) = 190.001 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 190.001 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 204.472 mm

· s_2 = 300·(210 / fst) = 331.577 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 204.472 mn > 125.000 mm ∴ **O.K**

12.3.10 내측 벽체 중앙부(-) Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	2624.780	0.000	2830.380	1796.300
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1700.000	1600.000	100.000	80.000	1600.000
e (mm)	β1	Øf	Øv		
927.360	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	6353.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0052] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 960.000 mm

· a = β1·c = 816.000 mm

· Cck = 0.85·fck·B·H = 39015000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 823.825 mm

· d" = X - H + d = 723.825 mm

· Cc = 0.85·fck·a·b = 18727.200 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2541.440 kN

· Pb = Cc + Cs - Ts = 17154.628 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 11378.553 kN.m

· eb = Mb / Pb = 663.293 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ # ∴ ####

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1651.185 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1600.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2830.380 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 2624.780 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1162.819 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 581.410 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00397

· k = - np + √((np)^2 + 2np) = 0.210

· j = 1 - k / 3 = 0.930

· x = k·d = 336.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.186 MPa

· fs = Mo / (As·(D - x/3)) = 190.001 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 190.001 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 204.472 mm

· s_2 = 300·(210 / fst) = 331.577 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 204.472 mn > 125.000 mm ∴ **O.K**

12.3.11 내측 벽체 하단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	3391.970	550.900	2569.100	2326.820
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1700.000	1584.719	115.281	80.000	1584.719
e (mm)	β1	Øf	Øv		
1320.295	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	7499.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0059] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 950.832 mm

· a = β1·c = 808.207 mm

· Cck = 0.85·fck·B·H = 39015000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 817.181 mm

· d" = X - H + d = 701.900 mm

· Cc = 0.85·fck·a·b = 18548.351 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2999.840 kN

· Pb = Cc + Cs - Ts = 16517.379 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 11762.800 kN.m

· eb = Mb / Pb = 712.147 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 2022.195 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1584.719 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2569.100 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 3391.970 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1140.414 kN > Vu = 550.900 kN

· 1/2·Øv·Vc = 570.207 kN > Vu = 550.900 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00473

· k = - np + √((np)^2 + 2np) = 0.226

· j = 1 - k / 3 = 0.925

· x = k·d = 358.147 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.867 MPa

· fs = Mo / (As·(D - x/3)) = 211.732 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 214.370 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 157.356 mm

· s_2 = 300·(210 / fst) = 293.884 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 157.356 mm > 125.000 mm ∴ **O.K**

12.3.12 내측 벽체 하단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	3143.180	550.900	2950.410	2326.820
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1700.000	1584.719	115.281	80.000	1584.719
e (mm)	β1	Øf	Øv		
1065.337	0.850	#NAME?	0.75		

		1단	H	32	@	250	=	3176.800	㎟	[4 EA/M]
			H	32	@	250	=	3176.800	㎟	[4 EA/M]
∴ USE As	=	2단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	7499.600	㎟	
∴ USE As'	=	1단	H	29	@	250	=	2569.600	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0059] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 950.832 mm

· a = β1·c = 808.207 mm

· Cck = 0.85·fck·B·H = 39015000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 817.181 mm

· d" = X - H + d = 701.900 mm

· Cc = 0.85·fck·a·b = 18548.351 kN

· Cs = (fs - 0.85·fck)·As' = 968.868 kN

· Ts = fy·As = 2999.840 kN

· Pb = Cc + Cs - Ts = 16517.379 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 11762.800 kN.m

· eb = Mb / Pb = 712.147 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1767.237 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1584.719 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2950.410 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 3143.180 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 1156.905 kN > Vu = 550.900 kN

· 1/2·Øv·Vc = 578.453 kN > Vu = 550.900 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00473

· k = - np + √((np)^2 + 2np) = 0.226

· j = 1 - k / 3 = 0.925

· x = k·d = 358.147 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.867 MPa

· fs = Mo / (As·(D - x/3)) = 211.732 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 214.370 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 32 / 2 = 84.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 157.356 mm

· s_2 = 300·(210 / fst) = 293.884 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 157.356 mm > 125.000 mm ∴ **O.K**

12.4 본선-벽체 단면검토

12.4.1 외측 벽체 상단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	968.130	324.470	293.550	526.340
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1066.667	966.667	100.000	80.000	800.000
e (mm)	β1	Øf	Øv		
3298.007	0.850	#NAME?	0.75		

			1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
				H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴	USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
				H	0	@	0	=	0.000	㎟	[0	EA/M]
			3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
				H	0	@	0	=	0.000	㎟	[0	EA/M]
							TOTAL	=	4053.600	㎟		
∴	USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0049] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 580.000 mm

· a = β1·c = 493.000 mm

· Cck = 0.85·fck·B·H = 24480000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 514.703 mm

· d" = X - H + d = 414.703 mm

· Cc = 0.85·fck·a·b = 11314.350 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 1621.440 kN

· Pb = Cc + Cs - Ts = 10125.009 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 4332.474 kN.m

· eb = Mb / Pb = 427.898 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'
= #NAME? kN
∴ a = #NAME? mn ⇒ # ∴ ####

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 3712.710 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ ####

· ε_t = ε_c × (d - c) / c = 0.003 × (966.667 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 293.550 kN ∴ ####

∴ Ø Mn = #NAME? kN.m #### Mu = 968.130 kN.m ∴ ####

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 529.830 kN > Vu = 324.470 kN

· 1/2·Øv·Vc = 264.915 kN < Vu = 324.470 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00419

· k = - np + √((np)^2 + 2np) = 0.215

· j = 1 - k / 3 = 0.928

· x = k·d = 207.833 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.644 MPa

· fs = Mo / (As·(D - x/3)) = 144.692 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 144.692 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 325.510 mm

· s_2 = 300·(210 / fst) = 435.408 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 325.510 mn > 125.000 mm ∴ **O.K**

12.4.2 외측 벽체 상단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	687.140	324.470	730.160	526.340
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1066.667	966.667	100.000	80.000	800.000
e (mm)	β1	Øf	Øv		
941.081	0.850	#NAME?	0.75		

		1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
			H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	4053.600	㎟		
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0049] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 580.000 mm

· a = β1·c = 493.000 mm

· Cck = 0.85·fck·B·H = 24480000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 514.703 mm

· d" = X - H + d = 414.703 mm

· Cc = 0.85·fck·a·b = 11314.350 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 1621.440 kN

· Pb = Cc + Cs - Ts = 10125.009 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 4332.474 kN.m

· eb = Mb / Pb = 427.898 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1355.784 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (966.667 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 730.160 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 687.140 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 545.022 kN > Vu = 324.470 kN

· 1/2·Øv·Vc = 272.511 kN < Vu = 324.470 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00419

· k = - np + √((np)^2 + 2np) = 0.215

· j = 1 - k / 3 = 0.928

· x = k·d = 207.833 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.644 MPa

· fs = Mo / (As·(D - x/3)) = 144.692 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 144.692 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 325.510 mm

· s_2 = 300·(210 / fst) = 435.408 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 325.510 mn > 125.000 mm ∴ **O.K**

12.4.3 외측 벽체 중앙부(-) Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	724.230	0.000	759.160	493.360
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	900.000	800.000	100.000	80.000	800.000
e (mm)	β1	Øf	Øv		
953.989	0.850	#NAME?	0.75		

		1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
			H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	4053.600	㎟		
∴	USE As'	= 1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0058] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 480.000 mm

· a = β1·c = 408.000 mm

· Cck = 0.85·fck·B·H = 20655000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 432.498 mm

· d" = X - H + d = 332.498 mm

· Cc = 0.85·fck·a·b = 9363.600 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 1621.440 kN

· Pb = Cc + Cs - Ts = 8174.259 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 3173.892 kN.m

· eb = Mb / Pb = 388.279 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1286.487 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (800.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 759.160 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 724.230 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 550.922 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 275.461 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00507

· k = - np + √((np)^2 + 2np) = 0.233

· j = 1 - k / 3 = 0.922

· x = k·d = 186.400 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.174 MPa

· fs = Mo / (As·(D - x/3)) = 164.947 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 164.947 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 258.676 mm

· s_2 = 300·(210 / fst) = 381.941 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 258.676 mn > 125.000 mm ∴ **O.K**

12.4.4 외측 벽체 중앙부(-) Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	307.410	0.000	789.490	493.360
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	900.000	800.000	100.000	80.000	800.000
e (mm)	β1	Øf	Øv		
389.378	0.850	#NAME?	0.75		

		1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
			H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	4053.600	㎟		
∴	USE As'	= 1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0058] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 480.000 mm

· a = β1·c = 408.000 mm

· Cck = 0.85·fck·B·H = 20655000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 432.498 mm

· d" = X - H + d = 332.498 mm

· Cc = 0.85·fck·a·b = 9363.600 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 1621.440 kN

· Pb = Cc + Cs - Ts = 8174.259 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 3173.892 kN.m

· eb = Mb / Pb = 388.279 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 721.876 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (800.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 789.490 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 307.410 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 552.173 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 276.087 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00507

· k = - np + √((np)^2 + 2np) = 0.233

· j = 1 - k / 3 = 0.922

· x = k·d = 186.400 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.174 MPa

· fs = Mo / (As·(D - x/3)) = 164.947 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 164.947 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 258.676 mm

· s_2 = 300·(210 / fst) = 381.941 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 258.676 mn > 125.000 mm ∴ **O.K**

12.4.5 외측 벽체 하단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	1264.220	474.710	844.850	831.200
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	900.000	800.000	100.000	80.000	800.000
e (mm)	β1	Øf	Øv		
1496.384	0.850	#NAME?	0.75		

		1단	H	29	@	250	=	2569.600	㎟	[4	EA/M]
			H	29	@	250	=	2569.600	㎟	[4	EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	5139.200	㎟		
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0070] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 480.000 mm

· a = β1·c = 408.000 mm

· Cck = 0.85·fck·B·H = 20655000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 426.267 mm

· d" = X - H + d = 326.267 mm

· Cc = 0.85·fck·a·b = 9363.600 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 2055.680 kN

· Pb = Cc + Cs - Ts = 7740.019 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 3366.504 kN.m

· eb = Mb / Pb = 434.948 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1822.651 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (800.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 844.850 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 1264.220 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 554.456 kN > Vu = 474.710 kN

· 1/2·Øv·Vc = 277.228 kN < Vu = 474.710 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00642

· k = - np + √((np)^2 + 2np) = 0.258

· j = 1 - k / 3 = 0.914

· x = k·d = 206.400 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 11.015 MPa

· fs = Mo / (As·(D - x/3)) = 221.194 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 221.194 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 29 / 2 = 85.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 142.272 mm

· s_2 = 300·(210 / fst) = 284.818 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 142.272 mn > 125.000 mm ∴ **O.K**

12.4.6 외측 벽체 하단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	1186.910	474.710	847.460	831.200
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	900.000	800.000	100.000	80.000	800.000
e (mm)	β1	Øf	Øv		
1400.550	0.850	#NAME?	0.75		

		1단	H	29	@	250	=	2569.600	㎟	[4	EA/M]
			H	29	@	250	=	2569.600	㎟	[4	EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	5139.200	㎟		
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0070] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 480.000 mm

· a = β1·c = 408.000 mm

· Cck = 0.85·fck·B·H = 20655000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 426.267 mm

· d" = X - H + d = 326.267 mm

· Cc = 0.85·fck·a·b = 9363.600 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 2055.680 kN

· Pb = Cc + Cs - Ts = 7740.019 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 3366.504 kN.m

· eb = Mb / Pb = 434.948 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1726.817 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (800.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 847.460 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 1186.910 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 554.564 kN > Vu = 474.710 kN

· 1/2·Øv·Vc = 277.282 kN < Vu = 474.710 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00642

· k = - np + √((np)^2 + 2np) = 0.258

· j = 1 - k / 3 = 0.914

· x = k·d = 206.400 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 11.015 MPa

· fs = Mo / (As·(D - x/3)) = 221.194 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 221.194 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 29 / 2 = 85.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 142.272 mm

· s_2 = 300·(210 / fst) = 284.818 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 142.272 mn > 125.000 mm ∴ **O.K**

12.4.7 중앙부 벽체 상단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	265.060	118.340	1482.570	3.350
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	666.667	586.667	80.000	100.000	420.000
e (mm)	β1	Øf	Øv		
178.784	0.850	#NAME?	0.75		

		1단	H	16	@	250	=	794.400	㎟	[4	EA/M]
			H	16	@	250	=	794.400	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	1588.800	㎟		
∴	USE As'	= 1단	H	16	@	250	=	794.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0036] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 352.000 mm

· a = β1·c = 299.200 mm

· Cck = 0.85·fck·B·H = 15300000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 327.990 mm

· d" = X - H + d = 247.990 mm

· Cc = 0.85·fck·a·b = 6866.640 kN

· Cs = (fs - 0.85·fck)·As' = 299.529 kN

· Ts = fy·As = 635.520 kN

· Pb = Cc + Cs - Ts = 6530.649 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1527.415 kN.m

· eb = Mb / Pb = 233.884 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 426.774 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (586.667 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1482.570 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 265.060 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 316.131 kN > Vu = 118.340 kN

· 1/2·Øv·Vc = 158.066 kN > Vu = 118.340 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00271

· k = - np + √((np)^2 + 2np) = 0.177

· j = 1 - k / 3 = 0.941

· x = k·d = 103.840 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 0.117 MPa

· fs = Mo / (As·(D - x/3)) = 3.819 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 3.819 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 16 / 2 = 72.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 27314.108 mm

· s_2 = 300·(280 / fst = 21995.287 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 21995.287 mn > 125.000 mm ∴ **O.K**

12.4.8 중앙부 벽체 상단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	0.001	118.340	1986.120	3.350
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	666.667	586.667	80.000	100.000	420.000
e (mm)	β1	Øf	Øv		
0.001	0.850	#NAME?	0.75		

		1단	H	16	@	250	=	794.400	㎟	[4	EA/M]
			H	16	@	250	=	794.400	㎟	[4	EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	1588.800	㎟		
∴ USE As'	=	1단	H	16	@	250	=	794.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0036] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 352.000 mm

· a = β1·c = 299.200 mm

· Cck = 0.85·fck·B·H = 15300000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 327.990 mm

· d" = X - H + d = 247.990 mm

· Cc = 0.85·fck·a·b = 6866.640 kN

· Cs = (fs - 0.85·fck)·As' = 299.529 kN

· Ts = fy·As = 635.520 kN

· Pb = Cc + Cs - Ts = 6530.649 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1527.415 kN.m

· eb = Mb / Pb = 233.884 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 247.991 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (586.667 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1986.120 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 0.001 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 330.849 kN > Vu = 118.340 kN

· 1/2·Øv·Vc = 165.425 kN > Vu = 118.340 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00271

· k = - np + √((np)^2 + 2np) = 0.177

· j = 1 - k / 3 = 0.941

· x = k·d = 103.840 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 0.117 MPa

· fs = Mo / (As·(D - x/3)) = 3.819 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 3.819 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 16 / 2 = 72.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 27314.108 mm

· s_2 = 300·(280 / fst = 21995.287 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 21995.287 mn > 125.000 mm ∴ **O.K**

12.4.9 중앙부 벽체 중앙부(+) Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	248.090	0.000	1495.070	3.160
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	500.000	420.000	80.000	100.000	420.000
e (mm)	β1	Øf	Øv		
165.939	0.850	#NAME?	0.75		

		1단	H	16	@	250	=	794.400	㎟	[4	EA/M]
			H	16	@	250	=	794.400	㎟	[4	EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	1588.800	㎟		
∴ USE As'	=	1단	H	16	@	250	=	794.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0048] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 252.000 mm

· a = β1·c = 214.200 mm

· Cck = 0.85·fck·B·H = 11475000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 245.142 mm

· d" = X - H + d = 165.142 mm

· Cc = 0.85·fck·a·b = 4915.890 kN

· Cs = (fs - 0.85·fck)·As' = 299.529 kN

· Ts = fy·As = 635.520 kN

· Pb = Cc + Cs - Ts = 4579.899 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 877.698 kN.m

· eb = Mb / Pb = 191.641 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 331.081 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (420.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1495.070 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 248.090 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 331.063 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 165.532 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00378

· k = - np + √((np)^2 + 2np) = 0.205

· j = 1 - k / 3 = 0.932

· x = k·d = 86.100 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 0.188 MPa

· fs = Mo / (As·(D - x/3)) = 5.083 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 5.083 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 16 / 2 = 72.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 20477.092 mm

· s_2 = 300·(280 / fst = 16525.674 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 16525.674 mn > 125.000 mm ∴ **O.K**

12.4.10 중앙부 벽체 중앙부(+) Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	0.001	0.000	2015.170	3.160
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	500.000	420.000	80.000	100.000	420.000
e (mm)	β1	Øf	Øv		
0.000	0.850	#NAME?	0.75		

		1단	H	16	@	250	=	794.400	㎟	[4	EA/M]
			H	16	@	250	=	794.400	㎟	[4	EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	1588.800	㎟		
∴ USE As'	=	1단	H	16	@	250	=	794.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0048] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 252.000 mm

· a = β1·c = 214.200 mm

· Cck = 0.85·fck·B·H = 11475000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 245.142 mm

· d" = X - H + d = 165.142 mm

· Cc = 0.85·fck·a·b = 4915.890 kN

· Cs = (fs - 0.85·fck)·As' = 299.529 kN

· Ts = fy·As = 635.520 kN

· Pb = Cc + Cs - Ts = 4579.899 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 877.698 kN.m

· eb = Mb / Pb = 191.641 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 165.142 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (420.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2015.170 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 0.001 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 351.331 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 175.666 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00378

· k = - np + √((np)^2 + 2np) = 0.205

· j = 1 - k / 3 = 0.932

· x = k·d = 86.100 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 0.188 MPa

· fs = Mo / (As·(D - x/3)) = 5.083 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 5.083 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 16 / 2 = 72.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 20477.092 mm

· s_2 = 300·(280 / fst = 16525.674 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 16525.674 mn > 125.000 mm ∴ **O.K**

12.4.11 중앙부 벽체 하단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	284.230	123.180	1568.620	2.530
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	500.000	420.000	80.000	100.000	420.000
e (mm)	β1	Øf	Øv		
181.197	0.850	#NAME?	0.75		

		1단	H	16	@	250	=	794.400	㎟	[4	EA/M]
			H	16	@	250	=	794.400	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	1588.800	㎟		
∴	USE As'	= 1단	H	16	@	250	=	794.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0048] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 252.000 mm

· a = β1·c = 214.200 mm

· Cck = 0.85·fck·B·H = 11475000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 245.142 mm

· d" = X - H + d = 165.142 mm

· Cc = 0.85·fck·a·b = 4915.890 kN

· Cs = (fs - 0.85·fck)·As' = 299.529 kN

· Ts = fy·As = 635.520 kN

· Pb = Cc + Cs - Ts = 4579.899 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 877.698 kN.m

· eb = Mb / Pb = 191.641 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 346.339 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (420.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1568.620 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 284.230 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 333.929 kN > Vu = 123.180 kN

· 1/2·Øv·Vc = 166.965 kN > Vu = 123.180 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00378

· k = - np + √((np)^2 + 2np) = 0.205

· j = 1 - k / 3 = 0.932

· x = k·d = 86.100 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 0.150 MPa

· fs = Mo / (As·(D - x/3)) = 4.070 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 4.070 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 16 / 2 = 72.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 25618.526 mm

· s_2 = 300·(280 / fst = 20638.821 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 20638.821 mn > 125.000 mm ∴ **O.K**

12.4.12 중앙부 벽체 하단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	0.001	123.180	2059.670	2.530
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	500.000	420.000	80.000	100.000	420.000
e (mm)	β1	Øf	Øv		
0.000	0.850	#NAME?	0.75		

		1단	H	16	@	250	=	794.400	㎟	[4 EA/M]
			H	16	@	250	=	794.400	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	1588.800	㎟	
∴ USE As'	=	1단	H	16	@	250	=	794.400	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0048] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 252.000 mm

· a = β1·c = 214.200 mm

· Cck = 0.85·fck·B·H = 11475000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 245.142 mm

· d" = X - H + d = 165.142 mm

· Cc = 0.85·fck·a·b = 4915.890 kN

· Cs = (fs - 0.85·fck)·As' = 299.529 kN

· Ts = fy·As = 635.520 kN

· Pb = Cc + Cs - Ts = 4579.899 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 877.698 kN.m

· eb = Mb / Pb = 191.641 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 165.142 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (420.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 2059.670 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 0.001 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 353.066 kN > Vu = 123.180 kN

· 1/2·Øv·Vc = 176.533 kN > Vu = 123.180 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00378

· k = - np + √((np)^2 + 2np) = 0.205

· j = 1 - k / 3 = 0.932

· x = k·d = 86.100 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 0.150 MPa

· fs = Mo / (As·(D - x/3)) = 4.070 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 4.070 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 16 / 2 = 72.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 25618.526 mm

· s_2 = 300·(280 / fst = 20638.821 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 20638.821 mn > 125.000 mm ∴ **O.K**

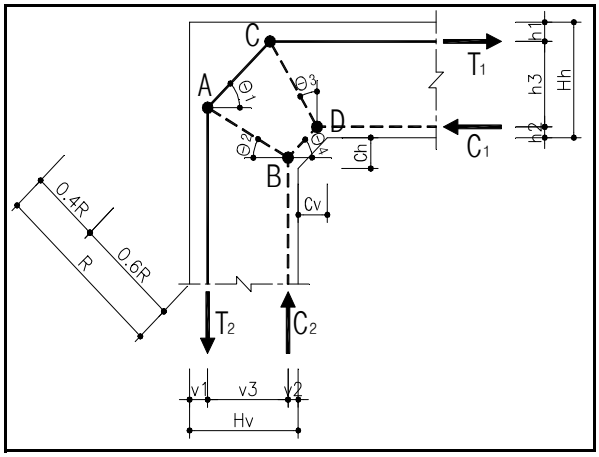
13. 우각부 보강검토

13.1 상부슬래브 (램프 벽체부)

(1) 계산조건

슬래브두께	H_h	=	1600.00 mm	벽체 높이	H_v	=	1700.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	1420.00 mm	벽체측 우력 거리	v_3	=	1520.00 mm
수직 거리	C_h	=	500.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	500.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	3641.380 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 2687.01 mm

② 사잇각

θ_1 = 45.00°

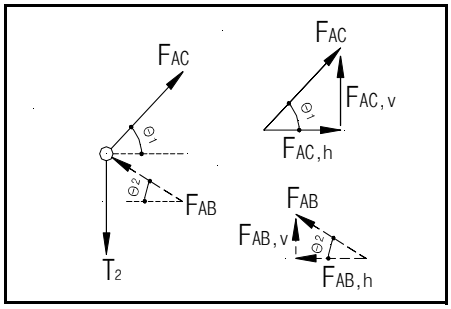
θ_2 = 12.68°

θ_3 = 17.29°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

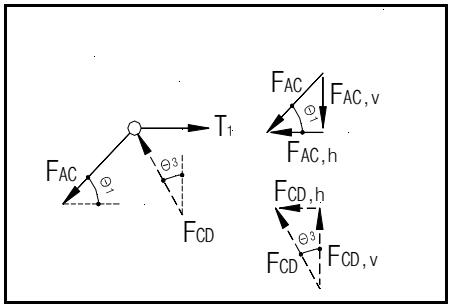
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\theta_2 \Rightarrow \quad F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \frac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$$

$$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\theta = F_{CD} \cdot \cos\theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\theta_1 + F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3} \times \sin\theta_3$

$= F_{AC}(\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \dfrac{M_u}{h_3} = \dfrac{3{,}641.380}{1.420} =$ 2,564.352 kN

$T_2 = \dfrac{M_u}{v_3} = \dfrac{3{,}641.380}{1.520} =$ 2,395.645 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \dfrac{T_2}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2} =$ 2,765.676 kN

식 ⑥ 으로부터

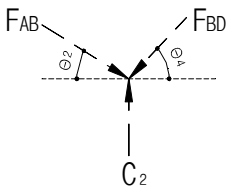
$F_{AC} = \dfrac{T_1}{\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3} =$ 2,765.676 kN

따라서 $F_{AC} =$ **2,765.676** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 2{,}004.519 \quad kN$$



- 스트럿(BD)의 단면력 산정

$\Sigma V = 0$:

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 2{,}765.676 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 2{,}048.176 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	2,765.676	타이
AB	-2,004.519	스트럿
BD	-2,765.676	스트럿
CD	-2,048.176	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 2,765.676 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{2{,}765{,}676.145}{0.85 \times 400} = 8{,}134.34 \quad mm^2$$

사용철근량

1단 주철근 As	= H 0 @ 250	=	0.00	mm^2	(1 cycle)
	= H 32 @ 250	=	3,176.80	mm^2	(2 cycle)
우각부철근 As	= H 32 @ 250	=	3,176.80	mm^2	(1 단)
	= H 32 @ 250	=	3,176.80	mm^2	(2 단)
	합계	=	**9,530.40**	mm^2	

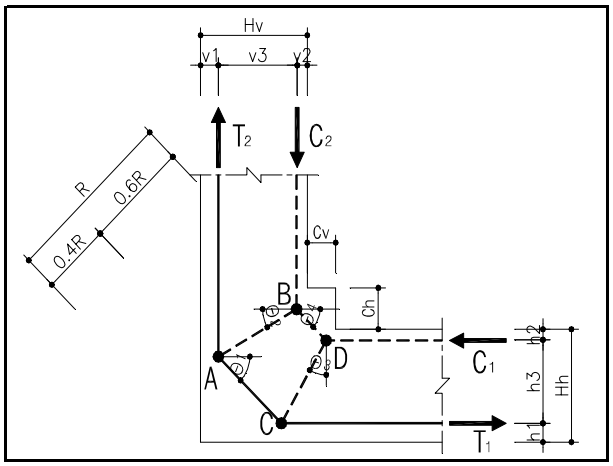
$A_{s,used}$ = 9,530.40 mm^2 > 8,134.34 mm^2 ……O.K

13.2 하부슬래브(램프 벽체부)

(1) 계산조건

슬래브두께	H_h	=	1600.00 mm	벽체 높이	H_v	=	1700.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	1420.00 mm	벽체측 우력 거리	v_3	=	1520.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	3391.970 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 2334.52 mm

② 사잇각

θ_1 = 45.00°

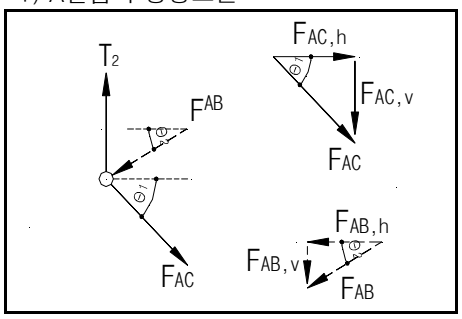
θ_2 = 3.68°

θ_3 = 7.93°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

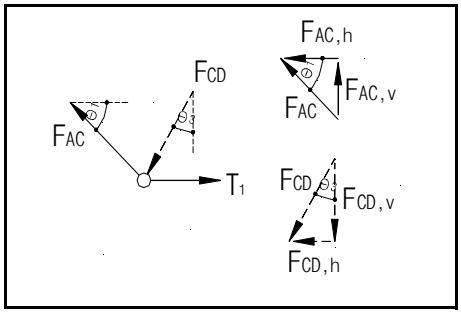
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\theta_2 \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$

$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\theta = F_{CD} \cdot \cos\theta_3$ => $F_{CD} = F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\theta_1 + F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3} \times \sin\theta_3$

$= F_{AC}(\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \dfrac{M_u}{h_3} = \dfrac{3{,}391.970}{1.420} =$ 2,388.711 kN

$T_2 = \dfrac{M_u}{v_3} = \dfrac{3{,}391.970}{1.520} =$ 2,231.559 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \dfrac{T_2}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2} =$ 2,965.225 kN

식 ⑥ 으로부터

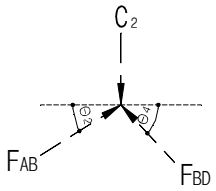
$F_{AC} = \dfrac{T_1}{\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3} =$ 2,965.225 kN

따라서 $F_{AC} =$ **2,965.225** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 2{,}101.061 \quad kN$$



- 스트럿(BD)의 단면력 산정

$\Sigma V = 0$:

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 2{,}965.225 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 2{,}116.963 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	**2,965.225**	타이
AB	**-2,101.061**	스트럿
BD	**-2,965.225**	스트럿
CD	**-2,116.963**	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 2,965.225 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{2{,}965{,}225.125}{0.85 \times 400} = 8{,}721.25 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	250	=	0.00	mm^2 (1 cycle)
	= H	32	@	250	=	3,176.80	mm^2 (2 cycle)
우각부철근 As	= H	32	@	250	=	3,176.80	mm^2 (1 단)
	= H	32	@	250	=	3,176.80	mm^2 (2 단)
				합계	=	**9,530.40**	mm^2

$A_{s,used}$ = 9,530.40 mm^2 > 8,721.25 mm^2 ……O.K

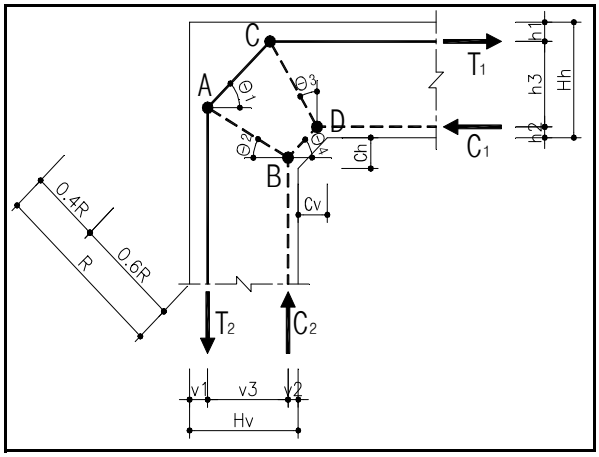
13. 우각부 보강검토

13.3 상부슬래브 (본선 벽체부)

(1) 계산조건

슬래브두께	H_h	=	900.00 mm	벽체 높이	H_v	=	900.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	720.00 mm	벽체측 우력 거리	v_3	=	720.00 mm
수직 거리	C_h	=	500.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	500.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	968.130 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1626.35 mm

② 사잇각

θ_1 = 45.00°

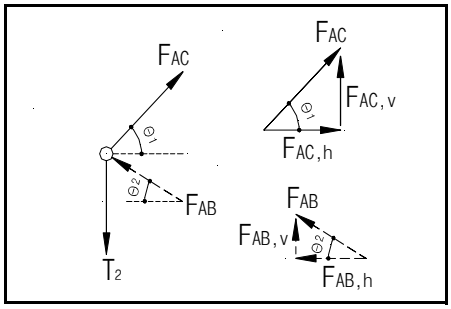
θ_2 = 29.48°

θ_3 = 29.48°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

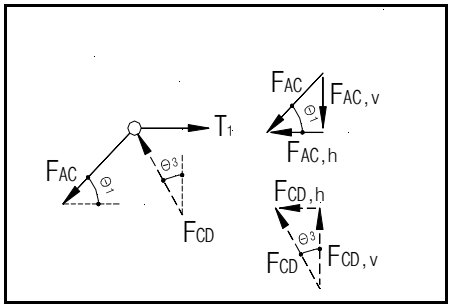
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\theta_2 \Rightarrow \quad F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \frac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$$

$$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2) \quad \cdots\cdots ③$$

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\Theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\Theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\Theta = F_{CD} \cdot \cos\Theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{968.130}{0.720} =$ 1,344.625 kN

$T_2 = \frac{M_u}{v_3} = \frac{968.130}{0.720} =$ 1,344.625 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 1,214.856 kN

식 ⑥ 으로부터

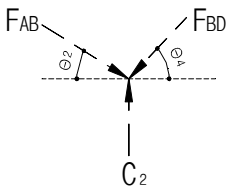
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 1,214.856 kN

따라서 F_{AC} = **1,214.856** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 986.781 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 1,214.856 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 986.781 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	1,214.856	타이
AB	-986.781	스트럿
BD	-1,214.856	스트럿
CD	-986.781	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 1,214.856 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{1,214,855.879}{0.85 \times 400} = 3,573.11 \quad mm^2$$

사용철근량

1단 주철근 As	= H 0 @ 250	=	0.00	mm^2	(1 cycle)
	= H 25 @ 250	=	2,026.80	mm^2	(2 cycle)
우각부철근 As	= H 22 @ 250	=	1,548.40	mm^2	(1 단)
	= H 22 @ 250	=	1,548.40	mm^2	(2 단)
	합계	=	**5,123.60**	mm^2	

$A_{s,used}$ = 5,123.60 mm^2 > 3,573.11 mm^2 ……O.K

14. 배력철근 검토

(1) 온도, 수축철근

-벽 체 : ρmin = 0.0020

-슬 래 브 : ρmin = 0.0020

- 주철근량 미만

(2) 배력철근

- 주철근의 20%이상

(3) 부재별 온도 / 배력철근

14.1 상부슬래브 : 램프

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
단부	H	32@	125	=	6353.600	1270.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중앙부	H	32@	125	=	6353.600	1676.080	1800.000	인장	H	16@	150	=	1324.000	O.K
	H	25@	250	=	2026.800				H	16@	300	=	662.000	
								압축	H	16@	300	=	662.000	
접합부	H	32@	125	=	6353.600	1270.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

14.2 상부 슬래브 : 본선

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
단부	H	25@	125	=	4053.600	810.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중앙부	H	25@	125	=	4053.600	810.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
벽체부	H	29@	125	=	5139.200	1433.200	1800.000	인장	H	16@	150	=	1324.000	O.K
	H	25@	250	=	2026.800				H	16@	300	=	662.000	
								압축	H	16@	300	=	662.000	

14.3 하부 슬래브 : 램프

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
단부	H	32@	125	=	6353.600	1270.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
지간 중앙부	H	32@	125	=	6353.600	1270.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중앙 벽체부	H	32@	125	=	6353.600	1270.720	1800.000	인장	H	16@	150	=	1324.000	O.K
									H					
								압축	H	16@	300	=	662.000	

14.4 하부 슬래브 : 본선

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
단부	H	25@	125	=	4053.600	810.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
지간 중앙부	H	25@	125	=	4053.600	810.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중앙 기둥부	H	32@	125	=	6353.600	1270.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

14.5 램프 벽체

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
상 단	H	32@	125	=	6353.600	1270.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중 앙	H	32@	125	=	6353.600	1270.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
하 단	H	32@	125	=	6353.600	1499.920	1800.000	인장	H	16@	150	=	1324.000	O.K
	H	19@	250	=	1146.000				H	16@	300	=	662.000	
								압축	H	16@	300	=	662.000	

14.6 본선-외측 벽체

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
상 단	H	25@	125	=	4053.600	810.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중 앙	H	25@	125	=	4053.600	810.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
하 단	H	29@	125	=	5139.200	1027.840	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

14.7 본선 중앙부 벽체

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
상 단	H	16@	125	=	1588.800	317.760	1000.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중 앙	H	16@	125	=	1588.800	317.760	1000.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
하 단	H	16@	125	=	1588.800	317.760	1000.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

15. 사용성 검토

부 재	최소두께 또는 높이 t (mm)			
	단순지지	일단연속	양단연속	캔틸레버
일방향 슬래브	L / 20	L / 24	L / 28	L / 10
보	L / 16	L / 18.5	L / 21	L / 8

부 재	지간 L (mm)	최소두께 t (mm)	사용두께 t (mm)	평 가
상부 슬래브 : 램프	10150.00	422.92	1600.00	O.K
상부 슬래브 : 본선	9600.00	400.00	900.00	O.K
하부 슬래브 : 램프	10550.00	439.58	1600.00	O.K
하부 슬래브 : 본선	9600.00	400.00	1300.00	O.K

16. 지지력 검토

16.1 하중 산정 : 램프

16.1.1 고정하중

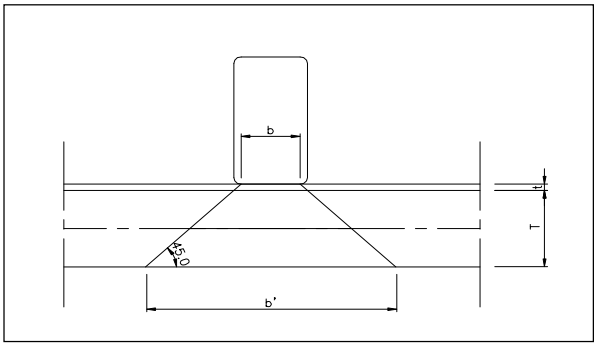
(1) 구체자중(부력검토 참조) = 2914.66 / 28.100 = 103.724 kN/m^2

(2) 상부연직하중(하중산정 참조) = 182.425 kN/m^2 (지하수위 미고려시)

(3) 아스콘 포장 = 0.00 x 23.000 = 0.000 kN/m^2

16.1.2 활하중

- 도로 노면 활하중 = 10.0 kN/m^2
- 지하차도 내부 활하중(DB-24)

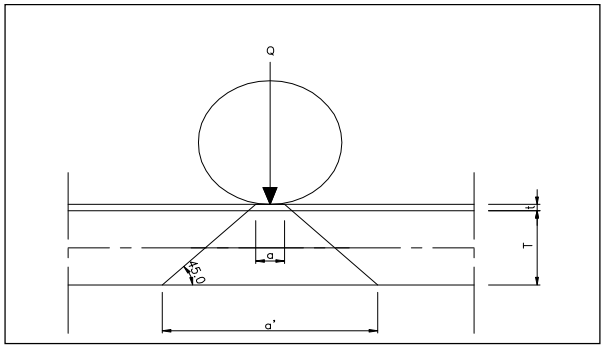


t = 40.0 mm (지하차도내부 포장두께)

T = 1600.0 mm (하부 슬래브 두께)

b' = 0.500 + 2 x (1.600 + 0.040) x cot 45°

= 3.78 m



a' = 0.200 + 2 x (1.600 + 0.040) x cot 45°

= 3.48 m

Qz' = 96.000 / (3.780 x 3.480) = 7.30 kN/m^2

16.2 허용 지지력 검토

(1) 최대 지반반력

Qmax = 103.724 + 182.425 + 0.000 + 10.000 + 7.298

= 303.447 kN/m^2

(2) 지반의 허용 지지력

Qmax = 303.447 kN/m^2 < Qa = 700.000 kN/m^2 ∴ **O.K !!**

(지반조사 보고서 참조)

16.3 하중 산정 : 본선

16.3.1 고정하중

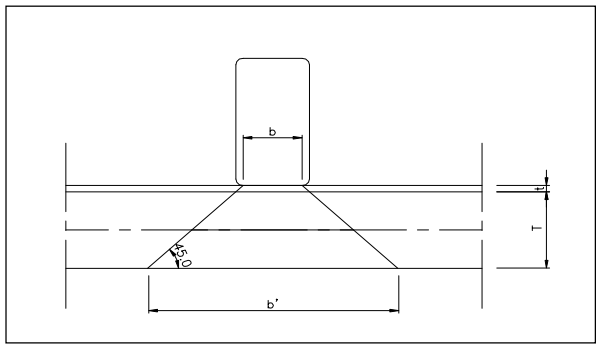
(1) 구체자중(부력검토 참조) = 1275.23 / 16.100 = 79.207 kN/m^2

(2) 상부연직하중(하중산정 참조) = 86.125 kN/m^2 (지하수위 미고려시)

(3) 아스콘 포장 = 0.00 x 23.000 = 0.000 kN/m^2

16.3.2 활하중

- 도로 노면 활하중 = 10.0 kN/m^2
- 지하차도 내부 활하중(DB-24)

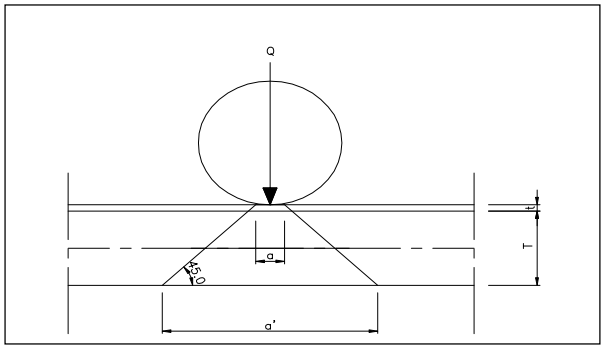


t = 50.0 mm (지하차도내부 포장두께)

T = 1300.0 mm (하부 슬래브 두께)

b' = 0.500 + 2 x (1.300 + 0.050) x cot 45°

= 3.20 m



a' = 0.200 + 2 x (1.300 + 0.050) x cot 45°

= 2.90 m

Qz' = 96.000 / (3.200 x 2.900) = 10.34 kN/m^2

16.4 허용 지지력 검토

(1) 최대 지반반력

Qmax = 79.207 + 86.125 + 0.000 + 10.000 + 10.345

= 185.677 kN/m^2

220

(2) 지반의 허용 지지력

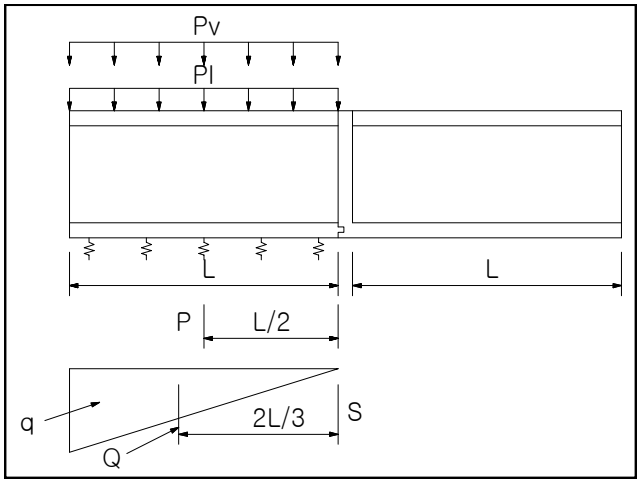
Qmax = 185.677 kN/m^2 < Qa = 400.000 kN/m^2 ∴ **O.K !!**

(지반조사 보고서 참조)

17. 신축이음부 검토

17-1. 램프

※ 가정 : BOX-TYPE 종방향의 강성 EI는 무한대로 하고, 저면은 스프링 받침으로 한다



$P = \sum Pl + \sum Pv \qquad Q = \sum q$

$P - S - Q = 0$

$P \times L/2 - Q \times 2/3 \times L = 0$

윗식에서

$S = -1/4 \times P$

$Pv = B \times H \times \gamma t$

$= 11.95 \times 8 \times 19.0$

$= 1816.4 \ kN/m$

$Po = 2 \times T1 / 3.0 \div 2 \times 96 / 3 = 64.0 \ kN/m$

$Pl = 2 \times Po \times (1 + i) = 2 \times 64.0 \times (1 + 0.2) = 153.6 \ kN/m$

$P = (Pv+Pl) \times L = (1816.4 + 153.6) \times 30.0 = 59100.0 \ kN$

$S = P / 4 = 59100 / 4 = 14775.0 \ kN$

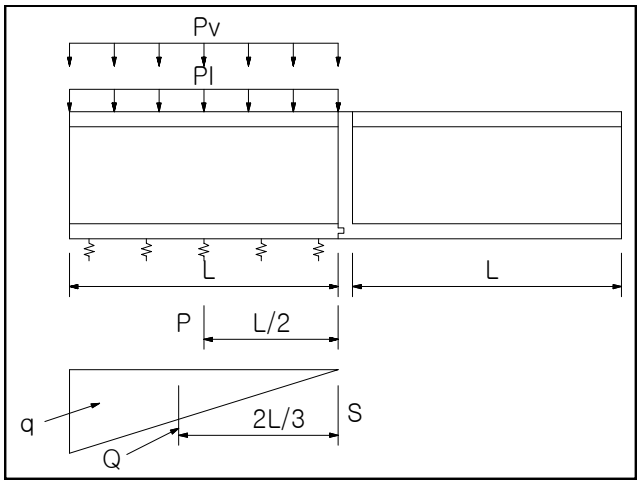
$(\therefore \ \tau a = 80 \ MPa)$

☞ 소요철근량 Areq = S / τa = 14775.0 x 1000 / 80 = 184,688 mm²

☞ 사용철근량 As = D32- 201 EA = 794.2 x 201 = 159,634 mm²

17-2. 본선

※ 가정 : BOX-TYPE 종방향의 강성 EI는 무한대로 하고, 저면은 스프링 받침으로 한다



$P = \sum Pl + \sum Pv \qquad Q = \sum q$

$P - S - Q = 0$

$P \times L/2 - Q \times 2/3 \times L = 0$

윗식에서

$S = -1/4 \times P$

$Pv = B \times H \times \gamma t$

$= 17 \times 0.6 \times 19.0$

$= 193.8 \ kN/m$

$Po = 2 \times T1 / 3.0 \div 2 \times 96 / 3 = 64.0 \ kN/m$

$Pl = 2 \times Po \times (1 + i) = 2 \times 64.0 \times (1 + 0.2) = 153.6 \ kN/m$

$P = (Pv+Pl) \times L = (193.8 + 153.6) \times 30.0 = 10422.0 \ kN$

$S = P / 4 = 10422 / 4 = 2605.5 \ kN$

$(\therefore \ \tau a = 80 \ MPa)$

☞ 소요철근량 Areq = S / τa = 2605.5 x 1000 / 80 = 32,569 mm²

☞ 사용철근량 As = D32- 340 EA = 794.2 x 340 = 270,028 mm²

※ 일체구조로 검토 : 램프x2ea + 본선

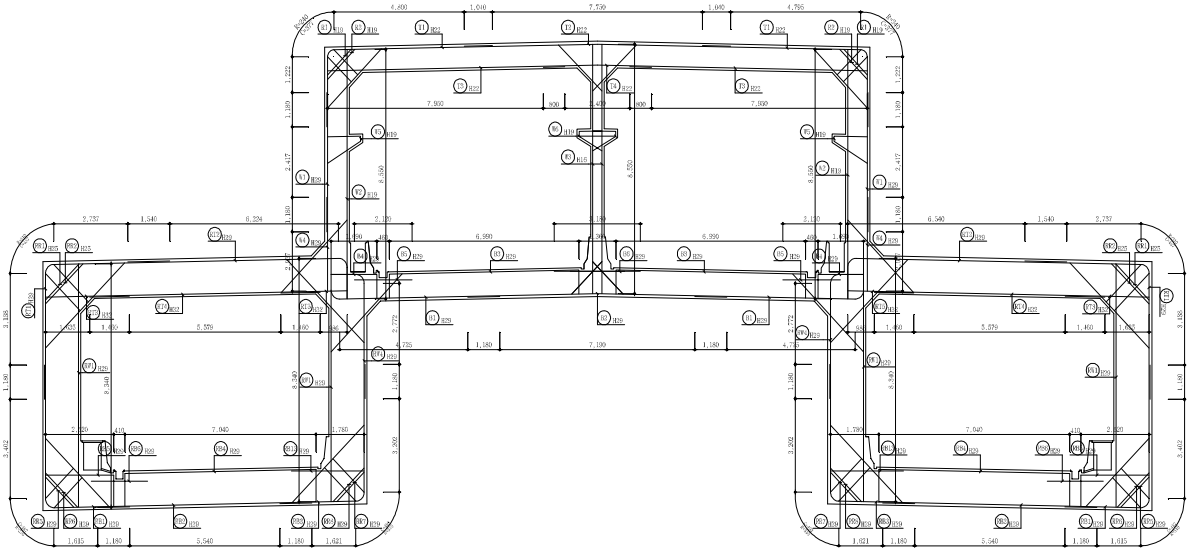
☞ 소요철근량 Areq = 369,375 + 32,569 = 401,944 mm²

☞ 사용철근량 As = 319,268 + 270,028 = 589,296 mm²

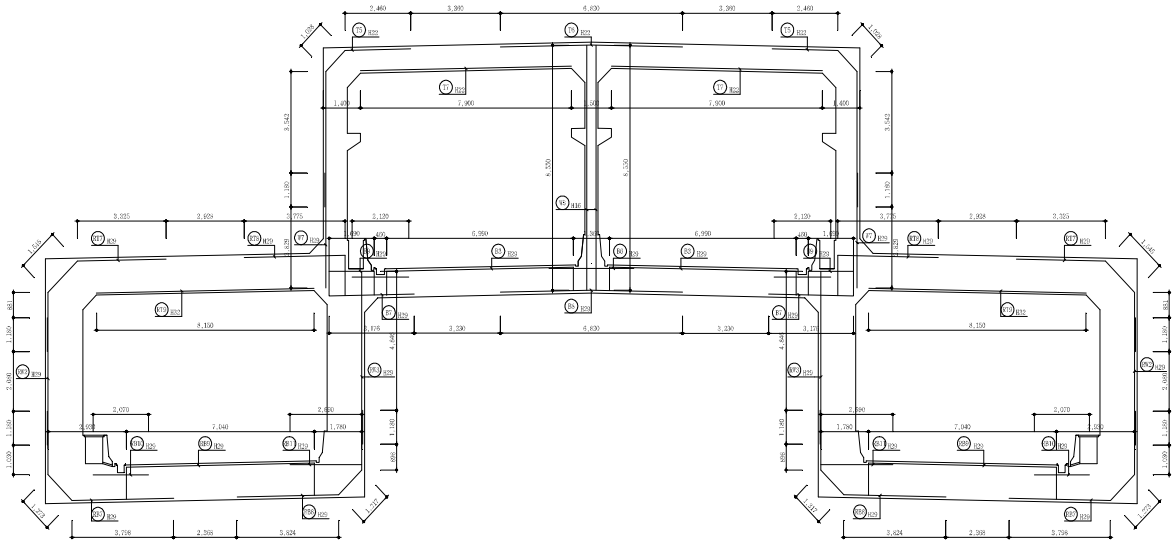
∴ O.K

18. 주철근조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



1.17 B6-1(STA.0+700.0)
- 본 선 -

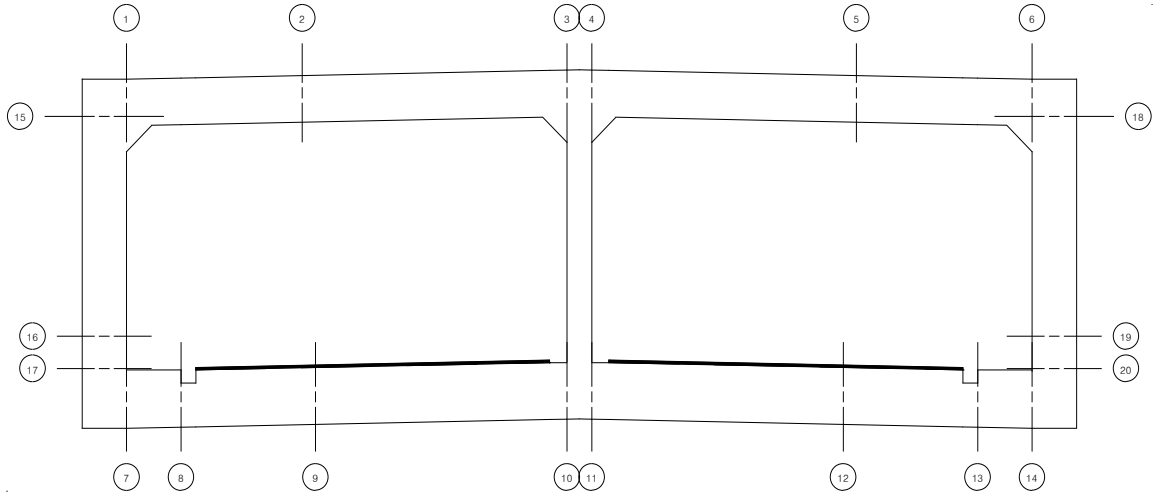
국회대로 지하차도

STA.0+700.000

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. INPUT DATA(상시)
16. INPUT DATA(기능수행)
17. INPUT DATA(붕괴방지)
18. OUTPUT DATA(상시)
19. OUTPUT DATA(기능수행)
20. OUTPUT DATA(붕괴방지)
21. 단면력정리
22. 단면검토 및 철근량 산정
23. 수평철근 검토
24. 거더,기둥,내측벽체 검토
25. 절점부 검토
26. 사용성 검토
27. 기초 지지력 검토
28. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qa(kN)	비 고
직접기초	159.287	400.000	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	1798.95	2711.157	1.507	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	950	1127.82	1581.71	3611.33	H29 - 8.0EA	5139.20	1.40
		중앙부	2	1000	820	829.32	1081.46	3075.10	H25 - 8.0EA	4053.60	1.30
		우측	3	1000	950	1409.56	1581.71	4554.22	H29 - 8.0EA	5139.20	1.12
	2경간	좌측	4	1000	950	1407.09	1581.71	4545.86	H29 - 8.0EA	5139.20	1.12
		중앙부	5	1000	820	821.49	1081.46	3045.07	H25 - 8.0EA	4053.60	1.32
		우측	6	1000	950	1127.82	1581.71	3611.33	H29 - 8.0EA	5139.20	1.40
하부슬래브	1경간	좌측	7	1000	1000	909.40	1329.54	2740.14	H25 - 8.0EA	4053.60	1.46
		측구부	8	1000	750	277.93	984.98	1104.07	H25 - 8.0EA	4053.60	3.54
		중앙부	9	1000	1020	920.13	1357.10	2716.22	H25 - 8.0EA	4053.60	1.47
		우측	10	1000	1000	1329.02	1669.07	4051.97	H29 - 8.0EA	5139.20	1.26
	2경간	좌측	11	1000	1000	1329.02	1669.07	4051.97	H29 - 8.0EA	5139.20	1.26
		중앙부	12	1000	1020	913.05	1357.10	2694.83	H25 - 8.0EA	4053.60	1.49
		측구부	13	1000	750	263.25	984.98	1045.05	H25 - 8.0EA	4053.60	3.74
		우측	14	1000	1000	899.18	1329.54	2708.57	H25 - 8.0EA	4053.60	1.48
좌측벽체	1층	상부	15	1000	950	1229.46	1581.71	3949.46	H29 - 8.0EA	5139.20	1.29
		중앙부	16	1000	820	255.10	623.44	924.07	H19 - 8.0EA	2292.00	2.44
		하부	17	1000	800	904.06	1053.89	3453.70	H25 - 8.0EA	4053.60	1.17
우측벽체	1층	상부	18	1000	950	1229.46	1581.71	3949.46	H29 - 8.0EA	5139.20	1.29
		중앙부	19	1000	820	255.10	623.44	924.07	H19 - 8.0EA	2292.00	2.44
		하부	20	1000	800	895.60	1053.89	3420.07	H25 - 8.0EA	4053.60	1.18

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부 슬래브	1 경간	좌측	1	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	2	1800.0	1986.0	O.K	810.7	1324.7	O.K
		우측	3	1800.0	1986.0	O.K	1027.8	1324.7	O.K
	2 경간	좌측	4	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	5	1800.0	1986.0	O.K	810.7	1324.7	O.K
		우측	6	1800.0	1986.0	O.K	1027.8	1324.7	O.K
하부 슬래브	1 경간	좌측	7	1800.0	1986.0	O.K	810.7	1324.7	O.K
		측구부	8	1800.0	1986.0	O.K	810.7	1324.7	O.K
		중앙부	9	1800.0	3310.0	O.K	810.7	2648.7	O.K
		우측	10	1800.0	2648.0	O.K	1027.8	1324.7	O.K
	2 경간	좌측	11	1800.0	2648.0	O.K	1027.8	1324.7	O.K
		중앙부	12	1800.0	3310.0	O.K	810.7	2648.7	O.K
		측구부	13	1800.0	1986.0	O.K	810.7	1324.7	O.K
		우측	14	1800.0	1986.0	O.K	810.7	1324.7	O.K
좌측 벽체	1 층	상부	15	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	16	1800.0	1986.0	O.K	458.4	661.3	O.K
		하부	17	1800.0	1986.0	O.K	810.7	1324.7	O.K
우측 벽체	1 층	상부	18	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	19	1800.0	1986.0	O.K	458.4	661.3	O.K
		하부	20	1800.0	1986.0	O.K	810.7	1324.7	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	519.6	524.3	925.06	2.00	2.95	H13	150	253.40	O.K
		중앙부	2	532.6	185.3	740.39	2.00	-	H13	300	253.40	O.K
		우측	3	519.6	706.5	925.06	2.00	116.80	H13	150	253.40	O.K
	2경간	좌측	4	519.6	704.7	925.06	2.00	115.67	H13	150	253.40	O.K
		중앙부	5	532.6	185.3	740.39	2.00	-	H13	300	253.40	O.K
		우측	6	519.6	524.3	925.06	2.00	2.95	H13	150	253.40	O.K
하부슬래브	1경간	좌측	7	649.5	501.0	1156.32	2.00	131.25	H13	150	253.40	O.K
		측구부	8	487.1	501.0	867.24	2.00	9.27	H13	150	253.40	O.K
		중앙부	9	662.5	215.3	920.98	2.00	-	H13	300	253.40	O.K
		우측	10	649.5	610.2	1156.32	2.00	131.25	H13	150	253.40	O.K
	2경간	좌측	11	649.5	610.2	1156.32	2.00	131.25	H13	150	253.40	O.K
		중앙부	12	662.5	215.3	920.98	2.00	-	H13	300	253.40	O.K
		측구부	13	487.1	499.7	867.24	2.00	8.38	H13	150	253.40	O.K
		우측	14	649.5	499.7	1156.32	2.00	131.25	H13	150	253.40	O.K
좌측벽체	1층	상부	15	519.6	394.9	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	16	532.6	393.3	948.18	2.00	-	H13	150	253.40	O.K
		하부	17	519.6	325.9	925.06	2.00	-	H13	150	253.40	O.K
우측벽체	1층	상부	18	519.6	394.9	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	19	532.6	389.8	948.18	2.00	-	H13	150	253.40	O.K
		하부	20	519.6	322.4	925.06	2.00	-	H13	150	253.40	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	950	H29 - 8.0EA	125	680.838	O.K	5.447
		중앙부	2	820	H25 - 8.0EA	125	250.576	O.K	2.005
		우측	3	950	H29 - 8.0EA	125	152.536	O.K	1.220
	2경간	좌측	4	950	H29 - 8.0EA	125	153.123	O.K	1.225
		중앙부	5	820	H25 - 8.0EA	125	254.167	O.K	2.033
		우측	6	950	H29 - 8.0EA	125	692.637	O.K	5.541
하부슬래브	1경간	좌측	7	1000	H25 - 8.0EA	125	241.516	O.K	1.932
		측구부	8	750	H25 - 8.0EA	125	883.269	O.K	7.066
		중앙부	9	1020	H25 - 8.0EA	125	315.566	O.K	2.525
		우측	10	1000	H29 - 8.0EA	125	202.985	O.K	1.624
	2경간	좌측	11	1000	H29 - 8.0EA	125	201.875	O.K	1.615
		중앙부	12	1020	H25 - 8.0EA	125	319.016	O.K	2.552
		측구부	13	750	H25 - 8.0EA	125	925.832	O.K	7.407
		우측	14	1000	H25 - 8.0EA	125	246.123	O.K	1.969
좌측벽체	1층	상부	15	950	H29 - 8.0EA	125	442.067	O.K	3.537
		중앙부	16	820	H19 - 8.0EA	-	-	-	-
		하부	17	800	H25 - 8.0EA	125	141.302	O.K	1.130
우측벽체	1층	상부	18	950	H29 - 8.0EA	125	451.298	O.K	3.610
		중앙부	19	820	H19 - 8.0EA	-	-	-	-
		하부	20	800	H25 - 8.0EA	125	144.237	O.K	1.154

2. 설 계 조 건

1) 구조형식

- 지중 2 련 지하차도 (내공 : 2@(8.9M × 4.75M), 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (γ_c) = 25.00 kN/m³
- Mortar (γ_{mot}) = 21.50 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sd
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 11.000 kN/m² (∵ 토피 : 3.000 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

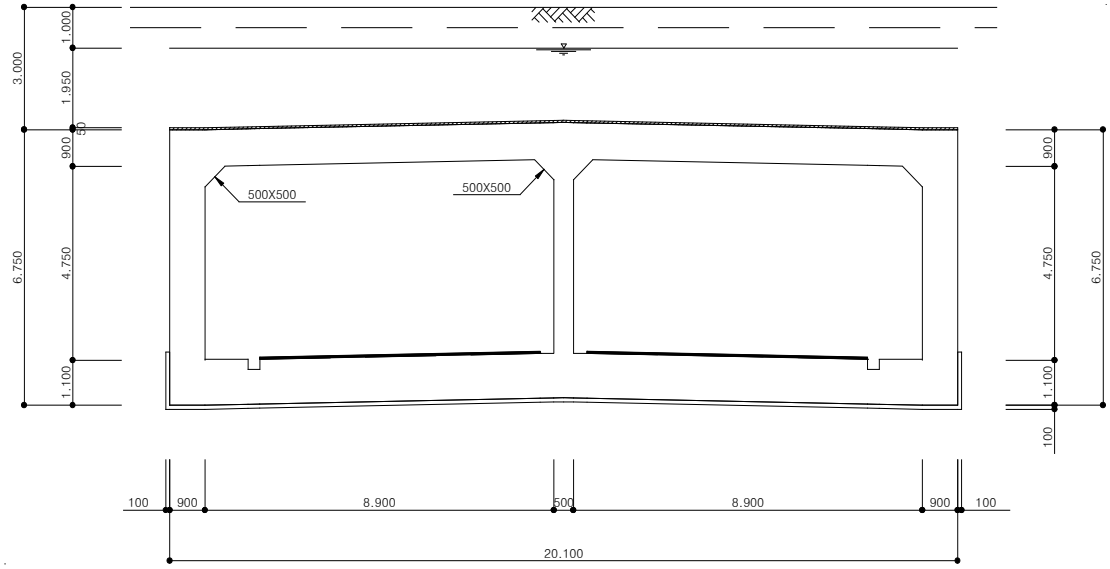
- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

10) 사용프로그램 : SAP2000

11) 참고문헌

- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정


3.000
1.000
1.950
50
900
6.750
4.750
1.100
500X500
500X500
900
4.750
6.750
1.100
100
100
900
8.900
500
8.900
900
100
20.100

4. 부 력 검 토

4.1 시공중 부력검토 (지하수위:G.L -9.6m) -상부슬래브 폐합전

: 부력에 대한 안전률 Fs = 1.10 (R/B)

1) 구체자중

- 하부슬래브	:	20.100 × 1.100 × 25.0	=	552.750	kN/m
- 좌측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 우측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 중간벽체 1	:	0.500 × 4.750 × 25.0	=	59.375	kN/m
		∴ Σ	=	825.875	kN/m

2) 상재 하중

∴ Σ	=	0.000	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 0.000^2 \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

∴ Σ = 0.000 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반편,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 0.350 \times 10.000$

$= 70.350$ kN/m

6) 안정검토

$R = 825.875 + 0.000 + 0.000 = 825.875$ kN/m

$Fs = R / U$

$= 825.875 / 70.350 = 11.740$

$\geq 1.100 \Rightarrow H \leq 10.672$ m

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 10.672m이하로 유지.

4.2 완공후 부력검토 (지하수위:G.L -9.6m)

: 부력에 대한 안전률 Fs = 1.20 (R/B)

부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려

1) 구체자중

- 상부슬래브	:	20.100 × 0.900 × 25.0	=	452.250	kN/m
- 하부슬래브	:	20.100 × 1.100 × 25.0	=	552.750	kN/m
- 좌측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 우측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 중간벽체 1	:	0.500 × 4.750 × 25.0	=	59.375	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 4EA × 25.0	=	12.500	kN/m
		∴ Σ	=	1290.625	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 20.100 × 23.0	=	231.150	kN/m
- 흙의 자중(지하수위 이상	:	2.450 × 20.100 × 19.0	=	935.655	kN/m
- 수목하중	:	20.100 × 10.0	=	201.000	kN/m
- 방수 Mortal	:	0.050 × 20.100 × 21.5	=	21.608	kN/m
		∴ Σ	=	1389.413	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 3.000^2 \times \tan(30.0 \times 2/3)$

$= 31.119$ kN/m

∴ Σ = 31.119 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 0.350 \times 10.000$

$= 70.350$ kN/m

6) 안정검토

$R = 1290.625 + 1389.413 + 0.000 = 2680.038$ kN/m

$Fs = R / U$

$= 2680.038 / 70.350$

$= 38.096 > 1.200$ ∴O.K

4.3 완공후 부력검토 (극한수위:G.L -1.0m)

: 부력에 대한 안전률 Fs = 1.05 (R/B)

부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려

(최소토피 H = 0.993 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	20.100 × 0.900 × 25.0	=	452.250	kN/m
- 하부슬래브	:	20.100 × 1.100 × 25.0	=	552.750	kN/m
- 좌측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 우측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 중간벽체 1	:	0.500 × 4.750 × 25.0	=	59.375	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 4EA × 25.0	=	12.500	kN/m
		∴ Σ	=	1290.625	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 20.100 × 23.0	=	231.150	kN/m
- 흙의 자중(지하수위 이상	:	2.450 × 20.100 × 19.0	=	935.655	kN/m
- 수목하중	:	20.100 × 10.0	=	201.000	kN/m
- 방수 Mortal	:	0.050 × 20.100 × 21.5	=	21.608	kN/m
		∴ Σ	=	1389.413	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 3.000^2 \times \tan(30.0 \times 2/3)$

$= 31.119$ kN/m

∴ Σ = 31.119 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 8.950 \times 10.000$

$= 1798.950$ kN/m

6) 안정검토

$R = 1290.625 + 1389.413 + 0.000 = 2711.157$ kN/m

$Fs = R / U$

$= 2711.157 / 1798.950$

$= 1.507 > 1.200$ ∴O.K

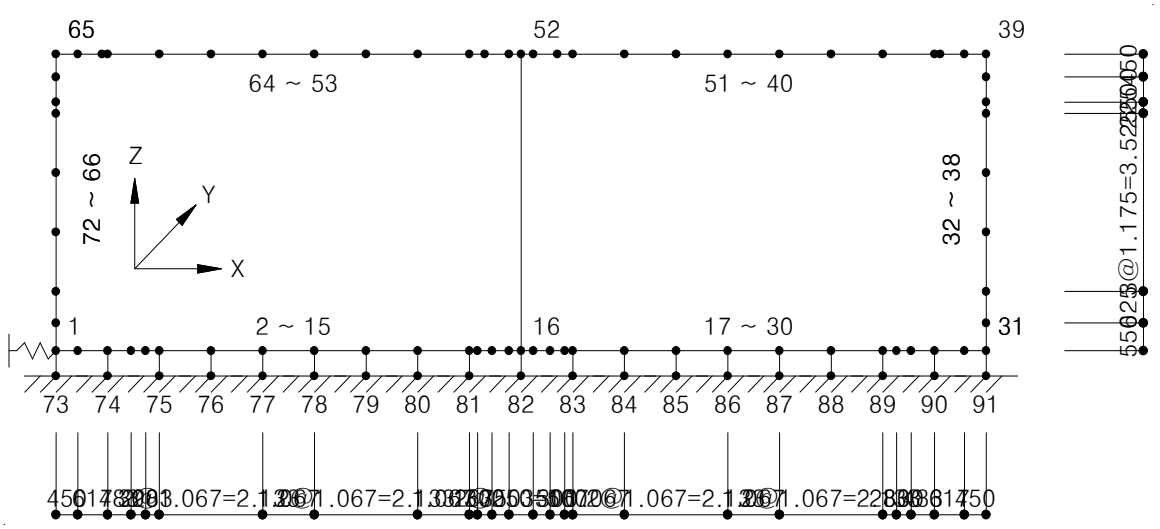
5. 해석모델 및 단면제원 (상시)

1) Modeling

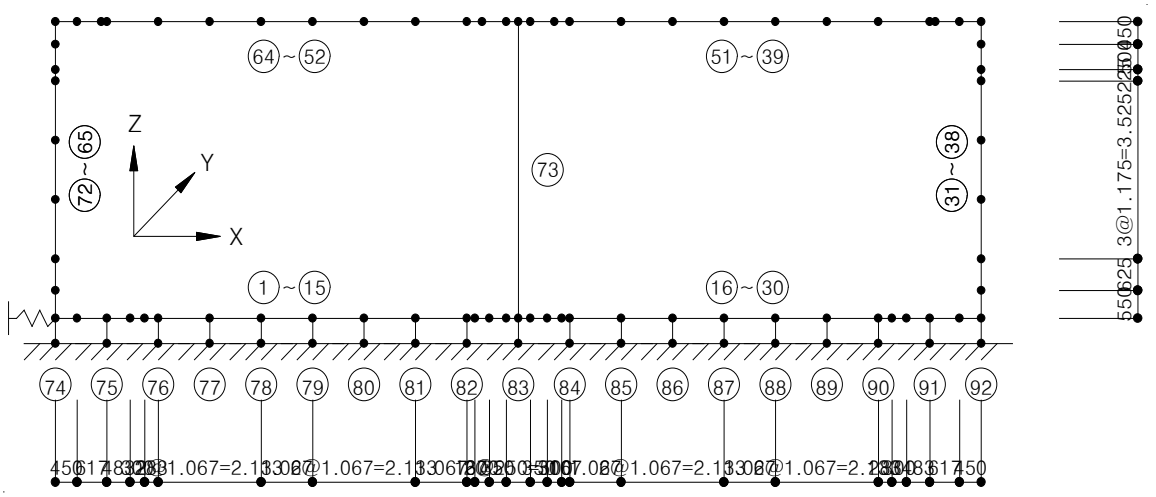
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.100 × 1.000	= 1.100	0.11092	1~3,5~26,28~30
2	0.850 × 1.000	= 0.850	0.05118	4,27
3	0.900 × 1.000	= 0.900	0.06075	31~36,41~62,67~72
4	1.400 × 1.000	= 1.400	0.22867	38~39,64~65
5	0.500 × 1.000	= 0.500	0.01042	73

NO	Section(Tapper)	부 재
6	SEC 3 ~ 4	37,63
7	SEC 4 ~ 3	40,66

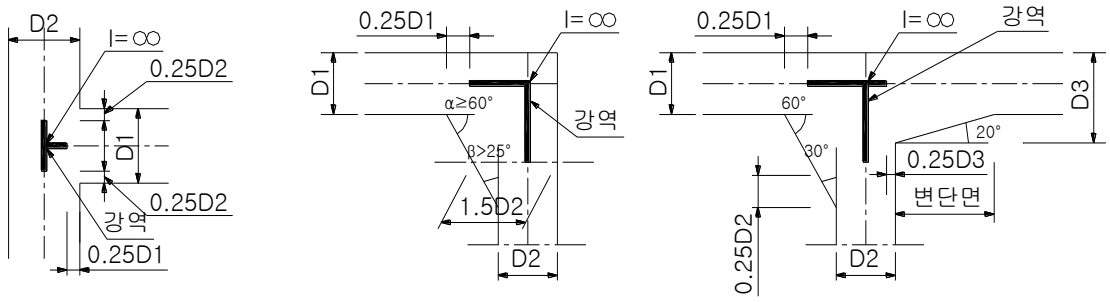
3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	47	12.800	6.375
2	0.450	0.500	48	11.733	6.375
3	1.067	0.500	49	10.667	6.375
4	1.550	0.500	50	10.350	6.375
5	1.850	0.500	51	9.850	6.375
6	2.133	0.500	52	9.600	6.375
7	3.200	0.500	53	9.350	6.375
8	4.267	0.500	54	8.850	6.375
9	5.333	0.500	55	8.533	6.375
10	6.400	0.500	56	7.467	6.375
11	7.467	0.500	57	6.400	6.375
12	8.533	0.500	58	5.333	6.375
13	8.700	0.500	59	4.267	6.375
14	9.000	0.500	60	3.200	6.375
15	9.350	0.500	61	2.133	6.375
16	9.600	0.500	62	1.067	6.375
17	9.850	0.500	63	0.950	6.375
18	10.200	0.500	64	0.450	6.375
19	10.500	0.500	65	0.000	6.375
20	10.667	0.500	66	0.000	5.925
21	11.733	0.500	67	0.000	5.425
22	12.800	0.500	68	0.000	5.200
23	13.867	0.500	69	0.000	4.025
24	14.933	0.500	70	0.000	2.850
25	16.000	0.500	71	0.000	1.675
26	17.067	0.500	72	0.000	1.050
27	17.350	0.500	73	0.000	0.000
28	17.650	0.500	74	1.067	0.000
29	18.133	0.500	75	2.133	0.000
30	18.750	0.500	76	3.200	0.000

31	19.200	0.500	77	4.267	0.000
32	19.200	1.050	78	5.333	0.000
33	19.200	1.675	79	6.400	0.000
34	19.200	2.850	80	7.467	0.000
35	19.200	4.025	81	8.533	0.000
36	19.200	5.200	82	9.600	0.000
37	19.200	5.425	83	10.667	0.000
38	19.200	5.925	84	11.733	0.000
39	19.200	6.375	85	12.800	0.000
40	18.750	6.375	86	13.867	0.000
41	18.250	6.375	87	14.933	0.000
42	18.133	6.375	88	16.000	0.000
43	17.067	6.375	89	17.067	0.000
44	16.000	6.375	90	18.133	0.000
45	14.933	6.375	91	19.200	0.000
46	13.867	6.375			

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

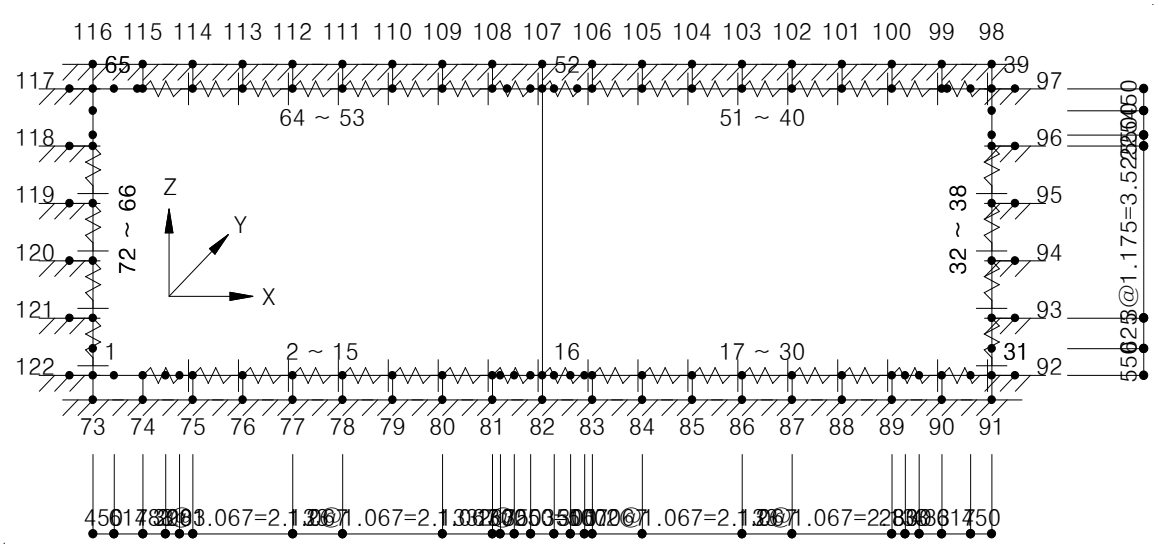
(1) 65 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(2) 65 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(3) 52 지점 - 슬래브 상면 좌측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(4) 52 지점 - 슬래브 상면 우측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(5) 52 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (500 × 500) / (2 × 500) = 700 mm
(6) 39 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(7) 39 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(8) 1 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1100 = 175 mm
(9) 1 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1100 / 2 - 0.25 × 900 = 325 mm
(10) 16 지점 - 슬래브 하면 좌측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1100 <= 0 mm
(11) 16 지점 - 슬래브 하면 우측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1100 <= 0 mm
(12) 16 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1100 / 2 - 0.25 × 500 = 425 mm
(13) 31 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1100 = 175 mm
(14) 31 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1100 / 2 - 0.25 × 900 = 325 mm

6. 해석모델 및 단면제원 (지진시)

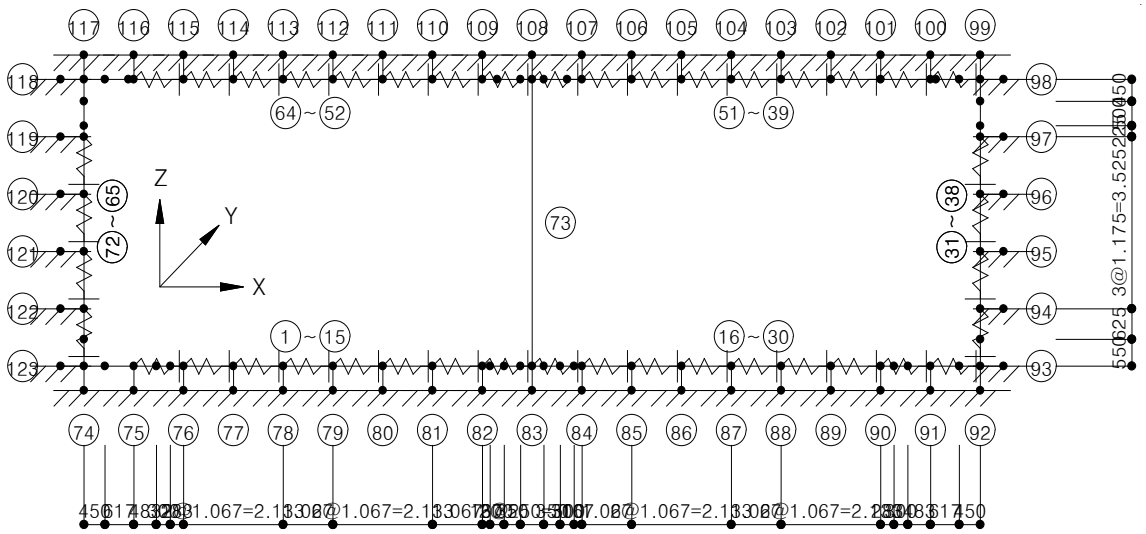
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)	I (m⁴)	부 재
1	1.100 × 1.000 = 1.100	0.11092	1~3,5~26,28~30
2	0.850 × 1.000 = 0.850	0.05118	4,27
3	0.900 × 1.000 = 0.900	0.06075	31~36,41~62,67~72
4	1.400 × 1.000 = 1.400	0.22867	38~39,64~65
5	0.500 × 1.000 = 0.500	0.01042	73

NO	Section(Tapper)	부 재
6	SEC 3 ~ 4	37,63
7	SEC 4 ~ 3	40,66

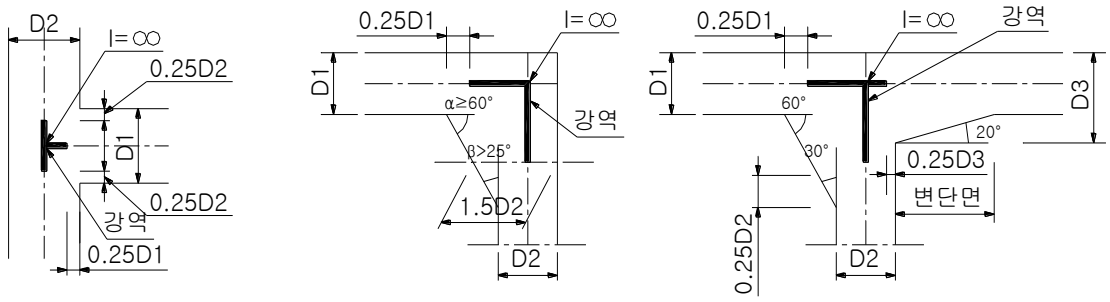
3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.500	0.500	62	1.567	6.375
2	0.950	0.500	63	1.450	6.375
3	1.567	0.500	64	0.950	6.375
4	2.050	0.500	65	0.500	6.375
5	2.350	0.500	66	0.500	5.925
6	2.633	0.500	67	0.500	5.425
7	3.700	0.500	68	0.500	5.200
8	4.767	0.500	69	0.500	4.025
9	5.833	0.500	70	0.500	2.850
10	6.900	0.500	71	0.500	1.675
11	7.967	0.500	72	0.500	1.050
12	9.033	0.500	73	0.500	0.000
13	9.200	0.500	74	1.567	0.000
14	9.500	0.500	75	2.633	0.000
15	9.850	0.500	76	3.700	0.000
16	10.100	0.500	77	4.767	0.000
17	10.350	0.500	78	5.833	0.000
18	10.700	0.500	79	6.900	0.000
19	11.000	0.500	80	7.967	0.000
20	11.167	0.500	81	9.033	0.000
21	12.233	0.500	82	10.100	0.000
22	13.300	0.500	83	11.167	0.000
23	14.367	0.500	84	12.233	0.000
24	15.433	0.500	85	13.300	0.000
25	16.500	0.500	86	14.367	0.000
26	17.567	0.500	87	15.433	0.000
27	17.850	0.500	88	16.500	0.000
28	18.150	0.500	89	17.567	0.000
29	18.633	0.500	90	18.633	0.000
30	19.250	0.500	91	19.700	0.000
31	19.700	0.500	92	20.200	0.500
32	19.700	1.050	93	20.200	1.675
33	19.700	1.675	94	20.200	2.850
34	19.700	2.850	95	20.200	4.025
35	19.700	4.025	96	20.200	5.200
36	19.700	5.200	97	20.200	6.375
37	19.700	5.425	98	19.700	6.875
38	19.700	5.925	99	18.633	6.875
39	19.700	6.375	100	17.567	6.875
40	19.250	6.375	101	16.500	6.875
41	18.750	6.375	102	15.433	6.875

42	18.633	6.375	103	14.367	6.875
43	17.567	6.375	104	13.300	6.875
44	16.500	6.375	105	12.233	6.875
45	15.433	6.375	106	11.167	6.875
46	14.367	6.375	107	10.100	6.875
47	13.300	6.375	108	9.033	6.875
48	12.233	6.375	109	7.967	6.875
49	11.167	6.375	110	6.900	6.875
50	10.850	6.375	111	5.833	6.875
51	10.350	6.375	112	4.767	6.875
52	10.100	6.375	113	3.700	6.875
53	9.850	6.375	114	2.633	6.875
54	9.350	6.375	115	1.567	6.875
55	9.033	6.375	116	0.500	6.875
56	7.967	6.375	117	0.000	6.375
57	6.900	6.375	118	0.000	5.200
58	5.833	6.375	119	0.000	4.025
59	4.767	6.375	120	0.000	2.850
60	3.700	6.375	121	0.000	1.675
61	2.633	6.375	122	0.000	0.500

8) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 65 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(2) 65 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(3) 52 지점 - 슬래브 상면 좌측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(4) 52 지점 - 슬래브 상면 우측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(5) 52 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (500 × 500) / (2 × 500) = 700 mm
(6) 39 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(7) 39 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(8) 1 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1100 = 175 mm
(9) 1 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1100 / 2 - 0.25 × 900 = 325 mm
(10) 16 지점 - 슬래브 하면 좌측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1100 <= 0 mm
(11) 16 지점 - 슬래브 하면 우측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1100 <= 0 mm
(12) 16 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1100 / 2 - 0.25 × 500 = 425 mm
(13) 31 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1100 = 175 mm
(14) 31 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1100 / 2 - 0.25 × 900 = 325 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 300000.00 kN/m²

Bv = √(B × B) = √(20.100 × 20.100) = 20.10 m (L > B)

Kvo = 1 / 0.3 × 1 × 300000 = 1000000.00 kN/m³

Kv = 1000000.000 × (20.100 / 0.3) $^{-3 / 4}$ = 42701.58 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 41990 kN/m	1,31
Kv2	Kv x (1.067/2 + 1.067/2) = 45548 kN/m	3,6~12,16,20~26,29
Kh	1E10 kN/m (무한강성)	16

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 점토 (EL. : 9.869 ~ -1.394, N=4)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8^2 = 31753.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0^2 = 12404.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m^2

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제3토층 ,점토

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m^3

Kv = 306945.670 × (20.100 / 0.3)$^{-3/4}$ = 13107.06 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 13107.060 = 4369.02 kN/m^3

(2) 하부슬래브 : 제3토층 , 점토

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m^3

Kv = 306945.670 × (20.100 / 0.3)$^{-3/4}$ = 13107.06 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 13107.060 = 4369.02 kN/m^3

(3) 측벽 : 제3토층 , 점토

① 수평방향 지반반력계수

Bv = √(H × H) = √(6.750 × 6.750) = 6.750 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m³

Kh = 306945.670 × (6.750 / 0.3)$^{-3 / 4}$ = 29711.50 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 29711.500 = 9903.83 kN/m³

(4) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 13981 kN/m	42~49,52,55~62
Ksb1	Ksb x (1.067/2 + 1.067/2) = 4660 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.175/2 + 1.175/2) = 34911 kN/m	33~36,68~71
Kss1	Kss x (1.175/2 + 1.175/2) = 11637 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 13981 kN/m	3,6~12,16,20~26,29
Ksb1	Ksb x (1.067/2 + 1.067/2) = 4660 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 12889 kN/m	1,31
Ksb1	Kh x (1.175/2 + 1.100/2) = 33797 kN/m	
Kv2	Kv x (1.067/2 + 0.900/2) = 12889 kN/m	39,65
Ksb2	Kh x (1.175/2 + 0.900/2) = 30826 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제3토층 ,점토

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kv = 119905.330 × (20.100 / 0.3)$^{-3 / 4}$ = 5120.15 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 5120.150 = 1706.72 kN/m³

(2) 하부슬래브 : 제3토층 , 점토

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kv = 119905.330 × (20.100 / 0.3)$^{-3 / 4}$ = 5120.15 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 5120.150 = 1706.72 kN/m³

(3) 측벽 : 제3토층 , 점토

① 수평방향 지반반력계수

Bv = √(H × H) = √(6.750 × 6.750) = 6.750 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kh = 119905.330 × (6.750 / 0.3)$^{-3 / 4}$ = 11606.51 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 11606.510 = 3868.84 kN/m³

(4) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 5462 kN/m	42~49,52,55~62
Ksb1	Ksb x (1.067/2 + 1.067/2) = 1821 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.175/2 + 1.175/2) = 13638 kN/m	33~36,68~71
Kss1	Kss x (1.175/2 + 1.175/2) = 4546 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 5462 kN/m	3,6~12,16,20~26,29
Ksb1	Ksb x (1.067/2 + 1.067/2) = 1821 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 5035 kN/m	1,31
Ksb1	Kh x (1.175/2 + 1.100/2) = 13202 kN/m	
Kv2	Kv x (1.067/2 + 0.900/2) = 5035 kN/m	39,65
Ksb2	Kh x (1.175/2 + 0.900/2) = 12042 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

	성능기 / 준 재현주기	기 능 수 행	붕 괴 방 지
설계지진	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.16 = 0.091
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.16 = 0.224

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 토 사	: 2.450 × 19.00	=	46.550	kN/m²
- 수목하중	:	=	10.000	kN/m²
- 방 수	: 0.050 × 21.50	=	1.075	kN/m²
	∴ Total Wd1	=	69.125	kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00	=	9.500	kN/m²
- 흙(지하수위 이하)	: 1.950 × 10.00	=	19.500	kN/m²
- 수목하중	:	=	10.000	kN/m²
- 방수	: 0.050 × 21.50	=	1.075	kN/m²
	∴ Total Wd2	=	51.575	kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

D / Bo	도로면의 활하중 (kN/m²)	D / Bo	도로면의 활하중 (kN/m²)
0.1	5.7	0.2	9.0
0.3	11.0	0.4	12.0

주) 토피고의 중간값은 Pvl 의 상위값을 적용한다.

① 상부 슬래브에 작용하는 하중 (Wl1) - 토피 3.000m

- Wl1 = 11.000 kN/m²

② 측벽에 작용하는 하중 (Wl2)

- Wl2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 2.950 × 19.000) × 0.500 = 33.775 kN/m²
Wh2 = 33.775 + 0.450 × 19.000 × 0.500 = 38.050 kN/m²
Wh3 = 38.050 + 0.500 × 19.000 × 0.500 = 42.800 kN/m²
Wh4 = 42.800 + 0.225 × 19.000 × 0.500 = 44.938 kN/m²
Wh5 = 44.938 + 1.175 × 19.000 × 0.500 = 56.100 kN/m²
Wh6 = 56.100 + 1.175 × 19.000 × 0.500 = 67.263 kN/m²
Wh7 = 67.263 + 1.175 × 19.000 × 0.500 = 78.425 kN/m²
Wh8 = 78.425 + 0.625 × 19.000 × 0.500 = 84.363 kN/m²
Wh9 = 84.363 + 0.550 × 19.000 × 0.500 = 89.588 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 2.450 × 10.000 = 22.750 kN/m²
Wh2 = 22.750 + 0.450 × 10.000 × 0.500 = 25.000 kN/m²
Wh3 = 25.000 + 0.500 × 10.000 × 0.500 = 27.500 kN/m²
Wh4 = 27.500 + 0.225 × 10.000 × 0.500 = 28.625 kN/m²
Wh5 = 28.625 + 1.175 × 10.000 × 0.500 = 34.500 kN/m²
Wh6 = 34.500 + 1.175 × 10.000 × 0.500 = 40.375 kN/m²
Wh7 = 40.375 + 1.175 × 10.000 × 0.500 = 46.250 kN/m²
Wh8 = 46.250 + 0.625 × 10.000 × 0.500 = 49.375 kN/m²
Wh9 = 49.375 + 0.550 × 10.000 × 0.500 = 52.125 kN/m²

6) 지하수압 (지하수위 : GL = -1.000 m)

① 상부슬래브에 작용하는 하중

- Ww1 = 1.950 × 10.000 = 19.500 kN/m²

② 측벽에 작용하는 하중

- Ww2 = 2.450 × 10.000 = 24.500 kN/m²
Ww3 = 24.500 + 0.450 × 10.000 = 29.000 kN/m²
Ww4 = 29.000 + 0.500 × 10.000 = 34.000 kN/m²
Ww5 = 34.000 + 0.225 × 10.000 = 36.250 kN/m²
Ww6 = 36.250 + 1.175 × 10.000 = 48.000 kN/m²
Ww7 = 48.000 + 1.175 × 10.000 = 59.750 kN/m²
Ww8 = 59.750 + 1.175 × 10.000 = 71.500 kN/m²
Ww9 = 71.500 + 0.625 × 10.000 = 77.750 kN/m²
Ww10 = 77.750 + 0.550 × 10.000 = 83.250 kN/m²

③ 하부슬래브에 작용하는 하중

- Ww11 = (3.000 + 6.750 - 1.000) × 10.000 = 87.500 kN/m²

7) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

8) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 1510^{-5}$
- 온도선팽창 계수 $\alpha = 1.010^{-5}$
- $\Delta T = \frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
매립토	2.513	198.900	124.300	19.000	0.051	0.081
실트질 자갈	0.000	198.900	124.300	20.000	0.000	0.000
점토	8.700	124.800	78.000	20.000	0.279	0.446
실트질 자갈	3.100	231.200	144.500	20.000	0.054	0.086
풍화암	15.687	504.800	315.500	20.000	0.124	0.199
계					0.508	0.812

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.508 = 0.635	1.25 Tg' = 1.25 × 0.812 = 1.015

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575
To(sec)	To = 0.2 × Ts = 0.2 × 0.575 = 0.115	To = 0.2 × Ts = 0.2 × 0.575 = 0.115

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $C_d = \frac{1.5}{40h+1} + 0.5$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa) - 붕괴방지수준시(재현주기 1000년적용)

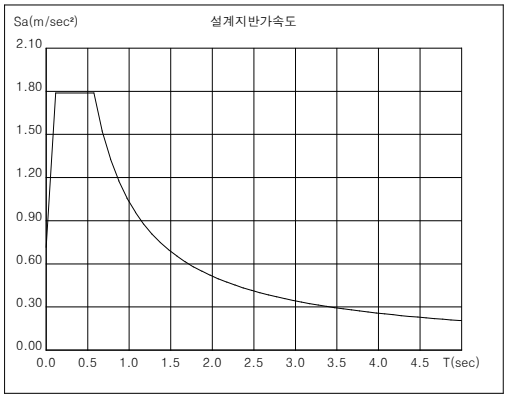
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg = 1.620 m/s²	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg = 2.076 m/s²

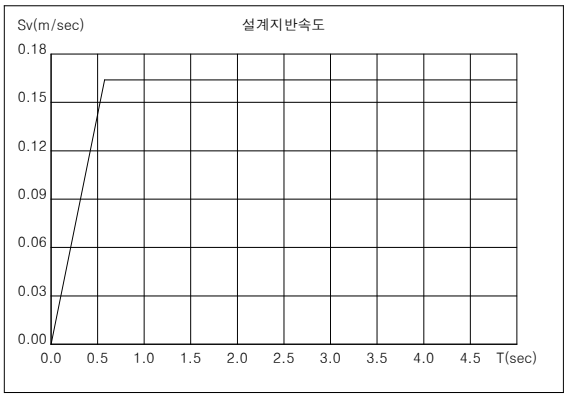
5) 속도 응답스펙트럼(Sv) - 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.635 / 2π × 1.620 = 0.164 m/s	Sv = Tg/2π × Sa = 1.015 / 2π × 2.076 = 0.335 m/s

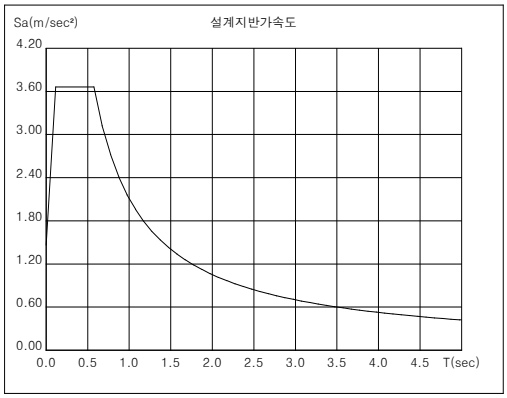
6) 설계응답 응답스펙트럼

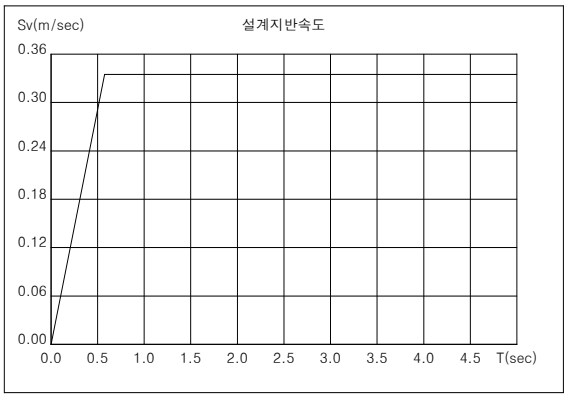
(1) 기능수행수준





(2) 붕괴방지수준





7) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 3.450 m
- 하부슬래브 EL. = 9.325 m
- 기반암 심도(H) = 30.000 m

(1) 기능수행 수준

$U(z) = 2 / \pi^2 \times Sv \times Tg \times \cos(\pi Z / 2H)$

$U(Zu) = 2 / \pi^2 \times 0.164 \times 0.635 \times \cos(\pi \times 3.450 / (2 \times 30.000)) = 0.020760$

$U(Zb) = 2 / \pi^2 \times 0.164 \times 0.635 \times \cos(\pi \times 9.325 / (2 \times 30.000)) = 0.018637$

(2) 붕괴방지 수준

$U(Zu) = 2 / \pi^2 \times 0.335 \times 1.015 \times \cos(\pi \times 3.450 / (2 \times 30.000)) = 0.067782$

$U(Zb) = 2 / \pi^2 \times 0.335 \times 1.015 \times \cos(\pi \times 9.325 / (2 \times 30.000)) = 0.060852$

$Po = Ksb,top \times (U(Zu) - U(Zb))$

기능수행수준	붕괴방지수준
$Po = 4369.020 \times (0.020760 - 0.018637)$ $= 9.275\ kN/m^2$	$Po = 1706.720 \times (0.067782 - 0.060852)$ $= 11.828\ kN/m^2$

8) 측벽 지반변위 하중

$P(z) = Kh \times (Uh(z) - Uh(b))$

(1) 기능수행수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
3.450	29711.500	0.020760	0.002123	63.078
3.900	29711.500	0.020665	0.002028	60.255
4.400	29711.500	0.020546	0.001909	56.719
4.625	29711.500	0.020487	0.001850	54.966
5.800	29711.500	0.020138	0.001501	44.597
6.975	29711.500	0.019711	0.001074	31.910
8.150	29711.500	0.019211	0.000574	17.054
8.775	29711.500	0.018915	0.000278	8.260
9.325	29711.500	0.018637	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
3.450	11606.510	0.067782	0.006930	80.433
3.900	11606.510	0.067472	0.006620	76.835
4.400	11606.510	0.067083	0.006231	72.320
4.625	11606.510	0.066893	0.006041	70.115
5.800	11606.510	0.065750	0.004898	56.849
6.975	11606.510	0.064359	0.003507	40.704
8.150	11606.510	0.062724	0.001872	21.727
8.775	11606.510	0.061758	0.000906	10.515
9.325	11606.510	0.060852	0.000000	0.000

9) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

Uh1 = 1 /(π×H) × Sv × Tg × sin(π×Zu/(2 × H))

Uh2 = 1 /(π×H) × Sv × Tg × sin(π×Zb/(2 × H))

구분	기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
Vu	31753.000 × 0.000174 = 5.530	12404.000 × 0.000569 = 7.060
Vb	31753.000 × 0.000490 = 15.560	12404.000 × 0.001600 = 19.850
Vs	(5.530 + 15.560) / 2 = 10.550	(7.060 + 19.850) / 2 = 13.450

10) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fu = 0.900×25.000×0.091×(1 - 0.015×3.450) = 1.942	fu = 0.900×25.000×0.224×(1 - 0.015×3.450) = 4.779

② 하부슬래브

기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fb = 1.100×25.000×0.091×(1 - 0.015×9.325) = 2.152	fb = 1.100×25.000×0.224×(1 - 0.015×9.325) = 5.298

③ 중간벽체

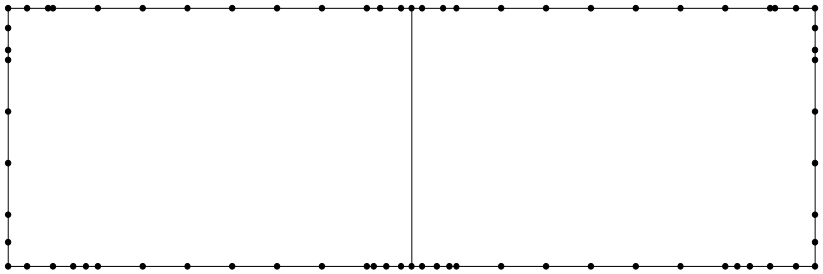
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fu1 = 0.500×25.000×0.091×(1-0.015×3.025) = 1.079	fu1 = 0.500×25.000×0.224×(1-0.015×3.025) = 2.655
fb1 = 0.500×25.000×0.091×(1-0.015×9.325) = 0.978	fb1 = 0.500×25.000×0.224×(1-0.015×9.325) = 2.408

④ 측벽

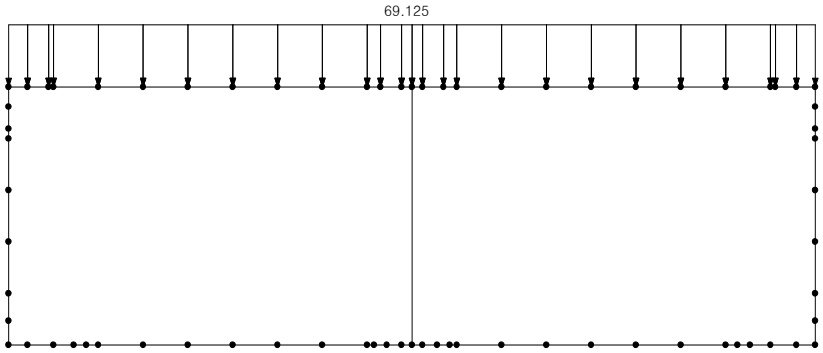
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
f1 = 0.900×25.000×0.091×(1-0.015×3.450) = 1.942	f1 = 0.900×25.000×0.224×(1-0.015×3.450) = 4.779
f2 = 0.900×25.000×0.091×(1-0.015×3.900) = 1.928	f2 = 0.900×25.000×0.224×(1-0.015×3.900) = 4.745
f3 = 0.900×25.000×0.091×(1-0.015×4.400) = 1.912	f3 = 0.900×25.000×0.224×(1-0.015×4.400) = 4.707
f4 = 0.900×25.000×0.091×(1-0.015×4.625) = 1.905	f4 = 0.900×25.000×0.224×(1-0.015×4.625) = 4.690
f5 = 0.900×25.000×0.091×(1-0.015×5.800) = 1.869	f5 = 0.900×25.000×0.224×(1-0.015×5.800) = 4.602
f6 = 0.900×25.000×0.091×(1-0.015×6.975) = 1.833	f6 = 0.900×25.000×0.224×(1-0.015×6.975) = 4.513
f7 = 0.900×25.000×0.091×(1-0.015×8.150) = 1.797	f7 = 0.900×25.000×0.224×(1-0.015×8.150) = 4.424
f8 = 0.900×25.000×0.091×(1-0.015×8.775) = 1.778	f8 = 0.900×25.000×0.224×(1-0.015×8.775) = 4.377
f9 = 0.900×25.000×0.091×(1-0.015×9.325) = 1.761	f9 = 0.900×25.000×0.224×(1-0.015×9.325) = 4.335

11. 하 중 재 하 (상시)

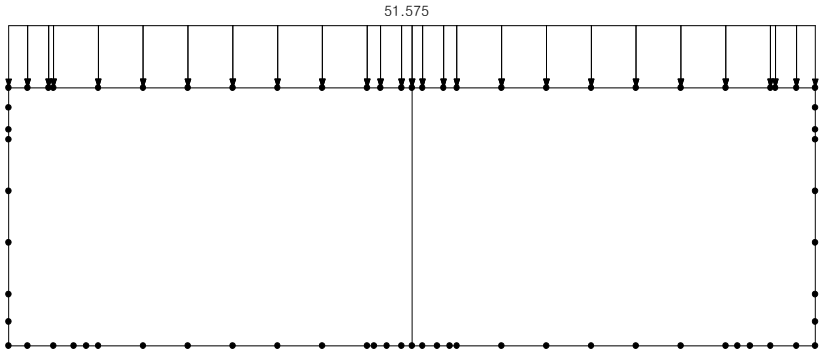
1) CASE1 - 구체자중(SW)



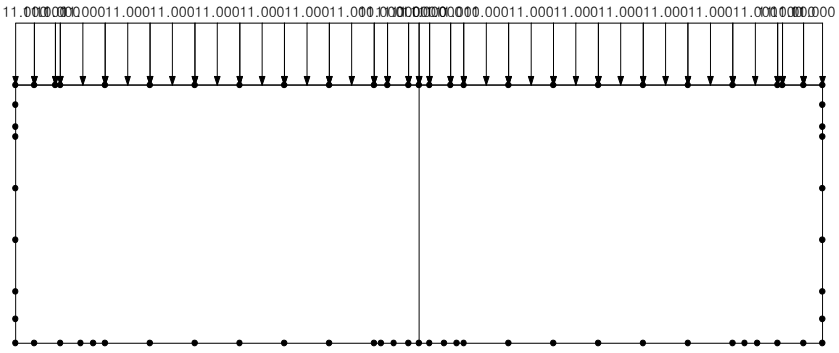
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



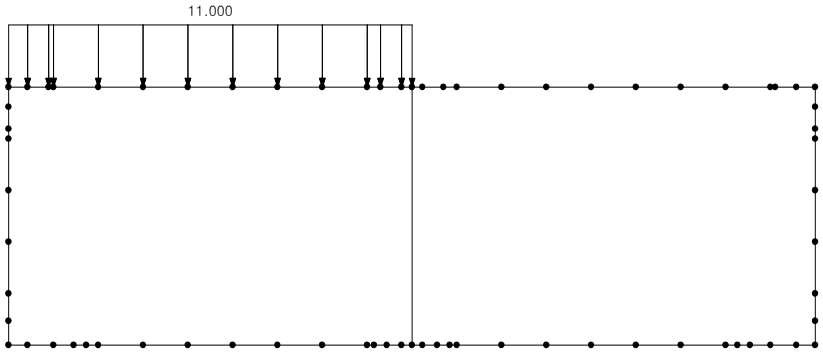
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



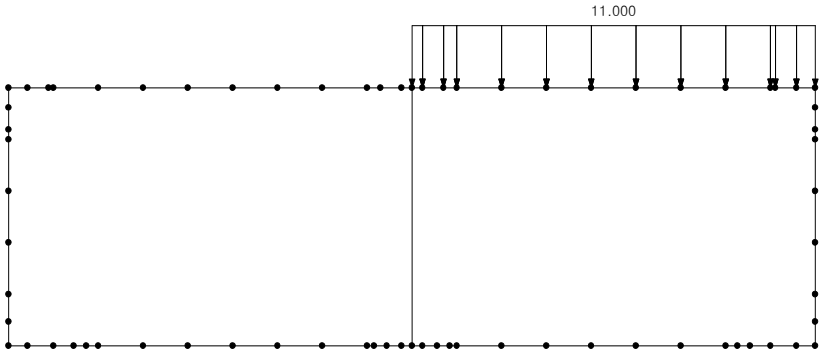
4) CASE4 - 만재활하중(LIVEFU)



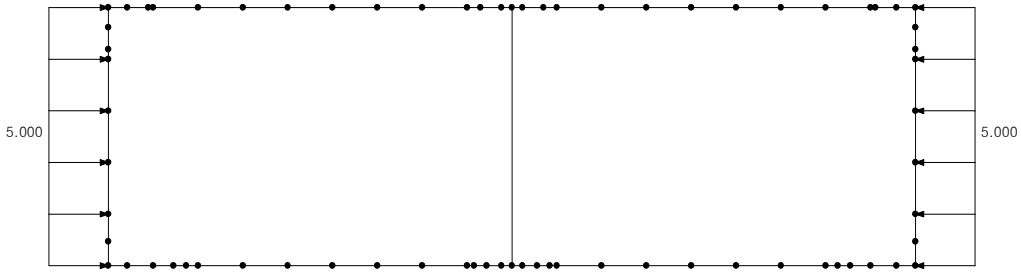
5) CASE5 - 편재활하중(좌측)(LIVELE)



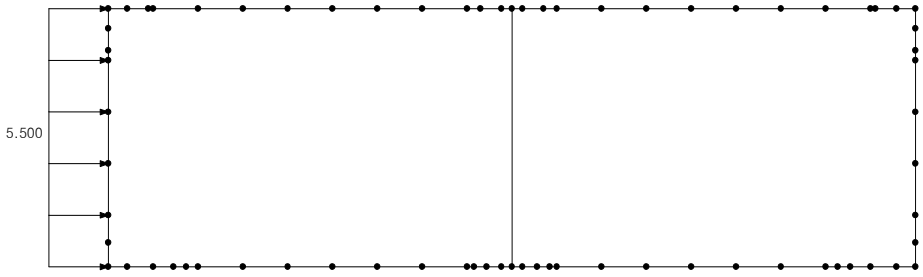
6) CASE6 - 편재활하중(우측)(LIVERI)



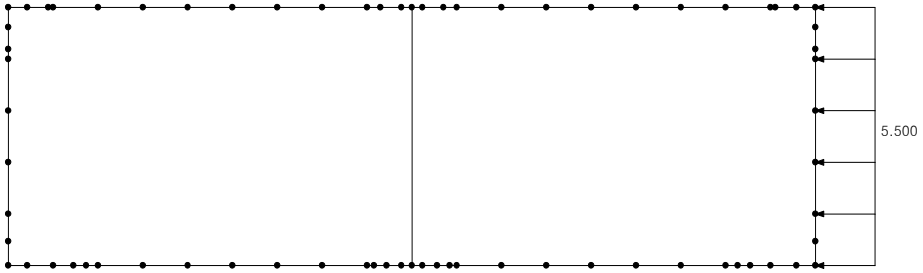
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



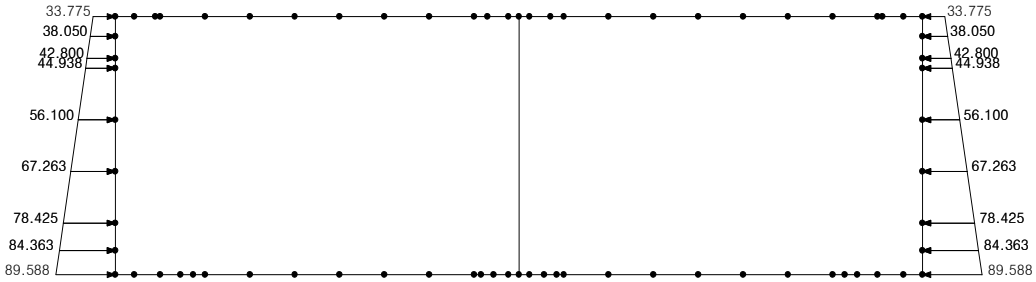
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



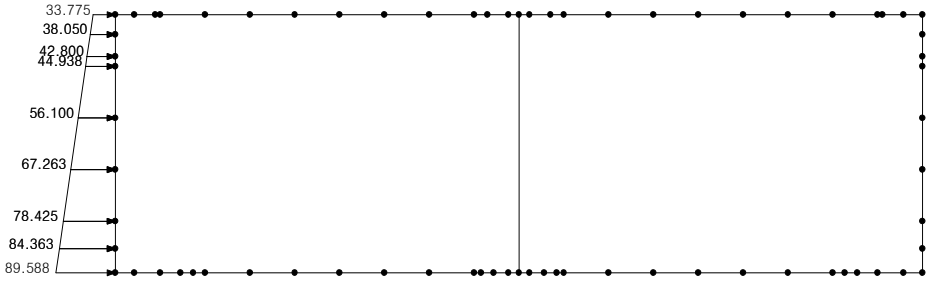
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



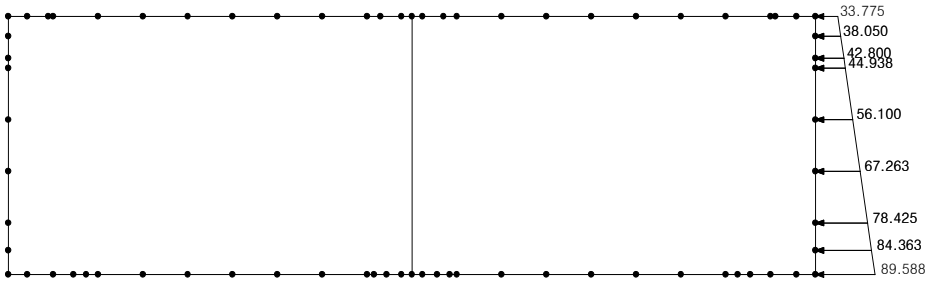
10) CASE10 - 양토압 : 지하수無(SOILB)



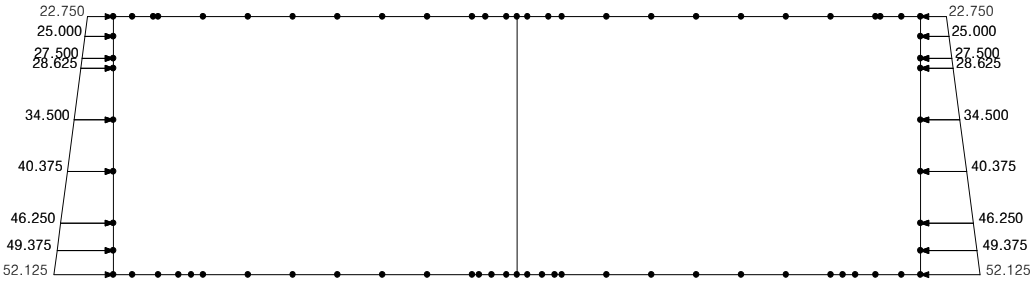
11) CASE11 - 편토압(좌측) : 지하수無(SOILL)



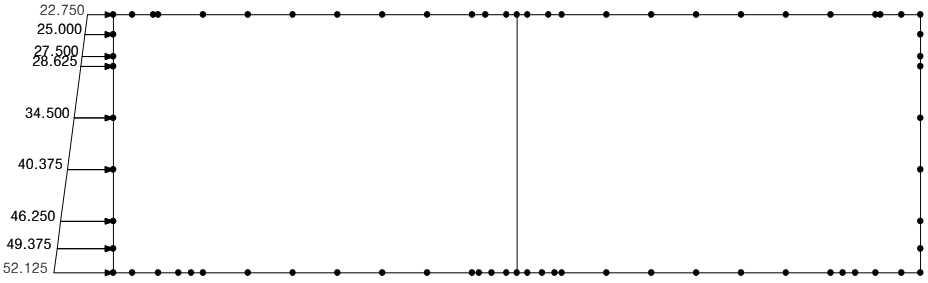
12) CASE12 - 편토압(우측) : 지하수無(SOILR)



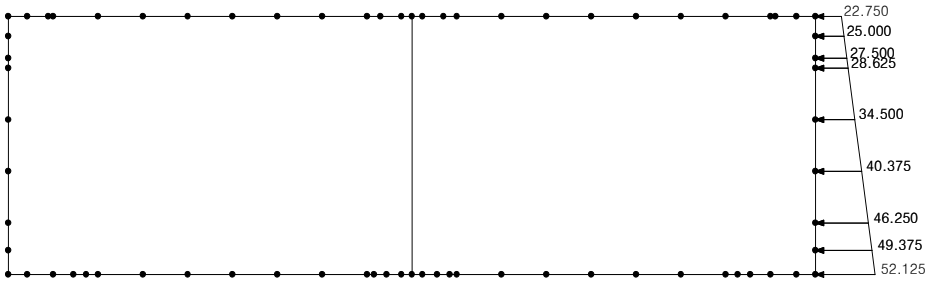
13) CASE13 - 양토압 : 지하수有(SOILBW)



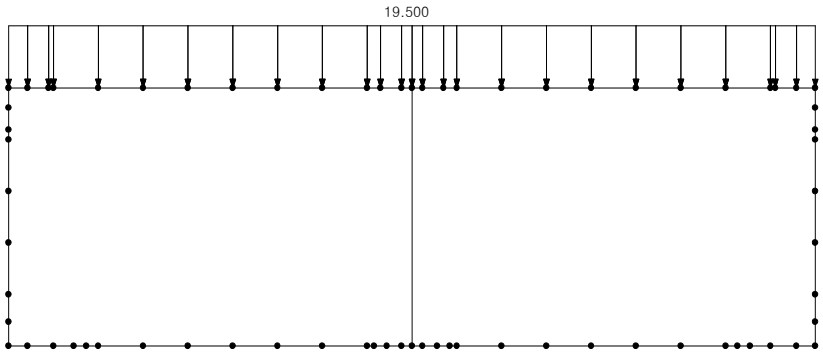
14) CASE14 - 편토압(좌측) : 지하수有(SOILLW)



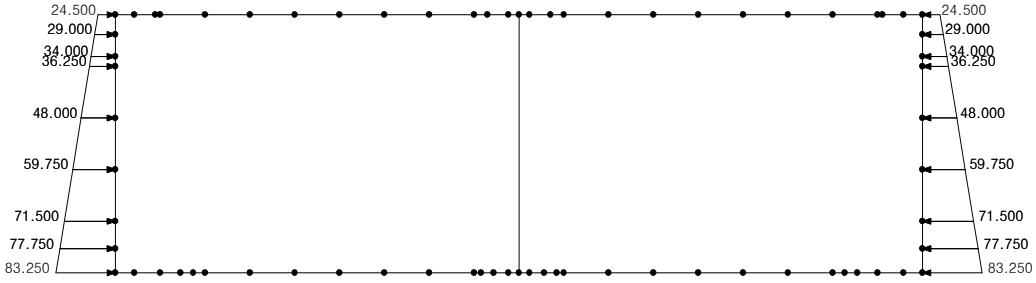
15) CASE15 - 편토압(우측) : 지하수有(SOILRW)



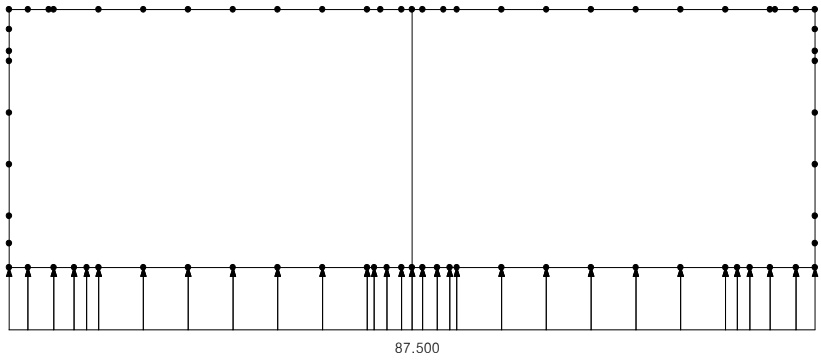
16) CASE16 - 연직수압(WATERV)



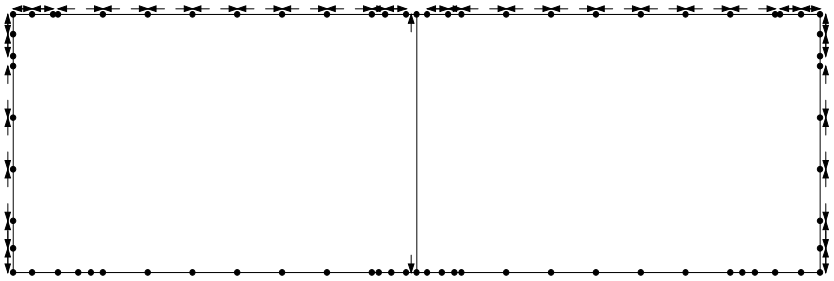
17) CASE17 - 수평수압(WATERH)



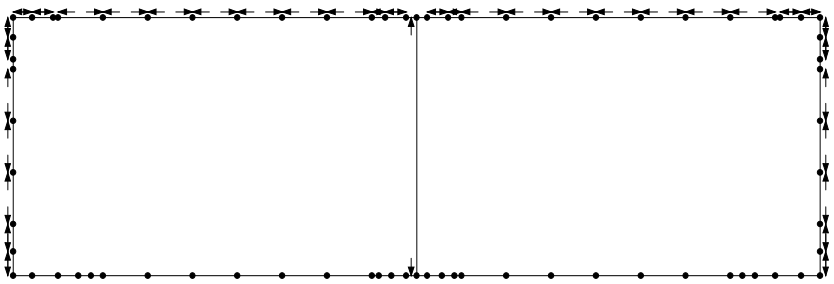
18) CASE18 - 부력(BUOYANCY)



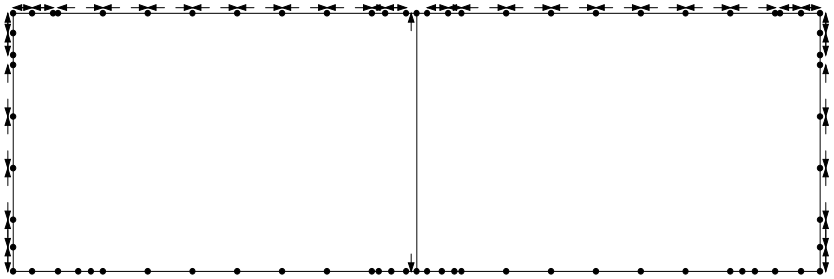
19) CASE19 - 온도변화(+) +10° C(TEMPPLUS)



20) CASE20 - 온도변화(-) -10° C(TEMPMINU)

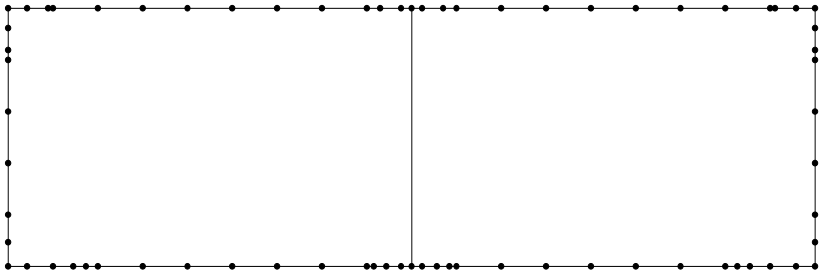


21) CASE21 - 건조수축 -15° C(SHRINK)

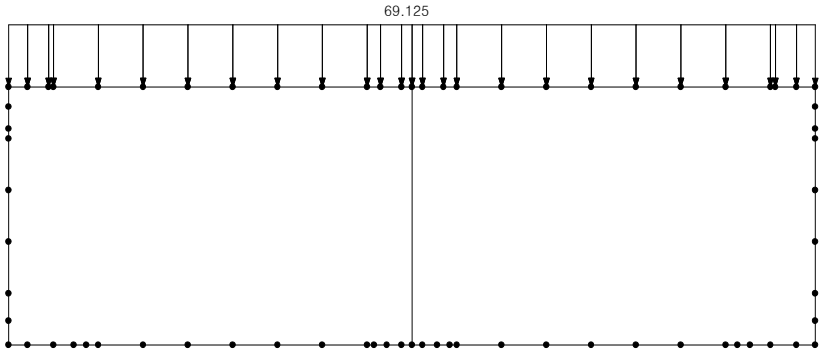


12. 하중 재하 (기능수행)

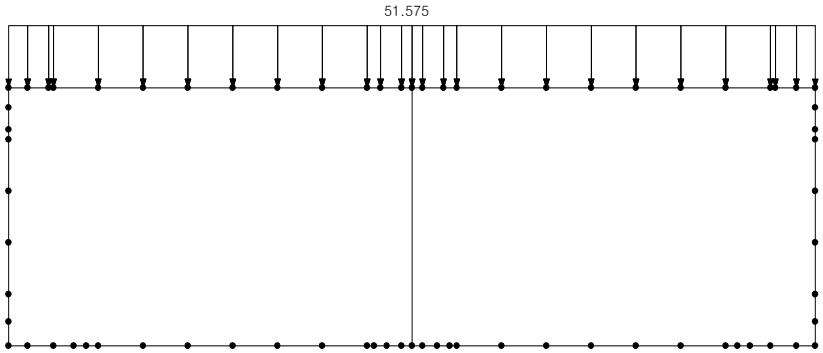
1) CASE1 - 구체자중(SW)



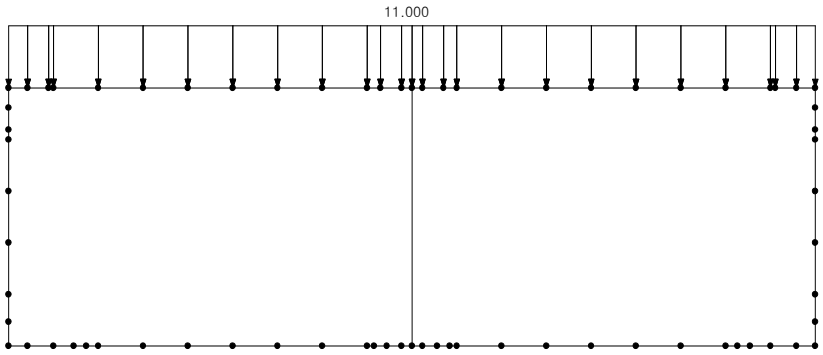
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



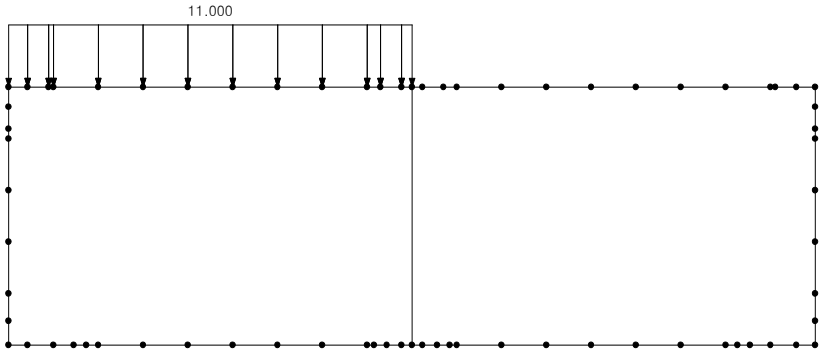
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



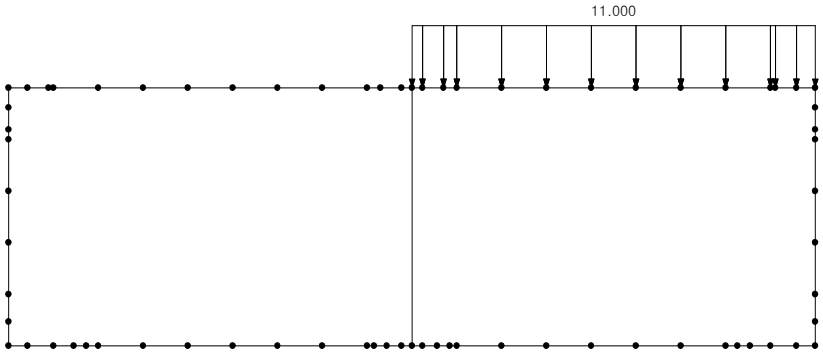
4) CASE4 - 지진시 만재활하중(LIVEFUE)



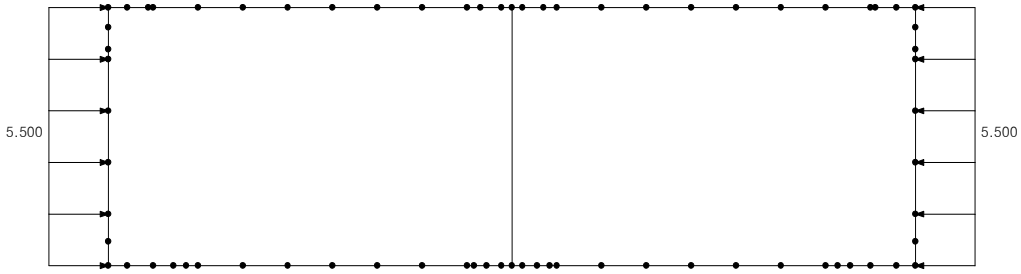
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



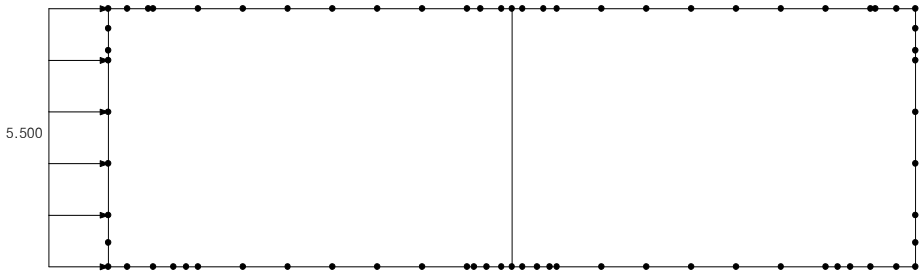
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



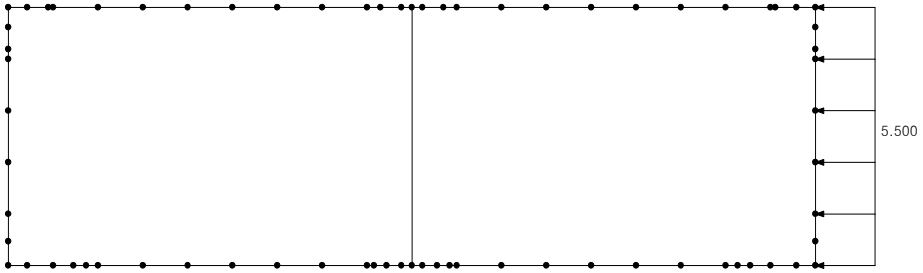
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



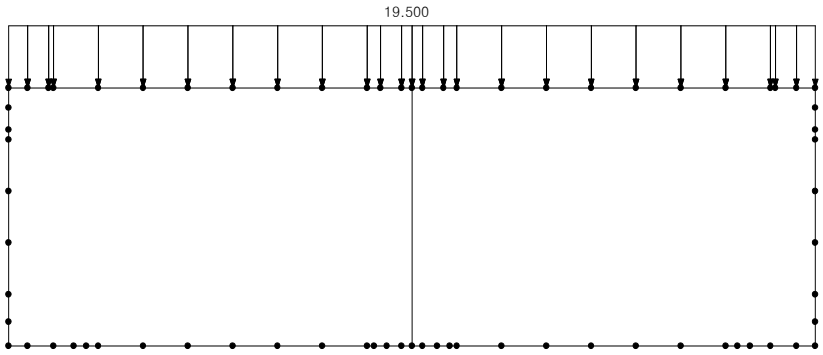
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



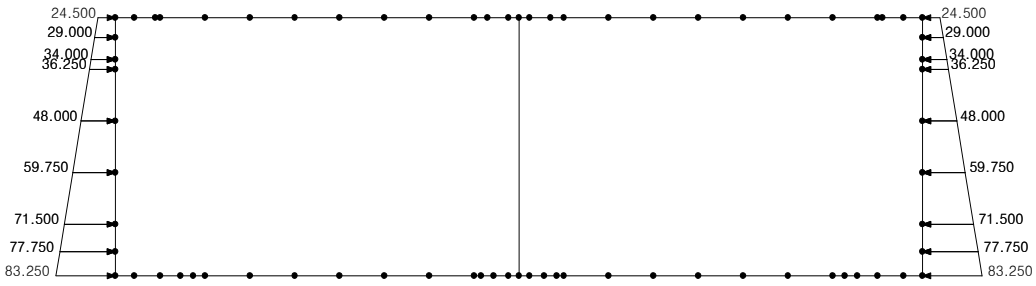
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



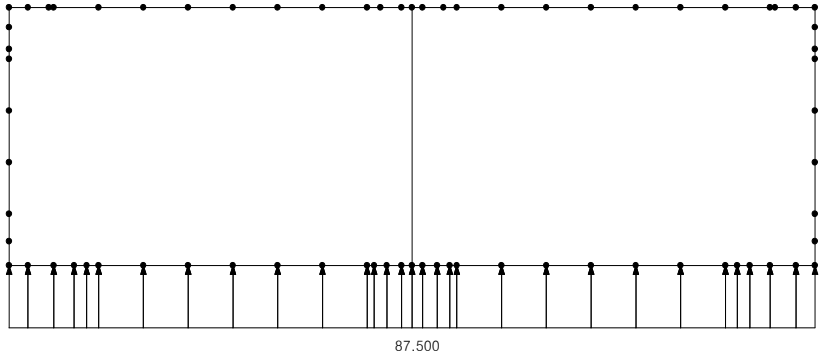
10) CASE10 - 연직수압(WATERV)



11) CASE11 - 수평수압(WATERH)

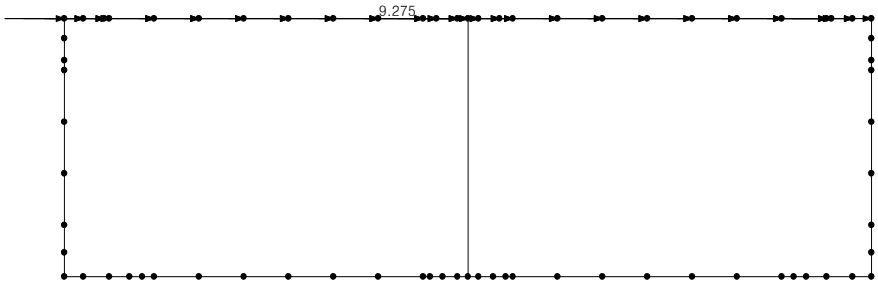


12) CASE12 - 부력(BUOYANCY)

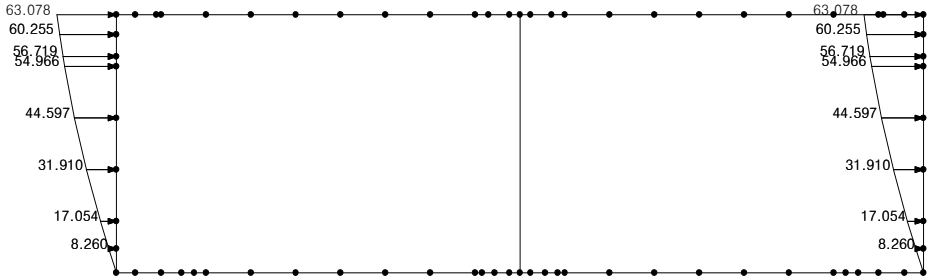


- 지진재하방향(좌측에서 우측으로)

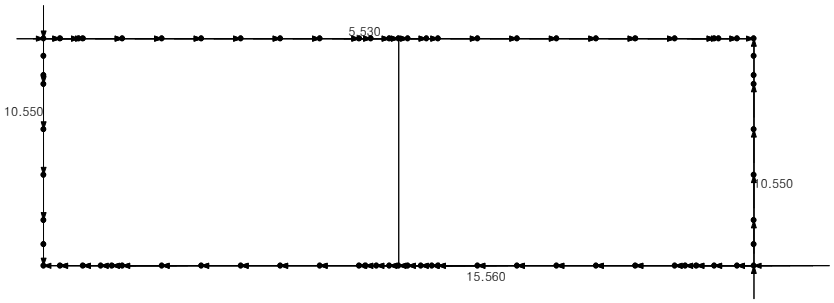
13) CASE13 - 슬래브 지반변위(기능수행)(FUNSLAB)



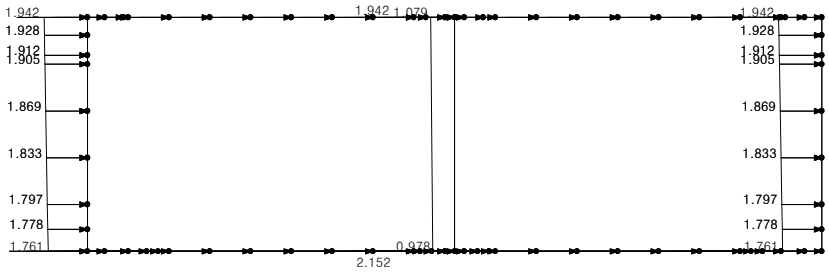
14) CASE14 - 벽체 지반변위(기능수행)(FUNWALL)



15) CASE15 - 주면전단력(기능수행)(FUNMS)

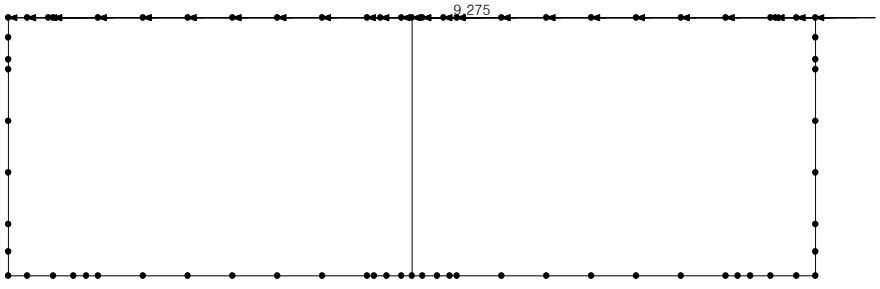


16) CASE16 - 구체 관성력(기능수행)(FUNINER)

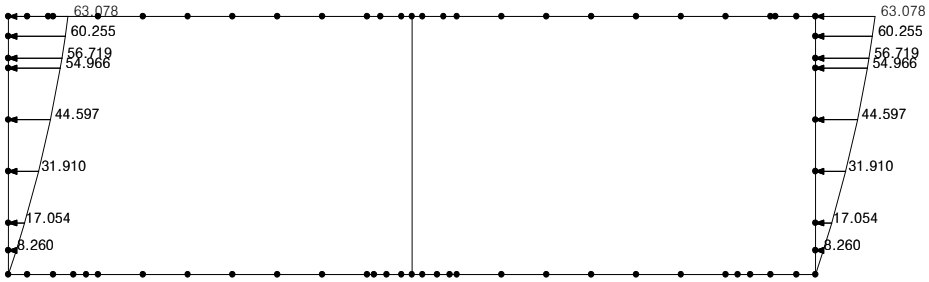


- 지진재하방향(우측에서 좌측으로)

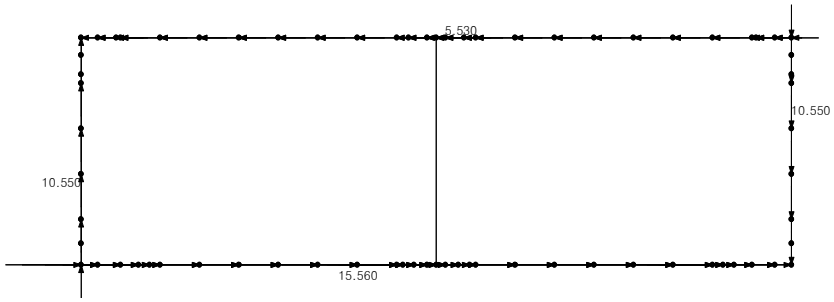
17) CASE17 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



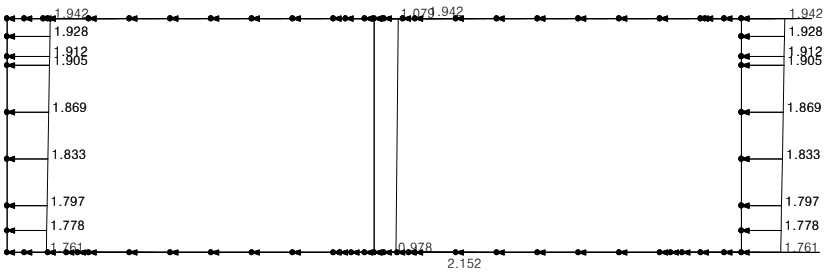
18) CASE18 - 벽체 지반변위(기능수행)2(FUNWALL2)



19) CASE19 - 주면전단력(기능수행)2(FUNMS2)

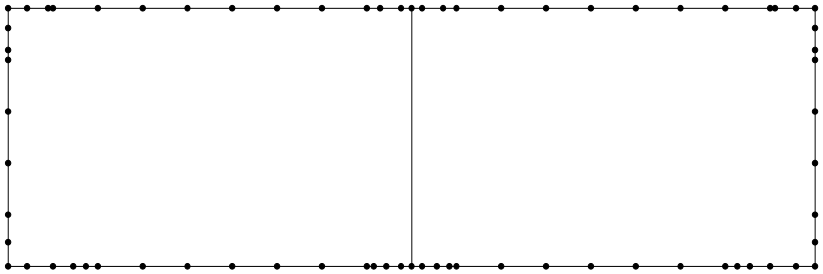


20) CASE20 - 구체 관성력(기능수행)2(FUNINER2)

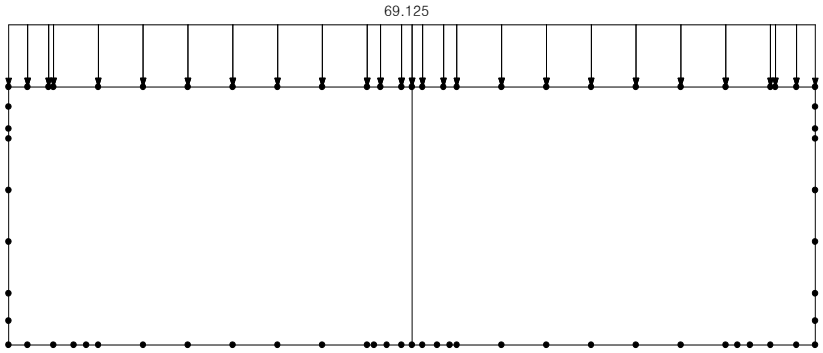


13. 하중 재하 (붕괴방지)

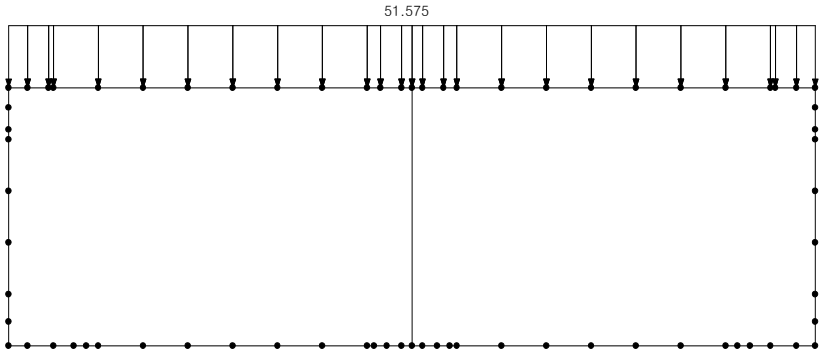
1) CASE1 - 구체자중(SW)



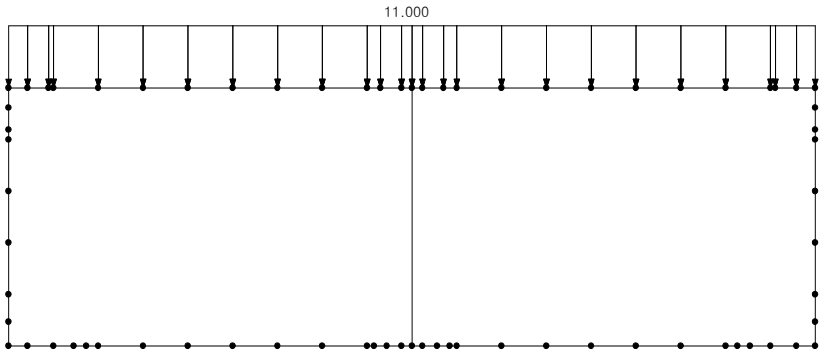
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



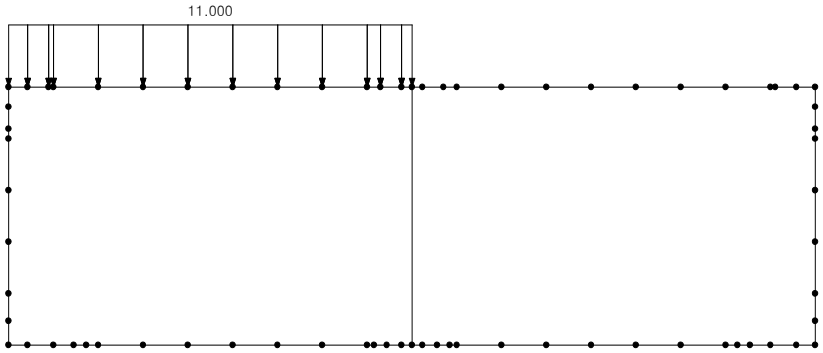
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



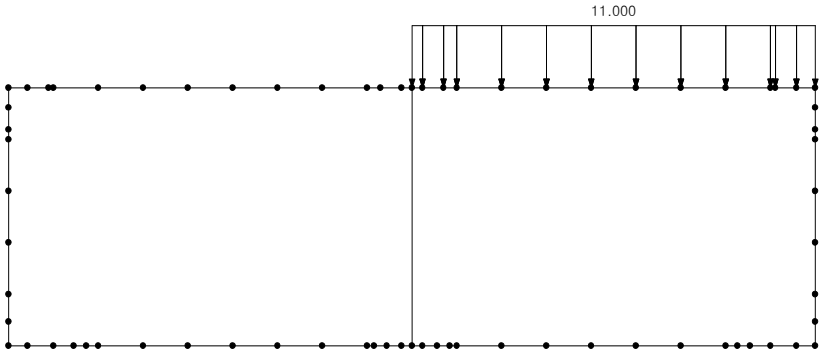
4) CASE4 - 지진시 만재활하중(LIVEFUE)



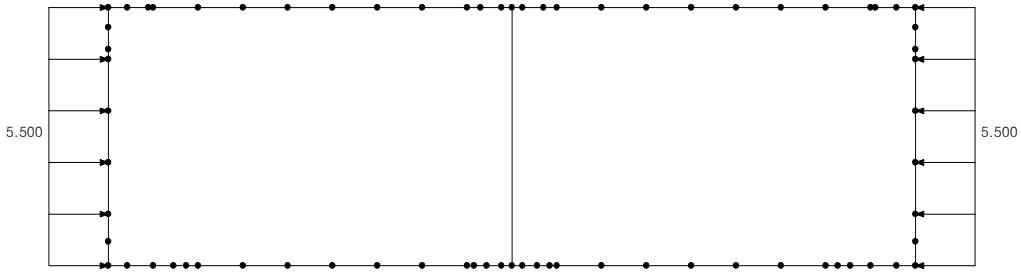
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



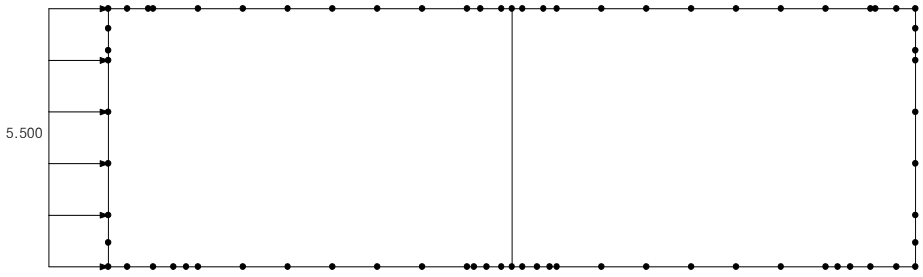
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



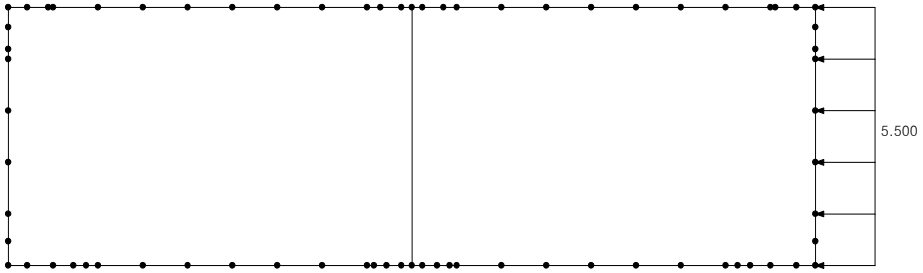
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



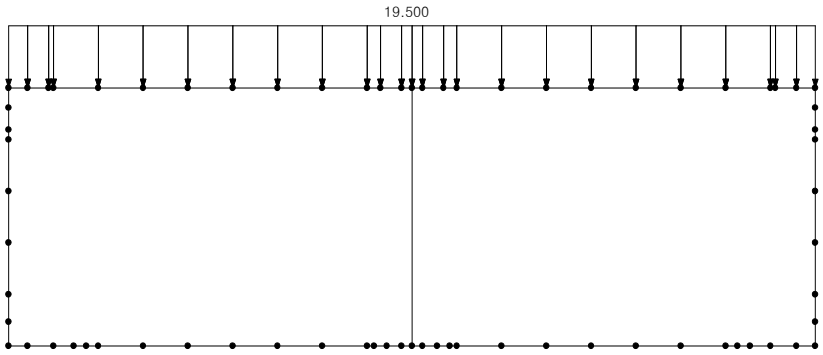
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



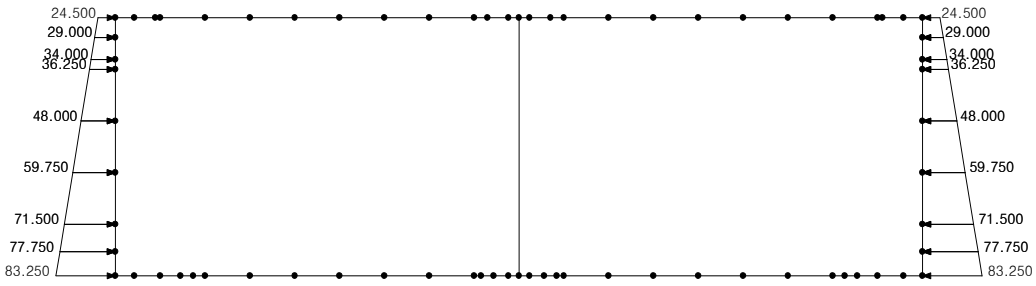
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



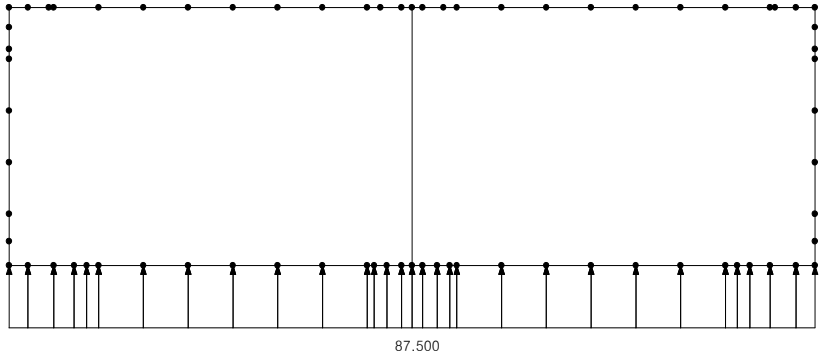
10) CASE10 - 연직수압(WATERV)



11) CASE11 - 수평수압(WATERH)

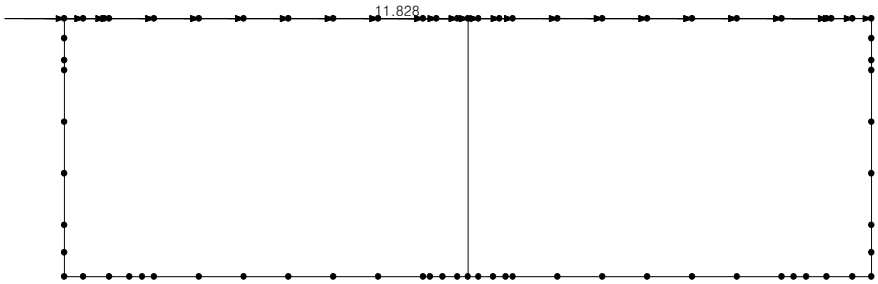


12) CASE12 - 부력(BUOYANCY)

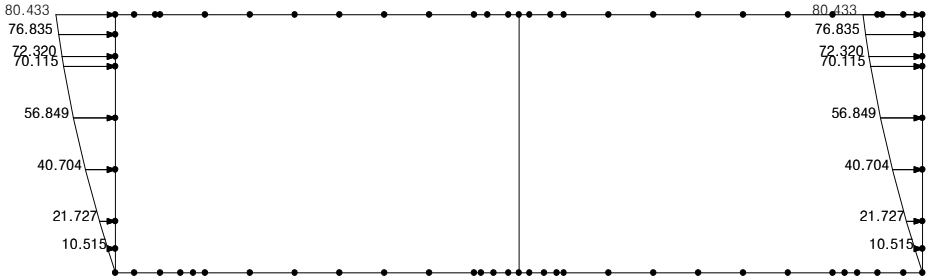


- 지진재하방향(좌측에서 우측으로)

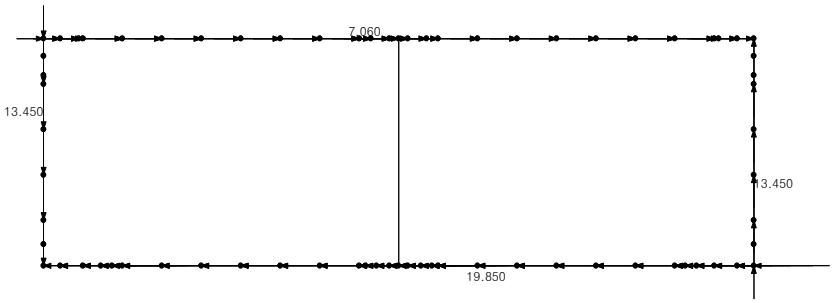
13) CASE13 - 슬래브 지반변위(붕괴방지)(COLSLAB)



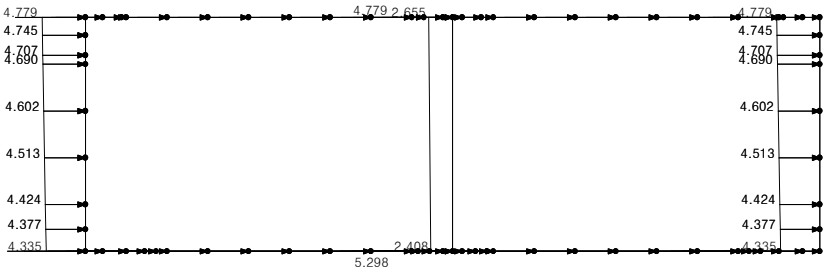
14) CASE14 - 벽체 지반변위(붕괴방지)(COLWALL)



15) CASE15 - 주면전단력(붕괴방지)(COLMS)

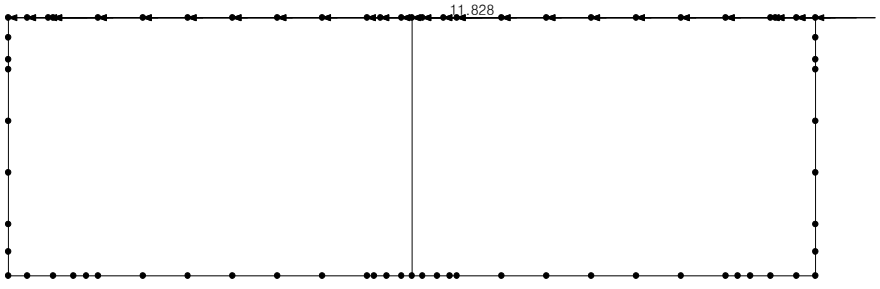


16) CASE16 - 구체 관성력(붕괴방지)(COLINER)

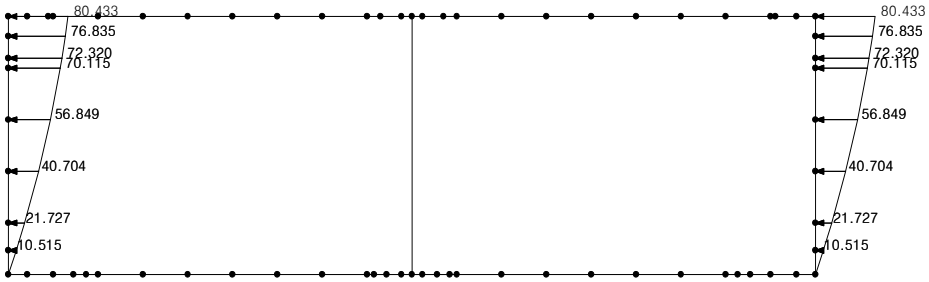


- 지진재하방향(우측에서 좌측으로)

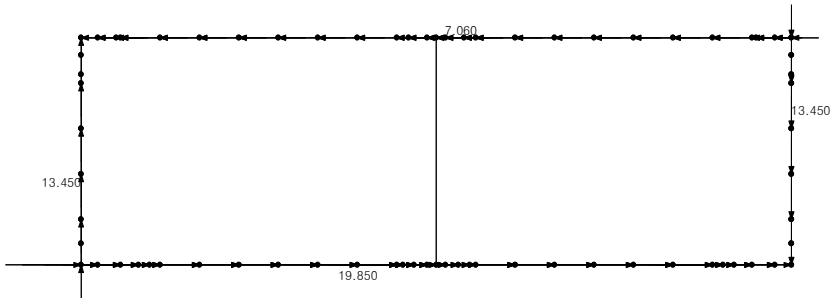
17) CASE17 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



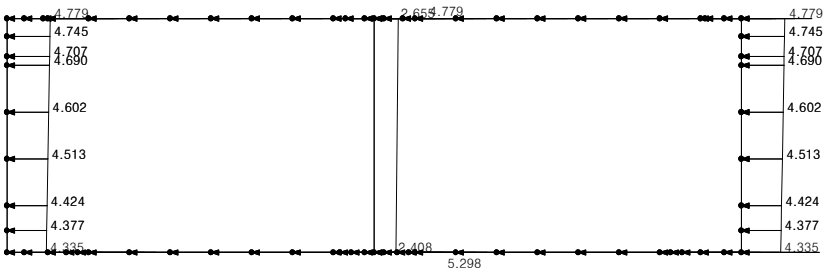
18) CASE18 - 벽체 지반변위(붕괴방지)2(COLWALL2)



19) CASE19 - 주면전단력(붕괴방지)2(COLMS2)



20) CASE20 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 0.975, h = 3.000 m

1) 계수하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.400						
LC2	1.200	1.560	1.600	1.600	1.200		
LC3	1.200		1.000				
LC4	1.200	1.560	1.600	0.800	1.200		
LC5	0.900	0.900		1.600			
LC6	0.900	0.900		0.800			
LC7	1.200	1.560	1.600	1.600	1.200	1.200	●
LC8	1.200	1.560	1.600	0.800	1.200	1.200	●
LC9	0.900	0.900		1.600			●
LC10	0.900	0.900		0.800			●

2) 사용하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.000						
LC2	1.000	1.000	1.000	1.000	1.000		
LC3	1.000		1.000				
LC4	1.000	1.000	1.000	0.500	1.000		
LC5	1.000	1.000		1.000			
LC6	1.000	1.000		0.500			
LC7	1.000	1.000	1.000	1.000	1.000	1.000	●
LC8	1.000	1.000	1.000	0.500	1.000	1.000	●
LC9	1.000	1.000		1.000			●
LC10	1.000	1.000		0.500			●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

15. INPUT DATA (상시)

```
; ACulvert SAP2000 데이터파일 : 평상시
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.000 Y=     0.000 Z=     0.500
  2    X=     0.450 Y=     0.000 Z=     0.500
  3    X=     1.067 Y=     0.000 Z=     0.500
  4    X=     1.550 Y=     0.000 Z=     0.500
  5    X=     1.850 Y=     0.000 Z=     0.500
  6    X=     2.133 Y=     0.000 Z=     0.500
  7    X=     3.200 Y=     0.000 Z=     0.500
  8    X=     4.267 Y=     0.000 Z=     0.500
  9    X=     5.333 Y=     0.000 Z=     0.500
  10   X=     6.400 Y=     0.000 Z=     0.500
  11   X=     7.467 Y=     0.000 Z=     0.500
  12   X=     8.533 Y=     0.000 Z=     0.500
  13   X=     8.700 Y=     0.000 Z=     0.500
  14   X=     9.000 Y=     0.000 Z=     0.500
  15   X=     9.350 Y=     0.000 Z=     0.500
  16   X=     9.600 Y=     0.000 Z=     0.500
  17   X=     9.850 Y=     0.000 Z=     0.500
  18   X=    10.200 Y=     0.000 Z=     0.500
  19   X=    10.500 Y=     0.000 Z=     0.500
  20   X=    10.667 Y=     0.000 Z=     0.500
  21   X=    11.733 Y=     0.000 Z=     0.500
  22   X=    12.800 Y=     0.000 Z=     0.500
  23   X=    13.867 Y=     0.000 Z=     0.500
  24   X=    14.933 Y=     0.000 Z=     0.500
  25   X=    16.000 Y=     0.000 Z=     0.500
  26   X=    17.067 Y=     0.000 Z=     0.500
  27   X=    17.350 Y=     0.000 Z=     0.500
  28   X=    17.650 Y=     0.000 Z=     0.500
  29   X=    18.133 Y=     0.000 Z=     0.500
  30   X=    18.750 Y=     0.000 Z=     0.500
  31   X=    19.200 Y=     0.000 Z=     0.500
  32   X=    19.200 Y=     0.000 Z=     1.050
  33   X=    19.200 Y=     0.000 Z=     1.675
  34   X=    19.200 Y=     0.000 Z=     2.850
  35   X=    19.200 Y=     0.000 Z=     4.025
  36   X=    19.200 Y=     0.000 Z=     5.200
  37   X=    19.200 Y=     0.000 Z=     5.425
  38   X=    19.200 Y=     0.000 Z=     5.925
  39   X=    19.200 Y=     0.000 Z=     6.375
  40   X=    18.750 Y=     0.000 Z=     6.375
  41   X=    18.250 Y=     0.000 Z=     6.375
  42   X=    18.133 Y=     0.000 Z=     6.375
  43   X=    17.067 Y=     0.000 Z=     6.375
  44   X=    16.000 Y=     0.000 Z=     6.375
  45   X=    14.933 Y=     0.000 Z=     6.375
  46   X=    13.867 Y=     0.000 Z=     6.375
  47   X=    12.800 Y=     0.000 Z=     6.375
  48   X=    11.733 Y=     0.000 Z=     6.375
  49   X=    10.667 Y=     0.000 Z=     6.375
  50   X=    10.350 Y=     0.000 Z=     6.375
  51   X=     9.850 Y=     0.000 Z=     6.375
  52   X=     9.600 Y=     0.000 Z=     6.375
  53   X=     9.350 Y=     0.000 Z=     6.375
  54   X=     8.850 Y=     0.000 Z=     6.375
  55   X=     8.533 Y=     0.000 Z=     6.375
  56   X=     7.467 Y=     0.000 Z=     6.375
  57   X=     6.400 Y=     0.000 Z=     6.375
  58   X=     5.333 Y=     0.000 Z=     6.375
  59   X=     4.267 Y=     0.000 Z=     6.375
  60   X=     3.200 Y=     0.000 Z=     6.375
  61   X=     2.133 Y=     0.000 Z=     6.375
  62   X=     1.067 Y=     0.000 Z=     6.375
  63   X=     0.950 Y=     0.000 Z=     6.375
  64   X=     0.450 Y=     0.000 Z=     6.375
  65   X=     0.000 Y=     0.000 Z=     6.375
  66   X=     0.000 Y=     0.000 Z=     5.925
  67   X=     0.000 Y=     0.000 Z=     5.425
  68   X=     0.000 Y=     0.000 Z=     5.200
  69   X=     0.000 Y=     0.000 Z=     4.025
  70   X=     0.000 Y=     0.000 Z=     2.850
  71   X=     0.000 Y=     0.000 Z=     1.675
  72   X=     0.000 Y=     0.000 Z=     1.050
  73   X=     0.000 Y=     0.000 Z=     0.000
  74   X=     1.067 Y=     0.000 Z=     0.000
  75   X=     2.133 Y=     0.000 Z=     0.000
  76   X=     3.200 Y=     0.000 Z=     0.000
  77   X=     4.267 Y=     0.000 Z=     0.000
  78   X=     5.333 Y=     0.000 Z=     0.000
  79   X=     6.400 Y=     0.000 Z=     0.000
  80   X=     7.467 Y=     0.000 Z=     0.000
  81   X=     8.533 Y=     0.000 Z=     0.000
  82   X=     9.600 Y=     0.000 Z=     0.000
  83   X=    10.667 Y=     0.000 Z=     0.000
  84   X=    11.733 Y=     0.000 Z=     0.000
  85   X=    12.800 Y=     0.000 Z=     0.000
  86   X=    13.867 Y=     0.000 Z=     0.000
  87   X=    14.933 Y=     0.000 Z=     0.000
  88   X=    16.000 Y=     0.000 Z=     0.000
  89   X=    17.067 Y=     0.000 Z=     0.000
  90   X=    18.133 Y=     0.000 Z=     0.000
  91   X=    19.200 Y=     0.000 Z=     0.000
RESTRAINT
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=1 UX=1e+010
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=41990. CE=0.99999 K=41990. OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=45548.5 CE=0.99999 K=45548.5 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.1,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=0.85,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.175 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.175 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.325 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    38 J= 38,  39 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    39 J= 39,  40 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 3 NSEG= 4 ANG=0
```

```
    42 J= 42,  43 SEC= 3 NSEG= 4 ANG=0
    43 J= 43,  44 SEC= 3 NSEG= 4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    51 J= 51,  52 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    52 J= 52,  53 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 NSEG= 4 ANG=0
    55 J= 55,  56 SEC= 3 NSEG= 4 ANG=0
    56 J= 56,  57 SEC= 3 NSEG= 4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    64 J= 64,  65 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    65 J= 65,  66 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    66 J= 66,  67 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    67 J= 67,  68 SEC= 3 NSEG= 4 ANG=180
    68 J= 68,  69 SEC= 3 NSEG= 4 ANG=180
    69 J= 69,  70 SEC= 3 NSEG= 4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,   1 SEC= 3 IOFF=0 JOFF=0.325 RIGID=1 NSEG=4 ANG=180
    73 J= 52,  16 SEC= 5 IOFF=0.7 JOFF=0.425 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,73 NLP=1 ANG=0
     2 J= 3,74 NLP=2 ANG=0
     3 J= 6,75 NLP=2 ANG=0
     4 J= 7,76 NLP=2 ANG=0
     5 J= 8,77 NLP=2 ANG=0
     6 J= 9,78 NLP=2 ANG=0
     7 J=10,79 NLP=2 ANG=0
     8 J=11,80 NLP=2 ANG=0
     9 J=12,81 NLP=2 ANG=0
    10 J=16,82 NLP=2 ANG=0
    11 J=20,83 NLP=2 ANG=0
    12 J=21,84 NLP=2 ANG=0
    13 J=22,85 NLP=2 ANG=0
    14 J=23,86 NLP=2 ANG=0
    15 J=24,87 NLP=2 ANG=0
    16 J=25,88 NLP=2 ANG=0
    17 J=26,89 NLP=2 ANG=0
    18 J=29,90 NLP=2 ANG=0
    19 J=31,91 NLP=1 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-69.125, -69.125
      ADD=40 RD=0,1 UZ=-69.125, -69.125
      ADD=41 RD=0,1 UZ=-69.125, -69.125
      ADD=42 RD=0,1 UZ=-69.125, -69.125
      ADD=43 RD=0,1 UZ=-69.125, -69.125
      ADD=44 RD=0,1 UZ=-69.125, -69.125
      ADD=45 RD=0,1 UZ=-69.125, -69.125
      ADD=46 RD=0,1 UZ=-69.125, -69.125
      ADD=47 RD=0,1 UZ=-69.125, -69.125
      ADD=48 RD=0,1 UZ=-69.125, -69.125
      ADD=49 RD=0,1 UZ=-69.125, -69.125
      ADD=50 RD=0,1 UZ=-69.125, -69.125
      ADD=51 RD=0,1 UZ=-69.125, -69.125
      ADD=52 RD=0,1 UZ=-69.125, -69.125
      ADD=53 RD=0,1 UZ=-69.125, -69.125
      ADD=54 RD=0,1 UZ=-69.125, -69.125
      ADD=55 RD=0,1 UZ=-69.125, -69.125
      ADD=56 RD=0,1 UZ=-69.125, -69.125
      ADD=57 RD=0,1 UZ=-69.125, -69.125
      ADD=58 RD=0,1 UZ=-69.125, -69.125
      ADD=59 RD=0,1 UZ=-69.125, -69.125
      ADD=60 RD=0,1 UZ=-69.125, -69.125
      ADD=61 RD=0,1 UZ=-69.125, -69.125
      ADD=62 RD=0,1 UZ=-69.125, -69.125
      ADD=63 RD=0,1 UZ=-69.125, -69.125
      ADD=64 RD=0,1 UZ=-69.125, -69.125
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-51.575, -51.575
      ADD=40 RD=0,1 UZ=-51.575, -51.575
      ADD=41 RD=0,1 UZ=-51.575, -51.575
      ADD=42 RD=0,1 UZ=-51.575, -51.575
      ADD=43 RD=0,1 UZ=-51.575, -51.575
      ADD=44 RD=0,1 UZ=-51.575, -51.575
      ADD=45 RD=0,1 UZ=-51.575, -51.575
      ADD=46 RD=0,1 UZ=-51.575, -51.575
      ADD=47 RD=0,1 UZ=-51.575, -51.575
      ADD=48 RD=0,1 UZ=-51.575, -51.575
      ADD=49 RD=0,1 UZ=-51.575, -51.575
      ADD=50 RD=0,1 UZ=-51.575, -51.575
      ADD=51 RD=0,1 UZ=-51.575, -51.575
      ADD=52 RD=0,1 UZ=-51.575, -51.575
      ADD=53 RD=0,1 UZ=-51.575, -51.575
      ADD=54 RD=0,1 UZ=-51.575, -51.575
      ADD=55 RD=0,1 UZ=-51.575, -51.575
      ADD=56 RD=0,1 UZ=-51.575, -51.575
      ADD=57 RD=0,1 UZ=-51.575, -51.575
      ADD=58 RD=0,1 UZ=-51.575, -51.575
      ADD=59 RD=0,1 UZ=-51.575, -51.575
      ADD=60 RD=0,1 UZ=-51.575, -51.575
      ADD=61 RD=0,1 UZ=-51.575, -51.575
      ADD=62 RD=0,1 UZ=-51.575, -51.575
      ADD=63 RD=0,1 UZ=-51.575, -51.575
      ADD=64 RD=0,1 UZ=-51.575, -51.575
NAME=LIVEFU  ; 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11, -11
      ADD=40 RD=0,1 UZ=-11, -11
      ADD=41 RD=0,1 UZ=-11, -11
      ADD=42 RD=0,1 UZ=-11, -11
      ADD=43 RD=0,1 UZ=-11, -11
      ADD=44 RD=0,1 UZ=-11, -11
      ADD=45 RD=0,1 UZ=-11, -11
      ADD=46 RD=0,1 UZ=-11, -11
      ADD=47 RD=0,1 UZ=-11, -11
      ADD=48 RD=0,1 UZ=-11, -11
      ADD=49 RD=0,1 UZ=-11, -11
      ADD=50 RD=0,1 UZ=-11, -11
      ADD=51 RD=0,1 UZ=-11, -11
      ADD=52 RD=0,1 UZ=-11, -11
      ADD=53 RD=0,1 UZ=-11, -11
      ADD=54 RD=0,1 UZ=-11, -11
      ADD=55 RD=0,1 UZ=-11, -11
      ADD=56 RD=0,1 UZ=-11, -11
      ADD=57 RD=0,1 UZ=-11, -11
      ADD=58 RD=0,1 UZ=-11, -11
      ADD=59 RD=0,1 UZ=-11, -11
      ADD=60 RD=0,1 UZ=-11, -11
      ADD=61 RD=0,1 UZ=-11, -11
      ADD=62 RD=0,1 UZ=-11, -11
      ADD=63 RD=0,1 UZ=-11, -11
      ADD=64 RD=0,1 UZ=-11, -11
NAME=LIVELE  ; 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=52 RD=0,1 UZ=-11, -11
      ADD=53 RD=0,1 UZ=-11, -11
      ADD=54 RD=0,1 UZ=-11, -11
      ADD=55 RD=0,1 UZ=-11, -11
      ADD=56 RD=0,1 UZ=-11, -11
      ADD=57 RD=0,1 UZ=-11, -11
      ADD=58 RD=0,1 UZ=-11, -11
      ADD=59 RD=0,1 UZ=-11, -11
      ADD=60 RD=0,1 UZ=-11, -11
      ADD=61 RD=0,1 UZ=-11, -11
      ADD=62 RD=0,1 UZ=-11, -11
      ADD=63 RD=0,1 UZ=-11, -11
      ADD=64 RD=0,1 UZ=-11, -11
NAME=LIVERI  ; 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11, -11
      ADD=40 RD=0,1 UZ=-11, -11
      ADD=41 RD=0,1 UZ=-11, -11
      ADD=42 RD=0,1 UZ=-11, -11
      ADD=43 RD=0,1 UZ=-11, -11
      ADD=44 RD=0,1 UZ=-11, -11
      ADD=45 RD=0,1 UZ=-11, -11
      ADD=46 RD=0,1 UZ=-11, -11
      ADD=47 RD=0,1 UZ=-11, -11
      ADD=48 RD=0,1 UZ=-11, -11
      ADD=49 RD=0,1 UZ=-11, -11
      ADD=50 RD=0,1 UZ=-11, -11
      ADD=51 RD=0,1 UZ=-11, -11
NAME=LIVEFUH  ; 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5, 5
      ADD=66 RD=0,1 UX=5, 5
      ADD=67 RD=0,1 UX=5, 5
      ADD=68 RD=0,1 UX=5, 5
      ADD=69 RD=0,1 UX=5, 5
      ADD=70 RD=0,1 UX=5, 5
      ADD=71 RD=0,1 UX=5, 5
      ADD=72 RD=0,1 UX=5, 5
      ADD=31 RD=0,1 UX=-5, -5
      ADD=32 RD=0,1 UX=-5, -5
```

```
      ADD=33 RD=0,1 UX=-5, -5
      ADD=34 RD=0,1 UX=-5, -5
      ADD=35 RD=0,1 UX=-5, -5
      ADD=36 RD=0,1 UX=-5, -5
      ADD=37 RD=0,1 UX=-5, -5
      ADD=38 RD=0,1 UX=-5, -5
NAME=LIVELEH  ; 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.5, 5.5
      ADD=66 RD=0,1 UX=5.5, 5.5
      ADD=67 RD=0,1 UX=5.5, 5.5
      ADD=68 RD=0,1 UX=5.5, 5.5
      ADD=69 RD=0,1 UX=5.5, 5.5
      ADD=70 RD=0,1 UX=5.5, 5.5
      ADD=71 RD=0,1 UX=5.5, 5.5
      ADD=72 RD=0,1 UX=5.5, 5.5
NAME=LIVERIH  ; 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-5.5, -5.5
      ADD=32 RD=0,1 UX=-5.5, -5.5
      ADD=33 RD=0,1 UX=-5.5, -5.5
      ADD=34 RD=0,1 UX=-5.5, -5.5
      ADD=35 RD=0,1 UX=-5.5, -5.5
      ADD=36 RD=0,1 UX=-5.5, -5.5
      ADD=37 RD=0,1 UX=-5.5, -5.5
      ADD=38 RD=0,1 UX=-5.5, -5.5
NAME=SOILB  ; 양토압 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=33.775, 38.05
      ADD=66 RD=0,1 UX=38.05, 42.8
      ADD=67 RD=0,1 UX=42.8, 44.938
      ADD=68 RD=0,1 UX=44.938, 56.1
      ADD=69 RD=0,1 UX=56.1, 67.263
      ADD=70 RD=0,1 UX=67.263, 78.425
      ADD=71 RD=0,1 UX=78.425, 84.363
      ADD=72 RD=0,1 UX=84.363, 89.588
      ADD=31 RD=0,1 UX=-89.588, -84.363
      ADD=32 RD=0,1 UX=-84.363, -78.425
      ADD=33 RD=0,1 UX=-78.425, -67.263
      ADD=34 RD=0,1 UX=-67.263, -56.1
      ADD=35 RD=0,1 UX=-56.1, -44.938
      ADD=36 RD=0,1 UX=-44.938, -42.8
      ADD=37 RD=0,1 UX=-42.8, -38.05
      ADD=38 RD=0,1 UX=-38.05, -33.775
NAME=SOILL  ; 편토압(좌측) : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=33.775, 38.05
      ADD=66 RD=0,1 UX=38.05, 42.8
      ADD=67 RD=0,1 UX=42.8, 44.938
      ADD=68 RD=0,1 UX=44.938, 56.1
      ADD=69 RD=0,1 UX=56.1, 67.263
      ADD=70 RD=0,1 UX=67.263, 78.425
      ADD=71 RD=0,1 UX=78.425, 84.363
      ADD=72 RD=0,1 UX=84.363, 89.588
NAME=SOILR  ; 편토압(우측) : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-89.588, -84.363
      ADD=32 RD=0,1 UX=-84.363, -78.425
      ADD=33 RD=0,1 UX=-78.425, -67.263
      ADD=34 RD=0,1 UX=-67.263, -56.1
      ADD=35 RD=0,1 UX=-56.1, -44.938
      ADD=36 RD=0,1 UX=-44.938, -42.8
      ADD=37 RD=0,1 UX=-42.8, -38.05
      ADD=38 RD=0,1 UX=-38.05, -33.775
NAME=SOILBW  ; 양토압 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=22.75, 25
      ADD=66 RD=0,1 UX=25, 27.5
      ADD=67 RD=0,1 UX=27.5, 28.625
      ADD=68 RD=0,1 UX=28.625, 34.5
      ADD=69 RD=0,1 UX=34.5, 40.375
      ADD=70 RD=0,1 UX=40.375, 46.25
      ADD=71 RD=0,1 UX=46.25, 49.375
      ADD=72 RD=0,1 UX=49.375, 52.125
      ADD=31 RD=0,1 UX=-52.125, -49.375
      ADD=32 RD=0,1 UX=-49.375, -46.25
      ADD=33 RD=0,1 UX=-46.25, -40.375
      ADD=34 RD=0,1 UX=-40.375, -34.5
      ADD=35 RD=0,1 UX=-34.5, -28.625
      ADD=36 RD=0,1 UX=-28.625, -27.5
      ADD=37 RD=0,1 UX=-27.5, -25
      ADD=38 RD=0,1 UX=-25, -22.75
NAME=SOILLW  ; 편토압(좌측) : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=22.75, 25
      ADD=66 RD=0,1 UX=25, 27.5
      ADD=67 RD=0,1 UX=27.5, 28.625
      ADD=68 RD=0,1 UX=28.625, 34.5
      ADD=69 RD=0,1 UX=34.5, 40.375
      ADD=70 RD=0,1 UX=40.375, 46.25
      ADD=71 RD=0,1 UX=46.25, 49.375
      ADD=72 RD=0,1 UX=49.375, 52.125
NAME=SOILRW  ; 편토압(우측) : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-52.125, -49.375
      ADD=32 RD=0,1 UX=-49.375, -46.25
      ADD=33 RD=0,1 UX=-46.25, -40.375
      ADD=34 RD=0,1 UX=-40.375, -34.5
      ADD=35 RD=0,1 UX=-34.5, -28.625
      ADD=36 RD=0,1 UX=-28.625, -27.5
      ADD=37 RD=0,1 UX=-27.5, -25
      ADD=38 RD=0,1 UX=-25, -22.75
NAME=WATERV  ; 연직수압
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-19.5, -19.5
      ADD=40 RD=0,1 UZ=-19.5, -19.5
      ADD=41 RD=0,1 UZ=-19.5, -19.5
      ADD=42 RD=0,1 UZ=-19.5, -19.5
      ADD=43 RD=0,1 UZ=-19.5, -19.5
      ADD=44 RD=0,1 UZ=-19.5, -19.5
      ADD=45 RD=0,1 UZ=-19.5, -19.5
      ADD=46 RD=0,1 UZ=-19.5, -19.5
      ADD=47 RD=0,1 UZ=-19.5, -19.5
      ADD=48 RD=0,1 UZ=-19.5, -19.5
      ADD=49 RD=0,1 UZ=-19.5, -19.5
      ADD=50 RD=0,1 UZ=-19.5, -19.5
      ADD=51 RD=0,1 UZ=-19.5, -19.5
      ADD=52 RD=0,1 UZ=-19.5, -19.5
      ADD=53 RD=0,1 UZ=-19.5, -19.5
      ADD=54 RD=0,1 UZ=-19.5, -19.5
      ADD=55 RD=0,1 UZ=-19.5, -19.5
      ADD=56 RD=0,1 UZ=-19.5, -19.5
      ADD=57 RD=0,1 UZ=-19.5, -19.5
      ADD=58 RD=0,1 UZ=-19.5, -19.5
      ADD=59 RD=0,1 UZ=-19.5, -19.5
      ADD=60 RD=0,1 UZ=-19.5, -19.5
      ADD=61 RD=0,1 UZ=-19.5, -19.5
      ADD=62 RD=0,1 UZ=-19.5, -19.5
      ADD=63 RD=0,1 UZ=-19.5, -19.5
      ADD=64 RD=0,1 UZ=-19.5, -19.5
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=24.5, 29
      ADD=66 RD=0,1 UX=29, 34
      ADD=67 RD=0,1 UX=34, 36.25
      ADD=68 RD=0,1 UX=36.25, 48
      ADD=69 RD=0,1 UX=48, 59.75
      ADD=70 RD=0,1 UX=59.75, 71.5
      ADD=71 RD=0,1 UX=71.5, 77.75
      ADD=72 RD=0,1 UX=77.75, 83.25
      ADD=31 RD=0,1 UX=-83.25, -77.75
      ADD=32 RD=0,1 UX=-77.75, -71.5
      ADD=33 RD=0,1 UX=-71.5, -59.75
      ADD=34 RD=0,1 UX=-59.75, -48
      ADD=35 RD=0,1 UX=-48, -36.25
      ADD=36 RD=0,1 UX=-36.25, -34
      ADD=37 RD=0,1 UX=-34, -29
      ADD=38 RD=0,1 UX=-29, -24.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=87.5, 87.5
      ADD=2 RD=0,1 UZ=87.5, 87.5
      ADD=3 RD=0,1 UZ=87.5, 87.5
      ADD=4 RD=0,1 UZ=87.5, 87.5
      ADD=5 RD=0,1 UZ=87.5, 87.5
      ADD=6 RD=0,1 UZ=87.5, 87.5
      ADD=7 RD=0,1 UZ=87.5, 87.5
      ADD=8 RD=0,1 UZ=87.5, 87.5
      ADD=9 RD=0,1 UZ=87.5, 87.5
      ADD=10 RD=0,1 UZ=87.5, 87.5
      ADD=11 RD=0,1 UZ=87.5, 87.5
      ADD=12 RD=0,1 UZ=87.5, 87.5
      ADD=13 RD=0,1 UZ=87.5, 87.5
      ADD=14 RD=0,1 UZ=87.5, 87.5
      ADD=15 RD=0,1 UZ=87.5, 87.5
      ADD=16 RD=0,1 UZ=87.5, 87.5
      ADD=17 RD=0,1 UZ=87.5, 87.5
      ADD=18 RD=0,1 UZ=87.5, 87.5
      ADD=19 RD=0,1 UZ=87.5, 87.5
      ADD=20 RD=0,1 UZ=87.5, 87.5
      ADD=21 RD=0,1 UZ=87.5, 87.5
      ADD=22 RD=0,1 UZ=87.5, 87.5
      ADD=23 RD=0,1 UZ=87.5, 87.5
      ADD=24 RD=0,1 UZ=87.5, 87.5
      ADD=25 RD=0,1 UZ=87.5, 87.5
      ADD=26 RD=0,1 UZ=87.5, 87.5
      ADD=27 RD=0,1 UZ=87.5, 87.5
      ADD=28 RD=0,1 UZ=87.5, 87.5
      ADD=29 RD=0,1 UZ=87.5, 87.5
      ADD=30 RD=0,1 UZ=87.5, 87.5
```

```
NAME=TEMPPLUS  ; 온도변화(+)
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=10
      ADD=32 T=10
      ADD=33 T=10
      ADD=34 T=10
      ADD=35 T=10
      ADD=36 T=10
      ADD=37 T=10
      ADD=38 T=10
      ADD=39 T=10
      ADD=40 T=10
      ADD=41 T=10
      ADD=42 T=10
      ADD=43 T=10
      ADD=44 T=10
      ADD=45 T=10
      ADD=46 T=10
      ADD=47 T=10
      ADD=48 T=10
      ADD=49 T=10
      ADD=50 T=10
      ADD=51 T=10
      ADD=52 T=10
      ADD=53 T=10
      ADD=54 T=10
      ADD=55 T=10
      ADD=56 T=10
      ADD=57 T=10
      ADD=58 T=10
      ADD=59 T=10
      ADD=60 T=10
      ADD=61 T=10
      ADD=62 T=10
      ADD=63 T=10
      ADD=64 T=10
      ADD=65 T=10
      ADD=66 T=10
      ADD=67 T=10
      ADD=68 T=10
      ADD=69 T=10
      ADD=70 T=10
      ADD=71 T=10
      ADD=72 T=10
      ADD=73 T=10
NAME=TEMPMINU  ; 온도변화(-)
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=-10
      ADD=32 T=-10
      ADD=33 T=-10
      ADD=34 T=-10
      ADD=35 T=-10
      ADD=36 T=-10
      ADD=37 T=-10
      ADD=38 T=-10
      ADD=39 T=-10
      ADD=40 T=-10
      ADD=41 T=-10
      ADD=42 T=-10
      ADD=43 T=-10
      ADD=44 T=-10
      ADD=45 T=-10
      ADD=46 T=-10
      ADD=47 T=-10
      ADD=48 T=-10
      ADD=49 T=-10
      ADD=50 T=-10
      ADD=51 T=-10
      ADD=52 T=-10
      ADD=53 T=-10
      ADD=54 T=-10
      ADD=55 T=-10
      ADD=56 T=-10
      ADD=57 T=-10
      ADD=58 T=-10
      ADD=59 T=-10
      ADD=60 T=-10
      ADD=61 T=-10
      ADD=62 T=-10
      ADD=63 T=-10
      ADD=64 T=-10
      ADD=65 T=-10
      ADD=66 T=-10
      ADD=67 T=-10
      ADD=68 T=-10
      ADD=69 T=-10
      ADD=70 T=-10
      ADD=71 T=-10
      ADD=72 T=-10
      ADD=73 T=-10
NAME=SHRINK  ; 건조수축
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=-15
      ADD=32 T=-15
      ADD=33 T=-15
      ADD=34 T=-15
      ADD=35 T=-15
      ADD=36 T=-15
      ADD=37 T=-15
      ADD=38 T=-15
      ADD=39 T=-15
      ADD=40 T=-15
      ADD=41 T=-15
      ADD=42 T=-15
      ADD=43 T=-15
      ADD=44 T=-15
      ADD=45 T=-15
      ADD=46 T=-15
      ADD=47 T=-15
      ADD=48 T=-15
      ADD=49 T=-15
      ADD=50 T=-15
      ADD=51 T=-15
      ADD=52 T=-15
      ADD=53 T=-15
      ADD=54 T=-15
      ADD=55 T=-15
      ADD=56 T=-15
      ADD=57 T=-15
      ADD=58 T=-15
      ADD=59 T=-15
      ADD=60 T=-15
      ADD=61 T=-15
      ADD=62 T=-15
      ADD=63 T=-15
      ADD=64 T=-15
      ADD=65 T=-15
      ADD=66 T=-15
      ADD=67 T=-15
      ADD=68 T=-15
      ADD=69 T=-15
      ADD=70 T=-15
      ADD=71 T=-15
      ADD=72 T=-15
      ADD=73 T=-15
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFU
      LOAD=LIVELE
      LOAD=LIVERI
      LOAD=LIVEFUH
      LOAD=LIVELEH
      LOAD=LIVERIH
      LOAD=SOILB
      LOAD=SOILL
      LOAD=SOILR
      LOAD=SOILBW
      LOAD=SOILLW
      LOAD=SOILRW
      LOAD=WATERV
      LOAD=WATERH
      LOAD=BUOYANCY
      LOAD=TEMPPLUS
      LOAD=TEMPMINU
      LOAD=SHRINK
      NLLINK=*
HISTORY
    NAME=UL01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
       LOAD= SW             SF=1.400   AT=1
    NAME=UL02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
       LOAD= SW             SF=1.200   AT=1
       LOAD= PAVE           SF=1.560   AT=1
       LOAD= LIVEFU         SF=1.600   AT=1
       LOAD= LIVEFUH        SF=1.600   AT=1
       LOAD= SOILB          SF=1.600   AT=1
       LOAD= TEMPPLUS       SF=1.200   AT=1
       LOAD= SHRINK         SF=1.200   AT=1
    NAME=UL03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
       LOAD= SW             SF=1.200   AT=1
       LOAD= PAVE           SF=1.560   AT=1
       LOAD= LIVEFU         SF=1.600   AT=1
       LOAD= LIVEFUH        SF=1.600   AT=1
       LOAD= SOILB          SF=1.600   AT=1
       LOAD= TEMPMINU       SF=1.200   AT=1
       LOAD= SHRINK         SF=1.200   AT=1
    NAME=UL04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
       LOAD= SW             SF=1.200   AT=1
```

```
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
NAME=UL21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
NAME=UL22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
NAME=UL23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILR         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
```

```
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILB          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILB          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILL          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILL          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL33    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL34    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL35    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILB          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL36    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILB          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL37    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILL          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL38    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILL          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL39    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL40    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL41    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILB          SF=1.600   AT=1
NAME=UL42    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILL          SF=1.600   AT=1
NAME=UL43    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILR          SF=1.600   AT=1
NAME=UL44    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILB          SF=0.800   AT=1
NAME=UL45    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILL          SF=0.800   AT=1
NAME=UL46    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILR          SF=0.800   AT=1
NAME=UL47    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL48    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL49    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL50    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL51    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL52    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
```

```
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL53    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL54    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL55    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL56    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL57    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL58    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL59    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL60    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL61    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL62    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL63    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL64    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL65    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL66    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL67    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL68    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
```

```
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPMINU      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL69     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVEFU        SF=1.600    AT=1
    LOAD= LIVEFUH       SF=0.800    AT=1
    LOAD= SOILRW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPPLUS      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL70     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVEFU        SF=1.600    AT=1
    LOAD= LIVEFUH       SF=0.800    AT=1
    LOAD= SOILRW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPMINU      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL71     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVELE        SF=1.600    AT=1
    LOAD= LIVELEH       SF=0.800    AT=1
    LOAD= SOILBW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPPLUS      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL72     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVELE        SF=1.600    AT=1
    LOAD= LIVELEH       SF=0.800    AT=1
    LOAD= SOILBW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPMINU      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL73     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVELE        SF=1.600    AT=1
    LOAD= LIVELEH       SF=0.800    AT=1
    LOAD= SOILLW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPPLUS      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL74     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVELE        SF=1.600    AT=1
    LOAD= LIVELEH       SF=0.800    AT=1
    LOAD= SOILLW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPMINU      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL75     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVELE        SF=1.600    AT=1
    LOAD= LIVELEH       SF=0.800    AT=1
    LOAD= SOILRW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPPLUS      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL76     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVELE        SF=1.600    AT=1
    LOAD= LIVELEH       SF=0.800    AT=1
    LOAD= SOILRW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPMINU      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL77     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVERI        SF=1.600    AT=1
    LOAD= LIVERIH       SF=0.800    AT=1
    LOAD= SOILBW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPPLUS      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL78     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVERI        SF=1.600    AT=1
    LOAD= LIVERIH       SF=0.800    AT=1
    LOAD= SOILBW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPMINU      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL79     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVERI        SF=1.600    AT=1
    LOAD= LIVERIH       SF=0.800    AT=1
    LOAD= SOILLW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPPLUS      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL80     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVERI        SF=1.600    AT=1
    LOAD= LIVERIH       SF=0.800    AT=1
    LOAD= SOILLW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPMINU      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL81     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVERI        SF=1.600    AT=1
    LOAD= LIVERIH       SF=0.800    AT=1
    LOAD= SOILRW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPPLUS      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL82     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=1.200    AT=1
    LOAD= PAVEW         SF=1.560    AT=1
    LOAD= LIVERI        SF=1.600    AT=1
    LOAD= LIVERIH       SF=0.800    AT=1
    LOAD= SOILRW        SF=0.800    AT=1
    LOAD= WATERV        SF=1.560    AT=1
    LOAD= WATERH        SF=0.800    AT=1
    LOAD= BUOYANCY      SF=1.200    AT=1
    LOAD= TEMPMINU      SF=1.200    AT=1
    LOAD= SHRINK        SF=1.200    AT=1
NAME=UL83     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=0.900    AT=1
    LOAD= PAVEW         SF=0.900    AT=1
    LOAD= SOILBW        SF=1.600    AT=1
    LOAD= WATERV        SF=0.900    AT=1
    LOAD= WATERH        SF=1.600    AT=1
NAME=UL84     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=0.900    AT=1
    LOAD= PAVEW         SF=0.900    AT=1
    LOAD= SOILLW        SF=1.600    AT=1
    LOAD= WATERV        SF=0.900    AT=1
    LOAD= WATERH        SF=1.600    AT=1
NAME=UL85     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=0.900    AT=1
    LOAD= PAVEW         SF=0.900    AT=1
    LOAD= SOILRW        SF=1.600    AT=1
    LOAD= WATERV        SF=0.900    AT=1
    LOAD= WATERH        SF=1.600    AT=1
NAME=UL86     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW            SF=0.900    AT=1
    LOAD= PAVEW         SF=0.900    AT=1
```

```
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= WATERV        SF=0.900   AT=1
   LOAD= WATERH        SF=0.800   AT=1
NAME=UL87    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
   LOAD= SOILLW        SF=0.800   AT=1
   LOAD= WATERV        SF=0.900   AT=1
   LOAD= WATERH        SF=0.800   AT=1
NAME=UL88    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
   LOAD= SOILRW        SF=0.800   AT=1
   LOAD= WATERV        SF=0.900   AT=1
   LOAD= WATERH        SF=0.800   AT=1
NAME=SV01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
NAME=SV02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
NAME=SV21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
NAME=SV22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
NAME=SV23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
```

```
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV33    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV34    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV35    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV36    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV37    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV38    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV39    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV40    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV41    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
NAME=SV42    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
NAME=SV43    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
NAME=SV44    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILB         SF=0.500   AT=1
NAME=SV45    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILL         SF=0.500   AT=1
NAME=SV46    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILR         SF=0.500   AT=1
NAME=SV47    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVEW         SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILBW        SF=1.000   AT=1
   LOAD= WATERV        SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= BUOYANCY      SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV48    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVEW         SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILBW        SF=1.000   AT=1
   LOAD= WATERV        SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= BUOYANCY      SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
```

```
NAME=SV49     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV50     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV51     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV52     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV53     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILBW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV54     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILBW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV55     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV56     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV57     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV58     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV59     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILBW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV60     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILBW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV61     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV62     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV63     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV64     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV65     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
```

```
   LOAD= LIVEFUH        SF=0.500    AT=1
   LOAD= SOILBW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPPLUS       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV66    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVEFU         SF=1.000    AT=1
   LOAD= LIVEFUH        SF=0.500    AT=1
   LOAD= SOILBW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPMINU       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV67    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVEFU         SF=1.000    AT=1
   LOAD= LIVEFUH        SF=0.500    AT=1
   LOAD= SOILLW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPPLUS       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV68    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVEFU         SF=1.000    AT=1
   LOAD= LIVEFUH        SF=0.500    AT=1
   LOAD= SOILLW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPMINU       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV69    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVEFU         SF=1.000    AT=1
   LOAD= LIVEFUH        SF=0.500    AT=1
   LOAD= SOILRW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPPLUS       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV70    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVEFU         SF=1.000    AT=1
   LOAD= LIVEFUH        SF=0.500    AT=1
   LOAD= SOILRW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPMINU       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV71    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVELE         SF=1.000    AT=1
   LOAD= LIVELEH        SF=0.500    AT=1
   LOAD= SOILBW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPPLUS       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV72    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVELE         SF=1.000    AT=1
   LOAD= LIVELEH        SF=0.500    AT=1
   LOAD= SOILBW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPMINU       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV73    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVELE         SF=1.000    AT=1
   LOAD= LIVELEH        SF=0.500    AT=1
   LOAD= SOILLW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPPLUS       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV74    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVELE         SF=1.000    AT=1
   LOAD= LIVELEH        SF=0.500    AT=1
   LOAD= SOILLW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPMINU       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV75    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVELE         SF=1.000    AT=1
   LOAD= LIVELEH        SF=0.500    AT=1
   LOAD= SOILRW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPPLUS       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV76    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVELE         SF=1.000    AT=1
   LOAD= LIVELEH        SF=0.500    AT=1
   LOAD= SOILRW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPMINU       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV77    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVERI         SF=1.000    AT=1
   LOAD= LIVERIH        SF=0.500    AT=1
   LOAD= SOILBW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPPLUS       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV78    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVERI         SF=1.000    AT=1
   LOAD= LIVERIH        SF=0.500    AT=1
   LOAD= SOILBW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPMINU       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV79    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVERI         SF=1.000    AT=1
   LOAD= LIVERIH        SF=0.500    AT=1
   LOAD= SOILLW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPPLUS       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV80    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVERI         SF=1.000    AT=1
   LOAD= LIVERIH        SF=0.500    AT=1
   LOAD= SOILLW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
   LOAD= BUOYANCY       SF=1.000    AT=1
   LOAD= TEMPMINU       SF=1.000    AT=1
   LOAD= SHRINK         SF=1.000    AT=1
NAME=SV81    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.000    AT=1
   LOAD= PAVEW          SF=1.000    AT=1
   LOAD= LIVERI         SF=1.000    AT=1
   LOAD= LIVERIH        SF=0.500    AT=1
   LOAD= SOILRW         SF=0.500    AT=1
   LOAD= WATERV         SF=1.000    AT=1
   LOAD= WATERH         SF=0.500    AT=1
```

```
      LOAD= BUOYANCY       SF=1.000   AT=1
      LOAD= TEMPPLUS       SF=1.000   AT=1
      LOAD= SHRINK         SF=1.000   AT=1
   NAME=SV82    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= LIVERI         SF=1.000   AT=1
      LOAD= LIVERIH        SF=0.500   AT=1
      LOAD= SOILRW         SF=0.500   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= BUOYANCY       SF=1.000   AT=1
      LOAD= TEMPMINU       SF=1.000   AT=1
      LOAD= SHRINK         SF=1.000   AT=1
   NAME=SV83    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILBW         SF=1.000   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=1.000   AT=1
   NAME=SV84    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILLW         SF=1.000   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=1.000   AT=1
   NAME=SV85    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILRW         SF=1.000   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=1.000   AT=1
   NAME=SV86    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILBW         SF=0.500   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=0.500   AT=1
   NAME=SV87    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILLW         SF=0.500   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=0.500   AT=1
   NAME=SV88    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILRW         SF=0.500   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=0.500   AT=1
COMBO
   NAME=ENVUSE  TYPE=ENVE
      HIST=SV01 SF=1
      HIST=SV02 SF=1
      HIST=SV03 SF=1
      HIST=SV04 SF=1
      HIST=SV05 SF=1
      HIST=SV06 SF=1
      HIST=SV07 SF=1
      HIST=SV08 SF=1
      HIST=SV09 SF=1
      HIST=SV10 SF=1
      HIST=SV11 SF=1
      HIST=SV12 SF=1
      HIST=SV13 SF=1
      HIST=SV14 SF=1
      HIST=SV15 SF=1
      HIST=SV16 SF=1
      HIST=SV17 SF=1
      HIST=SV18 SF=1
      HIST=SV19 SF=1
      HIST=SV20 SF=1
      HIST=SV21 SF=1
      HIST=SV22 SF=1
      HIST=SV23 SF=1
      HIST=SV24 SF=1
      HIST=SV25 SF=1
      HIST=SV26 SF=1
      HIST=SV27 SF=1
      HIST=SV28 SF=1
      HIST=SV29 SF=1
      HIST=SV30 SF=1
      HIST=SV31 SF=1
      HIST=SV32 SF=1
      HIST=SV33 SF=1
      HIST=SV34 SF=1
      HIST=SV35 SF=1
      HIST=SV36 SF=1
      HIST=SV37 SF=1
      HIST=SV38 SF=1
      HIST=SV39 SF=1
      HIST=SV40 SF=1
      HIST=SV41 SF=1
      HIST=SV42 SF=1
      HIST=SV43 SF=1
      HIST=SV44 SF=1
      HIST=SV45 SF=1
      HIST=SV46 SF=1
      HIST=SV47 SF=1
      HIST=SV48 SF=1
      HIST=SV49 SF=1
      HIST=SV50 SF=1
      HIST=SV51 SF=1
      HIST=SV52 SF=1
      HIST=SV53 SF=1
      HIST=SV54 SF=1
      HIST=SV55 SF=1
      HIST=SV56 SF=1
      HIST=SV57 SF=1
      HIST=SV58 SF=1
      HIST=SV59 SF=1
      HIST=SV60 SF=1
      HIST=SV61 SF=1
      HIST=SV62 SF=1
      HIST=SV63 SF=1
      HIST=SV64 SF=1
      HIST=SV65 SF=1
      HIST=SV66 SF=1
      HIST=SV67 SF=1
      HIST=SV68 SF=1
      HIST=SV69 SF=1
      HIST=SV70 SF=1
      HIST=SV71 SF=1
      HIST=SV72 SF=1
      HIST=SV73 SF=1
      HIST=SV74 SF=1
      HIST=SV75 SF=1
      HIST=SV76 SF=1
      HIST=SV77 SF=1
      HIST=SV78 SF=1
      HIST=SV79 SF=1
      HIST=SV80 SF=1
      HIST=SV81 SF=1
      HIST=SV82 SF=1
      HIST=SV83 SF=1
      HIST=SV84 SF=1
      HIST=SV85 SF=1
      HIST=SV86 SF=1
      HIST=SV87 SF=1
      HIST=SV88 SF=1
NAME=ENVULT  TYPE=ENVE
      HIST=UL01 SF=1
      HIST=UL02 SF=1
      HIST=UL03 SF=1
      HIST=UL04 SF=1
      HIST=UL05 SF=1
      HIST=UL06 SF=1
      HIST=UL07 SF=1
      HIST=UL08 SF=1
      HIST=UL09 SF=1
      HIST=UL10 SF=1
      HIST=UL11 SF=1
      HIST=UL12 SF=1
      HIST=UL13 SF=1
      HIST=UL14 SF=1
      HIST=UL15 SF=1
      HIST=UL16 SF=1
      HIST=UL17 SF=1
      HIST=UL18 SF=1
      HIST=UL19 SF=1
      HIST=UL20 SF=1
      HIST=UL21 SF=1
      HIST=UL22 SF=1
      HIST=UL23 SF=1
      HIST=UL24 SF=1
      HIST=UL25 SF=1
      HIST=UL26 SF=1
      HIST=UL27 SF=1
      HIST=UL28 SF=1
      HIST=UL29 SF=1
      HIST=UL30 SF=1
      HIST=UL31 SF=1
      HIST=UL32 SF=1
      HIST=UL33 SF=1
      HIST=UL34 SF=1
      HIST=UL35 SF=1
      HIST=UL36 SF=1
      HIST=UL37 SF=1
      HIST=UL38 SF=1
      HIST=UL39 SF=1
```

```
      HIST=UL40 SF=1
      HIST=UL41 SF=1
      HIST=UL42 SF=1
      HIST=UL43 SF=1
      HIST=UL44 SF=1
      HIST=UL45 SF=1
      HIST=UL46 SF=1
      HIST=UL47 SF=1
      HIST=UL48 SF=1
      HIST=UL49 SF=1
      HIST=UL50 SF=1
      HIST=UL51 SF=1
      HIST=UL52 SF=1
      HIST=UL53 SF=1
      HIST=UL54 SF=1
      HIST=UL55 SF=1
      HIST=UL56 SF=1
      HIST=UL57 SF=1
      HIST=UL58 SF=1
      HIST=UL59 SF=1
      HIST=UL60 SF=1
      HIST=UL61 SF=1
      HIST=UL62 SF=1
      HIST=UL63 SF=1
      HIST=UL64 SF=1
      HIST=UL65 SF=1
      HIST=UL66 SF=1
      HIST=UL67 SF=1
      HIST=UL68 SF=1
      HIST=UL69 SF=1
      HIST=UL70 SF=1
      HIST=UL71 SF=1
      HIST=UL72 SF=1
      HIST=UL73 SF=1
      HIST=UL74 SF=1
      HIST=UL75 SF=1
      HIST=UL76 SF=1
      HIST=UL77 SF=1
      HIST=UL78 SF=1
      HIST=UL79 SF=1
      HIST=UL80 SF=1
      HIST=UL81 SF=1
      HIST=UL82 SF=1
      HIST=UL83 SF=1
      HIST=UL84 SF=1
      HIST=UL85 SF=1
      HIST=UL86 SF=1
      HIST=UL87 SF=1
      HIST=UL88 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

16. INPUT DATA (기능수행)

```
; ACulvert SAP2000 데이터파일 : 내진(기능)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     0.950 Y=     0.000 Z=     0.500
  3    X=     1.567 Y=     0.000 Z=     0.500
  4    X=     2.050 Y=     0.000 Z=     0.500
  5    X=     2.350 Y=     0.000 Z=     0.500
  6    X=     2.633 Y=     0.000 Z=     0.500
  7    X=     3.700 Y=     0.000 Z=     0.500
  8    X=     4.767 Y=     0.000 Z=     0.500
  9    X=     5.833 Y=     0.000 Z=     0.500
  10   X=     6.900 Y=     0.000 Z=     0.500
  11   X=     7.967 Y=     0.000 Z=     0.500
  12   X=     9.033 Y=     0.000 Z=     0.500
  13   X=     9.200 Y=     0.000 Z=     0.500
  14   X=     9.500 Y=     0.000 Z=     0.500
  15   X=     9.850 Y=     0.000 Z=     0.500
  16   X=    10.100 Y=     0.000 Z=     0.500
  17   X=    10.350 Y=     0.000 Z=     0.500
  18   X=    10.700 Y=     0.000 Z=     0.500
  19   X=    11.000 Y=     0.000 Z=     0.500
  20   X=    11.167 Y=     0.000 Z=     0.500
  21   X=    12.233 Y=     0.000 Z=     0.500
  22   X=    13.300 Y=     0.000 Z=     0.500
  23   X=    14.367 Y=     0.000 Z=     0.500
  24   X=    15.433 Y=     0.000 Z=     0.500
  25   X=    16.500 Y=     0.000 Z=     0.500
  26   X=    17.567 Y=     0.000 Z=     0.500
  27   X=    17.850 Y=     0.000 Z=     0.500
  28   X=    18.150 Y=     0.000 Z=     0.500
  29   X=    18.633 Y=     0.000 Z=     0.500
  30   X=    19.250 Y=     0.000 Z=     0.500
  31   X=    19.700 Y=     0.000 Z=     0.500
  32   X=    19.700 Y=     0.000 Z=     1.050
  33   X=    19.700 Y=     0.000 Z=     1.675
  34   X=    19.700 Y=     0.000 Z=     2.850
  35   X=    19.700 Y=     0.000 Z=     4.025
  36   X=    19.700 Y=     0.000 Z=     5.200
  37   X=    19.700 Y=     0.000 Z=     5.425
  38   X=    19.700 Y=     0.000 Z=     5.925
  39   X=    19.700 Y=     0.000 Z=     6.375
  40   X=    19.250 Y=     0.000 Z=     6.375
  41   X=    18.750 Y=     0.000 Z=     6.375
  42   X=    18.633 Y=     0.000 Z=     6.375
  43   X=    17.567 Y=     0.000 Z=     6.375
  44   X=    16.500 Y=     0.000 Z=     6.375
  45   X=    15.433 Y=     0.000 Z=     6.375
  46   X=    14.367 Y=     0.000 Z=     6.375
  47   X=    13.300 Y=     0.000 Z=     6.375
  48   X=    12.233 Y=     0.000 Z=     6.375
  49   X=    11.167 Y=     0.000 Z=     6.375
  50   X=    10.850 Y=     0.000 Z=     6.375
  51   X=    10.350 Y=     0.000 Z=     6.375
  52   X=    10.100 Y=     0.000 Z=     6.375
  53   X=     9.850 Y=     0.000 Z=     6.375
  54   X=     9.350 Y=     0.000 Z=     6.375
  55   X=     9.033 Y=     0.000 Z=     6.375
  56   X=     7.967 Y=     0.000 Z=     6.375
  57   X=     6.900 Y=     0.000 Z=     6.375
  58   X=     5.833 Y=     0.000 Z=     6.375
  59   X=     4.767 Y=     0.000 Z=     6.375
  60   X=     3.700 Y=     0.000 Z=     6.375
  61   X=     2.633 Y=     0.000 Z=     6.375
  62   X=     1.567 Y=     0.000 Z=     6.375
  63   X=     1.450 Y=     0.000 Z=     6.375
  64   X=     0.950 Y=     0.000 Z=     6.375
  65   X=     0.500 Y=     0.000 Z=     6.375
  66   X=     0.500 Y=     0.000 Z=     5.925
  67   X=     0.500 Y=     0.000 Z=     5.425
  68   X=     0.500 Y=     0.000 Z=     5.200
  69   X=     0.500 Y=     0.000 Z=     4.025
  70   X=     0.500 Y=     0.000 Z=     2.850
  71   X=     0.500 Y=     0.000 Z=     1.675
  72   X=     0.500 Y=     0.000 Z=     1.050
  73   X=     0.500 Y=     0.000 Z=     0.000
  74   X=     1.567 Y=     0.000 Z=     0.000
  75   X=     2.633 Y=     0.000 Z=     0.000
  76   X=     3.700 Y=     0.000 Z=     0.000
  77   X=     4.767 Y=     0.000 Z=     0.000
  78   X=     5.833 Y=     0.000 Z=     0.000
  79   X=     6.900 Y=     0.000 Z=     0.000
  80   X=     7.967 Y=     0.000 Z=     0.000
  81   X=     9.033 Y=     0.000 Z=     0.000
  82   X=    10.100 Y=     0.000 Z=     0.000
  83   X=    11.167 Y=     0.000 Z=     0.000
  84   X=    12.233 Y=     0.000 Z=     0.000
  85   X=    13.300 Y=     0.000 Z=     0.000
  86   X=    14.367 Y=     0.000 Z=     0.000
  87   X=    15.433 Y=     0.000 Z=     0.000
  88   X=    16.500 Y=     0.000 Z=     0.000
  89   X=    17.567 Y=     0.000 Z=     0.000
  90   X=    18.633 Y=     0.000 Z=     0.000
  91   X=    19.700 Y=     0.000 Z=     0.000
  92   X=    20.200 Y=     0.000 Z=     0.500
  93   X=    20.200 Y=     0.000 Z=     1.675
  94   X=    20.200 Y=     0.000 Z=     2.850
  95   X=    20.200 Y=     0.000 Z=     4.025
  96   X=    20.200 Y=     0.000 Z=     5.200
  97   X=    20.200 Y=     0.000 Z=     6.375
  98   X=    19.700 Y=     0.000 Z=     6.875
  99   X=    18.633 Y=     0.000 Z=     6.875
  100  X=    17.567 Y=     0.000 Z=     6.875
  101  X=    16.500 Y=     0.000 Z=     6.875
  102  X=    15.433 Y=     0.000 Z=     6.875
  103  X=    14.367 Y=     0.000 Z=     6.875
  104  X=    13.300 Y=     0.000 Z=     6.875
  105  X=    12.233 Y=     0.000 Z=     6.875
  106  X=    11.167 Y=     0.000 Z=     6.875
  107  X=    10.100 Y=     0.000 Z=     6.875
  108  X=     9.033 Y=     0.000 Z=     6.875
  109  X=     7.967 Y=     0.000 Z=     6.875
  110  X=     6.900 Y=     0.000 Z=     6.875
  111  X=     5.833 Y=     0.000 Z=     6.875
  112  X=     4.767 Y=     0.000 Z=     6.875
  113  X=     3.700 Y=     0.000 Z=     6.875
  114  X=     2.633 Y=     0.000 Z=     6.875
  115  X=     1.567 Y=     0.000 Z=     6.875
  116  X=     0.500 Y=     0.000 Z=     6.875
  117  X=     0.000 Y=     0.000 Z=     6.375
  118  X=     0.000 Y=     0.000 Z=     5.200
  119  X=     0.000 Y=     0.000 Z=     4.025
  120  X=     0.000 Y=     0.000 Z=     2.850
  121  X=     0.000 Y=     0.000 Z=     1.675
  122  X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=92 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=93 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=94 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=95 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=96 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=97 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=98 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=99 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=100 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=101 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=102 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=103 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=104 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=105 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=106 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=107 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=108 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=109 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=110 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=111 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=112 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=113 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=114 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=115 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=116 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=117 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=118 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=119 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=120 DOF=UX,UY,UZ,RX,RY,RZ
```

```
  ADD=121 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=122 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=4660.3
  ADD=6 UX=4660.3
  ADD=7 UX=4660.3
  ADD=8 UX=4660.3
  ADD=9 UX=4660.3
  ADD=10 UX=4660.3
  ADD=11 UX=4660.3
  ADD=12 UX=4660.3
  ADD=16 UX=4660.3
  ADD=20 UX=4660.3
  ADD=21 UX=4660.3
  ADD=22 UX=4660.3
  ADD=23 UX=4660.3
  ADD=24 UX=4660.3
  ADD=25 UX=4660.3
  ADD=26 UX=4660.3
  ADD=29 UX=4660.3
  ADD=33 UZ=11637
  ADD=34 UZ=11637
  ADD=35 UZ=11637
  ADD=36 UZ=11637
  ADD=42 UX=4660.3
  ADD=43 UX=4660.3
  ADD=44 UX=4660.3
  ADD=45 UX=4660.3
  ADD=46 UX=4660.3
  ADD=47 UX=4660.3
  ADD=48 UX=4660.3
  ADD=49 UX=4660.3
  ADD=52 UX=4660.3
  ADD=55 UX=4660.3
  ADD=56 UX=4660.3
  ADD=57 UX=4660.3
  ADD=58 UX=4660.3
  ADD=59 UX=4660.3
  ADD=60 UX=4660.3
  ADD=61 UX=4660.3
  ADD=62 UX=4660.3
  ADD=68 UZ=11637
  ADD=69 UZ=11637
  ADD=70 UZ=11637
  ADD=71 UZ=11637
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=12888.6 CE=0.99999 K=12888.6 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=13980.9 CE=0.99999 K=13980.9 OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=33796.8 CE=0.99999 K=33796.8 OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=34911. CE=0.99999 K=34911. OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=30825.7 CE=0.99999 K=30825.7 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.1,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=0.85,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.175 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.175 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.325 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    38 J= 38,  39 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    39 J= 39,  40 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 3 NSEG= 4 ANG=0
    42 J= 42,  43 SEC= 3 NSEG= 4 ANG=0
    43 J= 43,  44 SEC= 3 NSEG= 4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    51 J= 51,  52 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    52 J= 52,  53 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 NSEG= 4 ANG=0
    55 J= 55,  56 SEC= 3 NSEG= 4 ANG=0
    56 J= 56,  57 SEC= 3 NSEG= 4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    64 J= 64,  65 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    65 J= 65,  66 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    66 J= 66,  67 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    67 J= 67,  68 SEC= 3 NSEG= 4 ANG=180
    68 J= 68,  69 SEC= 3 NSEG= 4 ANG=180
    69 J= 69,  70 SEC= 3 NSEG= 4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,   1 SEC= 3 IOFF=0 JOFF=0.325 RIGID=1 NSEG=4 ANG=180
    73 J= 52,  16 SEC= 5 IOFF=0.7 JOFF=0.425 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,73 NLP=1 ANG=0
     2 J= 3,74 NLP=2 ANG=0
     3 J= 6,75 NLP=2 ANG=0
     4 J= 7,76 NLP=2 ANG=0
     5 J= 8,77 NLP=2 ANG=0
     6 J= 9,78 NLP=2 ANG=0
     7 J=10,79 NLP=2 ANG=0
     8 J=11,80 NLP=2 ANG=0
     9 J=12,81 NLP=2 ANG=0
    10 J=16,82 NLP=2 ANG=0
    11 J=20,83 NLP=2 ANG=0
    12 J=21,84 NLP=2 ANG=0
    13 J=22,85 NLP=2 ANG=0
    14 J=23,86 NLP=2 ANG=0
    15 J=24,87 NLP=2 ANG=0
    16 J=25,88 NLP=2 ANG=0
    17 J=26,89 NLP=2 ANG=0
    18 J=29,90 NLP=2 ANG=0
    19 J=31,91 NLP=1 ANG=0
    20 J=31,92 NLP=3 ANG=0
    21 J=33,93 NLP=4 ANG=0
    22 J=34,94 NLP=4 ANG=0
    23 J=35,95 NLP=4 ANG=0
    24 J=36,96 NLP=4 ANG=0
    25 J=39,97 NLP=5 ANG=0
    26 J=39,98 NLP=1 ANG=0
    27 J=42,99 NLP=2 ANG=0
    28 J=43,100 NLP=2 ANG=0
    29 J=44,101 NLP=2 ANG=0
    30 J=45,102 NLP=2 ANG=0
    31 J=46,103 NLP=2 ANG=0
    32 J=47,104 NLP=2 ANG=0
    33 J=48,105 NLP=2 ANG=0
    34 J=49,106 NLP=2 ANG=0
    35 J=52,107 NLP=2 ANG=0
    36 J=55,108 NLP=2 ANG=0
    37 J=56,109 NLP=2 ANG=0
    38 J=57,110 NLP=2 ANG=0
```

```
    39 J=58,111 NLP=2 ANG=0
    40 J=59,112 NLP=2 ANG=0
    41 J=60,113 NLP=2 ANG=0
    42 J=61,114 NLP=2 ANG=0
    43 J=62,115 NLP=2 ANG=0
    44 J=65,116 NLP=1 ANG=0
    45 J=65,117 NLP=5 ANG=0
    46 J=68,118 NLP=4 ANG=0
    47 J=69,119 NLP=4 ANG=0
    48 J=70,120 NLP=4 ANG=0
    49 J=71,121 NLP=4 ANG=0
    50 J= 1,122 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-69.125, -69.125
      ADD=40 RD=0,1 UZ=-69.125, -69.125
      ADD=41 RD=0,1 UZ=-69.125, -69.125
      ADD=42 RD=0,1 UZ=-69.125, -69.125
      ADD=43 RD=0,1 UZ=-69.125, -69.125
      ADD=44 RD=0,1 UZ=-69.125, -69.125
      ADD=45 RD=0,1 UZ=-69.125, -69.125
      ADD=46 RD=0,1 UZ=-69.125, -69.125
      ADD=47 RD=0,1 UZ=-69.125, -69.125
      ADD=48 RD=0,1 UZ=-69.125, -69.125
      ADD=49 RD=0,1 UZ=-69.125, -69.125
      ADD=50 RD=0,1 UZ=-69.125, -69.125
      ADD=51 RD=0,1 UZ=-69.125, -69.125
      ADD=52 RD=0,1 UZ=-69.125, -69.125
      ADD=53 RD=0,1 UZ=-69.125, -69.125
      ADD=54 RD=0,1 UZ=-69.125, -69.125
      ADD=55 RD=0,1 UZ=-69.125, -69.125
      ADD=56 RD=0,1 UZ=-69.125, -69.125
      ADD=57 RD=0,1 UZ=-69.125, -69.125
      ADD=58 RD=0,1 UZ=-69.125, -69.125
      ADD=59 RD=0,1 UZ=-69.125, -69.125
      ADD=60 RD=0,1 UZ=-69.125, -69.125
      ADD=61 RD=0,1 UZ=-69.125, -69.125
      ADD=62 RD=0,1 UZ=-69.125, -69.125
      ADD=63 RD=0,1 UZ=-69.125, -69.125
      ADD=64 RD=0,1 UZ=-69.125, -69.125
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-51.575, -51.575
      ADD=40 RD=0,1 UZ=-51.575, -51.575
      ADD=41 RD=0,1 UZ=-51.575, -51.575
      ADD=42 RD=0,1 UZ=-51.575, -51.575
      ADD=43 RD=0,1 UZ=-51.575, -51.575
      ADD=44 RD=0,1 UZ=-51.575, -51.575
      ADD=45 RD=0,1 UZ=-51.575, -51.575
      ADD=46 RD=0,1 UZ=-51.575, -51.575
      ADD=47 RD=0,1 UZ=-51.575, -51.575
      ADD=48 RD=0,1 UZ=-51.575, -51.575
      ADD=49 RD=0,1 UZ=-51.575, -51.575
      ADD=50 RD=0,1 UZ=-51.575, -51.575
      ADD=51 RD=0,1 UZ=-51.575, -51.575
      ADD=52 RD=0,1 UZ=-51.575, -51.575
      ADD=53 RD=0,1 UZ=-51.575, -51.575
      ADD=54 RD=0,1 UZ=-51.575, -51.575
      ADD=55 RD=0,1 UZ=-51.575, -51.575
      ADD=56 RD=0,1 UZ=-51.575, -51.575
      ADD=57 RD=0,1 UZ=-51.575, -51.575
      ADD=58 RD=0,1 UZ=-51.575, -51.575
      ADD=59 RD=0,1 UZ=-51.575, -51.575
      ADD=60 RD=0,1 UZ=-51.575, -51.575
      ADD=61 RD=0,1 UZ=-51.575, -51.575
      ADD=62 RD=0,1 UZ=-51.575, -51.575
      ADD=63 RD=0,1 UZ=-51.575, -51.575
      ADD=64 RD=0,1 UZ=-51.575, -51.575
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11, -11
      ADD=40 RD=0,1 UZ=-11, -11
      ADD=41 RD=0,1 UZ=-11, -11
      ADD=42 RD=0,1 UZ=-11, -11
      ADD=43 RD=0,1 UZ=-11, -11
      ADD=44 RD=0,1 UZ=-11, -11
      ADD=45 RD=0,1 UZ=-11, -11
      ADD=46 RD=0,1 UZ=-11, -11
      ADD=47 RD=0,1 UZ=-11, -11
      ADD=48 RD=0,1 UZ=-11, -11
      ADD=49 RD=0,1 UZ=-11, -11
      ADD=50 RD=0,1 UZ=-11, -11
      ADD=51 RD=0,1 UZ=-11, -11
      ADD=52 RD=0,1 UZ=-11, -11
      ADD=53 RD=0,1 UZ=-11, -11
      ADD=54 RD=0,1 UZ=-11, -11
      ADD=55 RD=0,1 UZ=-11, -11
      ADD=56 RD=0,1 UZ=-11, -11
      ADD=57 RD=0,1 UZ=-11, -11
      ADD=58 RD=0,1 UZ=-11, -11
      ADD=59 RD=0,1 UZ=-11, -11
      ADD=60 RD=0,1 UZ=-11, -11
      ADD=61 RD=0,1 UZ=-11, -11
      ADD=62 RD=0,1 UZ=-11, -11
      ADD=63 RD=0,1 UZ=-11, -11
      ADD=64 RD=0,1 UZ=-11, -11
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=52 RD=0,1 UZ=-11, -11
      ADD=53 RD=0,1 UZ=-11, -11
      ADD=54 RD=0,1 UZ=-11, -11
      ADD=55 RD=0,1 UZ=-11, -11
      ADD=56 RD=0,1 UZ=-11, -11
      ADD=57 RD=0,1 UZ=-11, -11
      ADD=58 RD=0,1 UZ=-11, -11
      ADD=59 RD=0,1 UZ=-11, -11
      ADD=60 RD=0,1 UZ=-11, -11
      ADD=61 RD=0,1 UZ=-11, -11
      ADD=62 RD=0,1 UZ=-11, -11
      ADD=63 RD=0,1 UZ=-11, -11
      ADD=64 RD=0,1 UZ=-11, -11
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11, -11
      ADD=40 RD=0,1 UZ=-11, -11
      ADD=41 RD=0,1 UZ=-11, -11
      ADD=42 RD=0,1 UZ=-11, -11
      ADD=43 RD=0,1 UZ=-11, -11
      ADD=44 RD=0,1 UZ=-11, -11
      ADD=45 RD=0,1 UZ=-11, -11
      ADD=46 RD=0,1 UZ=-11, -11
      ADD=47 RD=0,1 UZ=-11, -11
      ADD=48 RD=0,1 UZ=-11, -11
      ADD=49 RD=0,1 UZ=-11, -11
      ADD=50 RD=0,1 UZ=-11, -11
      ADD=51 RD=0,1 UZ=-11, -11
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.5, 5.5
      ADD=66 RD=0,1 UX=5.5, 5.5
      ADD=67 RD=0,1 UX=5.5, 5.5
      ADD=68 RD=0,1 UX=5.5, 5.5
      ADD=69 RD=0,1 UX=5.5, 5.5
      ADD=70 RD=0,1 UX=5.5, 5.5
      ADD=71 RD=0,1 UX=5.5, 5.5
      ADD=72 RD=0,1 UX=5.5, 5.5
      ADD=31 RD=0,1 UX=-5.5, -5.5
      ADD=32 RD=0,1 UX=-5.5, -5.5
      ADD=33 RD=0,1 UX=-5.5, -5.5
      ADD=34 RD=0,1 UX=-5.5, -5.5
      ADD=35 RD=0,1 UX=-5.5, -5.5
      ADD=36 RD=0,1 UX=-5.5, -5.5
      ADD=37 RD=0,1 UX=-5.5, -5.5
      ADD=38 RD=0,1 UX=-5.5, -5.5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.5, 5.5
      ADD=66 RD=0,1 UX=5.5, 5.5
      ADD=67 RD=0,1 UX=5.5, 5.5
      ADD=68 RD=0,1 UX=5.5, 5.5
      ADD=69 RD=0,1 UX=5.5, 5.5
      ADD=70 RD=0,1 UX=5.5, 5.5
      ADD=71 RD=0,1 UX=5.5, 5.5
      ADD=72 RD=0,1 UX=5.5, 5.5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-5.5, -5.5
      ADD=32 RD=0,1 UX=-5.5, -5.5
      ADD=33 RD=0,1 UX=-5.5, -5.5
      ADD=34 RD=0,1 UX=-5.5, -5.5
      ADD=35 RD=0,1 UX=-5.5, -5.5
      ADD=36 RD=0,1 UX=-5.5, -5.5
      ADD=37 RD=0,1 UX=-5.5, -5.5
      ADD=38 RD=0,1 UX=-5.5, -5.5
NAME=WATERV  ; 연직수압
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-19.5, -19.5
      ADD=40 RD=0,1 UZ=-19.5, -19.5
      ADD=41 RD=0,1 UZ=-19.5, -19.5
      ADD=42 RD=0,1 UZ=-19.5, -19.5
      ADD=43 RD=0,1 UZ=-19.5, -19.5
      ADD=44 RD=0,1 UZ=-19.5, -19.5
      ADD=45 RD=0,1 UZ=-19.5, -19.5
      ADD=46 RD=0,1 UZ=-19.5, -19.5
      ADD=47 RD=0,1 UZ=-19.5, -19.5
      ADD=48 RD=0,1 UZ=-19.5, -19.5
      ADD=49 RD=0,1 UZ=-19.5, -19.5
      ADD=50 RD=0,1 UZ=-19.5, -19.5
```

```
      ADD=51 RD=0,1 UZ=-19.5, -19.5
      ADD=52 RD=0,1 UZ=-19.5, -19.5
      ADD=53 RD=0,1 UZ=-19.5, -19.5
      ADD=54 RD=0,1 UZ=-19.5, -19.5
      ADD=55 RD=0,1 UZ=-19.5, -19.5
      ADD=56 RD=0,1 UZ=-19.5, -19.5
      ADD=57 RD=0,1 UZ=-19.5, -19.5
      ADD=58 RD=0,1 UZ=-19.5, -19.5
      ADD=59 RD=0,1 UZ=-19.5, -19.5
      ADD=60 RD=0,1 UZ=-19.5, -19.5
      ADD=61 RD=0,1 UZ=-19.5, -19.5
      ADD=62 RD=0,1 UZ=-19.5, -19.5
      ADD=63 RD=0,1 UZ=-19.5, -19.5
      ADD=64 RD=0,1 UZ=-19.5, -19.5
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=24.5, 29
      ADD=66 RD=0,1 UX=29, 34
      ADD=67 RD=0,1 UX=34, 36.25
      ADD=68 RD=0,1 UX=36.25, 48
      ADD=69 RD=0,1 UX=48, 59.75
      ADD=70 RD=0,1 UX=59.75, 71.5
      ADD=71 RD=0,1 UX=71.5, 77.75
      ADD=72 RD=0,1 UX=77.75, 83.25
      ADD=31 RD=0,1 UX=-83.25, -77.75
      ADD=32 RD=0,1 UX=-77.75, -71.5
      ADD=33 RD=0,1 UX=-71.5, -59.75
      ADD=34 RD=0,1 UX=-59.75, -48
      ADD=35 RD=0,1 UX=-48, -36.25
      ADD=36 RD=0,1 UX=-36.25, -34
      ADD=37 RD=0,1 UX=-34, -29
      ADD=38 RD=0,1 UX=-29, -24.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=87.5, 87.5
      ADD=2 RD=0,1 UZ=87.5, 87.5
      ADD=3 RD=0,1 UZ=87.5, 87.5
      ADD=4 RD=0,1 UZ=87.5, 87.5
      ADD=5 RD=0,1 UZ=87.5, 87.5
      ADD=6 RD=0,1 UZ=87.5, 87.5
      ADD=7 RD=0,1 UZ=87.5, 87.5
      ADD=8 RD=0,1 UZ=87.5, 87.5
      ADD=9 RD=0,1 UZ=87.5, 87.5
      ADD=10 RD=0,1 UZ=87.5, 87.5
      ADD=11 RD=0,1 UZ=87.5, 87.5
      ADD=12 RD=0,1 UZ=87.5, 87.5
      ADD=13 RD=0,1 UZ=87.5, 87.5
      ADD=14 RD=0,1 UZ=87.5, 87.5
      ADD=15 RD=0,1 UZ=87.5, 87.5
      ADD=16 RD=0,1 UZ=87.5, 87.5
      ADD=17 RD=0,1 UZ=87.5, 87.5
      ADD=18 RD=0,1 UZ=87.5, 87.5
      ADD=19 RD=0,1 UZ=87.5, 87.5
      ADD=20 RD=0,1 UZ=87.5, 87.5
      ADD=21 RD=0,1 UZ=87.5, 87.5
      ADD=22 RD=0,1 UZ=87.5, 87.5
      ADD=23 RD=0,1 UZ=87.5, 87.5
      ADD=24 RD=0,1 UZ=87.5, 87.5
      ADD=25 RD=0,1 UZ=87.5, 87.5
      ADD=26 RD=0,1 UZ=87.5, 87.5
      ADD=27 RD=0,1 UZ=87.5, 87.5
      ADD=28 RD=0,1 UZ=87.5, 87.5
      ADD=29 RD=0,1 UZ=87.5, 87.5
      ADD=30 RD=0,1 UZ=87.5, 87.5
NAME=FUNSLAB  ; 슬래브 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=9.275, 9.275
      ADD=40 RD=0,1 UX=9.275, 9.275
      ADD=41 RD=0,1 UX=9.275, 9.275
      ADD=42 RD=0,1 UX=9.275, 9.275
      ADD=43 RD=0,1 UX=9.275, 9.275
      ADD=44 RD=0,1 UX=9.275, 9.275
      ADD=45 RD=0,1 UX=9.275, 9.275
      ADD=46 RD=0,1 UX=9.275, 9.275
      ADD=47 RD=0,1 UX=9.275, 9.275
      ADD=48 RD=0,1 UX=9.275, 9.275
      ADD=49 RD=0,1 UX=9.275, 9.275
      ADD=50 RD=0,1 UX=9.275, 9.275
      ADD=51 RD=0,1 UX=9.275, 9.275
      ADD=52 RD=0,1 UX=9.275, 9.275
      ADD=53 RD=0,1 UX=9.275, 9.275
      ADD=54 RD=0,1 UX=9.275, 9.275
      ADD=55 RD=0,1 UX=9.275, 9.275
      ADD=56 RD=0,1 UX=9.275, 9.275
      ADD=57 RD=0,1 UX=9.275, 9.275
      ADD=58 RD=0,1 UX=9.275, 9.275
      ADD=59 RD=0,1 UX=9.275, 9.275
      ADD=60 RD=0,1 UX=9.275, 9.275
      ADD=61 RD=0,1 UX=9.275, 9.275
      ADD=62 RD=0,1 UX=9.275, 9.275
      ADD=63 RD=0,1 UX=9.275, 9.275
      ADD=64 RD=0,1 UX=9.275, 9.275
NAME=FUNWALL  ; 벽체 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=63.078, 60.255
      ADD=66 RD=0,1 UX=60.255, 56.719
      ADD=67 RD=0,1 UX=56.719, 54.966
      ADD=68 RD=0,1 UX=54.966, 44.597
      ADD=69 RD=0,1 UX=44.597, 31.91
      ADD=70 RD=0,1 UX=31.91, 17.054
      ADD=71 RD=0,1 UX=17.054, 8.26
      ADD=72 RD=0,1 UX=8.26, 0
      ADD=31 RD=0,1 UX=0, 8.26
      ADD=32 RD=0,1 UX=8.26, 17.054
      ADD=33 RD=0,1 UX=17.054, 31.91
      ADD=34 RD=0,1 UX=31.91, 44.597
      ADD=35 RD=0,1 UX=44.597, 54.966
      ADD=36 RD=0,1 UX=54.966, 56.719
      ADD=37 RD=0,1 UX=56.719, 60.255
      ADD=38 RD=0,1 UX=60.255, 63.078
NAME=FUNMS  ; 주면전단력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=5.53, 5.53
      ADD=40 RD=0,1 UX=5.53, 5.53
      ADD=41 RD=0,1 UX=5.53, 5.53
      ADD=42 RD=0,1 UX=5.53, 5.53
      ADD=43 RD=0,1 UX=5.53, 5.53
      ADD=44 RD=0,1 UX=5.53, 5.53
      ADD=45 RD=0,1 UX=5.53, 5.53
      ADD=46 RD=0,1 UX=5.53, 5.53
      ADD=47 RD=0,1 UX=5.53, 5.53
      ADD=48 RD=0,1 UX=5.53, 5.53
      ADD=49 RD=0,1 UX=5.53, 5.53
      ADD=50 RD=0,1 UX=5.53, 5.53
      ADD=51 RD=0,1 UX=5.53, 5.53
      ADD=52 RD=0,1 UX=5.53, 5.53
      ADD=53 RD=0,1 UX=5.53, 5.53
      ADD=54 RD=0,1 UX=5.53, 5.53
      ADD=55 RD=0,1 UX=5.53, 5.53
      ADD=56 RD=0,1 UX=5.53, 5.53
      ADD=57 RD=0,1 UX=5.53, 5.53
      ADD=58 RD=0,1 UX=5.53, 5.53
      ADD=59 RD=0,1 UX=5.53, 5.53
      ADD=60 RD=0,1 UX=5.53, 5.53
      ADD=61 RD=0,1 UX=5.53, 5.53
      ADD=62 RD=0,1 UX=5.53, 5.53
      ADD=63 RD=0,1 UX=5.53, 5.53
      ADD=64 RD=0,1 UX=5.53, 5.53
      ADD=65 RD=0,1 UZ=-10.55, -10.55
      ADD=66 RD=0,1 UZ=-10.55, -10.55
      ADD=67 RD=0,1 UZ=-10.55, -10.55
      ADD=68 RD=0,1 UZ=-10.55, -10.55
      ADD=69 RD=0,1 UZ=-10.55, -10.55
      ADD=70 RD=0,1 UZ=-10.55, -10.55
      ADD=71 RD=0,1 UZ=-10.55, -10.55
      ADD=72 RD=0,1 UZ=-10.55, -10.55
      ADD=31 RD=0,1 UZ=10.55, 10.55
      ADD=32 RD=0,1 UZ=10.55, 10.55
      ADD=33 RD=0,1 UZ=10.55, 10.55
      ADD=34 RD=0,1 UZ=10.55, 10.55
      ADD=35 RD=0,1 UZ=10.55, 10.55
      ADD=36 RD=0,1 UZ=10.55, 10.55
      ADD=37 RD=0,1 UZ=10.55, 10.55
      ADD=38 RD=0,1 UZ=10.55, 10.55
      ADD=1 RD=0,1 UX=-15.56, -15.56
      ADD=2 RD=0,1 UX=-15.56, -15.56
      ADD=3 RD=0,1 UX=-15.56, -15.56
      ADD=4 RD=0,1 UX=-15.56, -15.56
      ADD=5 RD=0,1 UX=-15.56, -15.56
      ADD=6 RD=0,1 UX=-15.56, -15.56
      ADD=7 RD=0,1 UX=-15.56, -15.56
      ADD=8 RD=0,1 UX=-15.56, -15.56
      ADD=9 RD=0,1 UX=-15.56, -15.56
      ADD=10 RD=0,1 UX=-15.56, -15.56
      ADD=11 RD=0,1 UX=-15.56, -15.56
      ADD=12 RD=0,1 UX=-15.56, -15.56
      ADD=13 RD=0,1 UX=-15.56, -15.56
      ADD=14 RD=0,1 UX=-15.56, -15.56
      ADD=15 RD=0,1 UX=-15.56, -15.56
      ADD=16 RD=0,1 UX=-15.56, -15.56
      ADD=17 RD=0,1 UX=-15.56, -15.56
      ADD=18 RD=0,1 UX=-15.56, -15.56
      ADD=19 RD=0,1 UX=-15.56, -15.56
      ADD=20 RD=0,1 UX=-15.56, -15.56
      ADD=21 RD=0,1 UX=-15.56, -15.56
      ADD=22 RD=0,1 UX=-15.56, -15.56
      ADD=23 RD=0,1 UX=-15.56, -15.56
      ADD=24 RD=0,1 UX=-15.56, -15.56
      ADD=25 RD=0,1 UX=-15.56, -15.56
      ADD=26 RD=0,1 UX=-15.56, -15.56
```

```
      ADD=27 RD=0,1 UX=-15.56, -15.56
      ADD=28 RD=0,1 UX=-15.56, -15.56
      ADD=29 RD=0,1 UX=-15.56, -15.56
      ADD=30 RD=0,1 UX=-15.56, -15.56
NAME=FUNINER  ; 구체 관성력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=1.942, 1.942
      ADD=40 RD=0,1 UX=1.942, 1.942
      ADD=41 RD=0,1 UX=1.942, 1.942
      ADD=42 RD=0,1 UX=1.942, 1.942
      ADD=43 RD=0,1 UX=1.942, 1.942
      ADD=44 RD=0,1 UX=1.942, 1.942
      ADD=45 RD=0,1 UX=1.942, 1.942
      ADD=46 RD=0,1 UX=1.942, 1.942
      ADD=47 RD=0,1 UX=1.942, 1.942
      ADD=48 RD=0,1 UX=1.942, 1.942
      ADD=49 RD=0,1 UX=1.942, 1.942
      ADD=50 RD=0,1 UX=1.942, 1.942
      ADD=51 RD=0,1 UX=1.942, 1.942
      ADD=52 RD=0,1 UX=1.942, 1.942
      ADD=53 RD=0,1 UX=1.942, 1.942
      ADD=54 RD=0,1 UX=1.942, 1.942
      ADD=55 RD=0,1 UX=1.942, 1.942
      ADD=56 RD=0,1 UX=1.942, 1.942
      ADD=57 RD=0,1 UX=1.942, 1.942
      ADD=58 RD=0,1 UX=1.942, 1.942
      ADD=59 RD=0,1 UX=1.942, 1.942
      ADD=60 RD=0,1 UX=1.942, 1.942
      ADD=61 RD=0,1 UX=1.942, 1.942
      ADD=62 RD=0,1 UX=1.942, 1.942
      ADD=63 RD=0,1 UX=1.942, 1.942
      ADD=64 RD=0,1 UX=1.942, 1.942
      ADD=65 RD=0,1 UX=1.942, 1.928
      ADD=66 RD=0,1 UX=1.928, 1.912
      ADD=67 RD=0,1 UX=1.912, 1.905
      ADD=68 RD=0,1 UX=1.905, 1.869
      ADD=69 RD=0,1 UX=1.869, 1.833
      ADD=70 RD=0,1 UX=1.833, 1.797
      ADD=71 RD=0,1 UX=1.797, 1.778
      ADD=72 RD=0,1 UX=1.778, 1.761
      ADD=73 RD=0,1 UX=1.079, 0.978
      ADD=31 RD=0,1 UX=1.761, 1.778
      ADD=32 RD=0,1 UX=1.778, 1.797
      ADD=33 RD=0,1 UX=1.797, 1.833
      ADD=34 RD=0,1 UX=1.833, 1.869
      ADD=35 RD=0,1 UX=1.869, 1.905
      ADD=36 RD=0,1 UX=1.905, 1.912
      ADD=37 RD=0,1 UX=1.912, 1.928
      ADD=38 RD=0,1 UX=1.928, 1.942
      ADD=1 RD=0,1 UX=2.152, 2.152
      ADD=2 RD=0,1 UX=2.152, 2.152
      ADD=3 RD=0,1 UX=2.152, 2.152
      ADD=4 RD=0,1 UX=2.152, 2.152
      ADD=5 RD=0,1 UX=2.152, 2.152
      ADD=6 RD=0,1 UX=2.152, 2.152
      ADD=7 RD=0,1 UX=2.152, 2.152
      ADD=8 RD=0,1 UX=2.152, 2.152
      ADD=9 RD=0,1 UX=2.152, 2.152
      ADD=10 RD=0,1 UX=2.152, 2.152
      ADD=11 RD=0,1 UX=2.152, 2.152
      ADD=12 RD=0,1 UX=2.152, 2.152
      ADD=13 RD=0,1 UX=2.152, 2.152
      ADD=14 RD=0,1 UX=2.152, 2.152
      ADD=15 RD=0,1 UX=2.152, 2.152
      ADD=16 RD=0,1 UX=2.152, 2.152
      ADD=17 RD=0,1 UX=2.152, 2.152
      ADD=18 RD=0,1 UX=2.152, 2.152
      ADD=19 RD=0,1 UX=2.152, 2.152
      ADD=20 RD=0,1 UX=2.152, 2.152
      ADD=21 RD=0,1 UX=2.152, 2.152
      ADD=22 RD=0,1 UX=2.152, 2.152
      ADD=23 RD=0,1 UX=2.152, 2.152
      ADD=24 RD=0,1 UX=2.152, 2.152
      ADD=25 RD=0,1 UX=2.152, 2.152
      ADD=26 RD=0,1 UX=2.152, 2.152
      ADD=27 RD=0,1 UX=2.152, 2.152
      ADD=28 RD=0,1 UX=2.152, 2.152
      ADD=29 RD=0,1 UX=2.152, 2.152
      ADD=30 RD=0,1 UX=2.152, 2.152
NAME=FUNSLAB2  ; 슬래브 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-9.275, -9.275
      ADD=40 RD=0,1 UX=-9.275, -9.275
      ADD=41 RD=0,1 UX=-9.275, -9.275
      ADD=42 RD=0,1 UX=-9.275, -9.275
      ADD=43 RD=0,1 UX=-9.275, -9.275
      ADD=44 RD=0,1 UX=-9.275, -9.275
      ADD=45 RD=0,1 UX=-9.275, -9.275
      ADD=46 RD=0,1 UX=-9.275, -9.275
      ADD=47 RD=0,1 UX=-9.275, -9.275
      ADD=48 RD=0,1 UX=-9.275, -9.275
      ADD=49 RD=0,1 UX=-9.275, -9.275
      ADD=50 RD=0,1 UX=-9.275, -9.275
      ADD=51 RD=0,1 UX=-9.275, -9.275
      ADD=52 RD=0,1 UX=-9.275, -9.275
      ADD=53 RD=0,1 UX=-9.275, -9.275
      ADD=54 RD=0,1 UX=-9.275, -9.275
      ADD=55 RD=0,1 UX=-9.275, -9.275
      ADD=56 RD=0,1 UX=-9.275, -9.275
      ADD=57 RD=0,1 UX=-9.275, -9.275
      ADD=58 RD=0,1 UX=-9.275, -9.275
      ADD=59 RD=0,1 UX=-9.275, -9.275
      ADD=60 RD=0,1 UX=-9.275, -9.275
      ADD=61 RD=0,1 UX=-9.275, -9.275
      ADD=62 RD=0,1 UX=-9.275, -9.275
      ADD=63 RD=0,1 UX=-9.275, -9.275
      ADD=64 RD=0,1 UX=-9.275, -9.275
NAME=FUNWALL2  ; 벽체 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=-63.078, -60.255
      ADD=66 RD=0,1 UX=-60.255, -56.719
      ADD=67 RD=0,1 UX=-56.719, -54.966
      ADD=68 RD=0,1 UX=-54.966, -44.597
      ADD=69 RD=0,1 UX=-44.597, -31.91
      ADD=70 RD=0,1 UX=-31.91, -17.054
      ADD=71 RD=0,1 UX=-17.054, -8.26
      ADD=72 RD=0,1 UX=-8.26, -0
      ADD=31 RD=0,1 UX=-0, -8.26
      ADD=32 RD=0,1 UX=-8.26, -17.054
      ADD=33 RD=0,1 UX=-17.054, -31.91
      ADD=34 RD=0,1 UX=-31.91, -44.597
      ADD=35 RD=0,1 UX=-44.597, -54.966
      ADD=36 RD=0,1 UX=-54.966, -56.719
      ADD=37 RD=0,1 UX=-56.719, -60.255
      ADD=38 RD=0,1 UX=-60.255, -63.078
NAME=FUNMS2  ; 주면전단력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-5.53, -5.53
      ADD=40 RD=0,1 UX=-5.53, -5.53
      ADD=41 RD=0,1 UX=-5.53, -5.53
      ADD=42 RD=0,1 UX=-5.53, -5.53
      ADD=43 RD=0,1 UX=-5.53, -5.53
      ADD=44 RD=0,1 UX=-5.53, -5.53
      ADD=45 RD=0,1 UX=-5.53, -5.53
      ADD=46 RD=0,1 UX=-5.53, -5.53
      ADD=47 RD=0,1 UX=-5.53, -5.53
      ADD=48 RD=0,1 UX=-5.53, -5.53
      ADD=49 RD=0,1 UX=-5.53, -5.53
      ADD=50 RD=0,1 UX=-5.53, -5.53
      ADD=51 RD=0,1 UX=-5.53, -5.53
      ADD=52 RD=0,1 UX=-5.53, -5.53
      ADD=53 RD=0,1 UX=-5.53, -5.53
      ADD=54 RD=0,1 UX=-5.53, -5.53
      ADD=55 RD=0,1 UX=-5.53, -5.53
      ADD=56 RD=0,1 UX=-5.53, -5.53
      ADD=57 RD=0,1 UX=-5.53, -5.53
      ADD=58 RD=0,1 UX=-5.53, -5.53
      ADD=59 RD=0,1 UX=-5.53, -5.53
      ADD=60 RD=0,1 UX=-5.53, -5.53
      ADD=61 RD=0,1 UX=-5.53, -5.53
      ADD=62 RD=0,1 UX=-5.53, -5.53
      ADD=63 RD=0,1 UX=-5.53, -5.53
      ADD=64 RD=0,1 UX=-5.53, -5.53
      ADD=65 RD=0,1 UZ=10.55, 10.55
      ADD=66 RD=0,1 UZ=10.55, 10.55
      ADD=67 RD=0,1 UZ=10.55, 10.55
      ADD=68 RD=0,1 UZ=10.55, 10.55
      ADD=69 RD=0,1 UZ=10.55, 10.55
      ADD=70 RD=0,1 UZ=10.55, 10.55
      ADD=71 RD=0,1 UZ=10.55, 10.55
      ADD=72 RD=0,1 UZ=10.55, 10.55
      ADD=31 RD=0,1 UZ=-10.55, -10.55
      ADD=32 RD=0,1 UZ=-10.55, -10.55
      ADD=33 RD=0,1 UZ=-10.55, -10.55
      ADD=34 RD=0,1 UZ=-10.55, -10.55
      ADD=35 RD=0,1 UZ=-10.55, -10.55
      ADD=36 RD=0,1 UZ=-10.55, -10.55
      ADD=37 RD=0,1 UZ=-10.55, -10.55
      ADD=38 RD=0,1 UZ=-10.55, -10.55
      ADD=1 RD=0,1 UX=15.56, 15.56
      ADD=2 RD=0,1 UX=15.56, 15.56
      ADD=3 RD=0,1 UX=15.56, 15.56
      ADD=4 RD=0,1 UX=15.56, 15.56
      ADD=5 RD=0,1 UX=15.56, 15.56
      ADD=6 RD=0,1 UX=15.56, 15.56
      ADD=7 RD=0,1 UX=15.56, 15.56
      ADD=8 RD=0,1 UX=15.56, 15.56
      ADD=9 RD=0,1 UX=15.56, 15.56
      ADD=10 RD=0,1 UX=15.56, 15.56
      ADD=11 RD=0,1 UX=15.56, 15.56
```

```
      ADD=12 RD=0,1 UX=15.56, 15.56
      ADD=13 RD=0,1 UX=15.56, 15.56
      ADD=14 RD=0,1 UX=15.56, 15.56
      ADD=15 RD=0,1 UX=15.56, 15.56
      ADD=16 RD=0,1 UX=15.56, 15.56
      ADD=17 RD=0,1 UX=15.56, 15.56
      ADD=18 RD=0,1 UX=15.56, 15.56
      ADD=19 RD=0,1 UX=15.56, 15.56
      ADD=20 RD=0,1 UX=15.56, 15.56
      ADD=21 RD=0,1 UX=15.56, 15.56
      ADD=22 RD=0,1 UX=15.56, 15.56
      ADD=23 RD=0,1 UX=15.56, 15.56
      ADD=24 RD=0,1 UX=15.56, 15.56
      ADD=25 RD=0,1 UX=15.56, 15.56
      ADD=26 RD=0,1 UX=15.56, 15.56
      ADD=27 RD=0,1 UX=15.56, 15.56
      ADD=28 RD=0,1 UX=15.56, 15.56
      ADD=29 RD=0,1 UX=15.56, 15.56
      ADD=30 RD=0,1 UX=15.56, 15.56
NAME=FUNINER2  ; 구체 관성력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-1.942, -1.942
      ADD=40 RD=0,1 UX=-1.942, -1.942
      ADD=41 RD=0,1 UX=-1.942, -1.942
      ADD=42 RD=0,1 UX=-1.942, -1.942
      ADD=43 RD=0,1 UX=-1.942, -1.942
      ADD=44 RD=0,1 UX=-1.942, -1.942
      ADD=45 RD=0,1 UX=-1.942, -1.942
      ADD=46 RD=0,1 UX=-1.942, -1.942
      ADD=47 RD=0,1 UX=-1.942, -1.942
      ADD=48 RD=0,1 UX=-1.942, -1.942
      ADD=49 RD=0,1 UX=-1.942, -1.942
      ADD=50 RD=0,1 UX=-1.942, -1.942
      ADD=51 RD=0,1 UX=-1.942, -1.942
      ADD=52 RD=0,1 UX=-1.942, -1.942
      ADD=53 RD=0,1 UX=-1.942, -1.942
      ADD=54 RD=0,1 UX=-1.942, -1.942
      ADD=55 RD=0,1 UX=-1.942, -1.942
      ADD=56 RD=0,1 UX=-1.942, -1.942
      ADD=57 RD=0,1 UX=-1.942, -1.942
      ADD=58 RD=0,1 UX=-1.942, -1.942
      ADD=59 RD=0,1 UX=-1.942, -1.942
      ADD=60 RD=0,1 UX=-1.942, -1.942
      ADD=61 RD=0,1 UX=-1.942, -1.942
      ADD=62 RD=0,1 UX=-1.942, -1.942
      ADD=63 RD=0,1 UX=-1.942, -1.942
      ADD=64 RD=0,1 UX=-1.942, -1.942
      ADD=65 RD=0,1 UX=-1.942, -1.928
      ADD=66 RD=0,1 UX=-1.928, -1.912
      ADD=67 RD=0,1 UX=-1.912, -1.905
      ADD=68 RD=0,1 UX=-1.905, -1.869
      ADD=69 RD=0,1 UX=-1.869, -1.833
      ADD=70 RD=0,1 UX=-1.833, -1.797
      ADD=71 RD=0,1 UX=-1.797, -1.778
      ADD=72 RD=0,1 UX=-1.778, -1.761
      ADD=73 RD=0,1 UX=-1.079, -0.978
      ADD=31 RD=0,1 UX=-1.761, -1.778
      ADD=32 RD=0,1 UX=-1.778, -1.797
      ADD=33 RD=0,1 UX=-1.797, -1.833
      ADD=34 RD=0,1 UX=-1.833, -1.869
      ADD=35 RD=0,1 UX=-1.869, -1.905
      ADD=36 RD=0,1 UX=-1.905, -1.912
      ADD=37 RD=0,1 UX=-1.912, -1.928
      ADD=38 RD=0,1 UX=-1.928, -1.942
      ADD=1 RD=0,1 UX=-2.152, -2.152
      ADD=2 RD=0,1 UX=-2.152, -2.152
      ADD=3 RD=0,1 UX=-2.152, -2.152
      ADD=4 RD=0,1 UX=-2.152, -2.152
      ADD=5 RD=0,1 UX=-2.152, -2.152
      ADD=6 RD=0,1 UX=-2.152, -2.152
      ADD=7 RD=0,1 UX=-2.152, -2.152
      ADD=8 RD=0,1 UX=-2.152, -2.152
      ADD=9 RD=0,1 UX=-2.152, -2.152
      ADD=10 RD=0,1 UX=-2.152, -2.152
      ADD=11 RD=0,1 UX=-2.152, -2.152
      ADD=12 RD=0,1 UX=-2.152, -2.152
      ADD=13 RD=0,1 UX=-2.152, -2.152
      ADD=14 RD=0,1 UX=-2.152, -2.152
      ADD=15 RD=0,1 UX=-2.152, -2.152
      ADD=16 RD=0,1 UX=-2.152, -2.152
      ADD=17 RD=0,1 UX=-2.152, -2.152
      ADD=18 RD=0,1 UX=-2.152, -2.152
      ADD=19 RD=0,1 UX=-2.152, -2.152
      ADD=20 RD=0,1 UX=-2.152, -2.152
      ADD=21 RD=0,1 UX=-2.152, -2.152
      ADD=22 RD=0,1 UX=-2.152, -2.152
      ADD=23 RD=0,1 UX=-2.152, -2.152
      ADD=24 RD=0,1 UX=-2.152, -2.152
      ADD=25 RD=0,1 UX=-2.152, -2.152
      ADD=26 RD=0,1 UX=-2.152, -2.152
      ADD=27 RD=0,1 UX=-2.152, -2.152
      ADD=28 RD=0,1 UX=-2.152, -2.152
      ADD=29 RD=0,1 UX=-2.152, -2.152
      ADD=30 RD=0,1 UX=-2.152, -2.152
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=WATERV
      LOAD=WATERH
      LOAD=BUOYANCY
      LOAD=FUNSLAB
      LOAD=FUNWALL
      LOAD=FUNMS
      LOAD=FUNINER
      LOAD=FUNSLAB2
      LOAD=FUNWALL2
      LOAD=FUNMS2
      LOAD=FUNINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
    NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= FUNSLAB2      SF=1.000   AT=1
      LOAD= FUNWALL2      SF=1.000   AT=1
      LOAD= FUNMS2        SF=1.000   AT=1
      LOAD= FUNINER2      SF=1.000   AT=1
    NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVELEE       SF=1.000   AT=1
      LOAD= LIVELEHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
    NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVELEE       SF=1.000   AT=1
      LOAD= LIVELEHE      SF=1.000   AT=1
      LOAD= FUNSLAB2      SF=1.000   AT=1
      LOAD= FUNWALL2      SF=1.000   AT=1
      LOAD= FUNMS2        SF=1.000   AT=1
      LOAD= FUNINER2      SF=1.000   AT=1
    NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVERIE       SF=1.000   AT=1
      LOAD= LIVERIHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
    NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVERIE       SF=1.000   AT=1
      LOAD= LIVERIHE      SF=1.000   AT=1
      LOAD= FUNSLAB2      SF=1.000   AT=1
      LOAD= FUNWALL2      SF=1.000   AT=1
      LOAD= FUNMS2        SF=1.000   AT=1
      LOAD= FUNINER2      SF=1.000   AT=1
    NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=0.500   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
    NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=0.500   AT=1
      LOAD= FUNSLAB2      SF=1.000   AT=1
      LOAD= FUNWALL2      SF=1.000   AT=1
```

```
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
```

```
      LOAD= WATERV          SF=0.900    AT=1
      LOAD= WATERH          SF=1.000    AT=1
      LOAD= FUNSLAB         SF=1.000    AT=1
      LOAD= FUNWALL         SF=1.000    AT=1
      LOAD= FUNMS           SF=1.000    AT=1
      LOAD= FUNINER         SF=1.000    AT=1
   NAME=UE30     TYPE=NON     NSTEP=100     DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW              SF=0.900    AT=1
      LOAD= WATERV          SF=0.900    AT=1
      LOAD= WATERH          SF=1.000    AT=1
      LOAD= FUNSLAB2        SF=1.000    AT=1
      LOAD= FUNWALL2        SF=1.000    AT=1
      LOAD= FUNMS2          SF=1.000    AT=1
      LOAD= FUNINER2        SF=1.000    AT=1
   NAME=UE31     TYPE=NON     NSTEP=100     DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW              SF=0.900    AT=1
      LOAD= WATERV          SF=0.900    AT=1
      LOAD= WATERH          SF=0.500    AT=1
      LOAD= FUNSLAB         SF=1.000    AT=1
      LOAD= FUNWALL         SF=1.000    AT=1
      LOAD= FUNMS           SF=1.000    AT=1
      LOAD= FUNINER         SF=1.000    AT=1
   NAME=UE32     TYPE=NON     NSTEP=100     DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW              SF=0.900    AT=1
      LOAD= WATERV          SF=0.900    AT=1
      LOAD= WATERH          SF=0.500    AT=1
      LOAD= FUNSLAB2        SF=1.000    AT=1
      LOAD= FUNWALL2        SF=1.000    AT=1
      LOAD= FUNMS2          SF=1.000    AT=1
      LOAD= FUNINER2        SF=1.000    AT=1
COMBO
   NAME=ENVEQ   TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
      HIST=UE06 SF=1
      HIST=UE07 SF=1
      HIST=UE08 SF=1
      HIST=UE09 SF=1
      HIST=UE10 SF=1
      HIST=UE11 SF=1
      HIST=UE12 SF=1
      HIST=UE13 SF=1
      HIST=UE14 SF=1
      HIST=UE15 SF=1
      HIST=UE16 SF=1
      HIST=UE17 SF=1
      HIST=UE18 SF=1
      HIST=UE19 SF=1
      HIST=UE20 SF=1
      HIST=UE21 SF=1
      HIST=UE22 SF=1
      HIST=UE23 SF=1
      HIST=UE24 SF=1
      HIST=UE25 SF=1
      HIST=UE26 SF=1
      HIST=UE27 SF=1
      HIST=UE28 SF=1
      HIST=UE29 SF=1
      HIST=UE30 SF=1
      HIST=UE31 SF=1
      HIST=UE32 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

17. INPUT DATA (붕괴방지)

```
; ACulvert SAP2000 데이터파일 : 내진(붕괴)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     0.950 Y=     0.000 Z=     0.500
  3    X=     1.567 Y=     0.000 Z=     0.500
  4    X=     2.050 Y=     0.000 Z=     0.500
  5    X=     2.350 Y=     0.000 Z=     0.500
  6    X=     2.633 Y=     0.000 Z=     0.500
  7    X=     3.700 Y=     0.000 Z=     0.500
  8    X=     4.767 Y=     0.000 Z=     0.500
  9    X=     5.833 Y=     0.000 Z=     0.500
  10   X=     6.900 Y=     0.000 Z=     0.500
  11   X=     7.967 Y=     0.000 Z=     0.500
  12   X=     9.033 Y=     0.000 Z=     0.500
  13   X=     9.200 Y=     0.000 Z=     0.500
  14   X=     9.500 Y=     0.000 Z=     0.500
  15   X=     9.850 Y=     0.000 Z=     0.500
  16   X=    10.100 Y=     0.000 Z=     0.500
  17   X=    10.350 Y=     0.000 Z=     0.500
  18   X=    10.700 Y=     0.000 Z=     0.500
  19   X=    11.000 Y=     0.000 Z=     0.500
  20   X=    11.167 Y=     0.000 Z=     0.500
  21   X=    12.233 Y=     0.000 Z=     0.500
  22   X=    13.300 Y=     0.000 Z=     0.500
  23   X=    14.367 Y=     0.000 Z=     0.500
  24   X=    15.433 Y=     0.000 Z=     0.500
  25   X=    16.500 Y=     0.000 Z=     0.500
  26   X=    17.567 Y=     0.000 Z=     0.500
  27   X=    17.850 Y=     0.000 Z=     0.500
  28   X=    18.150 Y=     0.000 Z=     0.500
  29   X=    18.633 Y=     0.000 Z=     0.500
  30   X=    19.250 Y=     0.000 Z=     0.500
  31   X=    19.700 Y=     0.000 Z=     0.500
  32   X=    19.700 Y=     0.000 Z=     1.050
  33   X=    19.700 Y=     0.000 Z=     1.675
  34   X=    19.700 Y=     0.000 Z=     2.850
  35   X=    19.700 Y=     0.000 Z=     4.025
  36   X=    19.700 Y=     0.000 Z=     5.200
  37   X=    19.700 Y=     0.000 Z=     5.425
  38   X=    19.700 Y=     0.000 Z=     5.925
  39   X=    19.700 Y=     0.000 Z=     6.375
  40   X=    19.250 Y=     0.000 Z=     6.375
  41   X=    18.750 Y=     0.000 Z=     6.375
  42   X=    18.633 Y=     0.000 Z=     6.375
  43   X=    17.567 Y=     0.000 Z=     6.375
  44   X=    16.500 Y=     0.000 Z=     6.375
  45   X=    15.433 Y=     0.000 Z=     6.375
  46   X=    14.367 Y=     0.000 Z=     6.375
  47   X=    13.300 Y=     0.000 Z=     6.375
  48   X=    12.233 Y=     0.000 Z=     6.375
  49   X=    11.167 Y=     0.000 Z=     6.375
  50   X=    10.850 Y=     0.000 Z=     6.375
  51   X=    10.350 Y=     0.000 Z=     6.375
  52   X=    10.100 Y=     0.000 Z=     6.375
  53   X=     9.850 Y=     0.000 Z=     6.375
  54   X=     9.350 Y=     0.000 Z=     6.375
  55   X=     9.033 Y=     0.000 Z=     6.375
  56   X=     7.967 Y=     0.000 Z=     6.375
  57   X=     6.900 Y=     0.000 Z=     6.375
  58   X=     5.833 Y=     0.000 Z=     6.375
  59   X=     4.767 Y=     0.000 Z=     6.375
  60   X=     3.700 Y=     0.000 Z=     6.375
  61   X=     2.633 Y=     0.000 Z=     6.375
  62   X=     1.567 Y=     0.000 Z=     6.375
  63   X=     1.450 Y=     0.000 Z=     6.375
  64   X=     0.950 Y=     0.000 Z=     6.375
  65   X=     0.500 Y=     0.000 Z=     6.375
  66   X=     0.500 Y=     0.000 Z=     5.925
  67   X=     0.500 Y=     0.000 Z=     5.425
  68   X=     0.500 Y=     0.000 Z=     5.200
  69   X=     0.500 Y=     0.000 Z=     4.025
  70   X=     0.500 Y=     0.000 Z=     2.850
  71   X=     0.500 Y=     0.000 Z=     1.675
  72   X=     0.500 Y=     0.000 Z=     1.050
  73   X=     0.500 Y=     0.000 Z=     0.000
  74   X=     1.567 Y=     0.000 Z=     0.000
  75   X=     2.633 Y=     0.000 Z=     0.000
  76   X=     3.700 Y=     0.000 Z=     0.000
  77   X=     4.767 Y=     0.000 Z=     0.000
  78   X=     5.833 Y=     0.000 Z=     0.000
  79   X=     6.900 Y=     0.000 Z=     0.000
  80   X=     7.967 Y=     0.000 Z=     0.000
  81   X=     9.033 Y=     0.000 Z=     0.000
  82   X=    10.100 Y=     0.000 Z=     0.000
  83   X=    11.167 Y=     0.000 Z=     0.000
  84   X=    12.233 Y=     0.000 Z=     0.000
  85   X=    13.300 Y=     0.000 Z=     0.000
  86   X=    14.367 Y=     0.000 Z=     0.000
  87   X=    15.433 Y=     0.000 Z=     0.000
  88   X=    16.500 Y=     0.000 Z=     0.000
  89   X=    17.567 Y=     0.000 Z=     0.000
  90   X=    18.633 Y=     0.000 Z=     0.000
  91   X=    19.700 Y=     0.000 Z=     0.000
  92   X=    20.200 Y=     0.000 Z=     0.500
  93   X=    20.200 Y=     0.000 Z=     1.675
  94   X=    20.200 Y=     0.000 Z=     2.850
  95   X=    20.200 Y=     0.000 Z=     4.025
  96   X=    20.200 Y=     0.000 Z=     5.200
  97   X=    20.200 Y=     0.000 Z=     6.375
  98   X=    19.700 Y=     0.000 Z=     6.875
  99   X=    18.633 Y=     0.000 Z=     6.875
  100  X=    17.567 Y=     0.000 Z=     6.875
  101  X=    16.500 Y=     0.000 Z=     6.875
  102  X=    15.433 Y=     0.000 Z=     6.875
  103  X=    14.367 Y=     0.000 Z=     6.875
  104  X=    13.300 Y=     0.000 Z=     6.875
  105  X=    12.233 Y=     0.000 Z=     6.875
  106  X=    11.167 Y=     0.000 Z=     6.875
  107  X=    10.100 Y=     0.000 Z=     6.875
  108  X=     9.033 Y=     0.000 Z=     6.875
  109  X=     7.967 Y=     0.000 Z=     6.875
  110  X=     6.900 Y=     0.000 Z=     6.875
  111  X=     5.833 Y=     0.000 Z=     6.875
  112  X=     4.767 Y=     0.000 Z=     6.875
  113  X=     3.700 Y=     0.000 Z=     6.875
  114  X=     2.633 Y=     0.000 Z=     6.875
  115  X=     1.567 Y=     0.000 Z=     6.875
  116  X=     0.500 Y=     0.000 Z=     6.875
  117  X=     0.000 Y=     0.000 Z=     6.375
  118  X=     0.000 Y=     0.000 Z=     5.200
  119  X=     0.000 Y=     0.000 Z=     4.025
  120  X=     0.000 Y=     0.000 Z=     2.850
  121  X=     0.000 Y=     0.000 Z=     1.675
  122  X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=92 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=93 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=94 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=95 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=96 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=97 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=98 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=99 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=100 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=101 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=102 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=103 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=104 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=105 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=106 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=107 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=108 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=109 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=110 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=111 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=112 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=113 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=114 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=115 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=116 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=117 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=118 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=119 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=120 DOF=UX,UY,UZ,RX,RY,RZ
```

```
  ADD=121 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=122 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=1820.51
  ADD=6 UX=1820.51
  ADD=7 UX=1820.51
  ADD=8 UX=1820.51
  ADD=9 UX=1820.51
  ADD=10 UX=1820.51
  ADD=11 UX=1820.51
  ADD=12 UX=1820.51
  ADD=16 UX=1820.51
  ADD=20 UX=1820.51
  ADD=21 UX=1820.51
  ADD=22 UX=1820.51
  ADD=23 UX=1820.51
  ADD=24 UX=1820.51
  ADD=25 UX=1820.51
  ADD=26 UX=1820.51
  ADD=29 UX=1820.51
  ADD=33 UZ=4545.89
  ADD=34 UZ=4545.89
  ADD=35 UZ=4545.89
  ADD=36 UZ=4545.89
  ADD=42 UX=1820.51
  ADD=43 UX=1820.51
  ADD=44 UX=1820.51
  ADD=45 UX=1820.51
  ADD=46 UX=1820.51
  ADD=47 UX=1820.51
  ADD=48 UX=1820.51
  ADD=49 UX=1820.51
  ADD=52 UX=1820.51
  ADD=55 UX=1820.51
  ADD=56 UX=1820.51
  ADD=57 UX=1820.51
  ADD=58 UX=1820.51
  ADD=59 UX=1820.51
  ADD=60 UX=1820.51
  ADD=61 UX=1820.51
  ADD=62 UX=1820.51
  ADD=68 UZ=4545.89
  ADD=69 UZ=4545.89
  ADD=70 UZ=4545.89
  ADD=71 UZ=4545.89
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=5034.82 CE=0.99999 K=5034.82 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=5461.51 CE=0.99999 K=5461.51 OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=13202.4 CE=0.99999 K=13202.4 OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=13637.6 CE=0.99999 K=13637.6 OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=12041.8 CE=0.99999 K=12041.8 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.1,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=0.85,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.175 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.175 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.325 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    38 J= 38,  39 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    39 J= 39,  40 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 3 NSEG= 4 ANG=0
    42 J= 42,  43 SEC= 3 NSEG= 4 ANG=0
    43 J= 43,  44 SEC= 3 NSEG= 4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    51 J= 51,  52 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    52 J= 52,  53 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 NSEG= 4 ANG=0
    55 J= 55,  56 SEC= 3 NSEG= 4 ANG=0
    56 J= 56,  57 SEC= 3 NSEG= 4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    64 J= 64,  65 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    65 J= 65,  66 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    66 J= 66,  67 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    67 J= 67,  68 SEC= 3 NSEG= 4 ANG=180
    68 J= 68,  69 SEC= 3 NSEG= 4 ANG=180
    69 J= 69,  70 SEC= 3 NSEG= 4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,   1 SEC= 3 IOFF=0 JOFF=0.325 RIGID=1 NSEG=4 ANG=180
    73 J= 52,  16 SEC= 5 IOFF=0.7 JOFF=0.425 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,73 NLP=1 ANG=0
     2 J= 3,74 NLP=2 ANG=0
     3 J= 6,75 NLP=2 ANG=0
     4 J= 7,76 NLP=2 ANG=0
     5 J= 8,77 NLP=2 ANG=0
     6 J= 9,78 NLP=2 ANG=0
     7 J=10,79 NLP=2 ANG=0
     8 J=11,80 NLP=2 ANG=0
     9 J=12,81 NLP=2 ANG=0
    10 J=16,82 NLP=2 ANG=0
    11 J=20,83 NLP=2 ANG=0
    12 J=21,84 NLP=2 ANG=0
    13 J=22,85 NLP=2 ANG=0
    14 J=23,86 NLP=2 ANG=0
    15 J=24,87 NLP=2 ANG=0
    16 J=25,88 NLP=2 ANG=0
    17 J=26,89 NLP=2 ANG=0
    18 J=29,90 NLP=2 ANG=0
    19 J=31,91 NLP=1 ANG=0
    20 J=31,92 NLP=3 ANG=0
    21 J=33,93 NLP=4 ANG=0
    22 J=34,94 NLP=4 ANG=0
    23 J=35,95 NLP=4 ANG=0
    24 J=36,96 NLP=4 ANG=0
    25 J=39,97 NLP=5 ANG=0
    26 J=39,98 NLP=1 ANG=0
    27 J=42,99 NLP=2 ANG=0
    28 J=43,100 NLP=2 ANG=0
    29 J=44,101 NLP=2 ANG=0
    30 J=45,102 NLP=2 ANG=0
    31 J=46,103 NLP=2 ANG=0
    32 J=47,104 NLP=2 ANG=0
    33 J=48,105 NLP=2 ANG=0
    34 J=49,106 NLP=2 ANG=0
    35 J=52,107 NLP=2 ANG=0
    36 J=55,108 NLP=2 ANG=0
    37 J=56,109 NLP=2 ANG=0
    38 J=57,110 NLP=2 ANG=0
```

```
    39 J=58,111 NLP=2 ANG=0
    40 J=59,112 NLP=2 ANG=0
    41 J=60,113 NLP=2 ANG=0
    42 J=61,114 NLP=2 ANG=0
    43 J=62,115 NLP=2 ANG=0
    44 J=65,116 NLP=1 ANG=0
    45 J=65,117 NLP=5 ANG=0
    46 J=68,118 NLP=4 ANG=0
    47 J=69,119 NLP=4 ANG=0
    48 J=70,120 NLP=4 ANG=0
    49 J=71,121 NLP=4 ANG=0
    50 J= 1,122 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-69.125, -69.125
      ADD=40 RD=0,1 UZ=-69.125, -69.125
      ADD=41 RD=0,1 UZ=-69.125, -69.125
      ADD=42 RD=0,1 UZ=-69.125, -69.125
      ADD=43 RD=0,1 UZ=-69.125, -69.125
      ADD=44 RD=0,1 UZ=-69.125, -69.125
      ADD=45 RD=0,1 UZ=-69.125, -69.125
      ADD=46 RD=0,1 UZ=-69.125, -69.125
      ADD=47 RD=0,1 UZ=-69.125, -69.125
      ADD=48 RD=0,1 UZ=-69.125, -69.125
      ADD=49 RD=0,1 UZ=-69.125, -69.125
      ADD=50 RD=0,1 UZ=-69.125, -69.125
      ADD=51 RD=0,1 UZ=-69.125, -69.125
      ADD=52 RD=0,1 UZ=-69.125, -69.125
      ADD=53 RD=0,1 UZ=-69.125, -69.125
      ADD=54 RD=0,1 UZ=-69.125, -69.125
      ADD=55 RD=0,1 UZ=-69.125, -69.125
      ADD=56 RD=0,1 UZ=-69.125, -69.125
      ADD=57 RD=0,1 UZ=-69.125, -69.125
      ADD=58 RD=0,1 UZ=-69.125, -69.125
      ADD=59 RD=0,1 UZ=-69.125, -69.125
      ADD=60 RD=0,1 UZ=-69.125, -69.125
      ADD=61 RD=0,1 UZ=-69.125, -69.125
      ADD=62 RD=0,1 UZ=-69.125, -69.125
      ADD=63 RD=0,1 UZ=-69.125, -69.125
      ADD=64 RD=0,1 UZ=-69.125, -69.125
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-51.575, -51.575
      ADD=40 RD=0,1 UZ=-51.575, -51.575
      ADD=41 RD=0,1 UZ=-51.575, -51.575
      ADD=42 RD=0,1 UZ=-51.575, -51.575
      ADD=43 RD=0,1 UZ=-51.575, -51.575
      ADD=44 RD=0,1 UZ=-51.575, -51.575
      ADD=45 RD=0,1 UZ=-51.575, -51.575
      ADD=46 RD=0,1 UZ=-51.575, -51.575
      ADD=47 RD=0,1 UZ=-51.575, -51.575
      ADD=48 RD=0,1 UZ=-51.575, -51.575
      ADD=49 RD=0,1 UZ=-51.575, -51.575
      ADD=50 RD=0,1 UZ=-51.575, -51.575
      ADD=51 RD=0,1 UZ=-51.575, -51.575
      ADD=52 RD=0,1 UZ=-51.575, -51.575
      ADD=53 RD=0,1 UZ=-51.575, -51.575
      ADD=54 RD=0,1 UZ=-51.575, -51.575
      ADD=55 RD=0,1 UZ=-51.575, -51.575
      ADD=56 RD=0,1 UZ=-51.575, -51.575
      ADD=57 RD=0,1 UZ=-51.575, -51.575
      ADD=58 RD=0,1 UZ=-51.575, -51.575
      ADD=59 RD=0,1 UZ=-51.575, -51.575
      ADD=60 RD=0,1 UZ=-51.575, -51.575
      ADD=61 RD=0,1 UZ=-51.575, -51.575
      ADD=62 RD=0,1 UZ=-51.575, -51.575
      ADD=63 RD=0,1 UZ=-51.575, -51.575
      ADD=64 RD=0,1 UZ=-51.575, -51.575
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11, -11
      ADD=40 RD=0,1 UZ=-11, -11
      ADD=41 RD=0,1 UZ=-11, -11
      ADD=42 RD=0,1 UZ=-11, -11
      ADD=43 RD=0,1 UZ=-11, -11
      ADD=44 RD=0,1 UZ=-11, -11
      ADD=45 RD=0,1 UZ=-11, -11
      ADD=46 RD=0,1 UZ=-11, -11
      ADD=47 RD=0,1 UZ=-11, -11
      ADD=48 RD=0,1 UZ=-11, -11
      ADD=49 RD=0,1 UZ=-11, -11
      ADD=50 RD=0,1 UZ=-11, -11
      ADD=51 RD=0,1 UZ=-11, -11
      ADD=52 RD=0,1 UZ=-11, -11
      ADD=53 RD=0,1 UZ=-11, -11
      ADD=54 RD=0,1 UZ=-11, -11
      ADD=55 RD=0,1 UZ=-11, -11
      ADD=56 RD=0,1 UZ=-11, -11
      ADD=57 RD=0,1 UZ=-11, -11
      ADD=58 RD=0,1 UZ=-11, -11
      ADD=59 RD=0,1 UZ=-11, -11
      ADD=60 RD=0,1 UZ=-11, -11
      ADD=61 RD=0,1 UZ=-11, -11
      ADD=62 RD=0,1 UZ=-11, -11
      ADD=63 RD=0,1 UZ=-11, -11
      ADD=64 RD=0,1 UZ=-11, -11
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=52 RD=0,1 UZ=-11, -11
      ADD=53 RD=0,1 UZ=-11, -11
      ADD=54 RD=0,1 UZ=-11, -11
      ADD=55 RD=0,1 UZ=-11, -11
      ADD=56 RD=0,1 UZ=-11, -11
      ADD=57 RD=0,1 UZ=-11, -11
      ADD=58 RD=0,1 UZ=-11, -11
      ADD=59 RD=0,1 UZ=-11, -11
      ADD=60 RD=0,1 UZ=-11, -11
      ADD=61 RD=0,1 UZ=-11, -11
      ADD=62 RD=0,1 UZ=-11, -11
      ADD=63 RD=0,1 UZ=-11, -11
      ADD=64 RD=0,1 UZ=-11, -11
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11, -11
      ADD=40 RD=0,1 UZ=-11, -11
      ADD=41 RD=0,1 UZ=-11, -11
      ADD=42 RD=0,1 UZ=-11, -11
      ADD=43 RD=0,1 UZ=-11, -11
      ADD=44 RD=0,1 UZ=-11, -11
      ADD=45 RD=0,1 UZ=-11, -11
      ADD=46 RD=0,1 UZ=-11, -11
      ADD=47 RD=0,1 UZ=-11, -11
      ADD=48 RD=0,1 UZ=-11, -11
      ADD=49 RD=0,1 UZ=-11, -11
      ADD=50 RD=0,1 UZ=-11, -11
      ADD=51 RD=0,1 UZ=-11, -11
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.5, 5.5
      ADD=66 RD=0,1 UX=5.5, 5.5
      ADD=67 RD=0,1 UX=5.5, 5.5
      ADD=68 RD=0,1 UX=5.5, 5.5
      ADD=69 RD=0,1 UX=5.5, 5.5
      ADD=70 RD=0,1 UX=5.5, 5.5
      ADD=71 RD=0,1 UX=5.5, 5.5
      ADD=72 RD=0,1 UX=5.5, 5.5
      ADD=31 RD=0,1 UX=-5.5, -5.5
      ADD=32 RD=0,1 UX=-5.5, -5.5
      ADD=33 RD=0,1 UX=-5.5, -5.5
      ADD=34 RD=0,1 UX=-5.5, -5.5
      ADD=35 RD=0,1 UX=-5.5, -5.5
      ADD=36 RD=0,1 UX=-5.5, -5.5
      ADD=37 RD=0,1 UX=-5.5, -5.5
      ADD=38 RD=0,1 UX=-5.5, -5.5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.5, 5.5
      ADD=66 RD=0,1 UX=5.5, 5.5
      ADD=67 RD=0,1 UX=5.5, 5.5
      ADD=68 RD=0,1 UX=5.5, 5.5
      ADD=69 RD=0,1 UX=5.5, 5.5
      ADD=70 RD=0,1 UX=5.5, 5.5
      ADD=71 RD=0,1 UX=5.5, 5.5
      ADD=72 RD=0,1 UX=5.5, 5.5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-5.5, -5.5
      ADD=32 RD=0,1 UX=-5.5, -5.5
      ADD=33 RD=0,1 UX=-5.5, -5.5
      ADD=34 RD=0,1 UX=-5.5, -5.5
      ADD=35 RD=0,1 UX=-5.5, -5.5
      ADD=36 RD=0,1 UX=-5.5, -5.5
      ADD=37 RD=0,1 UX=-5.5, -5.5
      ADD=38 RD=0,1 UX=-5.5, -5.5
NAME=WATERV  ; 연직수압
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-19.5, -19.5
      ADD=40 RD=0,1 UZ=-19.5, -19.5
      ADD=41 RD=0,1 UZ=-19.5, -19.5
      ADD=42 RD=0,1 UZ=-19.5, -19.5
      ADD=43 RD=0,1 UZ=-19.5, -19.5
      ADD=44 RD=0,1 UZ=-19.5, -19.5
      ADD=45 RD=0,1 UZ=-19.5, -19.5
      ADD=46 RD=0,1 UZ=-19.5, -19.5
      ADD=47 RD=0,1 UZ=-19.5, -19.5
      ADD=48 RD=0,1 UZ=-19.5, -19.5
      ADD=49 RD=0,1 UZ=-19.5, -19.5
      ADD=50 RD=0,1 UZ=-19.5, -19.5
```

```
      ADD=51 RD=0,1 UZ=-19.5, -19.5
      ADD=52 RD=0,1 UZ=-19.5, -19.5
      ADD=53 RD=0,1 UZ=-19.5, -19.5
      ADD=54 RD=0,1 UZ=-19.5, -19.5
      ADD=55 RD=0,1 UZ=-19.5, -19.5
      ADD=56 RD=0,1 UZ=-19.5, -19.5
      ADD=57 RD=0,1 UZ=-19.5, -19.5
      ADD=58 RD=0,1 UZ=-19.5, -19.5
      ADD=59 RD=0,1 UZ=-19.5, -19.5
      ADD=60 RD=0,1 UZ=-19.5, -19.5
      ADD=61 RD=0,1 UZ=-19.5, -19.5
      ADD=62 RD=0,1 UZ=-19.5, -19.5
      ADD=63 RD=0,1 UZ=-19.5, -19.5
      ADD=64 RD=0,1 UZ=-19.5, -19.5
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=24.5, 29
      ADD=66 RD=0,1 UX=29, 34
      ADD=67 RD=0,1 UX=34, 36.25
      ADD=68 RD=0,1 UX=36.25, 48
      ADD=69 RD=0,1 UX=48, 59.75
      ADD=70 RD=0,1 UX=59.75, 71.5
      ADD=71 RD=0,1 UX=71.5, 77.75
      ADD=72 RD=0,1 UX=77.75, 83.25
      ADD=31 RD=0,1 UX=-83.25, -77.75
      ADD=32 RD=0,1 UX=-77.75, -71.5
      ADD=33 RD=0,1 UX=-71.5, -59.75
      ADD=34 RD=0,1 UX=-59.75, -48
      ADD=35 RD=0,1 UX=-48, -36.25
      ADD=36 RD=0,1 UX=-36.25, -34
      ADD=37 RD=0,1 UX=-34, -29
      ADD=38 RD=0,1 UX=-29, -24.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=87.5, 87.5
      ADD=2 RD=0,1 UZ=87.5, 87.5
      ADD=3 RD=0,1 UZ=87.5, 87.5
      ADD=4 RD=0,1 UZ=87.5, 87.5
      ADD=5 RD=0,1 UZ=87.5, 87.5
      ADD=6 RD=0,1 UZ=87.5, 87.5
      ADD=7 RD=0,1 UZ=87.5, 87.5
      ADD=8 RD=0,1 UZ=87.5, 87.5
      ADD=9 RD=0,1 UZ=87.5, 87.5
      ADD=10 RD=0,1 UZ=87.5, 87.5
      ADD=11 RD=0,1 UZ=87.5, 87.5
      ADD=12 RD=0,1 UZ=87.5, 87.5
      ADD=13 RD=0,1 UZ=87.5, 87.5
      ADD=14 RD=0,1 UZ=87.5, 87.5
      ADD=15 RD=0,1 UZ=87.5, 87.5
      ADD=16 RD=0,1 UZ=87.5, 87.5
      ADD=17 RD=0,1 UZ=87.5, 87.5
      ADD=18 RD=0,1 UZ=87.5, 87.5
      ADD=19 RD=0,1 UZ=87.5, 87.5
      ADD=20 RD=0,1 UZ=87.5, 87.5
      ADD=21 RD=0,1 UZ=87.5, 87.5
      ADD=22 RD=0,1 UZ=87.5, 87.5
      ADD=23 RD=0,1 UZ=87.5, 87.5
      ADD=24 RD=0,1 UZ=87.5, 87.5
      ADD=25 RD=0,1 UZ=87.5, 87.5
      ADD=26 RD=0,1 UZ=87.5, 87.5
      ADD=27 RD=0,1 UZ=87.5, 87.5
      ADD=28 RD=0,1 UZ=87.5, 87.5
      ADD=29 RD=0,1 UZ=87.5, 87.5
      ADD=30 RD=0,1 UZ=87.5, 87.5
NAME=COLSLAB  ; 슬래브 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=11.828, 11.828
      ADD=40 RD=0,1 UX=11.828, 11.828
      ADD=41 RD=0,1 UX=11.828, 11.828
      ADD=42 RD=0,1 UX=11.828, 11.828
      ADD=43 RD=0,1 UX=11.828, 11.828
      ADD=44 RD=0,1 UX=11.828, 11.828
      ADD=45 RD=0,1 UX=11.828, 11.828
      ADD=46 RD=0,1 UX=11.828, 11.828
      ADD=47 RD=0,1 UX=11.828, 11.828
      ADD=48 RD=0,1 UX=11.828, 11.828
      ADD=49 RD=0,1 UX=11.828, 11.828
      ADD=50 RD=0,1 UX=11.828, 11.828
      ADD=51 RD=0,1 UX=11.828, 11.828
      ADD=52 RD=0,1 UX=11.828, 11.828
      ADD=53 RD=0,1 UX=11.828, 11.828
      ADD=54 RD=0,1 UX=11.828, 11.828
      ADD=55 RD=0,1 UX=11.828, 11.828
      ADD=56 RD=0,1 UX=11.828, 11.828
      ADD=57 RD=0,1 UX=11.828, 11.828
      ADD=58 RD=0,1 UX=11.828, 11.828
      ADD=59 RD=0,1 UX=11.828, 11.828
      ADD=60 RD=0,1 UX=11.828, 11.828
      ADD=61 RD=0,1 UX=11.828, 11.828
      ADD=62 RD=0,1 UX=11.828, 11.828
      ADD=63 RD=0,1 UX=11.828, 11.828
      ADD=64 RD=0,1 UX=11.828, 11.828
NAME=COLWALL  ; 벽체 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=80.433, 76.835
      ADD=66 RD=0,1 UX=76.835, 72.32
      ADD=67 RD=0,1 UX=72.32, 70.115
      ADD=68 RD=0,1 UX=70.115, 56.849
      ADD=69 RD=0,1 UX=56.849, 40.704
      ADD=70 RD=0,1 UX=40.704, 21.727
      ADD=71 RD=0,1 UX=21.727, 10.515
      ADD=72 RD=0,1 UX=10.515, 0
      ADD=31 RD=0,1 UX=0, 10.515
      ADD=32 RD=0,1 UX=10.515, 21.727
      ADD=33 RD=0,1 UX=21.727, 40.704
      ADD=34 RD=0,1 UX=40.704, 56.849
      ADD=35 RD=0,1 UX=56.849, 70.115
      ADD=36 RD=0,1 UX=70.115, 72.32
      ADD=37 RD=0,1 UX=72.32, 76.835
      ADD=38 RD=0,1 UX=76.835, 80.433
NAME=COLMS  ; 주면전단력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=7.06, 7.06
      ADD=40 RD=0,1 UX=7.06, 7.06
      ADD=41 RD=0,1 UX=7.06, 7.06
      ADD=42 RD=0,1 UX=7.06, 7.06
      ADD=43 RD=0,1 UX=7.06, 7.06
      ADD=44 RD=0,1 UX=7.06, 7.06
      ADD=45 RD=0,1 UX=7.06, 7.06
      ADD=46 RD=0,1 UX=7.06, 7.06
      ADD=47 RD=0,1 UX=7.06, 7.06
      ADD=48 RD=0,1 UX=7.06, 7.06
      ADD=49 RD=0,1 UX=7.06, 7.06
      ADD=50 RD=0,1 UX=7.06, 7.06
      ADD=51 RD=0,1 UX=7.06, 7.06
      ADD=52 RD=0,1 UX=7.06, 7.06
      ADD=53 RD=0,1 UX=7.06, 7.06
      ADD=54 RD=0,1 UX=7.06, 7.06
      ADD=55 RD=0,1 UX=7.06, 7.06
      ADD=56 RD=0,1 UX=7.06, 7.06
      ADD=57 RD=0,1 UX=7.06, 7.06
      ADD=58 RD=0,1 UX=7.06, 7.06
      ADD=59 RD=0,1 UX=7.06, 7.06
      ADD=60 RD=0,1 UX=7.06, 7.06
      ADD=61 RD=0,1 UX=7.06, 7.06
      ADD=62 RD=0,1 UX=7.06, 7.06
      ADD=63 RD=0,1 UX=7.06, 7.06
      ADD=64 RD=0,1 UX=7.06, 7.06
      ADD=65 RD=0,1 UZ=-13.45, -13.45
      ADD=66 RD=0,1 UZ=-13.45, -13.45
      ADD=67 RD=0,1 UZ=-13.45, -13.45
      ADD=68 RD=0,1 UZ=-13.45, -13.45
      ADD=69 RD=0,1 UZ=-13.45, -13.45
      ADD=70 RD=0,1 UZ=-13.45, -13.45
      ADD=71 RD=0,1 UZ=-13.45, -13.45
      ADD=72 RD=0,1 UZ=-13.45, -13.45
      ADD=31 RD=0,1 UZ=13.45, 13.45
      ADD=32 RD=0,1 UZ=13.45, 13.45
      ADD=33 RD=0,1 UZ=13.45, 13.45
      ADD=34 RD=0,1 UZ=13.45, 13.45
      ADD=35 RD=0,1 UZ=13.45, 13.45
      ADD=36 RD=0,1 UZ=13.45, 13.45
      ADD=37 RD=0,1 UZ=13.45, 13.45
      ADD=38 RD=0,1 UZ=13.45, 13.45
      ADD=1 RD=0,1 UX=-19.85, -19.85
      ADD=2 RD=0,1 UX=-19.85, -19.85
      ADD=3 RD=0,1 UX=-19.85, -19.85
      ADD=4 RD=0,1 UX=-19.85, -19.85
      ADD=5 RD=0,1 UX=-19.85, -19.85
      ADD=6 RD=0,1 UX=-19.85, -19.85
      ADD=7 RD=0,1 UX=-19.85, -19.85
      ADD=8 RD=0,1 UX=-19.85, -19.85
      ADD=9 RD=0,1 UX=-19.85, -19.85
      ADD=10 RD=0,1 UX=-19.85, -19.85
      ADD=11 RD=0,1 UX=-19.85, -19.85
      ADD=12 RD=0,1 UX=-19.85, -19.85
      ADD=13 RD=0,1 UX=-19.85, -19.85
      ADD=14 RD=0,1 UX=-19.85, -19.85
      ADD=15 RD=0,1 UX=-19.85, -19.85
      ADD=16 RD=0,1 UX=-19.85, -19.85
      ADD=17 RD=0,1 UX=-19.85, -19.85
      ADD=18 RD=0,1 UX=-19.85, -19.85
      ADD=19 RD=0,1 UX=-19.85, -19.85
      ADD=20 RD=0,1 UX=-19.85, -19.85
      ADD=21 RD=0,1 UX=-19.85, -19.85
      ADD=22 RD=0,1 UX=-19.85, -19.85
      ADD=23 RD=0,1 UX=-19.85, -19.85
      ADD=24 RD=0,1 UX=-19.85, -19.85
      ADD=25 RD=0,1 UX=-19.85, -19.85
      ADD=26 RD=0,1 UX=-19.85, -19.85
```

```
      ADD=27 RD=0,1 UX=-19.85, -19.85
      ADD=28 RD=0,1 UX=-19.85, -19.85
      ADD=29 RD=0,1 UX=-19.85, -19.85
      ADD=30 RD=0,1 UX=-19.85, -19.85
NAME=COLINER  ; 구체 관성력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=4.779, 4.779
      ADD=40 RD=0,1 UX=4.779, 4.779
      ADD=41 RD=0,1 UX=4.779, 4.779
      ADD=42 RD=0,1 UX=4.779, 4.779
      ADD=43 RD=0,1 UX=4.779, 4.779
      ADD=44 RD=0,1 UX=4.779, 4.779
      ADD=45 RD=0,1 UX=4.779, 4.779
      ADD=46 RD=0,1 UX=4.779, 4.779
      ADD=47 RD=0,1 UX=4.779, 4.779
      ADD=48 RD=0,1 UX=4.779, 4.779
      ADD=49 RD=0,1 UX=4.779, 4.779
      ADD=50 RD=0,1 UX=4.779, 4.779
      ADD=51 RD=0,1 UX=4.779, 4.779
      ADD=52 RD=0,1 UX=4.779, 4.779
      ADD=53 RD=0,1 UX=4.779, 4.779
      ADD=54 RD=0,1 UX=4.779, 4.779
      ADD=55 RD=0,1 UX=4.779, 4.779
      ADD=56 RD=0,1 UX=4.779, 4.779
      ADD=57 RD=0,1 UX=4.779, 4.779
      ADD=58 RD=0,1 UX=4.779, 4.779
      ADD=59 RD=0,1 UX=4.779, 4.779
      ADD=60 RD=0,1 UX=4.779, 4.779
      ADD=61 RD=0,1 UX=4.779, 4.779
      ADD=62 RD=0,1 UX=4.779, 4.779
      ADD=63 RD=0,1 UX=4.779, 4.779
      ADD=64 RD=0,1 UX=4.779, 4.779
      ADD=65 RD=0,1 UX=4.779, 4.745
      ADD=66 RD=0,1 UX=4.745, 4.707
      ADD=67 RD=0,1 UX=4.707, 4.69
      ADD=68 RD=0,1 UX=4.69, 4.602
      ADD=69 RD=0,1 UX=4.602, 4.513
      ADD=70 RD=0,1 UX=4.513, 4.424
      ADD=71 RD=0,1 UX=4.424, 4.377
      ADD=72 RD=0,1 UX=4.377, 4.335
      ADD=73 RD=0,1 UX=2.655, 2.408
      ADD=31 RD=0,1 UX=4.335, 4.377
      ADD=32 RD=0,1 UX=4.377, 4.424
      ADD=33 RD=0,1 UX=4.424, 4.513
      ADD=34 RD=0,1 UX=4.513, 4.602
      ADD=35 RD=0,1 UX=4.602, 4.69
      ADD=36 RD=0,1 UX=4.69, 4.707
      ADD=37 RD=0,1 UX=4.707, 4.745
      ADD=38 RD=0,1 UX=4.745, 4.779
      ADD=1 RD=0,1 UX=5.298, 5.298
      ADD=2 RD=0,1 UX=5.298, 5.298
      ADD=3 RD=0,1 UX=5.298, 5.298
      ADD=4 RD=0,1 UX=5.298, 5.298
      ADD=5 RD=0,1 UX=5.298, 5.298
      ADD=6 RD=0,1 UX=5.298, 5.298
      ADD=7 RD=0,1 UX=5.298, 5.298
      ADD=8 RD=0,1 UX=5.298, 5.298
      ADD=9 RD=0,1 UX=5.298, 5.298
      ADD=10 RD=0,1 UX=5.298, 5.298
      ADD=11 RD=0,1 UX=5.298, 5.298
      ADD=12 RD=0,1 UX=5.298, 5.298
      ADD=13 RD=0,1 UX=5.298, 5.298
      ADD=14 RD=0,1 UX=5.298, 5.298
      ADD=15 RD=0,1 UX=5.298, 5.298
      ADD=16 RD=0,1 UX=5.298, 5.298
      ADD=17 RD=0,1 UX=5.298, 5.298
      ADD=18 RD=0,1 UX=5.298, 5.298
      ADD=19 RD=0,1 UX=5.298, 5.298
      ADD=20 RD=0,1 UX=5.298, 5.298
      ADD=21 RD=0,1 UX=5.298, 5.298
      ADD=22 RD=0,1 UX=5.298, 5.298
      ADD=23 RD=0,1 UX=5.298, 5.298
      ADD=24 RD=0,1 UX=5.298, 5.298
      ADD=25 RD=0,1 UX=5.298, 5.298
      ADD=26 RD=0,1 UX=5.298, 5.298
      ADD=27 RD=0,1 UX=5.298, 5.298
      ADD=28 RD=0,1 UX=5.298, 5.298
      ADD=29 RD=0,1 UX=5.298, 5.298
      ADD=30 RD=0,1 UX=5.298, 5.298
NAME=COLSLAB2  ; 슬래브 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-11.828, -11.828
      ADD=40 RD=0,1 UX=-11.828, -11.828
      ADD=41 RD=0,1 UX=-11.828, -11.828
      ADD=42 RD=0,1 UX=-11.828, -11.828
      ADD=43 RD=0,1 UX=-11.828, -11.828
      ADD=44 RD=0,1 UX=-11.828, -11.828
      ADD=45 RD=0,1 UX=-11.828, -11.828
      ADD=46 RD=0,1 UX=-11.828, -11.828
      ADD=47 RD=0,1 UX=-11.828, -11.828
      ADD=48 RD=0,1 UX=-11.828, -11.828
      ADD=49 RD=0,1 UX=-11.828, -11.828
      ADD=50 RD=0,1 UX=-11.828, -11.828
      ADD=51 RD=0,1 UX=-11.828, -11.828
      ADD=52 RD=0,1 UX=-11.828, -11.828
      ADD=53 RD=0,1 UX=-11.828, -11.828
      ADD=54 RD=0,1 UX=-11.828, -11.828
      ADD=55 RD=0,1 UX=-11.828, -11.828
      ADD=56 RD=0,1 UX=-11.828, -11.828
      ADD=57 RD=0,1 UX=-11.828, -11.828
      ADD=58 RD=0,1 UX=-11.828, -11.828
      ADD=59 RD=0,1 UX=-11.828, -11.828
      ADD=60 RD=0,1 UX=-11.828, -11.828
      ADD=61 RD=0,1 UX=-11.828, -11.828
      ADD=62 RD=0,1 UX=-11.828, -11.828
      ADD=63 RD=0,1 UX=-11.828, -11.828
      ADD=64 RD=0,1 UX=-11.828, -11.828
NAME=COLWALL2  ; 벽체 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=-80.433, -76.835
      ADD=66 RD=0,1 UX=-76.835, -72.32
      ADD=67 RD=0,1 UX=-72.32, -70.115
      ADD=68 RD=0,1 UX=-70.115, -56.849
      ADD=69 RD=0,1 UX=-56.849, -40.704
      ADD=70 RD=0,1 UX=-40.704, -21.727
      ADD=71 RD=0,1 UX=-21.727, -10.515
      ADD=72 RD=0,1 UX=-10.515, -0
      ADD=31 RD=0,1 UX=-0, -10.515
      ADD=32 RD=0,1 UX=-10.515, -21.727
      ADD=33 RD=0,1 UX=-21.727, -40.704
      ADD=34 RD=0,1 UX=-40.704, -56.849
      ADD=35 RD=0,1 UX=-56.849, -70.115
      ADD=36 RD=0,1 UX=-70.115, -72.32
      ADD=37 RD=0,1 UX=-72.32, -76.835
      ADD=38 RD=0,1 UX=-76.835, -80.433
NAME=COLMS2  ; 주면전단력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-7.06, -7.06
      ADD=40 RD=0,1 UX=-7.06, -7.06
      ADD=41 RD=0,1 UX=-7.06, -7.06
      ADD=42 RD=0,1 UX=-7.06, -7.06
      ADD=43 RD=0,1 UX=-7.06, -7.06
      ADD=44 RD=0,1 UX=-7.06, -7.06
      ADD=45 RD=0,1 UX=-7.06, -7.06
      ADD=46 RD=0,1 UX=-7.06, -7.06
      ADD=47 RD=0,1 UX=-7.06, -7.06
      ADD=48 RD=0,1 UX=-7.06, -7.06
      ADD=49 RD=0,1 UX=-7.06, -7.06
      ADD=50 RD=0,1 UX=-7.06, -7.06
      ADD=51 RD=0,1 UX=-7.06, -7.06
      ADD=52 RD=0,1 UX=-7.06, -7.06
      ADD=53 RD=0,1 UX=-7.06, -7.06
      ADD=54 RD=0,1 UX=-7.06, -7.06
      ADD=55 RD=0,1 UX=-7.06, -7.06
      ADD=56 RD=0,1 UX=-7.06, -7.06
      ADD=57 RD=0,1 UX=-7.06, -7.06
      ADD=58 RD=0,1 UX=-7.06, -7.06
      ADD=59 RD=0,1 UX=-7.06, -7.06
      ADD=60 RD=0,1 UX=-7.06, -7.06
      ADD=61 RD=0,1 UX=-7.06, -7.06
      ADD=62 RD=0,1 UX=-7.06, -7.06
      ADD=63 RD=0,1 UX=-7.06, -7.06
      ADD=64 RD=0,1 UX=-7.06, -7.06
      ADD=65 RD=0,1 UZ=13.45, 13.45
      ADD=66 RD=0,1 UZ=13.45, 13.45
      ADD=67 RD=0,1 UZ=13.45, 13.45
      ADD=68 RD=0,1 UZ=13.45, 13.45
      ADD=69 RD=0,1 UZ=13.45, 13.45
      ADD=70 RD=0,1 UZ=13.45, 13.45
      ADD=71 RD=0,1 UZ=13.45, 13.45
      ADD=72 RD=0,1 UZ=13.45, 13.45
      ADD=31 RD=0,1 UZ=-13.45, -13.45
      ADD=32 RD=0,1 UZ=-13.45, -13.45
      ADD=33 RD=0,1 UZ=-13.45, -13.45
      ADD=34 RD=0,1 UZ=-13.45, -13.45
      ADD=35 RD=0,1 UZ=-13.45, -13.45
      ADD=36 RD=0,1 UZ=-13.45, -13.45
      ADD=37 RD=0,1 UZ=-13.45, -13.45
      ADD=38 RD=0,1 UZ=-13.45, -13.45
      ADD=1 RD=0,1 UX=19.85, 19.85
      ADD=2 RD=0,1 UX=19.85, 19.85
      ADD=3 RD=0,1 UX=19.85, 19.85
      ADD=4 RD=0,1 UX=19.85, 19.85
      ADD=5 RD=0,1 UX=19.85, 19.85
      ADD=6 RD=0,1 UX=19.85, 19.85
      ADD=7 RD=0,1 UX=19.85, 19.85
      ADD=8 RD=0,1 UX=19.85, 19.85
      ADD=9 RD=0,1 UX=19.85, 19.85
      ADD=10 RD=0,1 UX=19.85, 19.85
      ADD=11 RD=0,1 UX=19.85, 19.85
```

```
      ADD=12 RD=0,1 UX=19.85, 19.85
      ADD=13 RD=0,1 UX=19.85, 19.85
      ADD=14 RD=0,1 UX=19.85, 19.85
      ADD=15 RD=0,1 UX=19.85, 19.85
      ADD=16 RD=0,1 UX=19.85, 19.85
      ADD=17 RD=0,1 UX=19.85, 19.85
      ADD=18 RD=0,1 UX=19.85, 19.85
      ADD=19 RD=0,1 UX=19.85, 19.85
      ADD=20 RD=0,1 UX=19.85, 19.85
      ADD=21 RD=0,1 UX=19.85, 19.85
      ADD=22 RD=0,1 UX=19.85, 19.85
      ADD=23 RD=0,1 UX=19.85, 19.85
      ADD=24 RD=0,1 UX=19.85, 19.85
      ADD=25 RD=0,1 UX=19.85, 19.85
      ADD=26 RD=0,1 UX=19.85, 19.85
      ADD=27 RD=0,1 UX=19.85, 19.85
      ADD=28 RD=0,1 UX=19.85, 19.85
      ADD=29 RD=0,1 UX=19.85, 19.85
      ADD=30 RD=0,1 UX=19.85, 19.85
  NAME=COLINER2  ; 구체 관성력(봉괴방지)2
    TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-4.779, -4.779
      ADD=40 RD=0,1 UX=-4.779, -4.779
      ADD=41 RD=0,1 UX=-4.779, -4.779
      ADD=42 RD=0,1 UX=-4.779, -4.779
      ADD=43 RD=0,1 UX=-4.779, -4.779
      ADD=44 RD=0,1 UX=-4.779, -4.779
      ADD=45 RD=0,1 UX=-4.779, -4.779
      ADD=46 RD=0,1 UX=-4.779, -4.779
      ADD=47 RD=0,1 UX=-4.779, -4.779
      ADD=48 RD=0,1 UX=-4.779, -4.779
      ADD=49 RD=0,1 UX=-4.779, -4.779
      ADD=50 RD=0,1 UX=-4.779, -4.779
      ADD=51 RD=0,1 UX=-4.779, -4.779
      ADD=52 RD=0,1 UX=-4.779, -4.779
      ADD=53 RD=0,1 UX=-4.779, -4.779
      ADD=54 RD=0,1 UX=-4.779, -4.779
      ADD=55 RD=0,1 UX=-4.779, -4.779
      ADD=56 RD=0,1 UX=-4.779, -4.779
      ADD=57 RD=0,1 UX=-4.779, -4.779
      ADD=58 RD=0,1 UX=-4.779, -4.779
      ADD=59 RD=0,1 UX=-4.779, -4.779
      ADD=60 RD=0,1 UX=-4.779, -4.779
      ADD=61 RD=0,1 UX=-4.779, -4.779
      ADD=62 RD=0,1 UX=-4.779, -4.779
      ADD=63 RD=0,1 UX=-4.779, -4.779
      ADD=64 RD=0,1 UX=-4.779, -4.779
      ADD=65 RD=0,1 UX=-4.779, -4.745
      ADD=66 RD=0,1 UX=-4.745, -4.707
      ADD=67 RD=0,1 UX=-4.707, -4.69
      ADD=68 RD=0,1 UX=-4.69, -4.602
      ADD=69 RD=0,1 UX=-4.602, -4.513
      ADD=70 RD=0,1 UX=-4.513, -4.424
      ADD=71 RD=0,1 UX=-4.424, -4.377
      ADD=72 RD=0,1 UX=-4.377, -4.335
      ADD=73 RD=0,1 UX=-2.655, -2.408
      ADD=31 RD=0,1 UX=-4.335, -4.377
      ADD=32 RD=0,1 UX=-4.377, -4.424
      ADD=33 RD=0,1 UX=-4.424, -4.513
      ADD=34 RD=0,1 UX=-4.513, -4.602
      ADD=35 RD=0,1 UX=-4.602, -4.69
      ADD=36 RD=0,1 UX=-4.69, -4.707
      ADD=37 RD=0,1 UX=-4.707, -4.745
      ADD=38 RD=0,1 UX=-4.745, -4.779
      ADD=1 RD=0,1 UX=-5.298, -5.298
      ADD=2 RD=0,1 UX=-5.298, -5.298
      ADD=3 RD=0,1 UX=-5.298, -5.298
      ADD=4 RD=0,1 UX=-5.298, -5.298
      ADD=5 RD=0,1 UX=-5.298, -5.298
      ADD=6 RD=0,1 UX=-5.298, -5.298
      ADD=7 RD=0,1 UX=-5.298, -5.298
      ADD=8 RD=0,1 UX=-5.298, -5.298
      ADD=9 RD=0,1 UX=-5.298, -5.298
      ADD=10 RD=0,1 UX=-5.298, -5.298
      ADD=11 RD=0,1 UX=-5.298, -5.298
      ADD=12 RD=0,1 UX=-5.298, -5.298
      ADD=13 RD=0,1 UX=-5.298, -5.298
      ADD=14 RD=0,1 UX=-5.298, -5.298
      ADD=15 RD=0,1 UX=-5.298, -5.298
      ADD=16 RD=0,1 UX=-5.298, -5.298
      ADD=17 RD=0,1 UX=-5.298, -5.298
      ADD=18 RD=0,1 UX=-5.298, -5.298
      ADD=19 RD=0,1 UX=-5.298, -5.298
      ADD=20 RD=0,1 UX=-5.298, -5.298
      ADD=21 RD=0,1 UX=-5.298, -5.298
      ADD=22 RD=0,1 UX=-5.298, -5.298
      ADD=23 RD=0,1 UX=-5.298, -5.298
      ADD=24 RD=0,1 UX=-5.298, -5.298
      ADD=25 RD=0,1 UX=-5.298, -5.298
      ADD=26 RD=0,1 UX=-5.298, -5.298
      ADD=27 RD=0,1 UX=-5.298, -5.298
      ADD=28 RD=0,1 UX=-5.298, -5.298
      ADD=29 RD=0,1 UX=-5.298, -5.298
      ADD=30 RD=0,1 UX=-5.298, -5.298
  MODE
    TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=WATERV
      LOAD=WATERH
      LOAD=BUOYANCY
      LOAD=COLSLAB
      LOAD=COLWALL
      LOAD=COLMS
      LOAD=COLINER
      LOAD=COLSLAB2
      LOAD=COLWALL2
      LOAD=COLMS2
      LOAD=COLINER2
      NLLINK=*
  HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
    NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= COLSLAB2      SF=1.000   AT=1
      LOAD= COLWALL2      SF=1.000   AT=1
      LOAD= COLMS2        SF=1.000   AT=1
      LOAD= COLINER2      SF=1.000   AT=1
    NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVELEE       SF=1.000   AT=1
      LOAD= LIVELEHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
    NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVELEE       SF=1.000   AT=1
      LOAD= LIVELEHE      SF=1.000   AT=1
      LOAD= COLSLAB2      SF=1.000   AT=1
      LOAD= COLWALL2      SF=1.000   AT=1
      LOAD= COLMS2        SF=1.000   AT=1
      LOAD= COLINER2      SF=1.000   AT=1
    NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVERIE       SF=1.000   AT=1
      LOAD= LIVERIHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
    NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVERIE       SF=1.000   AT=1
      LOAD= LIVERIHE      SF=1.000   AT=1
      LOAD= COLSLAB2      SF=1.000   AT=1
      LOAD= COLWALL2      SF=1.000   AT=1
      LOAD= COLMS2        SF=1.000   AT=1
      LOAD= COLINER2      SF=1.000   AT=1
    NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=0.500   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
```

```
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
```

```
      LOAD= COLSLAB2       SF=1.000   AT=1                                  HIST=UE27 SF=1
      LOAD= COLWALL2       SF=1.000   AT=1                                  HIST=UE28 SF=1
      LOAD= COLMS2         SF=1.000   AT=1                                  HIST=UE29 SF=1
      LOAD= COLINER2       SF=1.000   AT=1                                  HIST=UE30 SF=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE31 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE32 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                            OUTPUT
      LOAD= LIVERIE        SF=1.000   AT=1                               ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
      LOAD= LIVERIHE       SF=0.500   AT=1                               ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
      LOAD= WATERV         SF=1.200   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= WATERV         SF=1.200   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= WATERV         SF=0.900   AT=1
      LOAD= WATERH         SF=1.000   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= WATERV         SF=0.900   AT=1
      LOAD= WATERH         SF=1.000   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= WATERV         SF=0.900   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= WATERV         SF=0.900   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
      HIST=UE06 SF=1
      HIST=UE07 SF=1
      HIST=UE08 SF=1
      HIST=UE09 SF=1
      HIST=UE10 SF=1
      HIST=UE11 SF=1
      HIST=UE12 SF=1
      HIST=UE13 SF=1
      HIST=UE14 SF=1
      HIST=UE15 SF=1
      HIST=UE16 SF=1
      HIST=UE17 SF=1
      HIST=UE18 SF=1
      HIST=UE19 SF=1
      HIST=UE20 SF=1
      HIST=UE21 SF=1
      HIST=UE22 SF=1
      HIST=UE23 SF=1
      HIST=UE24 SF=1
      HIST=UE25 SF=1
      HIST=UE26 SF=1
```

18. OUTPUT DATA (상시)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVULT MAX	0.38889	196.95637	0.00000	41.82230
1	ENVULT MAX	0.54167	196.95637	0.00000	64.29776
1	ENVULT MAX	0.69444	196.95637	0.00000	86.89020
1	ENVULT MAX	0.84722	196.95637	0.00000	109.59961
1	ENVULT MAX	1.00000	196.95637	0.00000	132.42602
1	ENVULT MIN	0.38889	-699.71581	-704.35223	-1099.61900
1	ENVULT MIN	0.54167	-699.71581	-699.40223	-1051.55400
1	ENVULT MIN	0.69444	-699.71581	-694.45223	-1003.82900
1	ENVULT MIN	0.84722	-699.71581	-689.50223	-956.44474
1	ENVULT MIN	1.00000	-699.71581	-684.55223	-909.40054
2	ENVULT MAX	0.00000	196.95637	0.00000	132.42602
2	ENVULT MAX	0.25000	196.95637	0.00000	184.06583
2	ENVULT MAX	0.50000	196.95637	0.00000	236.69037
2	ENVULT MAX	0.75000	196.95637	0.00000	318.21237
2	ENVULT MAX	1.00000	196.95637	0.00000	400.51955
2	ENVULT MIN	0.00000	-699.71581	-684.55223	-909.40053
2	ENVULT MIN	0.25000	-699.71581	-673.44623	-805.08876
2	ENVULT MIN	0.50000	-699.71581	-662.34023	-702.49010
2	ENVULT MIN	0.75000	-699.71581	-651.23423	-601.60453
2	ENVULT MIN	1.00000	-699.71581	-640.12823	-502.43206
3	ENVULT MAX	0.00000	196.95637	0.00000	400.51955
3	ENVULT MAX	0.25000	196.95637	0.00000	435.54654
3	ENVULT MAX	0.50000	196.95637	0.00000	471.05469
3	ENVULT MAX	0.75000	196.95637	0.00000	507.04400
3	ENVULT MAX	1.00000	196.95637	0.00000	543.51446
3	ENVULT MIN	0.00000	-699.71581	-528.60332	-502.43206
3	ENVULT MIN	0.25000	-699.71581	-519.90932	-440.06771
3	ENVULT MIN	0.50000	-699.71581	-511.21532	-386.50150
3	ENVULT MIN	0.75000	-699.71581	-502.52132	-332.45413
3	ENVULT MIN	1.00000	-699.71581	-493.82732	-277.92560
4	ENVULT MAX	0.00000	196.95637	0.00000	543.51446
4	ENVULT MAX	0.25000	196.95637	0.00000	569.01281
4	ENVULT MAX	0.50000	196.95637	0.00000	595.00031
4	ENVULT MAX	0.75000	196.95637	0.00000	621.13125
4	ENVULT MAX	1.00000	196.95637	0.00000	647.40562
4	ENVULT MIN	0.00000	-699.71580	-493.82731	-277.92560
4	ENVULT MIN	0.25000	-699.71580	-487.86481	-243.83581
4	ENVULT MIN	0.50000	-699.71580	-481.90231	-209.60257
4	ENVULT MIN	0.75000	-699.71580	-475.93981	-175.22590
4	ENVULT MIN	1.00000	-699.71580	-469.97731	-140.70579
5	ENVULT MAX	0.00000	196.95637	0.00000	647.40562
5	ENVULT MAX	0.25000	196.95637	0.00000	672.34136
5	ENVULT MAX	0.50000	196.95637	0.00000	697.44229
5	ENVULT MAX	0.75000	196.95637	0.00000	722.70840
5	ENVULT MAX	1.00000	196.95637	0.00000	748.13969
5	ENVULT MIN	0.00000	-699.71580	-469.97731	-140.70579
5	ENVULT MIN	0.25000	-699.71580	-464.88331	-107.99157
5	ENVULT MIN	0.50000	-699.71580	-465.89389	-77.42839
5	ENVULT MIN	0.75000	-699.71580	-468.22864	-57.67287
5	ENVULT MIN	1.00000	-699.71580	-470.56339	-37.79347
6	ENVULT MAX	0.00000	196.95637	0.00000	748.13969
6	ENVULT MAX	0.25000	196.95637	0.00000	786.60154
6	ENVULT MAX	0.50000	196.95637	0.00000	827.41152
6	ENVULT MAX	0.75000	196.95637	0.00000	870.56963
6	ENVULT MAX	1.00000	196.95637	0.00000	916.07588
6	ENVULT MIN	0.00000	-699.71580	-354.79928	-37.79347
6	ENVULT MIN	0.25000	-699.71580	-335.59328	0.00000
6	ENVULT MIN	0.50000	-699.71580	-316.38728	0.00000
6	ENVULT MIN	0.75000	-699.71580	-307.74790	0.00000
6	ENVULT MIN	1.00000	-699.71580	-316.55065	0.00000
7	ENVULT MAX	0.00000	196.95637	32.10008	916.07588
7	ENVULT MAX	0.25000	196.95637	25.49802	913.56613
7	ENVULT MAX	0.50000	196.95637	18.89595	913.40451
7	ENVULT MAX	0.75000	196.95637	12.29389	915.59103
7	ENVULT MAX	1.00000	196.95637	5.69183	920.12568
7	ENVULT MIN	0.00000	-699.71580	-196.85676	0.00000
7	ENVULT MIN	0.25000	-699.71580	-177.65076	0.00000
7	ENVULT MIN	0.50000	-699.71580	-158.44476	0.00000
7	ENVULT MIN	0.75000	-699.71580	-162.45057	0.00000
7	ENVULT MIN	1.00000	-699.71580	-171.25332	0.00000
8	ENVULT MAX	0.00000	196.95637	151.59553	920.12568
8	ENVULT MAX	0.25000	196.95637	142.80103	880.89734
8	ENVULT MAX	0.50000	196.95637	134.00653	844.01273
8	ENVULT MAX	0.75000	196.95637	125.21203	809.47186
8	ENVULT MAX	1.00000	196.95637	133.84757	777.27472
8	ENVULT MIN	0.00000	-699.71580	-46.13239	0.00000
8	ENVULT MIN	0.25000	-699.71580	-26.94439	0.00000
8	ENVULT MIN	0.50000	-699.71580	-15.09168	0.00000
8	ENVULT MIN	0.75000	-699.71580	-21.68755	0.00000
8	ENVULT MIN	1.00000	-699.71580	-29.04243	0.00000
9	ENVULT MAX	0.00000	196.95637	289.86226	777.27472
9	ENVULT MAX	0.25000	196.95637	281.05951	701.12803
9	ENVULT MAX	0.50000	196.95637	272.25676	627.32947
9	ENVULT MAX	0.75000	196.95637	263.45401	555.87904
9	ENVULT MAX	1.00000	196.95637	280.12784	489.22484
9	ENVULT MIN	0.00000	-699.71580	0.00000	0.00000
9	ENVULT MIN	0.25000	-699.71580	0.00000	0.00000
9	ENVULT MIN	0.50000	-699.71580	0.00000	0.00000
9	ENVULT MIN	0.75000	-699.71580	0.00000	0.00000
9	ENVULT MIN	1.00000	-699.71580	0.00000	0.00000
10	ENVULT MAX	0.00000	196.95637	442.30226	489.22484
10	ENVULT MAX	0.25000	196.95637	433.49951	390.70328
10	ENVULT MAX	0.50000	196.95637	424.69676	291.65616
10	ENVULT MAX	0.75000	196.95637	419.80527	187.48584
10	ENVULT MAX	1.00000	196.95637	439.01127	84.09006
10	ENVULT MIN	0.00000	-699.71580	0.00000	0.00000
10	ENVULT MIN	0.25000	-699.71580	0.00000	0.00000
10	ENVULT MIN	0.50000	-699.71580	0.00000	0.00000
10	ENVULT MIN	0.75000	-699.71580	0.00000	0.00000
10	ENVULT MIN	1.00000	-699.71580	0.00000	-28.25009
11	ENVULT MAX	0.00000	196.95637	620.81386	84.09006
11	ENVULT MAX	0.25000	196.95637	612.01936	12.44307
11	ENVULT MAX	0.50000	196.95637	603.22486	0.00000
11	ENVULT MAX	0.75000	196.95637	604.15340	0.00000
11	ENVULT MAX	1.00000	196.95637	623.34140	0.00000
11	ENVULT MIN	0.00000	-699.71581	0.00000	-28.24599
11	ENVULT MIN	0.25000	-699.71581	0.00000	-176.89095
11	ENVULT MIN	0.50000	-699.71581	0.00000	-329.00864
11	ENVULT MIN	0.75000	-699.71581	0.00000	-482.15716
11	ENVULT MIN	1.00000	-699.71581	0.00000	-639.40099
12	ENVULT MAX	0.00000	196.95637	832.24444	0.00000
12	ENVULT MAX	0.25000	196.95637	830.86669	0.00000
12	ENVULT MAX	0.50000	196.95637	829.48894	0.00000
12	ENVULT MAX	0.75000	196.95637	828.11119	0.00000
12	ENVULT MAX	1.00000	196.95637	826.73344	0.00000
12	ENVULT MIN	0.00000	-699.71581	0.00000	-639.40099
12	ENVULT MIN	0.25000	-699.71581	0.00000	-674.11843
12	ENVULT MIN	0.50000	-699.71581	0.00000	-708.77836
12	ENVULT MIN	0.75000	-699.71581	0.00000	-743.38076
12	ENVULT MIN	1.00000	-699.71581	0.00000	-777.92564
13	ENVULT MAX	0.00000	196.95637	826.73344	0.00000
13	ENVULT MAX	0.25000	196.95637	824.25844	0.00000
13	ENVULT MAX	0.50000	196.95637	821.78344	0.00000
13	ENVULT MAX	0.75000	196.95637	819.30844	0.00000
13	ENVULT MAX	1.00000	196.95637	816.83344	0.00000
13	ENVULT MIN	0.00000	-699.71581	0.00000	-777.92564
13	ENVULT MIN	0.25000	-699.71581	0.00000	-839.83784
13	ENVULT MIN	0.50000	-699.71581	0.00000	-901.56441
13	ENVULT MIN	0.75000	-699.71581	0.00000	-963.10535
13	ENVULT MIN	1.00000	-699.71581	0.00000	-1024.46100
14	ENVULT MAX	0.00000	196.95637	816.83344	0.00000
14	ENVULT MAX	0.25000	196.95637	813.94594	0.00000
14	ENVULT MAX	0.50000	196.95637	811.05844	0.00000
14	ENVULT MAX	0.75000	196.95637	815.67922	0.00000
14	ENVULT MAX	1.00000	196.95637	821.97922	0.00000
14	ENVULT MIN	0.00000	-699.71580	0.00000	-1024.46100
14	ENVULT MIN	0.25000	-699.71580	0.00000	-1095.80700
14	ENVULT MIN	0.50000	-699.71580	0.00000	-1166.90100
14	ENVULT MIN	0.75000	-699.71580	0.00000	-1237.74200
14	ENVULT MIN	1.00000	-699.71580	0.00000	-1308.33100
15	ENVULT MAX	0.00000	196.95637	821.97922	0.00000
15	ENVULT MAX	0.25000	196.95637	826.47922	0.00000
15	ENVULT MAX	0.50000	196.95637	830.97922	0.00000
15	ENVULT MAX	0.75000	196.95637	835.47922	0.00000
15	ENVULT MAX	1.00000	196.95637	839.97922	0.00000
15	ENVULT MIN	0.00000	-699.71580	0.00000	-1308.33100
15	ENVULT MIN	0.25000	-699.71580	0.00000	-1358.59700
15	ENVULT MIN	0.50000	-699.71580	0.00000	-1408.73400
15	ENVULT MIN	0.75000	-699.71580	0.00000	-1458.74200
15	ENVULT MIN	1.00000	-699.71580	0.00000	-1508.62100
16	ENVULT MAX	0.00000	108.99093	0.00000	0.00000
16	ENVULT MAX	0.25000	108.99093	0.00000	0.00000
16	ENVULT MAX	0.50000	108.99093	0.00000	0.00000
16	ENVULT MAX	0.75000	108.99093	0.00000	0.00000
16	ENVULT MAX	1.00000	108.99093	0.00000	0.00000
16	ENVULT MIN	0.00000	-638.09207	-840.37078	-1512.77000
16	ENVULT MIN	0.25000	-638.09207	-835.87078	-1462.81000
16	ENVULT MIN	0.50000	-638.09207	-831.37078	-1412.72100
16	ENVULT MIN	0.75000	-638.09207	-826.87078	-1362.50400
16	ENVULT MIN	1.00000	-638.09207	-822.37078	-1312.15700
17	ENVULT MAX	0.00000	108.99093	0.00000	0.00000
17	ENVULT MAX	0.25000	108.99093	0.00000	0.00000
17	ENVULT MAX	0.50000	108.99093	0.00000	0.00000
17	ENVULT MAX	0.75000	108.99093	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVULT MAX	1.00000	108.99093	0.00000	0.00000
17	ENVULT MIN	0.00000	-638.09207	-822.37078	-1312.15700
17	ENVULT MIN	0.25000	-638.09207	-816.07078	-1241.45600
17	ENVULT MIN	0.50000	-638.09207	-812.34871	-1170.50200
17	ENVULT MIN	0.75000	-638.09207	-815.23621	-1099.29500
17	ENVULT MIN	1.00000	-638.09207	-818.12371	-1027.83500
18	ENVULT MAX	0.00000	108.99093	0.00000	0.00000
18	ENVULT MAX	0.25000	108.99093	0.00000	0.00000
18	ENVULT MAX	0.50000	108.99093	0.00000	0.00000
18	ENVULT MAX	0.75000	108.99093	0.00000	0.00000
18	ENVULT MAX	1.00000	108.99093	0.00000	0.00000
18	ENVULT MIN	0.00000	-638.09207	-818.12371	-1027.83500
18	ENVULT MIN	0.25000	-638.09207	-820.59871	-966.38322
18	ENVULT MIN	0.50000	-638.09207	-823.07371	-904.74551
18	ENVULT MIN	0.75000	-638.09207	-825.54871	-842.92216
18	ENVULT MIN	1.00000	-638.09207	-828.02371	-780.91320
19	ENVULT MAX	0.00000	108.99093	0.00000	0.00000
19	ENVULT MAX	0.25000	108.99093	0.00000	0.00000
19	ENVULT MAX	0.50000	108.99093	0.00000	0.00000
19	ENVULT MAX	0.75000	108.99093	0.00000	0.00000
19	ENVULT MAX	1.00000	108.99093	0.00000	0.00000
19	ENVULT MIN	0.00000	-638.09206	-828.02371	-780.91320
19	ENVULT MIN	0.25000	-638.09206	-829.40146	-746.31445
19	ENVULT MIN	0.50000	-638.09206	-830.77921	-711.65818
19	ENVULT MIN	0.75000	-638.09206	-832.15696	-676.94439
19	ENVULT MIN	1.00000	-638.09206	-833.53471	-642.17307
20	ENVULT MAX	0.00000	108.99093	0.00000	0.00000
20	ENVULT MAX	0.25000	108.99093	0.00000	0.00000
20	ENVULT MAX	0.50000	108.99093	0.00000	0.00000
20	ENVULT MAX	0.75000	108.99093	0.00000	12.44307
20	ENVULT MAX	1.00000	108.99093	0.00000	84.31224
20	ENVULT MIN	0.00000	-638.09205	-623.42122	-642.17307
20	ENVULT MIN	0.25000	-638.09205	-604.23322	-484.85916
20	ENVULT MIN	0.50000	-638.09205	-603.48787	-331.87522
20	ENVULT MIN	0.75000	-638.09205	-612.28237	-178.28607
20	ENVULT MIN	1.00000	-638.09205	-621.07687	-28.07858
21	ENVULT MAX	0.00000	108.99093	0.00000	84.31224
21	ENVULT MAX	0.25000	108.99093	0.00000	186.10188
21	ENVULT MAX	0.50000	108.99093	0.00000	290.17840
21	ENVULT MAX	0.75000	108.99093	0.00000	389.13173
21	ENVULT MAX	1.00000	108.99093	0.00000	486.29532
21	ENVULT MIN	0.00000	-638.09205	-438.80518	-28.07453
21	ENVULT MIN	0.25000	-638.09205	-419.59918	0.00000
21	ENVULT MIN	0.50000	-638.09205	-424.01766	0.00000
21	ENVULT MIN	0.75000	-638.09205	-432.82041	0.00000
21	ENVULT MIN	1.00000	-638.09205	-441.62316	0.00000
22	ENVULT MAX	0.00000	108.99093	0.00000	486.29532
22	ENVULT MAX	0.25000	108.99093	0.00000	552.26425
22	ENVULT MAX	0.50000	108.99093	0.00000	623.31621
22	ENVULT MAX	0.75000	108.99093	0.00000	696.71630
22	ENVULT MAX	1.00000	108.99093	0.00000	772.46452
22	ENVULT MIN	0.00000	-638.09206	-279.27539	0.00000
22	ENVULT MIN	0.25000	-638.09206	-261.96022	0.00000
22	ENVULT MIN	0.50000	-638.09206	-270.76297	0.00000
22	ENVULT MIN	0.75000	-638.09206	-279.56572	0.00000
22	ENVULT MIN	1.00000	-638.09206	-288.36847	0.00000
23	ENVULT MAX	0.00000	108.99093	26.72685	772.46452
23	ENVULT MAX	0.25000	108.99093	19.56154	804.09507
23	ENVULT MAX	0.50000	108.99093	12.96567	838.06937
23	ENVULT MAX	0.75000	108.99093	25.32350	874.38739
23	ENVULT MAX	1.00000	108.99093	44.51150	913.04915
23	ENVULT MIN	0.00000	-638.09207	-133.20238	0.00000
23	ENVULT MIN	0.25000	-638.09207	-123.08602	0.00000
23	ENVULT MIN	0.50000	-638.09207	-131.88052	0.00000
23	ENVULT MIN	0.75000	-638.09207	-140.67502	0.00000
23	ENVULT MIN	1.00000	-638.09207	-149.46952	0.00000
24	ENVULT MAX	0.00000	108.99093	168.53826	913.04915
24	ENVULT MAX	0.25000	108.99093	159.73551	907.84955
24	ENVULT MAX	0.50000	108.99093	156.70950	904.99809
24	ENVULT MAX	0.75000	108.99093	175.91550	904.49475
24	ENVULT MAX	1.00000	108.99093	195.12150	906.33955
24	ENVULT MIN	0.00000	-638.09207	-3.19905	0.00000
24	ENVULT MIN	0.25000	-638.09207	-9.80111	0.00000
24	ENVULT MIN	0.50000	-638.09207	-16.40317	0.00000
24	ENVULT MIN	0.75000	-638.09207	-23.00524	0.00000
24	ENVULT MIN	1.00000	-638.09207	-29.60730	0.00000
25	ENVULT MAX	0.00000	108.99093	313.85980	906.33955
25	ENVULT MAX	0.25000	108.99093	305.05705	860.17428
25	ENVULT MAX	0.50000	108.99093	314.66748	816.35715
25	ENVULT MAX	0.75000	108.99093	333.87348	774.88815
25	ENVULT MAX	1.00000	108.99093	353.07948	735.76728
25	ENVULT MIN	0.00000	-638.09206	0.00000	0.00000
25	ENVULT MIN	0.25000	-638.09206	0.00000	0.00000
25	ENVULT MIN	0.50000	-638.09206	0.00000	0.00000
25	ENVULT MIN	0.75000	-638.09206	0.00000	0.00000
25	ENVULT MIN	1.00000	-638.09206	0.00000	-25.42107
26	ENVULT MAX	0.00000	108.99093	468.50614	735.76728
26	ENVULT MAX	0.25000	108.99093	466.17139	710.20236
26	ENVULT MAX	0.75000	108.99093	463.56847	659.56806
26	ENVULT MAX	1.00000	108.99093	468.66247	634.49868
26	ENVULT MIN	0.00000	-638.09204	0.00000	-25.42107
26	ENVULT MIN	0.25000	-638.09204	0.00000	-45.16683
26	ENVULT MIN	0.50000	-638.09204	0.00000	-64.78872
26	ENVULT MIN	0.75000	-638.09204	0.00000	-94.07929
26	ENVULT MIN	1.00000	-638.09204	0.00000	-126.64796
27	ENVULT MAX	0.00000	108.99093	468.66247	634.49868
27	ENVULT MAX	0.25000	108.99093	474.62497	608.08264
27	ENVULT MAX	0.50000	108.99093	480.58747	581.81004
27	ENVULT MAX	0.75000	108.99093	486.54997	555.68088
27	ENVULT MAX	1.00000	108.99093	492.51247	529.69515
27	ENVULT MIN	0.00000	-638.09204	0.00000	-126.64796
27	ENVULT MIN	0.25000	-638.09204	0.00000	-161.01378
27	ENVULT MIN	0.50000	-638.09204	0.00000	-195.23616
27	ENVULT MIN	0.75000	-638.09204	0.00000	-229.31510
27	ENVULT MIN	1.00000	-638.09204	0.00000	-263.25060
28	ENVULT MAX	0.00000	108.99093	492.51247	529.69515
28	ENVULT MAX	0.25000	108.99093	501.20647	492.12058
28	ENVULT MAX	0.50000	108.99093	509.90047	455.88286
28	ENVULT MAX	0.75000	108.99093	518.59447	420.12630
28	ENVULT MAX	1.00000	108.99093	527.28847	384.85090
28	ENVULT MIN	0.00000	-638.09205	0.00000	-263.25060
28	ENVULT MIN	0.25000	-638.09205	0.00000	-317.53072
28	ENVULT MIN	0.50000	-638.09205	0.00000	-371.32967
28	ENVULT MIN	0.75000	-638.09205	0.00000	-429.27262
28	ENVULT MIN	1.00000	-638.09205	0.00000	-492.41780
29	ENVULT MAX	0.00000	108.99093	640.08482	384.85090
29	ENVULT MAX	0.25000	108.99093	651.19082	302.46194
29	ENVULT MAX	0.50000	108.99093	662.29682	221.75847
29	ENVULT MAX	0.75000	108.99093	673.40282	169.45469
29	ENVULT MAX	1.00000	108.99093	684.50882	117.73979
29	ENVULT MIN	0.00000	-638.09207	0.00000	-492.41780
29	ENVULT MIN	0.25000	-638.09207	0.00000	-591.53800
29	ENVULT MIN	0.50000	-638.09207	0.00000	-692.37130
29	ENVULT MIN	0.75000	-638.09207	0.00000	-794.91770
29	ENVULT MIN	1.00000	-638.09207	0.00000	-899.17720
30	ENVULT MAX	0.00000	108.99093	684.50881	117.73979
30	ENVULT MAX	0.15278	108.99093	689.45881	94.87992
30	ENVULT MAX	0.30556	108.99093	694.40881	72.13704
30	ENVULT MAX	0.45833	108.99093	699.35881	49.51114
30	ENVULT MAX	0.61111	108.99093	704.30881	27.00222
30	ENVULT MIN	0.00000	-638.09211	0.00000	-899.17721
30	ENVULT MIN	0.15278	-638.09211	0.00000	-946.19812
30	ENVULT MIN	0.30556	-638.09211	0.00000	-993.55934
30	ENVULT MIN	0.45833	-638.09211	0.00000	-1041.26100
30	ENVULT MIN	0.61111	-638.09211	0.00000	-1089.30300
31	ENVULT MAX	0.59091	0.00000	108.99093	0.00000
31	ENVULT MAX	0.69318	0.00000	108.99093	0.00000
31	ENVULT MAX	0.79545	0.00000	108.99093	0.00000
31	ENVULT MAX	0.89773	0.00000	108.99093	0.00000
31	ENVULT MAX	1.00000	0.00000	108.99093	0.00000
31	ENVULT MIN	0.59091	-868.65203	-566.10455	-1017.51300
31	ENVULT MIN	0.69318	-867.13328	-553.90252	-986.01353
31	ENVULT MIN	0.79545	-865.61453	-541.77643	-955.19791
31	ENVULT MIN	0.89773	-864.09578	-529.72627	-925.06226
31	ENVULT MIN	1.00000	-862.57703	-517.75205	-895.60228
32	ENVULT MAX	0.00000	0.00000	108.99093	0.00000
32	ENVULT MAX	0.25000	0.00000	108.99093	0.00000
32	ENVULT MAX	0.50000	0.00000	108.99093	0.00000
32	ENVULT MAX	0.75000	0.00000	108.99093	0.00000
32	ENVULT MAX	1.00000	0.00000	108.99093	0.00000
32	ENVULT MIN	0.00000	-862.57702	-517.75208	-895.60230
32	ENVULT MIN	0.25000	-858.35827	-484.88880	-827.24338
32	ENVULT MIN	0.50000	-854.13952	-452.61145	-768.70332
32	ENVULT MIN	0.75000	-849.92077	-420.92005	-713.55755
32	ENVULT MIN	1.00000	-845.70202	-389.81458	-661.74809
33	ENVULT MAX	0.00000	0.00000	108.99093	0.00000
33	ENVULT MAX	0.25000	0.00000	108.99093	0.00000
33	ENVULT MAX	0.50000	0.00000	108.99093	0.00000
33	ENVULT MAX	0.75000	0.00000	108.99093	10.10658
33	ENVULT MAX	1.00000	0.00000	108.99093	30.53606
33	ENVULT MIN	0.00000	-845.70204	-389.81456	-661.74809
33	ENVULT MIN	0.25000	-837.77079	-332.92253	-587.42487
33	ENVULT MIN	0.50000	-829.83954	-278.10144	-549.82037
33	ENVULT MIN	0.75000	-821.90829	-225.35128	-549.78481
33	ENVULT MIN	1.00000	-813.97704	-174.67206	-550.12891
34	ENVULT MAX	0.00000	0.00000	108.99093	30.53657
34	ENVULT MAX	0.25000	0.00000	108.99093	37.43203
34	ENVULT MAX	0.50000	0.00000	109.99617	41.45193
34	ENVULT MAX	0.75000	0.00000	112.34617	36.92567
34	ENVULT MAX	1.00000	0.00000	136.44384	20.40092
34	ENVULT MIN	0.00000	-813.97702	-174.67205	-550.12891
34	ENVULT MIN	0.25000	-806.04577	-140.19854	-550.85269
34	ENVULT MIN	0.50000	-798.11452	-107.96741	-551.95614
34	ENVULT MIN	0.75000	-790.18327	-77.04793	-577.90140
34	ENVULT MIN	1.00000	-782.25202	-47.44011	-608.90529
35	ENVULT MAX	0.00000	0.00000	136.44383	20.40139

26	ENVULT MAX	0.50000	108.99093	463.83664	684.80261
FRAME	LOAD	DIST	P	V2	M3
35	ENVULT MAX	0.50000	0.00000	205.28064	0.00000
35	ENVULT MAX	0.75000	0.00000	241.22830	0.00000
35	ENVULT MAX	1.00000	0.00000	275.10501	0.00000
35	ENVULT MIN	0.00000	-782.25202	-47.44011	-608.90529
35	ENVULT MIN	0.25000	-774.32077	-31.42129	-640.66852
35	ENVULT MIN	0.50000	-766.38952	-30.68573	-674.39133
35	ENVULT MIN	0.75000	-758.45827	-30.68573	-709.80911
35	ENVULT MIN	1.00000	-750.52702	-30.68573	-745.91721
36	ENVULT MAX	0.00000	0.00000	275.10512	0.00000
36	ENVULT MAX	0.25000	0.00000	281.35590	0.00000
36	ENVULT MAX	0.50000	0.00000	287.53074	0.00000
36	ENVULT MAX	0.75000	0.00000	293.62965	0.00000
36	ENVULT MAX	1.00000	0.00000	299.65262	0.00000
36	ENVULT MIN	0.00000	-750.52704	-30.68573	-745.91721
36	ENVULT MIN	0.25000	-749.00829	-30.68573	-752.91027
36	ENVULT MIN	0.50000	-747.48954	-30.68573	-759.92865
36	ENVULT MIN	0.75000	-745.97079	-30.68573	-766.97234
36	ENVULT MIN	1.00000	-744.45204	-30.68573	-774.04135
37	ENVULT MAX	0.00000	0.00000	299.65249	0.00000
37	ENVULT MAX	0.22500	0.00000	311.47062	0.00000
37	ENVULT MAX	0.45000	0.00000	322.98499	0.00000
37	ENVULT MAX	0.67500	0.00000	334.19562	0.00000
37	ENVULT MAX	0.90000	0.00000	345.10249	0.00000
37	ENVULT MIN	0.00000	-744.45206	-30.68573	-774.04135
37	ENVULT MIN	0.22500	-741.20363	-30.68573	-788.25529
37	ENVULT MIN	0.45000	-737.53331	-30.68573	-802.57048
37	ENVULT MIN	0.67500	-733.44113	-30.68573	-816.98693
37	ENVULT MIN	0.90000	-728.92706	-30.68573	-831.50462
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
40	ENVULT MAX	0.10000	30.68573	0.00000	11.79011
40	ENVULT MAX	0.32500	30.68573	0.00000	20.76455
40	ENVULT MAX	0.55000	30.68573	0.00000	45.18035
40	ENVULT MAX	0.77500	30.68573	0.00000	91.52454
40	ENVULT MAX	1.00000	30.68573	0.00000	136.11477
40	ENVULT MIN	0.10000	-389.90252	-622.68853	-611.61225
40	ENVULT MIN	0.32500	-389.90252	-603.72080	-543.06836
40	ENVULT MIN	0.55000	-389.90252	-585.17495	-476.63462
40	ENVULT MIN	0.77500	-389.90252	-567.05098	-412.26355
40	ENVULT MIN	1.00000	-389.90252	-549.34888	-349.90770
41	ENVULT MAX	0.00000	30.68573	0.00000	136.11477
41	ENVULT MAX	0.25000	30.68573	0.00000	147.93742
41	ENVULT MAX	0.50000	30.68573	0.00000	161.12861
41	ENVULT MAX	0.75000	30.68573	0.00000	174.18938
41	ENVULT MAX	1.00000	30.68573	0.00000	187.11973
41	ENVULT MIN	0.00000	-389.90252	-549.34885	-349.90771
41	ENVULT MIN	0.25000	-389.90252	-544.80115	-334.01956
41	ENVULT MIN	0.50000	-389.90252	-540.25344	-318.26444
41	ENVULT MIN	0.75000	-389.90252	-535.70574	-302.64233
41	ENVULT MIN	1.00000	-389.90252	-531.15804	-292.26088
42	ENVULT MAX	0.00000	30.68573	0.00000	187.11973
42	ENVULT MAX	0.25000	30.68573	0.00000	298.92238
42	ENVULT MAX	0.50000	30.68573	0.00000	399.89874
42	ENVULT MAX	0.75000	30.68573	0.00000	490.04883
42	ENVULT MAX	1.00000	30.68573	0.00000	569.37264
42	ENVULT MIN	0.00000	-389.90252	-531.15807	-292.26088
42	ENVULT MIN	0.25000	-389.90252	-489.72345	-212.19659
42	ENVULT MIN	0.50000	-389.90252	-448.28883	-138.11362
42	ENVULT MIN	0.75000	-389.90252	-406.85421	-70.01197
42	ENVULT MIN	1.00000	-389.90252	-365.41959	-7.89163
43	ENVULT MAX	0.00000	30.68573	0.00000	569.37264
43	ENVULT MAX	0.25000	30.68573	0.00000	637.92935
43	ENVULT MAX	0.50000	30.68573	0.00000	695.63946
43	ENVULT MAX	0.75000	30.68573	0.00000	742.50297
43	ENVULT MAX	1.00000	30.68573	0.00000	778.51988
43	ENVULT MIN	0.00000	-389.90252	-365.41959	-7.89163
43	ENVULT MIN	0.25000	-389.90252	-323.94610	0.00000
43	ENVULT MIN	0.50000	-389.90252	-282.47261	0.00000
43	ENVULT MIN	0.75000	-389.90252	-240.99912	0.00000

35	ENVULT MAX	0.25000	0.00000	167.26205	0.00000
FRAME	LOAD	DIST	P	V2	M3
44	ENVULT MAX	0.25000	30.68573	1.41223	803.69020
44	ENVULT MAX	0.50000	30.68573	8.61448	818.01392
44	ENVULT MAX	0.75000	30.68573	22.57764	821.49104
44	ENVULT MAX	1.00000	30.68573	58.54487	814.12156
44	ENVULT MIN	0.00000	-389.90253	-199.52563	0.00000
44	ENVULT MIN	0.25000	-389.90253	-158.05214	0.00000
44	ENVULT MIN	0.50000	-389.90253	-116.57865	0.00000
44	ENVULT MIN	0.75000	-389.90253	-75.10516	0.00000
44	ENVULT MIN	1.00000	-389.90253	-42.15482	0.00000
45	ENVULT MAX	0.00000	31.31944	58.54487	814.12156
45	ENVULT MAX	0.25000	31.31944	94.47840	795.92763
45	ENVULT MAX	0.50000	31.31944	133.09634	766.90743
45	ENVULT MAX	0.75000	31.31944	173.72026	727.06095
45	ENVULT MAX	1.00000	31.31944	214.34419	676.38819
45	ENVULT MIN	0.00000	-389.90252	-42.31325	0.00000
45	ENVULT MIN	0.25000	-389.90252	-19.86929	0.00000
45	ENVULT MIN	0.50000	-389.90252	0.00000	0.00000
45	ENVULT MIN	0.75000	-389.90252	0.00000	0.00000
45	ENVULT MIN	1.00000	-389.90252	0.00000	0.00000
46	ENVULT MAX	0.00000	32.88267	214.34419	676.38819
46	ENVULT MAX	0.25000	32.88267	255.00623	614.82638
46	ENVULT MAX	0.50000	32.88267	295.66826	543.31981
46	ENVULT MAX	0.75000	32.88267	336.33030	468.52277
46	ENVULT MAX	1.00000	32.88267	376.99234	389.48389
46	ENVULT MIN	0.00000	-389.90252	0.00000	0.00000
46	ENVULT MIN	0.25000	-389.90252	0.00000	0.00000
46	ENVULT MIN	0.50000	-389.90252	0.00000	0.00000
46	ENVULT MIN	0.75000	-389.90252	0.00000	0.00000
46	ENVULT MIN	1.00000	-389.90252	0.00000	0.00000
47	ENVULT MAX	0.00000	33.97676	376.99234	389.48389
47	ENVULT MAX	0.25000	33.97676	417.65437	299.59840
47	ENVULT MAX	0.50000	33.97676	458.31641	198.86632
47	ENVULT MAX	0.75000	33.97676	498.97844	87.28764
47	ENVULT MAX	1.00000	33.97676	539.64048	0.00000
47	ENVULT MIN	0.00000	-389.90252	0.00000	0.00000
47	ENVULT MIN	0.25000	-389.90252	0.00000	-15.83083
47	ENVULT MIN	0.50000	-389.90252	0.00000	-40.21534
47	ENVULT MIN	0.75000	-389.90252	0.00000	-84.40079
47	ENVULT MIN	1.00000	-389.90252	0.00000	-204.46293
48	ENVULT MAX	0.00000	34.62014	539.64048	0.00000
48	ENVULT MAX	0.25000	34.62014	580.26441	0.00000
48	ENVULT MAX	0.50000	34.62014	620.88834	0.00000
48	ENVULT MAX	0.75000	34.62014	661.51226	0.00000
48	ENVULT MAX	1.00000	34.62014	702.13619	0.00000
48	ENVULT MIN	0.00000	-389.90252	0.00000	-204.46293
48	ENVULT MIN	0.25000	-389.90252	0.00000	-333.99333
48	ENVULT MIN	0.50000	-389.90252	0.00000	-474.34862
48	ENVULT MIN	0.75000	-389.90252	0.00000	-642.00252
48	ENVULT MIN	1.00000	-389.90252	0.00000	-823.70867
49	ENVULT MAX	0.00000	34.74854	702.13619	0.00000
49	ENVULT MAX	0.25000	34.74854	714.21666	0.00000
49	ENVULT MAX	0.50000	34.74854	726.29714	0.00000
49	ENVULT MAX	0.75000	34.74854	738.37761	0.00000
49	ENVULT MAX	1.00000	34.74854	750.48337	0.00000
49	ENVULT MIN	0.00000	-389.90252	0.00000	-823.70867
49	ENVULT MIN	0.25000	-389.90252	0.00000	-879.83166
49	ENVULT MIN	0.50000	-389.90252	0.00000	-936.91202
49	ENVULT MIN	0.75000	-389.90252	0.00000	-994.94975
49	ENVULT MIN	1.00000	-389.90252	0.00000	-1053.94500
50	ENVULT MAX	0.00000	34.77321	750.48339	0.00000
50	ENVULT MAX	0.22500	34.77321	767.97455	0.00000
50	ENVULT MAX	0.45000	34.77321	785.46571	0.00000
50	ENVULT MAX	0.67500	34.77321	802.95688	0.00000
50	ENVULT MAX	0.90000	34.77321	820.44804	0.00000
50	ENVULT MIN	0.00000	-389.90252	0.00000	-1053.94500
50	ENVULT MIN	0.22500	-389.90252	0.00000	-1139.33600
50	ENVULT MIN	0.45000	-389.90252	0.00000	-1226.65600
50	ENVULT MIN	0.67500	-389.90252	0.00000	-1315.90600
50	ENVULT MIN	0.90000	-389.90252	0.00000	-1407.08500
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000

43	ENVULT MIN	1.00000	-389.90252	-199.52563	0.00000
44	ENVULT MAX	0.00000	30.68573	0.00000	778.51988
FRAME	LOAD	DIST	P	V2	M3
53	ENVULT MAX	0.10000	32.10238	0.00000	0.00000
53	ENVULT MAX	0.32500	32.10238	0.00000	0.00000
53	ENVULT MAX	0.55000	32.10238	0.00000	0.00000
53	ENVULT MAX	0.77500	32.10238	0.00000	0.00000
53	ENVULT MAX	1.00000	32.10238	0.00000	0.00000
53	ENVULT MIN	0.10000	-389.90253	-821.00128	-1409.55900
53	ENVULT MIN	0.32500	-389.90253	-803.72794	-1318.17500
53	ENVULT MIN	0.55000	-389.90253	-786.57900	-1228.72000
53	ENVULT MIN	0.77500	-389.90253	-769.43006	-1141.19400
53	ENVULT MIN	1.00000	-389.90253	-752.28113	-1055.59800
54	ENVULT MAX	0.00000	32.08102	0.00000	0.00000
54	ENVULT MAX	0.25000	32.08102	0.00000	0.00000
54	ENVULT MAX	0.50000	32.08102	0.00000	0.00000
54	ENVULT MAX	0.75000	32.08102	0.00000	0.00000
54	ENVULT MAX	1.00000	32.08102	0.00000	0.00000
54	ENVULT MIN	0.00000	-389.90253	-752.28113	-1055.59800
54	ENVULT MIN	0.25000	-389.90253	-740.20065	-996.45861
54	ENVULT MIN	0.50000	-389.90253	-728.12018	-938.27639
54	ENVULT MIN	0.75000	-389.90253	-716.03971	-881.05156
54	ENVULT MIN	1.00000	-389.90253	-703.95923	-824.78410
55	ENVULT MAX	0.00000	31.96106	0.00000	0.00000
55	ENVULT MAX	0.25000	31.96106	0.00000	0.00000
55	ENVULT MAX	0.50000	31.96106	0.00000	0.00000
55	ENVULT MAX	0.75000	31.96106	0.00000	0.00000
55	ENVULT MAX	1.00000	31.96106	0.00000	0.00000
55	ENVULT MIN	0.00000	-389.90253	-703.95923	-824.78410
55	ENVULT MIN	0.25000	-389.90253	-663.33530	-642.59210
55	ENVULT MIN	0.50000	-389.90253	-622.71138	-474.44311
55	ENVULT MIN	0.75000	-389.90253	-582.08745	-333.64531
55	ENVULT MIN	1.00000	-389.90253	-541.46352	-203.67239
56	ENVULT MAX	0.00000	31.33424	0.00000	0.00000
56	ENVULT MAX	0.25000	31.33424	0.00000	86.05416
56	ENVULT MAX	0.50000	31.33424	0.00000	197.18991
56	ENVULT MAX	0.75000	31.33424	0.00000	297.47905
56	ENVULT MAX	1.00000	31.33424	0.00000	386.92160
56	ENVULT MIN	0.00000	-389.90252	-541.46352	-203.67239
56	ENVULT MIN	0.25000	-389.90252	-500.80149	-83.16731
56	ENVULT MIN	0.50000	-389.90252	-460.13945	-40.21534
56	ENVULT MIN	0.75000	-389.90252	-419.47741	-15.83083
56	ENVULT MIN	1.00000	-389.90252	-378.81538	0.00000
57	ENVULT MAX	0.00000	30.68573	0.00000	386.92160
57	ENVULT MAX	0.25000	30.68573	0.00000	465.51756
57	ENVULT MAX	0.50000	30.68573	0.00000	546.54126
57	ENVULT MAX	0.75000	30.68573	0.00000	619.47932
57	ENVULT MAX	1.00000	30.68573	0.00000	681.57079
57	ENVULT MIN	0.00000	-389.90252	-378.81538	0.00000
57	ENVULT MIN	0.25000	-389.90252	-338.15334	0.00000
57	ENVULT MIN	0.50000	-389.90252	-297.49130	0.00000
57	ENVULT MIN	0.75000	-389.90252	-256.82927	0.00000
57	ENVULT MIN	1.00000	-389.90252	-216.16723	0.00000
58	ENVULT MAX	0.00000	30.68573	0.00000	681.57079
58	ENVULT MAX	0.25000	30.68573	0.00000	732.77270
58	ENVULT MAX	0.50000	30.68573	0.00000	773.14835
58	ENVULT MAX	0.75000	30.68573	20.81735	802.69771
58	ENVULT MAX	1.00000	30.68573	43.26131	821.42080
58	ENVULT MIN	0.00000	-389.90252	-216.16723	0.00000
58	ENVULT MIN	0.25000	-389.90252	-175.54330	0.00000
58	ENVULT MIN	0.50000	-389.90252	-134.91938	0.00000
58	ENVULT MIN	0.75000	-389.90252	-96.13888	0.00000
58	ENVULT MIN	1.00000	-389.90252	-60.20536	0.00000
59	ENVULT MAX	0.00000	30.68573	43.26132	821.42080
59	ENVULT MAX	0.25000	30.68573	76.04910	829.31994
59	ENVULT MAX	0.50000	30.68573	117.52259	826.37248
59	ENVULT MAX	0.75000	30.68573	158.99608	812.57842
59	ENVULT MAX	1.00000	30.68573	200.46957	787.93776
59	ENVULT MIN	0.00000	-389.90252	-60.20536	0.00000
59	ENVULT MIN	0.25000	-389.90252	-24.23812	0.00000
59	ENVULT MIN	0.50000	-389.90252	-8.61448	0.00000
59	ENVULT MIN	0.75000	-389.90252	-1.41223	0.00000
59	ENVULT MIN	1.00000	-389.90252	0.00000	0.00000
60	ENVULT MAX	0.00000	30.68573	200.46956	787.93776
60	ENVULT MAX	0.25000	30.68573	241.94305	752.45050
60	ENVULT MAX	0.50000	30.68573	283.41654	706.11665
60	ENVULT MAX	0.75000	30.68573	324.89003	648.93620
60	ENVULT MAX	1.00000	30.68573	366.36352	580.90915
60	ENVULT MIN	0.00000	-389.90253	0.00000	0.00000
60	ENVULT MIN	0.25000	-389.90253	0.00000	0.00000
60	ENVULT MIN	0.50000	-389.90253	0.00000	0.00000
60	ENVULT MIN	0.75000	-389.90253	0.00000	0.00000
60	ENVULT MIN	1.00000	-389.90253	0.00000	-14.32045
61	ENVULT MAX	0.00000	30.68573	366.36353	580.90915
61	ENVULT MAX	0.25000	30.68573	407.79815	502.11450
61	ENVULT MAX	0.50000	30.68573	449.23277	412.49357
61	ENVULT MAX	0.75000	30.68573	490.66739	312.04637
61	ENVULT MAX	1.00000	30.68573	532.10201	200.77289
61	ENVULT MIN	0.00000	-389.90253	0.00000	-14.32045
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
61	ENVULT MIN	1.00000	-389.90253	0.00000	-299.86923
62	ENVULT MAX	0.00000	30.68573	532.10197	200.77289
62	ENVULT MAX	0.25000	30.68573	536.64967	187.90061
62	ENVULT MAX	0.50000	30.68573	541.19737	174.89792
62	ENVULT MAX	0.75000	30.68573	545.74507	161.76481
62	ENVULT MAX	1.00000	30.68573	550.29278	148.50128
62	ENVULT MIN	0.00000	-389.90253	0.00000	-299.86922
62	ENVULT MIN	0.25000	-389.90253	0.00000	-310.28304
62	ENVULT MIN	0.50000	-389.90253	0.00000	-325.93751
62	ENVULT MIN	0.75000	-389.90253	0.00000	-341.72500
62	ENVULT MIN	1.00000	-389.90253	0.00000	-357.64551
63	ENVULT MAX	0.00000	30.68573	550.29280	148.50128
63	ENVULT MAX	0.22500	30.68573	567.99490	103.32327
63	ENVULT MAX	0.45000	30.68573	586.11888	57.16588
63	ENVULT MAX	0.67500	30.68573	604.66473	20.76455
63	ENVULT MAX	0.90000	30.68573	623.63245	11.79011
63	ENVULT MIN	0.00000	-389.90253	0.00000	-357.64551
63	ENVULT MIN	0.22500	-389.90253	0.00000	-420.12584
63	ENVULT MIN	0.45000	-389.90253	0.00000	-484.62138
63	ENVULT MIN	0.67500	-389.90253	0.00000	-551.17961
63	ENVULT MIN	0.90000	-389.90253	0.00000	-619.84797
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
66	ENVULT MAX	0.10000	0.00000	30.68573	0.00000
66	ENVULT MAX	0.32500	0.00000	30.68573	0.00000
66	ENVULT MAX	0.55000	0.00000	30.68573	0.00000
66	ENVULT MAX	0.77500	0.00000	30.68573	0.00000
66	ENVULT MAX	1.00000	0.00000	30.68573	0.00000
66	ENVULT MIN	0.10000	-729.87102	-345.10248	-843.48429
66	ENVULT MIN	0.32500	-734.38508	-334.19561	-828.40388
66	ENVULT MIN	0.55000	-738.47727	-322.98498	-813.42473
66	ENVULT MIN	0.77500	-742.14758	-311.47061	-798.54683
66	ENVULT MIN	1.00000	-745.39602	-299.65248	-783.77018
67	ENVULT MAX	0.00000	0.00000	30.68573	0.00000
67	ENVULT MAX	0.25000	0.00000	30.68573	0.00000
67	ENVULT MAX	0.50000	0.00000	30.68573	0.00000
67	ENVULT MAX	0.75000	0.00000	30.68573	0.00000
67	ENVULT MAX	1.00000	0.00000	30.68573	0.00000
67	ENVULT MIN	0.00000	-745.39599	-299.65260	-783.77018
67	ENVULT MIN	0.25000	-746.91474	-293.62963	-776.41982
67	ENVULT MIN	0.50000	-748.43349	-287.53073	-769.09477
67	ENVULT MIN	0.75000	-749.95224	-281.35588	-761.79504
67	ENVULT MIN	1.00000	-751.47099	-275.10510	-754.52062
68	ENVULT MAX	0.00000	0.00000	30.68573	0.00000
68	ENVULT MAX	0.25000	0.00000	30.68573	0.00000
68	ENVULT MAX	0.50000	0.00000	30.68573	0.00000
68	ENVULT MAX	0.75000	0.00000	33.69921	0.00000
68	ENVULT MAX	1.00000	0.00000	52.88796	22.50186
68	ENVULT MIN	0.00000	-751.47095	-275.10502	-754.52062
68	ENVULT MIN	0.25000	-759.40220	-241.22830	-716.94324
68	ENVULT MIN	0.50000	-767.33345	-205.28064	-680.05616
68	ENVULT MIN	0.75000	-775.26470	-167.26205	-644.48995
68	ENVULT MIN	1.00000	-783.19595	-139.47970	-611.38844
69	ENVULT MAX	0.00000	0.00000	52.88796	22.50191
69	ENVULT MAX	0.25000	0.00000	82.49579	38.04961
69	ENVULT MAX	0.50000	0.00000	113.41526	41.59881
69	ENVULT MAX	0.75000	0.00000	145.64640	37.57816
69	ENVULT MAX	1.00000	0.00000	179.18918	30.54669
69	ENVULT MIN	0.00000	-783.19595	-139.47971	-611.38844
69	ENVULT MIN	0.25000	-791.12720	-117.34802	-579.04628
69	ENVULT MIN	0.50000	-799.05845	-114.99802	-551.85944
69	ENVULT MIN	0.75000	-806.98970	-114.43878	-550.08685
69	ENVULT MIN	1.00000	-814.92095	-114.43878	-548.69393
70	ENVULT MAX	0.00000	0.00000	179.18918	30.54658
70	ENVULT MAX	0.25000	0.00000	228.83315	9.93155
70	ENVULT MAX	0.50000	0.00000	281.58331	0.00000
70	ENVULT MAX	0.75000	0.00000	336.40440	0.00000
70	ENVULT MAX	1.00000	0.00000	393.29643	0.00000

61	ENVULT MIN	0.25000	-389.90253	0.00000	-76.73567
61	ENVULT MIN	0.50000	-389.90253	0.00000	-145.13221
61	ENVULT MIN	0.75000	-389.90253	0.00000	-219.51006
FRAME	LOAD	DIST	P	V2	M3
70	ENVULT MIN	0.75000	-838.71473	-114.43878	-591.54127
70	ENVULT MIN	1.00000	-846.64598	-114.43878	-671.58121
71	ENVULT MAX	0.00000	0.00000	393.29644	0.00000
71	ENVULT MAX	0.25000	0.00000	424.40191	0.00000
71	ENVULT MAX	0.50000	0.00000	456.09331	0.00000
71	ENVULT MAX	0.75000	0.00000	488.37066	0.00000
71	ENVULT MAX	1.00000	0.00000	521.23394	0.00000
71	ENVULT MIN	0.00000	-846.64595	-114.43878	-671.58121
71	ENVULT MIN	0.25000	-850.86470	-114.43878	-724.24189
71	ENVULT MIN	0.50000	-855.08345	-114.43878	-780.23888
71	ENVULT MIN	0.75000	-859.30220	-114.43878	-839.63017
71	ENVULT MIN	1.00000	-863.52095	-114.43878	-904.06307
72	ENVULT MAX	0.00000	0.00000	521.23392	0.00000
72	ENVULT MAX	0.10227	0.00000	533.20814	0.00000
72	ENVULT MAX	0.20455	0.00000	545.25829	0.00000
72	ENVULT MAX	0.30682	0.00000	557.38439	0.00000
72	ENVULT MAX	0.40909	0.00000	569.58642	0.00000
72	ENVULT MIN	0.00000	-863.52097	-114.43878	-904.06306
72	ENVULT MIN	0.10227	-865.03972	-114.43878	-933.71889
72	ENVULT MIN	0.20455	-866.55847	-114.43878	-964.05040
72	ENVULT MIN	0.30682	-868.07722	-114.43878	-995.06187
72	ENVULT MIN	0.40909	-869.59597	-114.43878	-1026.75800
73	ENVULT MAX	0.11915	0.00000	87.96544	210.21262
73	ENVULT MAX	0.32128	0.00000	87.96544	105.75366
73	ENVULT MAX	0.52340	0.00000	87.96544	14.80729
73	ENVULT MAX	0.72553	0.00000	87.96544	103.16425
73	ENVULT MAX	0.92766	0.00000	87.96544	207.62320
73	ENVULT MIN	0.11915	-1727.53400	-87.96544	-210.21262
73	ENVULT MIN	0.32128	-1745.34600	-87.96544	-105.75366
73	ENVULT MIN	0.52340	-1763.15900	-87.96544	-14.80729
73	ENVULT MIN	0.72553	-1780.97100	-87.96544	-103.16425
73	ENVULT MIN	0.92766	-1798.78400	-87.96544	-207.62320

70	ENVULT MIN	0.00000	-814.92098	-114.43878	-548.69393
70	ENVULT MIN	0.25000	-822.85223	-114.43878	-547.68069
70	ENVULT MIN	0.50000	-830.78348	-114.43878	-547.25810

2) 사용하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVUSE MAX	0.38889	115.42489	0.00000	0.00000
1	ENVUSE MAX	0.54167	115.42489	0.00000	0.00000
1	ENVUSE MAX	0.69444	115.42489	0.00000	0.00000
1	ENVUSE MAX	0.84722	115.42489	0.00000	3.69638
1	ENVUSE MAX	1.00000	115.42489	0.00000	28.90872
1	ENVUSE MIN	0.38889	-460.62060	-497.93001	-778.84447
1	ENVUSE MIN	0.54167	-460.62060	-493.80501	-744.87165
1	ENVUSE MIN	0.69444	-460.62060	-489.68001	-711.18243
1	ENVUSE MIN	0.84722	-460.62060	-485.55501	-677.77680
1	ENVUSE MIN	1.00000	-460.62060	-481.43001	-644.65476
2	ENVUSE MAX	0.00000	115.42489	0.00000	28.90872
2	ENVUSE MAX	0.25000	115.42489	0.00000	85.94901
2	ENVUSE MAX	0.50000	115.42489	0.00000	143.64361
2	ENVUSE MAX	0.75000	115.42489	0.00000	201.99252
2	ENVUSE MAX	1.00000	115.42489	0.00000	260.99574
2	ENVUSE MIN	0.00000	-460.62060	-481.43001	-644.65476
2	ENVUSE MIN	0.25000	-460.62060	-472.17501	-571.37289
2	ENVUSE MIN	0.50000	-460.62060	-462.92001	-499.51860
2	ENVUSE MIN	0.75000	-460.62060	-453.66501	-429.09189
2	ENVUSE MIN	1.00000	-460.62060	-449.57701	-360.09277
3	ENVUSE MAX	0.00000	115.42489	0.00000	260.99574
3	ENVUSE MAX	0.25000	115.42489	0.00000	285.77231
3	ENVUSE MAX	0.50000	115.42489	0.00000	310.94984
3	ENVUSE MAX	0.75000	115.42489	0.00000	336.52834
3	ENVUSE MAX	1.00000	115.42489	0.00000	362.50781
3	ENVUSE MIN	0.00000	-460.62060	-376.90604	-360.09277
3	ENVUSE MIN	0.25000	-460.62060	-369.66104	-315.01878
3	ENVUSE MIN	0.50000	-460.62060	-362.41604	-275.43620
3	ENVUSE MIN	0.75000	-460.62060	-355.17104	-237.67335
3	ENVUSE MIN	1.00000	-460.62060	-347.92604	-199.50954
4	ENVUSE MAX	0.00000	115.42489	0.00000	362.50781
4	ENVUSE MAX	0.25000	115.42489	0.00000	378.82841
4	ENVUSE MAX	0.50000	115.42489	0.00000	395.26854
4	ENVUSE MAX	0.75000	115.42489	0.00000	411.82821
4	ENVUSE MAX	1.00000	115.42489	0.00000	428.50740
4	ENVUSE MIN	0.00000	-460.62060	-347.92604	-199.50954
4	ENVUSE MIN	0.25000	-460.62060	-342.95729	-175.62102
4	ENVUSE MIN	0.50000	-460.62060	-337.98854	-151.61297
4	ENVUSE MIN	0.75000	-460.62060	-333.01979	-127.48538
4	ENVUSE MIN	1.00000	-460.62060	-328.05104	-103.23827
5	ENVUSE MAX	0.00000	115.42489	0.00000	428.50740
5	ENVUSE MAX	0.25000	115.42489	0.00000	444.36665
5	ENVUSE MAX	0.50000	115.42489	0.00000	460.36355
5	ENVUSE MAX	0.75000	115.42489	0.00000	476.49810
5	ENVUSE MAX	1.00000	115.42489	0.00000	493.72637
5	ENVUSE MIN	0.00000	-460.62060	-328.05104	-103.23827
5	ENVUSE MIN	0.25000	-460.62060	-326.03737	-80.39193
5	ENVUSE MIN	0.50000	-460.62060	-327.98299	-57.92917
5	ENVUSE MIN	0.75000	-460.62060	-329.92862	-35.32874
5	ENVUSE MIN	1.00000	-460.62060	-331.87424	-12.59067
6	ENVUSE MAX	0.00000	115.42489	0.00000	493.72637
6	ENVUSE MAX	0.25000	115.42489	0.00000	521.48086
6	ENVUSE MAX	0.50000	115.42489	0.00000	551.19212
6	ENVUSE MAX	0.75000	115.42489	0.00000	582.86016
6	ENVUSE MAX	1.00000	115.42489	0.00000	616.48498
6	ENVUSE MIN	0.00000	-460.62060	-254.86922	-12.58560
6	ENVUSE MIN	0.25000	-460.62060	-238.86422	0.00000
6	ENVUSE MIN	0.50000	-460.62060	-222.85922	0.00000
6	ENVUSE MIN	0.75000	-460.62060	-217.05176	0.00000
6	ENVUSE MIN	1.00000	-460.62060	-224.38739	0.00000
7	ENVUSE MAX	0.00000	115.42489	15.57869	616.48498
7	ENVUSE MAX	0.25000	115.42489	8.24307	615.75539
7	ENVUSE MAX	0.50000	115.42489	0.90744	616.98258
7	ENVUSE MAX	0.75000	115.42489	0.00000	620.16655
7	ENVUSE MAX	1.00000	115.42489	0.00000	625.30729
7	ENVUSE MIN	0.00000	-460.62060	-144.14758	0.00000
7	ENVUSE MIN	0.25000	-460.62060	-128.14258	0.00000
7	ENVUSE MIN	0.50000	-460.62060	-112.13758	0.00000
7	ENVUSE MIN	0.75000	-460.62060	-115.51194	0.00000
7	ENVUSE MIN	1.00000	-460.62060	-122.84756	0.00000
8	ENVUSE MAX	0.00000	115.42489	102.17512	625.30729
8	ENVUSE MAX	0.25000	115.42489	94.84637	599.05418
8	ENVUSE MAX	0.50000	115.42489	87.51762	574.75417
8	ENVUSE MAX	0.75000	115.42489	80.18887	552.40728
8	ENVUSE MAX	1.00000	115.42489	95.34427	532.01350
8	ENVUSE MIN	0.00000	-460.62060	-38.58292	0.00000
8	ENVUSE MIN	0.25000	-460.62060	-22.59292	0.00000
8	ENVUSE MIN	0.50000	-460.62060	-8.79772	0.00000
8	ENVUSE MIN	0.75000	-460.62060	-16.12647	0.00000
8	ENVUSE MIN	1.00000	-460.62060	-23.45522	0.00000
9	ENVUSE MAX	0.75000	115.42489	180.79866	386.47854
9	ENVUSE MAX	1.00000	115.42489	196.80366	337.92212
9	ENVUSE MIN	0.00000	-460.62060	0.00000	0.00000
9	ENVUSE MIN	0.25000	-460.62060	0.00000	0.00000
9	ENVUSE MIN	0.50000	-460.62060	0.00000	0.00000
9	ENVUSE MIN	0.75000	-460.62060	0.00000	0.00000
9	ENVUSE MIN	1.00000	-460.62060	0.00000	0.00000
10	ENVUSE MAX	0.00000	115.42489	303.26000	337.92212
10	ENVUSE MAX	0.25000	115.42489	295.92438	274.10711
10	ENVUSE MAX	0.50000	115.42489	288.58875	206.29900
10	ENVUSE MAX	0.75000	115.42489	290.51198	134.22155
10	ENVUSE MAX	1.00000	115.42489	306.51698	61.56087
10	ENVUSE MIN	0.00000	-460.62060	0.00000	0.00000
10	ENVUSE MIN	0.25000	-460.62060	0.00000	0.00000
10	ENVUSE MIN	0.50000	-460.62060	0.00000	0.00000
10	ENVUSE MIN	0.75000	-460.62060	0.00000	0.00000
10	ENVUSE MIN	1.00000	-460.62060	0.00000	-16.65104
11	ENVUSE MAX	0.00000	115.42489	426.59752	61.56087
11	ENVUSE MAX	0.25000	115.42489	419.26877	11.62180
11	ENVUSE MAX	0.50000	115.42489	411.94002	0.00000
11	ENVUSE MAX	0.75000	115.42489	417.81512	0.00000
11	ENVUSE MAX	1.00000	115.42489	433.80512	0.00000
11	ENVUSE MIN	0.00000	-460.62061	0.00000	-16.64763
11	ENVUSE MIN	0.25000	-460.62061	0.00000	-119.39221
11	ENVUSE MIN	0.50000	-460.62061	0.00000	-224.01728
11	ENVUSE MIN	0.75000	-460.62061	0.00000	-328.79834
11	ENVUSE MIN	1.00000	-460.62061	0.00000	-435.65069
12	ENVUSE MAX	0.00000	115.42489	573.69984	0.00000
12	ENVUSE MAX	0.25000	115.42489	572.55171	0.00000
12	ENVUSE MAX	0.50000	115.42489	571.40359	0.00000
12	ENVUSE MAX	0.75000	115.42489	570.25546	0.00000
12	ENVUSE MAX	1.00000	115.42489	569.10734	0.00000
12	ENVUSE MIN	0.00000	-460.62061	0.00000	-435.65069
12	ENVUSE MIN	0.25000	-460.62061	0.00000	-459.57869
12	ENVUSE MIN	0.50000	-460.62061	0.00000	-483.45876
12	ENVUSE MIN	0.75000	-460.62061	0.00000	-507.29089
12	ENVUSE MIN	1.00000	-460.62061	0.00000	-531.07509
13	ENVUSE MAX	0.00000	115.42489	569.10734	0.00000
13	ENVUSE MAX	0.25000	115.42489	567.04484	0.00000
13	ENVUSE MAX	0.50000	115.42489	564.98234	0.00000
13	ENVUSE MAX	0.75000	115.42489	562.91984	0.00000
13	ENVUSE MAX	1.00000	115.42489	560.85734	0.00000
13	ENVUSE MIN	0.00000	-460.62061	0.00000	-531.07509
13	ENVUSE MIN	0.25000	-460.62061	0.00000	-573.68080
13	ENVUSE MIN	0.50000	-460.62061	0.00000	-616.13181
13	ENVUSE MIN	0.75000	-460.62061	0.00000	-658.42815
13	ENVUSE MIN	1.00000	-460.62061	0.00000	-700.56979
14	ENVUSE MAX	0.00000	115.42489	560.85734	0.00000
14	ENVUSE MAX	0.25000	115.42489	558.45109	0.00000
14	ENVUSE MAX	0.50000	115.42489	558.94193	0.00000
14	ENVUSE MAX	0.75000	115.42489	564.19193	0.00000
14	ENVUSE MAX	1.00000	115.42489	569.44193	0.00000
14	ENVUSE MIN	0.00000	-460.62060	0.00000	-700.56979
14	ENVUSE MIN	0.25000	-460.62060	0.00000	-749.53953
14	ENVUSE MIN	0.50000	-460.62060	0.00000	-798.29873
14	ENVUSE MIN	0.75000	-460.62060	0.00000	-846.84738
14	ENVUSE MIN	1.00000	-460.62060	0.00000	-895.18548
15	ENVUSE MAX	0.00000	115.42489	569.44193	0.00000
15	ENVUSE MAX	0.25000	115.42489	573.19193	0.00000
15	ENVUSE MAX	0.50000	115.42489	576.94193	0.00000
15	ENVUSE MAX	0.75000	115.42489	580.69193	0.00000
15	ENVUSE MAX	1.00000	115.42489	584.44193	0.00000
15	ENVUSE MIN	0.00000	-460.62060	0.00000	-895.18548
15	ENVUSE MIN	0.25000	-460.62060	0.00000	-929.58379
15	ENVUSE MIN	0.50000	-460.62060	0.00000	-963.87468
15	ENVUSE MIN	0.75000	-460.62060	0.00000	-998.05815
15	ENVUSE MIN	1.00000	-460.62060	0.00000	-1032.13400
16	ENVUSE MAX	0.00000	67.80071	0.00000	0.00000
16	ENVUSE MAX	0.25000	67.80071	0.00000	0.00000
16	ENVUSE MAX	0.50000	67.80071	0.00000	0.00000
16	ENVUSE MAX	0.75000	67.80071	0.00000	0.00000
16	ENVUSE MAX	1.00000	67.80071	0.00000	0.00000
16	ENVUSE MIN	0.00000	-422.10577	-584.68666	-1034.72700
16	ENVUSE MIN	0.25000	-422.10577	-580.93666	-1000.60100
16	ENVUSE MIN	0.50000	-422.10577	-577.18666	-966.36688
16	ENVUSE MIN	0.75000	-422.10577	-573.43666	-932.02559
16	ENVUSE MIN	1.00000	-422.10577	-569.68666	-897.57688
17	ENVUSE MAX	0.00000	67.80071	0.00000	0.00000
17	ENVUSE MAX	0.25000	67.80071	0.00000	0.00000
17	ENVUSE MAX	0.50000	67.80071	0.00000	0.00000

9	ENVUSE MAX	0.00000	115.42489	198.00906	532.01350
9	ENVUSE MAX	0.25000	115.42489	190.67343	480.17298
9	ENVUSE MAX	0.50000	115.42489	183.33781	432.57192
FRAME	LOAD	DIST	P	V2	M3
17	ENVUSE MIN	0.25000	-422.10577	-564.43666	-849.16821
17	ENVUSE MIN	0.50000	-422.10577	-559.18666	-800.54900
17	ENVUSE MIN	0.75000	-422.10577	-559.25751	-751.71924
17	ENVUSE MIN	1.00000	-422.10577	-561.66376	-702.67894
18	ENVUSE MAX	0.00000	67.80071	0.00000	0.00000
18	ENVUSE MAX	0.25000	67.80071	0.00000	0.00000
18	ENVUSE MAX	0.50000	67.80071	0.00000	0.00000
18	ENVUSE MAX	0.75000	67.80071	0.00000	0.00000
18	ENVUSE MAX	1.00000	67.80071	0.00000	0.00000
18	ENVUSE MIN	0.00000	-422.10577	-561.66376	-702.67894
18	ENVUSE MIN	0.25000	-422.10577	-563.72626	-660.47681
18	ENVUSE MIN	0.50000	-422.10577	-565.78876	-618.12000
18	ENVUSE MIN	0.75000	-422.10577	-567.85126	-575.60850
18	ENVUSE MIN	1.00000	-422.10577	-569.91376	-532.94231
19	ENVUSE MAX	0.00000	67.80071	0.00000	0.00000
19	ENVUSE MAX	0.25000	67.80071	0.00000	0.00000
19	ENVUSE MAX	0.50000	67.80071	0.00000	0.00000
19	ENVUSE MAX	0.75000	67.80071	0.00000	0.00000
19	ENVUSE MAX	1.00000	67.80071	0.00000	0.00000
19	ENVUSE MIN	0.00000	-422.10576	-569.91376	-532.94231
19	ENVUSE MIN	0.25000	-422.10576	-571.06188	-509.12445
19	ENVUSE MIN	0.50000	-422.10576	-572.21001	-485.25865
19	ENVUSE MIN	0.75000	-422.10576	-573.35813	-461.34491
19	ENVUSE MIN	1.00000	-422.10576	-574.50626	-437.38324
20	ENVUSE MAX	0.00000	67.80071	0.00000	0.00000
20	ENVUSE MAX	0.25000	67.80071	0.00000	0.00000
20	ENVUSE MAX	0.50000	67.80071	0.00000	0.00000
20	ENVUSE MAX	0.75000	67.80071	0.00000	11.62180
20	ENVUSE MAX	1.00000	67.80071	0.00000	61.69973
20	ENVUSE MIN	0.00000	-422.10576	-433.85501	-437.38324
20	ENVUSE MIN	0.25000	-422.10576	-417.86501	-330.48709
20	ENVUSE MIN	0.50000	-422.10576	-412.10440	-225.80889
20	ENVUSE MIN	0.75000	-422.10576	-419.43315	-120.26416
20	ENVUSE MIN	1.00000	-422.10576	-426.76190	-16.54513
21	ENVUSE MAX	0.00000	67.80071	0.00000	61.69973
21	ENVUSE MAX	0.25000	67.80071	0.00000	133.35658
21	ENVUSE MAX	0.50000	67.80071	0.00000	205.37540
21	ENVUSE MAX	0.75000	67.80071	0.00000	273.12489
21	ENVUSE MAX	1.00000	67.80071	0.00000	336.60504
21	ENVUSE MIN	0.00000	-422.10576	-306.38817	-16.54176
21	ENVUSE MIN	0.25000	-422.10576	-290.38317	0.00000
21	ENVUSE MIN	0.50000	-422.10576	-288.16431	0.00000
21	ENVUSE MIN	0.75000	-422.10576	-295.49994	0.00000
21	ENVUSE MIN	1.00000	-422.10576	-302.83556	0.00000
22	ENVUSE MAX	0.00000	67.80071	0.00000	336.60504
22	ENVUSE MAX	0.25000	67.80071	0.00000	385.10730
22	ENVUSE MAX	0.50000	67.80071	0.00000	431.04952
22	ENVUSE MAX	0.75000	67.80071	0.00000	477.41565
22	ENVUSE MAX	1.00000	67.80071	0.00000	529.00713
22	ENVUSE MIN	0.00000	-422.10576	-196.27089	0.00000
22	ENVUSE MIN	0.25000	-422.10576	-180.26589	0.00000
22	ENVUSE MIN	0.50000	-422.10576	-182.40418	0.00000
22	ENVUSE MIN	0.75000	-422.10576	-189.73981	0.00000
22	ENVUSE MIN	1.00000	-422.10576	-197.07543	0.00000
23	ENVUSE MAX	0.00000	67.80071	21.96331	529.00713
23	ENVUSE MAX	0.25000	67.80071	14.63456	549.04679
23	ENVUSE MAX	0.50000	67.80071	7.30581	571.03957
23	ENVUSE MAX	0.75000	67.80071	21.52672	594.98546
23	ENVUSE MAX	1.00000	67.80071	37.51672	620.88446
23	ENVUSE MIN	0.00000	-422.10577	-94.94102	0.00000
23	ENVUSE MIN	0.25000	-422.10577	-78.95102	0.00000
23	ENVUSE MIN	0.50000	-422.10577	-86.18887	0.00000
23	ENVUSE MIN	0.75000	-422.10577	-93.51762	0.00000
23	ENVUSE MIN	1.00000	-422.10577	-100.84637	0.00000
24	ENVUSE MAX	0.00000	67.80071	121.15065	620.88446
24	ENVUSE MAX	0.25000	67.80071	113.81503	615.32812
24	ENVUSE MAX	0.50000	67.80071	111.05304	611.72856
24	ENVUSE MAX	0.75000	67.80071	127.05804	610.08578
24	ENVUSE MAX	1.00000	67.80071	143.06304	610.39977
24	ENVUSE MIN	0.00000	-422.10577	0.00000	0.00000
24	ENVUSE MIN	0.25000	-422.10577	0.00000	0.00000
24	ENVUSE MIN	0.50000	-422.10577	0.00000	0.00000
24	ENVUSE MIN	0.75000	-422.10577	-6.68508	0.00000
24	ENVUSE MIN	1.00000	-422.10577	-14.02071	0.00000
25	ENVUSE MAX	0.00000	67.80071	222.70561	610.39977
25	ENVUSE MAX	0.25000	67.80071	215.36998	576.36307
25	ENVUSE MAX	0.50000	67.80071	221.78434	544.28314
25	ENVUSE MAX	0.75000	67.80071	237.78934	514.15999
25	ENVUSE MAX	1.00000	67.80071	253.79434	485.99362
25	ENVUSE MIN	0.00000	-422.10576	0.00000	0.00000
25	ENVUSE MIN	0.25000	-422.10576	0.00000	0.00000
25	ENVUSE MIN	0.50000	-422.10576	0.00000	0.00000
25	ENVUSE MIN	0.75000	-422.10576	0.00000	0.00000
25	ENVUSE MIN	1.00000	-422.10576	0.00000	-4.01326
26	ENVUSE MAX	0.00000	67.80071	330.58846	485.99362
17	ENVUSE MAX	0.75000	67.80071	0.00000	0.00000
17	ENVUSE MAX	1.00000	67.80071	0.00000	0.00000
17	ENVUSE MIN	0.00000	-422.10577	-569.68666	-897.57688
FRAME	LOAD	DIST	P	V2	M3
26	ENVUSE MIN	0.00000	-422.10575	0.00000	-4.01650
26	ENVUSE MIN	0.25000	-422.10575	0.00000	-26.66043
26	ENVUSE MIN	0.50000	-422.10575	0.00000	-49.16671
26	ENVUSE MIN	0.75000	-422.10575	0.00000	-71.54478
26	ENVUSE MIN	1.00000	-422.10575	0.00000	-94.45213
27	ENVUSE MAX	0.00000	67.80071	327.22926	420.44056
27	ENVUSE MAX	0.25000	67.80071	332.19801	403.67283
27	ENVUSE MAX	0.50000	67.80071	337.16676	387.02462
27	ENVUSE MAX	0.75000	67.80071	342.13551	370.49595
27	ENVUSE MAX	1.00000	67.80071	347.10426	354.08681
27	ENVUSE MIN	0.00000	-422.10575	0.00000	-94.45213
27	ENVUSE MIN	0.25000	-422.10575	0.00000	-118.60281
27	ENVUSE MIN	0.50000	-422.10575	0.00000	-142.63396
27	ENVUSE MIN	0.75000	-422.10575	0.00000	-166.54558
27	ENVUSE MIN	1.00000	-422.10575	0.00000	-190.33766
28	ENVUSE MAX	0.00000	67.80071	347.10426	354.08681
28	ENVUSE MAX	0.25000	67.80071	354.34926	327.96480
28	ENVUSE MAX	0.50000	67.80071	361.59426	302.24375
28	ENVUSE MAX	0.75000	67.80071	368.83926	276.92367
28	ENVUSE MAX	1.00000	67.80071	376.08426	252.00455
28	ENVUSE MIN	0.00000	-422.10576	0.00000	-190.33766
28	ENVUSE MIN	0.25000	-422.10576	0.00000	-228.34622
28	ENVUSE MIN	0.50000	-422.10576	0.00000	-265.95381
28	ENVUSE MIN	0.75000	-422.10576	0.00000	-308.85910
28	ENVUSE MIN	1.00000	-422.10576	0.00000	-353.83386
29	ENVUSE MAX	0.00000	67.80071	449.54989	252.00455
29	ENVUSE MAX	0.25000	67.80071	453.63788	192.95441
29	ENVUSE MAX	0.50000	67.80071	462.89288	134.55857
29	ENVUSE MAX	0.75000	67.80071	472.14788	76.81705
29	ENVUSE MAX	1.00000	67.80071	481.40288	19.72983
29	ENVUSE MIN	0.00000	-422.10577	0.00000	-353.83386
29	ENVUSE MIN	0.25000	-422.10577	0.00000	-422.80031
29	ENVUSE MIN	0.50000	-422.10577	0.00000	-493.19435
29	ENVUSE MIN	0.75000	-422.10577	0.00000	-565.01597
29	ENVUSE MIN	1.00000	-422.10577	0.00000	-638.26518
30	ENVUSE MAX	0.00000	67.80071	481.40287	19.72983
30	ENVUSE MAX	0.15278	67.80071	485.52787	0.00000
30	ENVUSE MAX	0.30556	67.80071	489.65287	0.00000
30	ENVUSE MAX	0.45833	67.80071	493.77787	0.00000
30	ENVUSE MAX	0.61111	67.80071	497.90287	0.00000
30	ENVUSE MIN	0.00000	-422.10579	0.00000	-638.26518
30	ENVUSE MIN	0.15278	-422.10579	0.00000	-671.37266
30	ENVUSE MIN	0.30556	-422.10579	0.00000	-704.76373
30	ENVUSE MIN	0.45833	-422.10579	0.00000	-738.43839
30	ENVUSE MIN	0.61111	-422.10579	0.00000	-772.39665
31	ENVUSE MAX	0.59091	0.00000	67.80071	0.00000
31	ENVUSE MAX	0.69318	0.00000	67.80071	0.00000
31	ENVUSE MAX	0.79545	0.00000	67.80071	0.00000
31	ENVUSE MAX	0.89773	0.00000	67.80071	0.00000
31	ENVUSE MAX	1.00000	0.00000	67.80071	0.00000
31	ENVUSE MIN	0.59091	-603.96456	-377.11357	-730.28530
31	ENVUSE MIN	0.69318	-602.69894	-369.48730	-709.28737
31	ENVUSE MIN	0.79545	-601.43331	-361.90849	-688.71709
31	ENVUSE MIN	0.89773	-600.16769	-354.37715	-668.57178
31	ENVUSE MIN	1.00000	-598.90206	-346.89326	-648.84877
32	ENVUSE MAX	0.00000	0.00000	67.80071	0.00000
32	ENVUSE MAX	0.25000	0.00000	67.80071	0.00000
32	ENVUSE MAX	0.50000	0.00000	67.80071	0.00000
32	ENVUSE MAX	0.75000	0.00000	67.80071	0.00000
32	ENVUSE MAX	1.00000	0.00000	67.80071	0.00000
32	ENVUSE MIN	0.00000	-598.90205	-346.89328	-648.84878
32	ENVUSE MIN	0.25000	-595.38643	-326.35372	-596.25612
32	ENVUSE MIN	0.50000	-591.87080	-306.18038	-553.81134
32	ENVUSE MIN	0.75000	-588.35518	-286.37326	-516.18676
32	ENVUSE MIN	1.00000	-584.83955	-266.93234	-480.64738
33	ENVUSE MAX	0.00000	0.00000	67.80071	0.00000
33	ENVUSE MAX	0.25000	0.00000	67.80071	0.00000
33	ENVUSE MAX	0.50000	0.00000	67.80071	0.00000
33	ENVUSE MAX	0.75000	0.00000	67.80071	0.00000
33	ENVUSE MAX	1.00000	0.00000	67.80071	0.00000
33	ENVUSE MIN	0.00000	-584.83956	-266.93233	-480.64738
33	ENVUSE MIN	0.25000	-578.23019	-231.37481	-428.25743
33	ENVUSE MIN	0.50000	-571.62081	-197.11163	-398.81668
33	ENVUSE MIN	0.75000	-565.01144	-164.14278	-392.85652
33	ENVUSE MIN	1.00000	-558.40206	-132.46827	-387.13365
34	ENVUSE MAX	0.00000	0.00000	67.80071	0.00000
34	ENVUSE MAX	0.25000	0.00000	67.80071	0.00000
34	ENVUSE MAX	0.50000	0.00000	67.80071	0.00000
34	ENVUSE MAX	0.75000	0.00000	76.21981	0.00000
34	ENVUSE MAX	1.00000	0.00000	90.75125	0.00000
34	ENVUSE MIN	0.00000	-558.40206	-132.46825	-387.13365
34	ENVUSE MIN	0.25000	-551.79268	-107.83833	-381.64808
34	ENVUSE MIN	0.50000	-545.18331	-87.69388	-376.39980
34	ENVUSE MIN	0.75000	-538.57393	-68.36920	-389.82928
34	ENVUSE MIN	1.00000	-531.96456	-49.86431	-406.95281

26	ENVUSE MAX	0.25000	67.80071	328.64284	468.68183
26	ENVUSE MAX	0.50000	67.80071	326.69721	452.46375
26	ENVUSE MAX	0.75000	67.80071	324.75159	436.38333
26	ENVUSE MAX	1.00000	67.80071	327.22926	420.44056
FRAME	LOAD	DIST	P	V2	M3
35	ENVUSE MAX	1.00000	0.00000	172.06930	0.00000
35	ENVUSE MIN	0.00000	-531.96456	-49.86431	-406.95281
35	ENVUSE MIN	0.25000	-525.35518	-39.85255	-424.55094
35	ENVUSE MIN	0.50000	-518.74581	-32.22765	-443.37380
35	ENVUSE MIN	0.75000	-512.13643	-25.01260	-463.25602
35	ENVUSE MIN	1.00000	-505.52706	-22.23356	-483.56968
36	ENVUSE MAX	0.00000	0.00000	171.95978	0.00000
36	ENVUSE MAX	0.25000	0.00000	175.58527	0.00000
36	ENVUSE MAX	0.50000	0.00000	179.16330	0.00000
36	ENVUSE MAX	0.75000	0.00000	182.69386	0.00000
36	ENVUSE MAX	1.00000	0.00000	186.17697	0.00000
36	ENVUSE MIN	0.00000	-505.52707	-23.21784	-483.56968
36	ENVUSE MIN	0.25000	-504.26144	-23.21784	-487.50875
36	ENVUSE MIN	0.50000	-502.99582	-23.21784	-491.46364
36	ENVUSE MIN	0.75000	-501.73019	-23.21784	-495.43435
36	ENVUSE MIN	1.00000	-500.46457	-23.21784	-499.42088
37	ENVUSE MAX	0.00000	0.00000	186.12230	0.00000
37	ENVUSE MAX	0.22500	0.00000	192.94613	0.00000
37	ENVUSE MAX	0.45000	0.00000	199.58012	0.00000
37	ENVUSE MAX	0.67500	0.00000	206.02426	0.00000
37	ENVUSE MAX	0.90000	0.00000	212.27855	0.00000
37	ENVUSE MIN	0.00000	-500.46458	-24.86072	-499.42088
37	ENVUSE MIN	0.22500	-497.75755	-24.86072	-507.44140
37	ENVUSE MIN	0.45000	-494.69896	-24.86072	-515.52520
37	ENVUSE MIN	0.67500	-491.28880	-24.86072	-523.67229
37	ENVUSE MIN	0.90000	-487.52708	-24.86072	-531.88265
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.10000	36.72705	0.00000	10.76670
40	ENVUSE MAX	0.32500	36.72705	0.00000	39.44506
40	ENVUSE MAX	0.55000	36.72705	0.00000	71.02974
40	ENVUSE MAX	0.77500	36.72705	0.00000	101.83326
40	ENVUSE MAX	1.00000	36.72705	0.00000	131.43759
40	ENVUSE MIN	0.10000	-237.48708	-411.48956	-390.26107
40	ENVUSE MIN	0.32500	-237.48708	-398.49440	-348.61338
40	ENVUSE MIN	0.55000	-237.48708	-385.85081	-308.26866
40	ENVUSE MIN	0.77500	-237.48708	-373.55878	-269.18734
40	ENVUSE MIN	1.00000	-237.48708	-361.61831	-231.32989
41	ENVUSE MAX	0.00000	37.74632	0.00000	131.43759
41	ENVUSE MAX	0.25000	37.74632	0.00000	139.26229
41	ENVUSE MAX	0.50000	37.74632	0.00000	147.93603
41	ENVUSE MAX	0.75000	37.74632	0.00000	156.52197
41	ENVUSE MAX	1.00000	37.74632	0.00000	165.02012
41	ENVUSE MIN	0.00000	-237.44100	-361.61829	-231.32989
41	ENVUSE MIN	0.25000	-237.44100	-358.55947	-221.68266
41	ENVUSE MIN	0.50000	-237.44100	-355.50065	-212.11548
41	ENVUSE MIN	0.75000	-237.44100	-352.44184	-202.62837
41	ENVUSE MIN	1.00000	-237.44100	-349.38302	-193.22131
42	ENVUSE MAX	0.00000	39.87522	0.00000	165.02012
42	ENVUSE MAX	0.25000	39.87522	0.00000	238.40331
42	ENVUSE MAX	0.50000	39.87522	0.00000	304.49784
42	ENVUSE MAX	0.75000	39.87522	0.00000	363.30371
42	ENVUSE MAX	1.00000	39.87522	0.00000	414.82093
42	ENVUSE MIN	0.00000	-237.41293	-349.38304	-193.22131
42	ENVUSE MIN	0.25000	-237.41293	-321.51380	-111.20024
42	ENVUSE MIN	0.50000	-237.41293	-293.64456	-35.82507
42	ENVUSE MIN	0.75000	-237.41293	-265.77532	0.00000
42	ENVUSE MIN	1.00000	-237.41293	-237.90609	0.00000
43	ENVUSE MAX	0.00000	42.82356	0.00000	414.82093
43	ENVUSE MAX	0.25000	42.82356	0.00000	459.08756
43	ENVUSE MAX	0.50000	42.82356	0.00000	496.05184
43	ENVUSE MAX	0.75000	42.82356	0.00000	525.71379
43	ENVUSE MAX	1.00000	42.82356	0.00000	548.07340
43	ENVUSE MIN	0.00000	-237.41293	-237.90608	0.00000
43	ENVUSE MIN	0.25000	-237.41293	-210.01070	0.00000
43	ENVUSE MIN	0.50000	-237.41293	-182.11532	0.00000

35	ENVUSE MAX	0.00000	0.00000	90.75125	0.00000
35	ENVUSE MAX	0.25000	0.00000	109.07369	0.00000
35	ENVUSE MAX	0.50000	0.00000	131.36656	0.00000
35	ENVUSE MAX	0.75000	0.00000	152.36510	0.00000
FRAME	LOAD	DIST	P	V2	M3
44	ENVUSE MAX	0.75000	45.11634	21.54202	571.33818
44	ENVUSE MAX	1.00000	45.11634	45.98299	564.48843
44	ENVUSE MIN	0.00000	-237.41293	-126.32456	0.00000
44	ENVUSE MIN	0.25000	-237.41293	-98.42918	0.00000
44	ENVUSE MIN	0.50000	-237.41293	-70.72251	0.00000
44	ENVUSE MIN	0.75000	-237.41293	-45.76138	0.00000
44	ENVUSE MIN	1.00000	-237.41293	-20.80025	0.00000
45	ENVUSE MAX	0.00000	46.89492	45.98299	564.48843
45	ENVUSE MAX	0.25000	46.89492	70.40105	550.35302
45	ENVUSE MAX	0.50000	46.89492	96.49687	528.92895
45	ENVUSE MAX	0.75000	46.89492	123.84643	500.21623
45	ENVUSE MAX	1.00000	46.89492	151.19600	464.21484
45	ENVUSE MIN	0.00000	-237.41293	-21.75700	0.00000
45	ENVUSE MIN	0.25000	-237.41293	0.00000	0.00000
45	ENVUSE MIN	0.50000	-237.41293	0.00000	0.00000
45	ENVUSE MIN	0.75000	-237.41293	0.00000	0.00000
45	ENVUSE MIN	1.00000	-237.41293	0.00000	0.00000
46	ENVUSE MAX	0.00000	48.24455	151.19600	464.21484
46	ENVUSE MAX	0.25000	48.24455	178.57121	420.88077
46	ENVUSE MAX	0.50000	48.24455	205.94643	370.80800
46	ENVUSE MAX	0.75000	48.24455	233.32165	318.15548
46	ENVUSE MAX	1.00000	48.24455	260.69687	262.32858
46	ENVUSE MIN	0.00000	-237.41293	0.00000	0.00000
46	ENVUSE MIN	0.25000	-237.41293	0.00000	0.00000
46	ENVUSE MIN	0.50000	-237.41293	0.00000	0.00000
46	ENVUSE MIN	0.75000	-237.41293	0.00000	0.00000
46	ENVUSE MIN	1.00000	-237.41293	0.00000	0.00000
47	ENVUSE MAX	0.00000	49.20455	260.69687	262.32858
47	ENVUSE MAX	0.25000	49.20455	288.07209	199.19935
47	ENVUSE MAX	0.50000	49.20455	315.44731	128.76777
47	ENVUSE MAX	0.75000	49.20455	342.82253	51.03386
47	ENVUSE MAX	1.00000	49.20455	370.19775	0.00000
47	ENVUSE MIN	0.00000	-237.41293	0.00000	0.00000
47	ENVUSE MIN	0.25000	-237.41293	0.00000	-17.49041
47	ENVUSE MIN	0.50000	-237.41293	0.00000	-38.03748
47	ENVUSE MIN	0.75000	-237.41293	0.00000	-60.18556
47	ENVUSE MIN	1.00000	-237.41293	0.00000	-142.00693
48	ENVUSE MAX	0.00000	49.79026	370.19775	0.00000
48	ENVUSE MAX	0.25000	49.79026	397.54731	0.00000
48	ENVUSE MAX	0.50000	49.79026	424.93393	0.00000
48	ENVUSE MAX	0.75000	49.79026	452.80316	0.00000
48	ENVUSE MAX	1.00000	49.79026	480.67240	0.00000
48	ENVUSE MIN	0.00000	-237.41293	0.00000	-142.00693
48	ENVUSE MIN	0.25000	-237.41293	0.00000	-230.78020
48	ENVUSE MIN	0.50000	-237.41293	0.00000	-327.10139
48	ENVUSE MIN	0.75000	-237.41293	0.00000	-441.96450
48	ENVUSE MIN	1.00000	-237.41293	0.00000	-566.13250
49	ENVUSE MAX	0.00000	49.93026	480.67239	0.00000
49	ENVUSE MAX	0.25000	49.93026	488.95996	0.00000
49	ENVUSE MAX	0.50000	49.93026	497.24753	0.00000
49	ENVUSE MAX	0.75000	49.93026	505.53510	0.00000
49	ENVUSE MAX	1.00000	49.93026	513.82267	0.00000
49	ENVUSE MIN	0.00000	-237.41293	0.00000	-566.13250
49	ENVUSE MIN	0.25000	-237.41293	0.00000	-604.46276
49	ENVUSE MIN	0.50000	-237.41293	0.00000	-643.43755
49	ENVUSE MIN	0.75000	-237.41293	0.00000	-683.05689
49	ENVUSE MIN	1.00000	-237.41293	0.00000	-723.32078
50	ENVUSE MAX	0.00000	49.97046	513.82268	0.00000
50	ENVUSE MAX	0.22500	49.97046	525.58737	0.00000
50	ENVUSE MAX	0.45000	49.97046	537.35206	0.00000
50	ENVUSE MAX	0.67500	49.97046	549.11675	0.00000
50	ENVUSE MAX	0.90000	49.97046	560.88143	0.00000
50	ENVUSE MIN	0.00000	-237.41293	0.00000	-723.32078
50	ENVUSE MIN	0.22500	-237.41293	0.00000	-781.58461
50	ENVUSE MIN	0.45000	-237.41293	0.00000	-841.14730
50	ENVUSE MIN	0.67500	-237.41293	0.00000	-902.00883
50	ENVUSE MIN	0.90000	-237.41293	0.00000	-964.16921
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000

43	ENVUSE MIN	0.75000	-237.41293	-154.21994	0.00000
43	ENVUSE MIN	1.00000	-237.41293	-126.32456	0.00000
44	ENVUSE MAX	0.00000	45.11634	0.00000	548.07340
44	ENVUSE MAX	0.25000	45.11634	2.02652	563.13066
44	ENVUSE MAX	0.50000	45.11634	8.02840	570.88559
FRAME	LOAD	DIST	P	V2	M3
53	ENVUSE MAX	0.55000	48.29557	0.00000	0.00000
53	ENVUSE MAX	0.77500	48.29557	0.00000	0.00000
53	ENVUSE MAX	1.00000	48.29557	0.00000	0.00000
53	ENVUSE MIN	0.10000	-237.41293	-561.22721	-965.71527
53	ENVUSE MIN	0.32500	-237.41293	-549.46252	-903.42671
53	ENVUSE MIN	0.55000	-237.41293	-537.69784	-842.43699
53	ENVUSE MIN	0.77500	-237.41293	-525.93315	-782.74613
53	ENVUSE MIN	1.00000	-237.41293	-514.16846	-724.35411
54	ENVUSE MAX	0.00000	48.25789	0.00000	0.00000
54	ENVUSE MAX	0.25000	48.25789	0.00000	0.00000
54	ENVUSE MAX	0.50000	48.25789	0.00000	0.00000
54	ENVUSE MAX	0.75000	48.25789	0.00000	0.00000
54	ENVUSE MAX	1.00000	48.25789	0.00000	0.00000
54	ENVUSE MIN	0.00000	-237.41293	-514.16845	-724.35411
54	ENVUSE MIN	0.25000	-237.41293	-505.88088	-683.99993
54	ENVUSE MIN	0.50000	-237.41293	-497.59331	-644.29029
54	ENVUSE MIN	0.75000	-237.41293	-489.30574	-605.22520
54	ENVUSE MIN	1.00000	-237.41293	-481.01817	-566.80464
55	ENVUSE MAX	0.00000	48.12453	0.00000	0.00000
55	ENVUSE MAX	0.25000	48.12453	0.00000	0.00000
55	ENVUSE MAX	0.50000	48.12453	0.00000	0.00000
55	ENVUSE MAX	0.75000	48.12453	0.00000	0.00000
55	ENVUSE MAX	1.00000	48.12453	0.00000	0.00000
55	ENVUSE MIN	0.00000	-237.41293	-481.01818	-566.80464
55	ENVUSE MIN	0.25000	-237.41293	-453.38583	-442.33299
55	ENVUSE MIN	0.50000	-237.41293	-426.03627	-327.16045
55	ENVUSE MIN	0.75000	-237.41293	-398.68671	-230.56269
55	ENVUSE MIN	1.00000	-237.41293	-371.33715	-141.51284
56	ENVUSE MAX	0.00000	47.55199	0.00000	0.00000
56	ENVUSE MAX	0.25000	47.55199	0.00000	50.26293
56	ENVUSE MAX	0.50000	47.55199	0.00000	127.72001
56	ENVUSE MAX	0.75000	47.55199	0.00000	197.87475
56	ENVUSE MAX	1.00000	47.55199	0.00000	260.72716
56	ENVUSE MIN	0.00000	-237.41293	-371.33715	-141.51284
56	ENVUSE MIN	0.25000	-237.41293	-343.96193	-60.18556
56	ENVUSE MIN	0.50000	-237.41293	-316.58671	-38.03748
56	ENVUSE MIN	0.75000	-237.41293	-289.21149	-17.49041
56	ENVUSE MIN	1.00000	-237.41293	-261.83627	0.00000
57	ENVUSE MAX	0.00000	46.60675	0.00000	260.72716
57	ENVUSE MAX	0.25000	46.60675	0.00000	316.27722
57	ENVUSE MAX	0.50000	46.60675	0.00000	372.82141
57	ENVUSE MAX	0.75000	46.60675	0.00000	423.78886
57	ENVUSE MAX	1.00000	46.60675	0.00000	467.45397
57	ENVUSE MIN	0.00000	-237.41293	-261.83627	0.00000
57	ENVUSE MIN	0.25000	-237.41293	-234.46105	0.00000
57	ENVUSE MIN	0.50000	-237.41293	-207.08583	0.00000
57	ENVUSE MIN	0.75000	-237.41293	-179.71062	0.00000
57	ENVUSE MIN	1.00000	-237.41293	-152.33540	0.00000
58	ENVUSE MAX	0.00000	45.26824	0.00000	467.45397
58	ENVUSE MAX	0.25000	45.26824	0.00000	503.78608
58	ENVUSE MAX	0.50000	45.26824	0.00000	532.82953
58	ENVUSE MAX	0.75000	45.26824	0.00000	554.58432
58	ENVUSE MAX	1.00000	45.26824	22.33774	569.05046
58	ENVUSE MIN	0.00000	-237.41292	-152.33540	0.00000
58	ENVUSE MIN	0.25000	-237.41292	-124.98583	0.00000
58	ENVUSE MIN	0.50000	-237.41292	-97.63627	0.00000
58	ENVUSE MIN	0.75000	-237.41292	-71.43886	0.00000
58	ENVUSE MIN	1.00000	-237.41292	-47.02079	0.00000
59	ENVUSE MAX	0.00000	43.49800	21.49181	569.05046
59	ENVUSE MAX	0.25000	43.49800	46.45294	576.23124
59	ENVUSE MAX	0.50000	43.49800	71.41407	576.10969
59	ENVUSE MAX	0.75000	43.49800	99.01914	568.68580
59	ENVUSE MAX	1.00000	43.49800	126.91452	553.95957
59	ENVUSE MIN	0.00000	-237.41293	-47.02079	0.00000
59	ENVUSE MIN	0.25000	-237.41293	-22.57983	0.00000
59	ENVUSE MIN	0.50000	-237.41293	-8.02840	0.00000
59	ENVUSE MIN	0.75000	-237.41293	-2.02652	0.00000
59	ENVUSE MIN	1.00000	-237.41293	0.00000	0.00000
60	ENVUSE MAX	0.00000	41.20974	126.91452	553.95957
60	ENVUSE MAX	0.25000	41.20974	154.80990	531.93100
60	ENVUSE MAX	0.50000	41.20974	182.70528	502.60009
60	ENVUSE MAX	0.75000	41.20974	210.60066	465.96684
60	ENVUSE MAX	1.00000	41.20974	238.49604	422.03125
60	ENVUSE MIN	0.00000	-237.41293	0.00000	0.00000
60	ENVUSE MIN	0.25000	-237.41293	0.00000	0.00000
60	ENVUSE MIN	0.50000	-237.41293	0.00000	0.00000
60	ENVUSE MIN	0.75000	-237.41293	0.00000	0.00000
60	ENVUSE MIN	1.00000	-237.41293	0.00000	0.00000
61	ENVUSE MAX	0.00000	38.26326	238.49605	422.03125
61	ENVUSE MAX	0.25000	38.26326	266.36528	370.84476
61	ENVUSE MAX	0.50000	38.26326	294.23452	312.36961
61	ENVUSE MAX	0.75000	38.26326	322.10376	246.60580
61	ENVUSE MAX	1.00000	38.26326	349.97300	173.55334
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
53	ENVUSE MAX	0.10000	48.29557	0.00000	0.00000
53	ENVUSE MAX	0.32500	48.29557	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
62	ENVUSE MAX	0.25000	36.13787	353.03179	165.09150
62	ENVUSE MAX	0.50000	36.13787	356.09061	156.54185
62	ENVUSE MAX	0.75000	36.13787	359.14943	147.90441
62	ENVUSE MAX	1.00000	36.13787	362.20825	139.17916
62	ENVUSE MIN	0.00000	-237.41293	0.00000	-197.97653
62	ENVUSE MIN	0.25000	-237.41293	0.00000	-207.40381
62	ENVUSE MIN	0.50000	-237.41293	0.00000	-216.91115
62	ENVUSE MIN	0.75000	-237.41293	0.00000	-226.49856
62	ENVUSE MIN	1.00000	-237.41293	0.00000	-236.16602
63	ENVUSE MAX	0.00000	35.12192	362.20826	139.17916
63	ENVUSE MAX	0.22500	35.12192	374.14873	109.20746
63	ENVUSE MAX	0.45000	35.12192	386.44076	78.52070
63	ENVUSE MAX	0.67500	35.12192	399.08436	47.20924
63	ENVUSE MAX	0.90000	35.12192	412.07951	15.18706
63	ENVUSE MIN	0.00000	-237.41294	0.00000	-236.16602
63	ENVUSE MIN	0.22500	-237.41294	0.00000	-274.10127
63	ENVUSE MIN	0.45000	-237.41294	0.00000	-313.26038
63	ENVUSE MIN	0.67500	-237.41294	0.00000	-353.68291
63	ENVUSE MIN	0.90000	-237.41294	0.00000	-395.40839
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
66	ENVUSE MAX	0.10000	0.00000	23.29010	0.00000
66	ENVUSE MAX	0.32500	0.00000	23.29010	0.00000
66	ENVUSE MAX	0.55000	0.00000	23.29010	0.00000
66	ENVUSE MAX	0.77500	0.00000	23.29010	0.00000
66	ENVUSE MAX	1.00000	0.00000	23.29010	0.00000
66	ENVUSE MIN	0.10000	-488.11705	-212.10240	-539.36994
66	ENVUSE MIN	0.32500	-491.87877	-205.84811	-530.80788
66	ENVUSE MIN	0.55000	-495.28893	-199.40396	-522.30911
66	ENVUSE MIN	0.77500	-498.34752	-192.76998	-513.87361
66	ENVUSE MIN	1.00000	-501.05455	-185.94615	-505.50140
67	ENVUSE MAX	0.00000	0.00000	22.23356	0.00000
67	ENVUSE MAX	0.25000	0.00000	22.23356	0.00000
67	ENVUSE MAX	0.50000	0.00000	22.23356	0.00000
67	ENVUSE MAX	0.75000	0.00000	22.23356	0.00000
67	ENVUSE MAX	1.00000	0.00000	22.24760	0.00000
67	ENVUSE MIN	0.00000	-501.05453	-185.98693	-505.50140
67	ENVUSE MIN	0.25000	-502.32016	-182.50383	-501.33902
67	ENVUSE MIN	0.50000	-503.58578	-178.97326	-497.19247
67	ENVUSE MIN	0.75000	-504.85141	-175.39523	-493.06173
67	ENVUSE MIN	1.00000	-506.11703	-171.76975	-488.94682
68	ENVUSE MAX	0.00000	0.00000	22.23356	0.00000
68	ENVUSE MAX	0.25000	0.00000	26.45385	0.00000
68	ENVUSE MAX	0.50000	0.00000	33.66890	0.00000
68	ENVUSE MAX	0.75000	0.00000	41.29380	0.00000
68	ENVUSE MAX	1.00000	0.00000	53.26922	0.00000
68	ENVUSE MIN	0.00000	-506.11701	-171.85367	-488.94682
68	ENVUSE MIN	0.25000	-512.72639	-152.14947	-467.71484
68	ENVUSE MIN	0.50000	-519.33576	-131.15094	-446.91432
68	ENVUSE MIN	0.75000	-525.94514	-108.85807	-426.93933
68	ENVUSE MIN	1.00000	-532.55451	-92.64866	-408.50478
69	ENVUSE MAX	0.00000	0.00000	53.26922	0.00000
69	ENVUSE MAX	0.25000	0.00000	71.77411	0.00000
69	ENVUSE MAX	0.50000	0.00000	91.09878	0.00000
69	ENVUSE MAX	0.75000	0.00000	111.24324	0.00000
69	ENVUSE MAX	1.00000	0.00000	134.64443	0.00000
69	ENVUSE MIN	0.00000	-532.55451	-92.64867	-408.50478
69	ENVUSE MIN	0.25000	-539.16389	-78.11722	-390.54483
69	ENVUSE MIN	0.50000	-545.77326	-70.92686	-376.33936
69	ENVUSE MIN	0.75000	-552.38264	-70.92686	-381.16943
69	ENVUSE MIN	1.00000	-558.99201	-70.92686	-386.23679
70	ENVUSE MAX	0.00000	0.00000	134.64443	0.00000
70	ENVUSE MAX	0.25000	0.00000	166.31894	0.00000
70	ENVUSE MAX	0.50000	0.00000	199.28779	0.00000
70	ENVUSE MAX	0.75000	0.00000	233.55098	0.00000

61	ENVUSE MIN	0.00000	-237.41293	0.00000	0.00000
61	ENVUSE MIN	0.25000	-237.41293	0.00000	0.00000
61	ENVUSE MIN	0.50000	-237.41293	0.00000	-40.21169
61	ENVUSE MIN	0.75000	-237.41293	0.00000	-115.77115
61	ENVUSE MIN	1.00000	-237.41293	0.00000	-197.97653
62	ENVUSE MAX	0.00000	36.13787	349.97297	173.55334
FRAME	LOAD	DIST	P	V2	M3
71	ENVUSE MAX	0.00000	0.00000	269.10850	0.00000
71	ENVUSE MAX	0.25000	0.00000	288.54942	0.00000
71	ENVUSE MAX	0.50000	0.00000	308.35655	0.00000
71	ENVUSE MAX	0.75000	0.00000	328.52989	0.00000
71	ENVUSE MAX	1.00000	0.00000	349.06944	0.00000
71	ENVUSE MIN	0.00000	-585.42951	-70.92686	-486.79307
71	ENVUSE MIN	0.25000	-588.94514	-70.92686	-522.86448
71	ENVUSE MIN	0.50000	-592.46076	-70.92686	-561.02107
71	ENVUSE MIN	0.75000	-595.97639	-70.92686	-601.29910
71	ENVUSE MIN	1.00000	-599.49201	-70.92686	-654.13676
72	ENVUSE MAX	0.00000	0.00000	349.06943	0.00000
72	ENVUSE MAX	0.10227	0.00000	356.55331	0.00000
72	ENVUSE MAX	0.20455	0.00000	364.08466	0.00000
72	ENVUSE MAX	0.30682	0.00000	371.66347	0.00000
72	ENVUSE MAX	0.40909	0.00000	379.28974	0.00000
72	ENVUSE MIN	0.00000	-599.49202	-70.92686	-654.13676
72	ENVUSE MIN	0.10227	-600.75765	-70.92686	-673.98217
72	ENVUSE MIN	0.20455	-602.02327	-70.92686	-694.24989
72	ENVUSE MIN	0.30682	-603.28890	-70.92686	-714.94259
72	ENVUSE MIN	0.40909	-604.55452	-70.92686	-736.06292
73	ENVUSE MAX	0.11915	0.00000	54.97840	131.38289
73	ENVUSE MAX	0.32128	0.00000	54.97840	66.09604
73	ENVUSE MAX	0.52340	0.00000	54.97840	9.25456
73	ENVUSE MAX	0.72553	0.00000	54.97840	64.47765
73	ENVUSE MAX	0.92766	0.00000	54.97840	129.76450
73	ENVUSE MIN	0.11915	-1182.54000	-54.97840	-131.38289
73	ENVUSE MIN	0.32128	-1197.38400	-54.97840	-66.09604
73	ENVUSE MIN	0.52340	-1212.22800	-54.97840	-9.25456
73	ENVUSE MIN	0.72553	-1227.07100	-54.97840	-64.47765
73	ENVUSE MIN	0.92766	-1241.91500	-54.97840	-129.76450
70	ENVUSE MAX	1.00000	0.00000	269.10850	0.00000
70	ENVUSE MIN	0.00000	-558.99203	-70.92686	-386.23679
70	ENVUSE MIN	0.25000	-565.60140	-70.92686	-391.54144
70	ENVUSE MIN	0.50000	-572.21078	-70.92686	-397.21526
70	ENVUSE MIN	0.75000	-578.82015	-70.92686	-430.83018
70	ENVUSE MIN	1.00000	-585.42953	-70.92686	-486.79307

19. OUTPUT DATA (기능수행)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.38889	101.21120	0.00000	268.48262
1	ENVEQ MAX	0.54167	100.28940	0.00000	269.69689
1	ENVEQ MAX	0.69444	99.36760	0.00000	271.06714
1	ENVEQ MAX	0.84722	98.44580	0.00000	272.59336
1	ENVEQ MAX	1.00000	97.52400	0.00000	274.27556
1	ENVEQ MIN	0.38889	-295.96731	-189.08072	-382.27826
1	ENVEQ MIN	0.54167	-295.04551	-191.34947	-371.07852
1	ENVEQ MIN	0.69444	-294.12371	-193.61822	-361.03453
1	ENVEQ MIN	0.84722	-293.20191	-195.88697	-350.87357
1	ENVEQ MIN	1.00000	-292.28011	-198.15572	-340.59562
2	ENVEQ MAX	0.00000	97.52403	0.00000	274.27556
2	ENVEQ MAX	0.25000	95.45584	0.00000	278.61736
2	ENVEQ MAX	0.50000	93.38766	0.00000	286.60502
2	ENVEQ MAX	0.75000	91.31947	0.00000	303.40709
2	ENVEQ MAX	1.00000	89.25129	0.00000	320.99433
2	ENVEQ MIN	0.00000	-292.28011	-198.15559	-340.59562
2	ENVEQ MIN	0.25000	-290.21192	-203.24584	-317.10998
2	ENVEQ MIN	0.50000	-288.14374	-208.33609	-293.03545
2	ENVEQ MIN	0.75000	-286.07555	-213.42634	-268.37205
2	ENVEQ MIN	1.00000	-284.00737	-218.51659	-243.11977
3	ENVEQ MAX	0.00000	87.97541	20.83205	320.99433
3	ENVEQ MAX	0.25000	86.35639	17.84349	325.16812
3	ENVEQ MAX	0.50000	84.73737	14.85493	329.82307
3	ENVEQ MAX	0.75000	83.11836	11.86636	334.95918
3	ENVEQ MAX	1.00000	81.49934	8.87780	340.57645
3	ENVEQ MIN	0.00000	-281.68989	-134.56106	-243.11977
3	ENVEQ MIN	0.25000	-280.07088	-138.54581	-230.03314
3	ENVEQ MIN	0.50000	-278.45186	-142.53056	-216.78301
3	ENVEQ MIN	0.75000	-276.83284	-146.51531	-203.17202
3	ENVEQ MIN	1.00000	-275.21383	-150.50006	-189.20016
4	ENVEQ MAX	0.00000	81.49936	9.21916	340.57645
4	ENVEQ MAX	0.25000	80.49376	7.78478	344.28657
4	ENVEQ MAX	0.50000	79.48816	6.35041	348.14014
4	ENVEQ MAX	0.75000	78.48256	4.91603	352.13714
4	ENVEQ MAX	1.00000	77.47696	3.48166	356.27758
4	ENVEQ MIN	0.00000	-275.21383	-150.50000	-189.20006
4	ENVEQ MIN	0.25000	-274.20823	-152.41250	-180.39792
4	ENVEQ MIN	0.50000	-273.20263	-154.32500	-171.48821
4	ENVEQ MIN	0.75000	-272.19703	-156.23750	-162.47092
4	ENVEQ MIN	1.00000	-271.19143	-158.15000	-153.34605
5	ENVEQ MAX	0.00000	77.47697	3.72291	356.27758
5	ENVEQ MAX	0.25000	76.52836	1.97185	360.33364
5	ENVEQ MAX	0.50000	75.57974	0.22078	364.55488
5	ENVEQ MAX	0.75000	74.63113	0.00000	368.94130
5	ENVEQ MAX	1.00000	73.68251	0.00000	373.49291
5	ENVEQ MIN	0.00000	-271.19143	-158.14995	-153.34617
5	ENVEQ MIN	0.25000	-270.24281	-160.48470	-144.65405
5	ENVEQ MIN	0.50000	-269.29420	-162.81945	-135.83805
5	ENVEQ MIN	0.75000	-268.34558	-165.15420	-126.89815
5	ENVEQ MIN	1.00000	-267.39696	-167.48895	-117.83437
6	ENVEQ MAX	0.00000	72.42141	40.92525	373.49291
6	ENVEQ MAX	0.25000	68.84483	32.12250	370.48749
6	ENVEQ MAX	0.50000	65.26825	24.71791	369.83019
6	ENVEQ MAX	0.75000	61.69166	18.11585	371.52103
6	ENVEQ MAX	1.00000	58.11508	11.51378	375.56001
6	ENVEQ MIN	0.00000	-265.12975	-82.62094	-117.83427
6	ENVEQ MIN	0.25000	-261.55316	-91.42369	-97.93683
6	ENVEQ MIN	0.50000	-257.97658	-100.22644	-79.85802
6	ENVEQ MIN	0.75000	-254.40000	-109.02919	-63.01527
6	ENVEQ MIN	1.00000	-250.82341	-117.83194	-44.41141
7	ENVEQ MAX	0.00000	56.86505	63.99844	375.56001
7	ENVEQ MAX	0.25000	53.28847	55.19569	360.41231
7	ENVEQ MAX	0.50000	49.71189	46.39294	347.61274
7	ENVEQ MAX	0.75000	46.13530	37.59019	337.16130
7	ENVEQ MAX	1.00000	42.55872	28.78744	329.05800
7	ENVEQ MIN	0.00000	-248.59987	-38.64757	-44.41142
7	ENVEQ MIN	0.25000	-245.02328	-45.24963	-36.54188
7	ENVEQ MIN	0.50000	-241.44670	-51.85169	-26.91124
7	ENVEQ MIN	0.75000	-237.87012	-58.76676	-15.51949
7	ENVEQ MIN	1.00000	-234.29353	-67.56951	-2.36665
8	ENVEQ MAX	0.00000	41.31711	108.29062	329.05800
8	ENVEQ MAX	0.25000	37.74388	99.49612	301.37041
8	ENVEQ MAX	0.50000	34.17064	90.70162	276.02657
8	ENVEQ MAX	0.75000	30.59741	81.90712	253.02645
8	ENVEQ MAX	1.00000	27.02418	73.11262	232.37007
8	ENVEQ MIN	0.00000	-232.11086	-5.19405	-2.36666
8	ENVEQ MIN	0.25000	-228.53763	-11.78993	-0.10354
8	ENVEQ MIN	0.50000	-224.96440	-18.38580	0.00000
8	ENVEQ MIN	0.75000	-221.39117	-24.98168	0.00000
8	ENVEQ MIN	1.00000	-217.81794	-31.57755	0.00000
9	ENVEQ MAX	0.00000	25.78835	158.78037	232.37007
9	ENVEQ MAX	0.25000	22.21177	149.97762	192.32382
9	ENVEQ MAX	0.50000	18.63518	141.17487	155.90866
9	ENVEQ MAX	0.75000	15.05860	132.37212	121.84164
9	ENVEQ MAX	1.00000	11.48202	123.56937	90.12274
9	ENVEQ MIN	0.00000	-215.67332	0.00000	0.00000
9	ENVEQ MIN	0.25000	-212.09673	0.00000	0.00000
9	ENVEQ MIN	0.50000	-208.52015	0.00000	0.00000
9	ENVEQ MIN	0.75000	-204.94357	-3.39364	0.00000
9	ENVEQ MIN	1.00000	-201.36698	-9.99570	0.00000
10	ENVEQ MAX	0.00000	10.24934	213.84877	90.12274
10	ENVEQ MAX	0.25000	6.67276	205.04602	39.14612
10	ENVEQ MAX	0.50000	3.09617	196.24327	3.83839
10	ENVEQ MAX	0.75000	0.00000	187.44052	0.00000
10	ENVEQ MAX	1.00000	0.00000	178.63777	0.00000
10	ENVEQ MIN	0.00000	-199.25766	0.00000	0.00000
10	ENVEQ MIN	0.25000	-195.68108	0.00000	-4.84555
10	ENVEQ MIN	0.50000	-192.10450	0.00000	-38.10827
10	ENVEQ MIN	0.75000	-188.52791	0.00000	-85.41764
10	ENVEQ MIN	1.00000	-184.95133	0.00000	-130.37888
11	ENVEQ MAX	0.00000	0.00000	273.97698	0.00000
11	ENVEQ MAX	0.25000	0.00000	265.18248	0.00000
11	ENVEQ MAX	0.50000	2.50875	256.38798	0.00000
11	ENVEQ MAX	0.75000	6.08198	247.59348	0.00000
11	ENVEQ MAX	1.00000	9.65522	238.79898	0.00000
11	ENVEQ MIN	0.00000	-184.62576	0.00000	-130.37888
11	ENVEQ MIN	0.25000	-188.19899	0.00000	-199.49809
11	ENVEQ MIN	0.50000	-191.77222	0.00000	-268.99735
11	ENVEQ MIN	0.75000	-195.34546	0.00000	-336.15288
11	ENVEQ MIN	1.00000	-198.91869	0.00000	-400.96468
12	ENVEQ MAX	0.00000	11.23434	338.51971	0.00000
12	ENVEQ MAX	0.25000	11.79412	337.14196	0.00000
12	ENVEQ MAX	0.50000	12.35391	335.76421	0.00000
12	ENVEQ MAX	0.75000	12.91369	334.38646	0.00000
12	ENVEQ MAX	1.00000	13.47347	333.00871	0.00000
12	ENVEQ MIN	0.00000	-200.90356	0.00000	-400.96468
12	ENVEQ MIN	0.25000	-201.46334	0.00000	-415.06912
12	ENVEQ MIN	0.50000	-202.02312	0.00000	-429.11603
12	ENVEQ MIN	0.75000	-202.58291	0.00000	-443.10543
12	ENVEQ MIN	1.00000	-203.14269	0.00000	-457.03730
13	ENVEQ MAX	0.00000	13.47346	333.00880	0.00000
13	ENVEQ MAX	0.25000	14.47906	330.53380	0.00000
13	ENVEQ MAX	0.50000	15.48466	328.05880	0.00000
13	ENVEQ MAX	0.75000	16.49026	325.58380	0.00000
13	ENVEQ MAX	1.00000	17.49586	323.10880	0.00000
13	ENVEQ MIN	0.00000	-203.14269	0.00000	-457.03730
13	ENVEQ MIN	0.25000	-204.14829	0.00000	-481.92015
13	ENVEQ MIN	0.50000	-205.15389	0.00000	-506.61737
13	ENVEQ MIN	0.75000	-206.15949	0.00000	-531.12897
13	ENVEQ MIN	1.00000	-207.16509	0.00000	-555.45494
14	ENVEQ MAX	0.00000	17.49584	323.10893	0.00000
14	ENVEQ MAX	0.25000	18.66904	320.22143	0.00000
14	ENVEQ MAX	0.50000	19.84224	317.33393	0.00000
14	ENVEQ MAX	0.75000	21.01544	314.44643	0.00000
14	ENVEQ MAX	1.00000	22.18864	311.55893	0.00000
14	ENVEQ MIN	0.00000	-207.16509	0.00000	-555.45494
14	ENVEQ MIN	0.25000	-208.33829	0.00000	-583.60065
14	ENVEQ MIN	0.50000	-209.51149	0.00000	-611.49369
14	ENVEQ MIN	0.75000	-210.68469	0.00000	-639.13409
14	ENVEQ MIN	1.00000	-211.85789	0.00000	-666.52182
15	ENVEQ MAX	0.00000	22.18862	311.55906	0.00000
15	ENVEQ MAX	0.25000	23.02662	309.49656	0.00000
15	ENVEQ MAX	0.50000	23.86462	307.43406	0.00000
15	ENVEQ MAX	0.75000	24.70262	305.37156	0.00000
15	ENVEQ MAX	1.00000	25.54062	303.30906	0.00000
15	ENVEQ MIN	0.00000	-211.85789	0.00000	-666.52182
15	ENVEQ MIN	0.25000	-212.69589	0.00000	-685.92981
15	ENVEQ MIN	0.50000	-213.53389	0.00000	-705.20889
15	ENVEQ MIN	0.75000	-214.37189	0.00000	-724.35907
15	ENVEQ MIN	1.00000	-215.20989	0.00000	-743.38033
16	ENVEQ MAX	0.00000	25.54062	0.00000	0.00000
16	ENVEQ MAX	0.25000	24.70262	0.00000	0.00000
16	ENVEQ MAX	0.50000	23.86462	0.00000	0.00000
16	ENVEQ MAX	0.75000	23.02662	0.00000	0.00000
16	ENVEQ MAX	1.00000	22.18862	0.00000	0.00000
16	ENVEQ MIN	0.00000	-215.20989	-303.30906	-743.38033
16	ENVEQ MIN	0.25000	-214.37189	-305.37156	-724.35907
16	ENVEQ MIN	0.50000	-213.53389	-307.43406	-705.20889
16	ENVEQ MIN	0.75000	-212.69589	-309.49656	-685.92981
16	ENVEQ MIN	1.00000	-211.85789	-311.55906	-666.52182
17	ENVEQ MAX	0.00000	22.18864	0.00000	0.00000
17	ENVEQ MAX	0.25000	21.01544	0.00000	0.00000
17	ENVEQ MAX	0.50000	19.84224	0.00000	0.00000
17	ENVEQ MAX	0.75000	18.66904	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	17.49584	0.00000	0.00000
17	ENVEQ MIN	0.00000	-211.85789	-311.55893	-666.52182
17	ENVEQ MIN	0.25000	-210.68469	-314.44643	-639.13409
17	ENVEQ MIN	0.50000	-209.51149	-317.33393	-611.49369
17	ENVEQ MIN	0.75000	-208.33829	-320.22143	-583.60065
17	ENVEQ MIN	1.00000	-207.16509	-323.10893	-555.45494
18	ENVEQ MAX	0.00000	17.49586	0.00000	0.00000
18	ENVEQ MAX	0.25000	16.49026	0.00000	0.00000
18	ENVEQ MAX	0.50000	15.48466	0.00000	0.00000
18	ENVEQ MAX	0.75000	14.47906	0.00000	0.00000
18	ENVEQ MAX	1.00000	13.47346	0.00000	0.00000
18	ENVEQ MIN	0.00000	-207.16509	-323.10880	-555.45494
18	ENVEQ MIN	0.25000	-206.15949	-325.58380	-531.12897
18	ENVEQ MIN	0.50000	-205.15389	-328.05880	-506.61737
18	ENVEQ MIN	0.75000	-204.14829	-330.53380	-481.92015
18	ENVEQ MIN	1.00000	-203.14269	-333.00880	-457.03730
19	ENVEQ MAX	0.00000	13.47347	0.00000	0.00000
19	ENVEQ MAX	0.25000	12.91369	0.00000	0.00000
19	ENVEQ MAX	0.50000	12.35391	0.00000	0.00000
19	ENVEQ MAX	0.75000	11.79412	0.00000	0.00000
19	ENVEQ MAX	1.00000	11.23434	0.00000	0.00000
19	ENVEQ MIN	0.00000	-203.14269	-333.00871	-457.03730
19	ENVEQ MIN	0.25000	-202.58291	-334.38646	-443.10543
19	ENVEQ MIN	0.50000	-202.02312	-335.76421	-429.11603
19	ENVEQ MIN	0.75000	-201.46334	-337.14196	-415.06912
19	ENVEQ MIN	1.00000	-200.90356	-338.51971	-400.96468
20	ENVEQ MAX	0.00000	9.65522	0.00000	0.00000
20	ENVEQ MAX	0.25000	6.08198	0.00000	0.00000
20	ENVEQ MAX	0.50000	2.50875	0.00000	0.00000
20	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
20	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
20	ENVEQ MIN	0.00000	-198.91869	-238.79898	-400.96468
20	ENVEQ MIN	0.25000	-195.34546	-247.59348	-336.15288
20	ENVEQ MIN	0.50000	-191.77222	-256.38798	-268.99735
20	ENVEQ MIN	0.75000	-188.19899	-265.18248	-199.49809
20	ENVEQ MIN	1.00000	-184.62576	-273.97698	-130.37888
21	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
21	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
21	ENVEQ MAX	0.50000	3.09617	0.00000	3.83840
21	ENVEQ MAX	0.75000	6.67276	0.00000	39.14612
21	ENVEQ MAX	1.00000	10.24934	0.00000	90.12274
21	ENVEQ MIN	0.00000	-184.95133	-178.63777	-130.37888
21	ENVEQ MIN	0.25000	-188.52791	-187.44052	-85.41764
21	ENVEQ MIN	0.50000	-192.10450	-196.24327	-38.10827
21	ENVEQ MIN	0.75000	-195.68108	-205.04602	-4.84555
21	ENVEQ MIN	1.00000	-199.25766	-213.84877	0.00000
22	ENVEQ MAX	0.00000	11.48202	9.99569	90.12274
22	ENVEQ MAX	0.25000	15.05860	3.39363	121.84164
22	ENVEQ MAX	0.50000	18.63518	0.00000	155.90866
22	ENVEQ MAX	0.75000	22.21177	0.00000	192.32382
22	ENVEQ MAX	1.00000	25.78835	0.00000	232.37007
22	ENVEQ MIN	0.00000	-201.36698	-123.56937	0.00000
22	ENVEQ MIN	0.25000	-204.94357	-132.37212	0.00000
22	ENVEQ MIN	0.50000	-208.52015	-141.17487	0.00000
22	ENVEQ MIN	0.75000	-212.09673	-149.97762	0.00000
22	ENVEQ MIN	1.00000	-215.67332	-158.78037	0.00000
23	ENVEQ MAX	0.00000	27.02418	31.57755	232.37007
23	ENVEQ MAX	0.25000	30.59741	24.98167	253.02645
23	ENVEQ MAX	0.50000	34.17064	18.38580	276.02657
23	ENVEQ MAX	0.75000	37.74388	11.78992	301.37041
23	ENVEQ MAX	1.00000	41.31711	5.19405	329.05800
23	ENVEQ MIN	0.00000	-217.81794	-73.11262	0.00000
23	ENVEQ MIN	0.25000	-221.39117	-81.90712	0.00000
23	ENVEQ MIN	0.50000	-224.96440	-90.70162	0.00000
23	ENVEQ MIN	0.75000	-228.53763	-99.49612	-0.10354
23	ENVEQ MIN	1.00000	-232.11086	-108.29062	-2.36665
24	ENVEQ MAX	0.00000	42.55872	67.56950	329.05800
24	ENVEQ MAX	0.25000	46.13530	58.76675	337.16130
24	ENVEQ MAX	0.50000	49.71189	51.85169	347.61274
24	ENVEQ MAX	0.75000	53.28847	45.24963	360.41231
24	ENVEQ MAX	1.00000	56.86505	38.64757	375.56001
24	ENVEQ MIN	0.00000	-234.29353	-28.78744	-2.36666
24	ENVEQ MIN	0.25000	-237.87012	-37.59019	-15.51950
24	ENVEQ MIN	0.50000	-241.44670	-46.39294	-26.91124
24	ENVEQ MIN	0.75000	-245.02328	-55.19569	-36.54188
24	ENVEQ MIN	1.00000	-248.59987	-63.99844	-44.41142
25	ENVEQ MAX	0.00000	58.11508	117.83194	375.56001
25	ENVEQ MAX	0.25000	61.69166	109.02919	371.52103
25	ENVEQ MAX	0.50000	65.26825	100.22644	369.83019
25	ENVEQ MAX	0.75000	68.84483	91.42369	370.48749
25	ENVEQ MAX	1.00000	72.42141	82.62094	373.49291
25	ENVEQ MIN	0.00000	-250.82341	-11.51378	-44.41142
25	ENVEQ MIN	0.25000	-254.40000	-18.11584	-63.01528
25	ENVEQ MIN	0.50000	-257.97658	-24.71791	-79.85803
25	ENVEQ MIN	0.75000	-261.55316	-32.12250	-97.93685
25	ENVEQ MIN	1.00000	-265.12975	-40.92525	-117.83429
26	ENVEQ MAX	0.00000	73.68251	167.48895	373.49291
26	ENVEQ MAX	0.25000	74.63113	165.15420	368.94130
26	ENVEQ MAX	0.75000	76.52836	160.48470	360.33364
26	ENVEQ MAX	1.00000	77.47697	158.14995	356.27758
26	ENVEQ MIN	0.00000	-267.39696	0.00000	-117.83427
26	ENVEQ MIN	0.25000	-268.34558	0.00000	-126.89805
26	ENVEQ MIN	0.50000	-269.29420	-0.22075	-135.83794
26	ENVEQ MIN	0.75000	-270.24281	-1.97181	-144.65395
26	ENVEQ MIN	1.00000	-271.19143	-3.72287	-153.34607
27	ENVEQ MAX	0.00000	77.47696	158.15000	356.27758
27	ENVEQ MAX	0.25000	78.48256	156.23750	352.13714
27	ENVEQ MAX	0.50000	79.48816	154.32500	348.14014
27	ENVEQ MAX	0.75000	80.49376	152.41250	344.28657
27	ENVEQ MAX	1.00000	81.49936	150.50000	340.57645
27	ENVEQ MIN	0.00000	-271.19143	-3.48167	-153.34613
27	ENVEQ MIN	0.25000	-272.19703	-4.91604	-162.47100
27	ENVEQ MIN	0.50000	-273.20263	-6.35042	-171.48829
27	ENVEQ MIN	0.75000	-274.20823	-7.78479	-180.39801
27	ENVEQ MIN	1.00000	-275.21383	-9.21917	-189.20014
28	ENVEQ MAX	0.00000	81.49934	150.50006	340.57645
28	ENVEQ MAX	0.25000	83.11836	146.51531	334.95918
28	ENVEQ MAX	0.50000	84.73737	142.53056	329.82307
28	ENVEQ MAX	0.75000	86.35639	138.54581	325.16812
28	ENVEQ MAX	1.00000	87.97541	134.56106	320.99433
28	ENVEQ MIN	0.00000	-275.21383	-8.87787	-189.20008
28	ENVEQ MIN	0.25000	-276.83284	-11.86643	-203.17195
28	ENVEQ MIN	0.50000	-278.45186	-14.85499	-216.78295
28	ENVEQ MIN	0.75000	-280.07088	-17.84356	-230.03308
28	ENVEQ MIN	1.00000	-281.68989	-20.83212	-243.11977
29	ENVEQ MAX	0.00000	89.25129	218.51659	320.99433
29	ENVEQ MAX	0.25000	91.31947	213.42634	303.40709
29	ENVEQ MAX	0.50000	93.38766	208.33609	286.60502
29	ENVEQ MAX	0.75000	95.45584	203.24584	278.61736
29	ENVEQ MAX	1.00000	97.52403	198.15559	274.27556
29	ENVEQ MIN	0.00000	-284.00737	0.00000	-243.11977
29	ENVEQ MIN	0.25000	-286.07555	0.00000	-268.37205
29	ENVEQ MIN	0.50000	-288.14374	0.00000	-293.03545
29	ENVEQ MIN	0.75000	-290.21192	0.00000	-317.10998
29	ENVEQ MIN	1.00000	-292.28011	0.00000	-340.59562
30	ENVEQ MAX	0.00000	97.52400	198.15572	274.27556
30	ENVEQ MAX	0.15278	98.44580	195.88697	272.59336
30	ENVEQ MAX	0.30556	99.36760	193.61822	271.06714
30	ENVEQ MAX	0.45833	100.28940	191.34947	269.69689
30	ENVEQ MAX	0.61111	101.21120	189.08072	268.48262
30	ENVEQ MIN	0.00000	-292.28011	0.00000	-340.59562
30	ENVEQ MIN	0.15278	-293.20191	0.00000	-350.87357
30	ENVEQ MIN	0.30556	-294.12371	0.00000	-361.03453
30	ENVEQ MIN	0.45833	-295.04551	0.00000	-371.07852
30	ENVEQ MIN	0.61111	-295.96731	0.00000	-382.27826
31	ENVEQ MAX	0.59091	0.00000	114.67055	229.83991
31	ENVEQ MAX	0.69318	0.00000	114.42725	223.62176
31	ENVEQ MAX	0.79545	0.00000	114.13634	217.42734
31	ENVEQ MAX	0.89773	0.00000	113.79782	211.25932
31	ENVEQ MAX	1.00000	0.00000	113.41168	205.12038
31	ENVEQ MIN	0.59091	-246.56553	-270.41848	-326.64667
31	ENVEQ MIN	0.69318	-244.45335	-265.53632	-312.36226
31	ENVEQ MIN	0.79545	-242.34116	-260.63818	-298.37033
31	ENVEQ MIN	0.89773	-240.22897	-255.72407	-284.67177
31	ENVEQ MIN	1.00000	-238.11678	-250.79398	-271.26747
32	ENVEQ MAX	0.00000	0.00000	113.41166	205.12038
32	ENVEQ MAX	0.25000	0.00000	112.10078	188.24215
32	ENVEQ MAX	0.50000	0.00000	110.44564	181.66691
32	ENVEQ MAX	0.75000	0.00000	108.44625	178.31694
32	ENVEQ MAX	1.00000	0.00000	106.10260	173.59026
32	ENVEQ MIN	0.00000	-238.11692	-250.79398	-271.26747
32	ENVEQ MIN	0.25000	-232.24973	-237.02705	-235.58425
32	ENVEQ MIN	0.50000	-226.38254	-223.16000	-213.58246
32	ENVEQ MIN	0.75000	-220.51535	-209.19283	-196.39862
32	ENVEQ MIN	1.00000	-214.64817	-195.12554	-179.68836
33	ENVEQ MAX	0.00000	0.00000	133.71503	173.59026
33	ENVEQ MAX	0.25000	0.00000	128.43855	152.96853
33	ENVEQ MAX	0.50000	0.00000	124.41966	132.16753
33	ENVEQ MAX	0.75000	0.00000	126.37887	109.45898
33	ENVEQ MAX	1.00000	0.00000	126.81299	83.93159
33	ENVEQ MIN	0.00000	-282.91831	-195.12554	-179.68836
33	ENVEQ MIN	0.25000	-271.88800	-168.46957	-149.73557
33	ENVEQ MIN	0.50000	-260.85768	-141.58285	-121.96796
33	ENVEQ MIN	0.75000	-249.82737	-114.46539	-96.70679
33	ENVEQ MIN	1.00000	-238.79706	-89.74858	-74.27331
34	ENVEQ MAX	0.00000	0.00000	173.48421	83.93159
34	ENVEQ MAX	0.25000	0.00000	172.47290	76.18117
34	ENVEQ MAX	0.50000	0.00000	175.50879	89.87506
34	ENVEQ MAX	0.75000	0.00000	180.27088	95.45954
34	ENVEQ MAX	1.00000	0.00000	183.23573	92.91363
34	ENVEQ MIN	0.00000	-307.21569	-89.74858	-74.27331
34	ENVEQ MIN	0.25000	-296.18537	-79.36940	-75.24935
34	ENVEQ MIN	0.50000	-285.15506	-68.05588	-123.98289
34	ENVEQ MIN	0.75000	-274.12475	-55.80801	-171.96101
34	ENVEQ MIN	1.00000	-263.28499	-42.62579	-218.63906
35	ENVEQ MAX	0.00000	0.00000	245.62736	92.91360

26	ENVEQ MAX	0.50000	75.57974	162.81945	364.55488
FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	246.50582	70.57356
35	ENVEQ MAX	0.75000	0.00000	244.50454	72.60311
35	ENVEQ MAX	1.00000	0.00000	240.87625	69.94977
35	ENVEQ MIN	0.00000	-337.14412	-43.45228	-218.63906
35	ENVEQ MIN	0.25000	-332.31193	-29.42083	-282.61170
35	ENVEQ MIN	0.50000	-327.47974	-14.62527	-344.53187
35	ENVEQ MIN	0.75000	-322.64755	0.00000	-404.55722
35	ENVEQ MIN	1.00000	-317.81537	0.00000	-463.08066
36	ENVEQ MAX	0.00000	0.00000	317.59323	69.94981
36	ENVEQ MAX	0.25000	0.00000	316.71448	68.92409
36	ENVEQ MAX	0.50000	0.00000	315.77934	67.71704
36	ENVEQ MAX	0.75000	0.00000	314.78781	66.32726
36	ENVEQ MAX	1.00000	0.00000	313.73988	64.75336
36	ENVEQ MIN	0.00000	-391.86072	0.00000	-463.08066
36	ENVEQ MIN	0.25000	-390.93541	0.00000	-478.33798
36	ENVEQ MIN	0.50000	-390.01009	0.00000	-493.47913
36	ENVEQ MIN	0.75000	-389.08478	0.00000	-508.50182
36	ENVEQ MIN	1.00000	-388.15947	0.00000	-523.40378
37	ENVEQ MAX	0.00000	0.00000	313.73988	64.75335
37	ENVEQ MAX	0.22500	0.00000	311.47941	61.08804
37	ENVEQ MAX	0.45000	0.00000	309.00246	56.67057
37	ENVEQ MAX	0.67500	0.00000	306.30904	51.49082
37	ENVEQ MAX	0.90000	0.00000	303.39915	45.53868
37	ENVEQ MIN	0.00000	-388.15956	0.00000	-523.40378
37	ENVEQ MIN	0.22500	-386.09800	0.00000	-554.61174
37	ENVEQ MIN	0.45000	-383.61456	0.00000	-589.51587
37	ENVEQ MIN	0.67500	-380.70925	0.00000	-624.12918
37	ENVEQ MIN	0.90000	-377.38206	0.00000	-658.42729
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.10000	0.00000	0.00000	44.09405
40	ENVEQ MAX	0.32500	0.00000	0.00000	50.81330
40	ENVEQ MAX	0.55000	0.00000	0.00000	57.16947
40	ENVEQ MAX	0.77500	0.00000	0.00000	63.19816
40	ENVEQ MAX	1.00000	0.00000	0.00000	68.93497
40	ENVEQ MIN	0.10000	-350.93050	-323.45142	-635.63347
40	ENVEQ MIN	0.32500	-349.04646	-315.06736	-599.82872
40	ENVEQ MIN	0.55000	-347.16243	-307.10517	-564.94345
40	ENVEQ MIN	0.77500	-345.27839	-299.56486	-530.93020
40	ENVEQ MIN	1.00000	-343.39435	-292.44642	-497.74150
41	ENVEQ MAX	0.00000	0.00000	0.00000	68.93512
41	ENVEQ MAX	0.25000	0.00000	0.00000	70.39464
41	ENVEQ MAX	0.50000	0.00000	0.00000	71.83684
41	ENVEQ MAX	0.75000	0.00000	0.00000	73.26170
41	ENVEQ MAX	1.00000	0.00000	0.00000	74.66925
41	ENVEQ MIN	0.00000	-343.39432	-292.44653	-497.74150
41	ENVEQ MIN	0.25000	-342.90447	-290.65058	-489.24178
41	ENVEQ MIN	0.50000	-342.41462	-288.85463	-480.79459
41	ENVEQ MIN	0.75000	-341.92477	-287.05868	-472.39993
41	ENVEQ MIN	1.00000	-341.43493	-285.26273	-464.05780
42	ENVEQ MAX	0.00000	0.00000	0.00000	74.66913
42	ENVEQ MAX	0.25000	0.00000	0.00000	87.30247
42	ENVEQ MAX	0.50000	0.00000	0.00000	99.14142
42	ENVEQ MAX	0.75000	0.00000	0.00000	115.69590
42	ENVEQ MAX	1.00000	0.00000	0.00000	138.59151
42	ENVEQ MIN	0.00000	-352.27983	-285.25530	-464.05780
42	ENVEQ MIN	0.25000	-347.81675	-268.89220	-390.47354
42	ENVEQ MIN	0.50000	-343.35368	-252.52910	-321.25003
42	ENVEQ MIN	0.75000	-338.89060	-236.16600	-262.10764
42	ENVEQ MIN	1.00000	-334.42753	-219.80290	-210.48209
43	ENVEQ MAX	0.00000	0.00000	0.00000	138.59151
43	ENVEQ MAX	0.25000	0.00000	0.00000	159.25427
43	ENVEQ MAX	0.50000	0.00000	0.00000	192.89885
43	ENVEQ MAX	0.75000	0.00000	0.00000	222.17448
43	ENVEQ MAX	1.00000	0.00000	0.00000	247.08116
43	ENVEQ MIN	0.00000	-345.34351	-219.79459	-210.48209
43	ENVEQ MIN	0.25000	-340.87625	-203.41614	-162.39341
43	ENVEQ MIN	0.50000	-336.40899	-187.03769	-124.79509
43	ENVEQ MIN	0.75000	-331.94172	-170.65924	-90.47341

35	ENVEQ MAX	0.25000	0.00000	246.88009	82.60189
FRAME	LOAD	DIST	P	V2	M3
44	ENVEQ MAX	0.25000	0.00000	0.00000	267.61620
44	ENVEQ MAX	0.50000	0.00000	2.65412	283.78229
44	ENVEQ MAX	0.75000	0.00000	8.05580	295.57942
44	ENVEQ MAX	1.00000	0.00000	13.45749	303.00761
44	ENVEQ MIN	0.00000	-338.46005	-154.27150	-63.34961
44	ENVEQ MIN	0.25000	-333.99279	-137.89305	-45.30062
44	ENVEQ MIN	0.50000	-329.52553	-121.51460	-29.40848
44	ENVEQ MIN	0.75000	-325.05827	-105.13615	-15.02745
44	ENVEQ MIN	1.00000	-326.21115	-88.75770	-2.08732
45	ENVEQ MAX	0.00000	0.00000	12.28173	303.00761
45	ENVEQ MAX	0.25000	0.00000	17.67835	306.06315
45	ENVEQ MAX	0.50000	0.00000	24.35884	304.75792
45	ENVEQ MAX	0.75000	0.00000	32.29007	299.09192
45	ENVEQ MAX	1.00000	0.00000	47.44838	289.06516
45	ENVEQ MIN	0.00000	-331.64485	-88.74795	-2.08732
45	ENVEQ MIN	0.25000	-327.18177	-72.38485	0.00000
45	ENVEQ MIN	0.50000	-323.41564	-56.02175	0.00000
45	ENVEQ MIN	0.75000	-327.87871	-42.98770	0.00000
45	ENVEQ MIN	1.00000	-332.34179	-32.91400	0.00000
46	ENVEQ MAX	0.00000	0.00000	47.46003	289.06516
46	ENVEQ MAX	0.25000	0.00000	63.83848	274.65914
46	ENVEQ MAX	0.50000	0.00000	80.21693	255.88417
46	ENVEQ MAX	0.75000	0.00000	96.59538	232.74024
46	ENVEQ MAX	1.00000	0.00000	112.97383	205.89775
46	ENVEQ MIN	0.00000	-324.91315	-33.12165	0.00000
46	ENVEQ MIN	0.25000	-325.15425	-23.03850	0.00000
46	ENVEQ MIN	0.50000	-329.62151	-16.36676	0.00000
46	ENVEQ MIN	0.75000	-334.08877	-10.96508	0.00000
46	ENVEQ MIN	1.00000	-338.55604	-5.56339	0.00000
47	ENVEQ MAX	0.00000	0.00000	112.98531	205.89775
47	ENVEQ MAX	0.25000	0.00000	129.36376	184.44715
47	ENVEQ MAX	0.50000	0.00000	145.74221	166.62643
47	ENVEQ MAX	0.75000	0.00000	162.12066	144.43676
47	ENVEQ MAX	1.00000	0.00000	178.49911	117.87814
47	ENVEQ MIN	0.00000	-326.96944	-7.01964	0.00000
47	ENVEQ MIN	0.25000	-331.43670	-1.61795	0.00000
47	ENVEQ MIN	0.50000	-335.90396	0.00000	0.00000
47	ENVEQ MIN	0.75000	-340.37122	0.00000	0.00000
47	ENVEQ MIN	1.00000	-344.83849	0.00000	-21.37939
48	ENVEQ MAX	0.00000	0.00000	178.51011	117.87814
48	ENVEQ MAX	0.25000	0.00000	194.87321	86.98361
48	ENVEQ MAX	0.50000	0.00000	211.23631	51.73187
48	ENVEQ MAX	0.75000	0.00000	227.59941	33.24361
48	ENVEQ MAX	1.00000	0.00000	243.96251	24.65202
48	ENVEQ MIN	0.00000	-333.32139	0.00000	-21.37939
48	ENVEQ MIN	0.25000	-337.78447	0.00000	-46.57003
48	ENVEQ MIN	0.50000	-342.24754	0.00000	-85.42157
48	ENVEQ MIN	0.75000	-346.71062	0.00000	-134.70966
48	ENVEQ MIN	1.00000	-351.17369	0.00000	-194.73874
49	ENVEQ MAX	0.00000	0.00000	243.97313	24.65186
49	ENVEQ MAX	0.25000	0.00000	248.83908	21.90540
49	ENVEQ MAX	0.50000	0.00000	253.70503	19.03176
49	ENVEQ MAX	0.75000	0.00000	258.57098	16.03093
49	ENVEQ MAX	1.00000	0.00000	263.43693	12.90293
49	ENVEQ MIN	0.00000	-339.72735	0.00000	-194.73874
49	ENVEQ MIN	0.25000	-341.05455	0.00000	-214.26643
49	ENVEQ MIN	0.50000	-342.38175	0.00000	-234.17974
49	ENVEQ MIN	0.75000	-343.70895	0.00000	-254.47867
49	ENVEQ MIN	1.00000	-345.03615	0.00000	-275.16324
50	ENVEQ MAX	0.00000	0.00000	263.43674	12.90294
50	ENVEQ MAX	0.22500	0.00000	270.34424	8.30076
50	ENVEQ MAX	0.45000	0.00000	277.25174	3.44229
50	ENVEQ MAX	0.67500	0.00000	284.15924	0.00000
50	ENVEQ MAX	0.90000	0.00000	291.06674	0.00000
50	ENVEQ MIN	0.00000	-345.03615	0.00000	-275.16324
50	ENVEQ MIN	0.22500	-346.92019	0.00000	-305.18842
50	ENVEQ MIN	0.45000	-348.80422	0.00000	-335.99069
50	ENVEQ MIN	0.67500	-350.68826	0.00000	-367.57006
50	ENVEQ MIN	0.90000	-352.57230	0.00000	-399.92652
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000

43	ENVEQ MIN	1.00000	-327.47446	-154.28079	-63.34961
44	ENVEQ MAX	0.00000	0.00000	0.00000	247.08116
FRAME	LOAD	DIST	P	V2	M3
53	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.55000	0.00000	0.00000	3.44238
53	ENVEQ MAX	0.77500	0.00000	0.00000	8.30083
53	ENVEQ MAX	1.00000	0.00000	0.00000	12.90299
53	ENVEQ MIN	0.10000	-352.57230	-291.06674	-399.92652
53	ENVEQ MIN	0.32500	-350.68826	-284.15924	-367.57006
53	ENVEQ MIN	0.55000	-348.80422	-277.25174	-335.99069
53	ENVEQ MIN	0.77500	-346.92019	-270.34424	-305.18842
53	ENVEQ MIN	1.00000	-345.03615	-263.43674	-275.16324
54	ENVEQ MAX	0.00000	0.00000	0.00000	12.90300
54	ENVEQ MAX	0.25000	0.00000	0.00000	16.03102
54	ENVEQ MAX	0.50000	0.00000	0.00000	19.03187
54	ENVEQ MAX	0.75000	0.00000	0.00000	21.90553
54	ENVEQ MAX	1.00000	0.00000	0.00000	24.65201
54	ENVEQ MIN	0.00000	-345.03615	-263.43693	-275.16324
54	ENVEQ MIN	0.25000	-343.70895	-258.57098	-254.47867
54	ENVEQ MIN	0.50000	-342.38175	-253.70503	-234.17974
54	ENVEQ MIN	0.75000	-341.05455	-248.83908	-214.26643
54	ENVEQ MIN	1.00000	-339.72735	-243.97313	-194.73874
55	ENVEQ MAX	0.00000	0.00000	0.00000	24.65193
55	ENVEQ MAX	0.25000	0.00000	0.00000	33.24361
55	ENVEQ MAX	0.50000	0.00000	0.00000	51.73187
55	ENVEQ MAX	0.75000	0.00000	0.00000	86.98361
55	ENVEQ MAX	1.00000	0.00000	0.00000	117.87814
55	ENVEQ MIN	0.00000	-351.17369	-243.96251	-194.73874
55	ENVEQ MIN	0.25000	-346.71062	-227.59941	-134.70966
55	ENVEQ MIN	0.50000	-342.24754	-211.23631	-85.42157
55	ENVEQ MIN	0.75000	-337.78447	-194.87321	-46.57003
55	ENVEQ MIN	1.00000	-333.32139	-178.51011	-21.37939
56	ENVEQ MAX	0.00000	0.00000	0.00000	117.87814
56	ENVEQ MAX	0.25000	0.00000	0.00000	144.43676
56	ENVEQ MAX	0.50000	0.00000	0.00000	166.62643
56	ENVEQ MAX	0.75000	0.00000	1.61795	184.44715
56	ENVEQ MAX	1.00000	0.00000	7.01964	205.89775
56	ENVEQ MIN	0.00000	-344.83849	-178.49911	-21.37939
56	ENVEQ MIN	0.25000	-340.37122	-162.12066	0.00000
56	ENVEQ MIN	0.50000	-335.90396	-145.74221	0.00000
56	ENVEQ MIN	0.75000	-331.43670	-129.36376	0.00000
56	ENVEQ MIN	1.00000	-326.96944	-112.98531	0.00000
57	ENVEQ MAX	0.00000	0.00000	5.56339	205.89775
57	ENVEQ MAX	0.25000	0.00000	10.96508	232.74024
57	ENVEQ MAX	0.50000	0.00000	16.36676	255.88417
57	ENVEQ MAX	0.75000	0.00000	23.03850	274.65914
57	ENVEQ MAX	1.00000	0.00000	33.12165	289.06516
57	ENVEQ MIN	0.00000	-338.55604	-112.97383	0.00000
57	ENVEQ MIN	0.25000	-334.08877	-96.59538	0.00000
57	ENVEQ MIN	0.50000	-329.62151	-80.21693	0.00000
57	ENVEQ MIN	0.75000	-325.15425	-63.83848	0.00000
57	ENVEQ MIN	1.00000	-324.91315	-47.46003	0.00000
58	ENVEQ MAX	0.00000	0.00000	32.91400	289.06516
58	ENVEQ MAX	0.25000	0.00000	42.98770	299.09192
58	ENVEQ MAX	0.50000	0.00000	56.02175	304.75792
58	ENVEQ MAX	0.75000	0.00000	72.38485	306.06315
58	ENVEQ MAX	1.00000	0.00000	88.74795	303.00761
58	ENVEQ MIN	0.00000	-332.34179	-47.44838	0.00000
58	ENVEQ MIN	0.25000	-327.87871	-32.29007	0.00000
58	ENVEQ MIN	0.50000	-323.41564	-24.35884	0.00000
58	ENVEQ MIN	0.75000	-327.18177	-17.67835	0.00000
58	ENVEQ MIN	1.00000	-331.64485	-12.28173	-2.08732
59	ENVEQ MAX	0.00000	0.00000	88.75770	303.00761
59	ENVEQ MAX	0.25000	0.00000	105.13615	295.57942
59	ENVEQ MAX	0.50000	0.00000	121.51460	283.78229
59	ENVEQ MAX	0.75000	0.00000	137.89305	267.61620
59	ENVEQ MAX	1.00000	0.00000	154.27150	247.08116
59	ENVEQ MIN	0.00000	-326.21115	-13.45749	-2.08732
59	ENVEQ MIN	0.25000	-325.05827	-8.05580	-15.02745
59	ENVEQ MIN	0.50000	-329.52553	-2.65412	-29.40848
59	ENVEQ MIN	0.75000	-333.99279	0.00000	-45.30062
59	ENVEQ MIN	1.00000	-338.46005	0.00000	-63.34961
60	ENVEQ MAX	0.00000	0.00000	154.28079	247.08116
60	ENVEQ MAX	0.25000	0.00000	170.65924	222.17448
60	ENVEQ MAX	0.50000	0.00000	187.03769	192.89885
60	ENVEQ MAX	0.75000	0.00000	203.41614	159.25427
60	ENVEQ MAX	1.00000	0.00000	219.79459	138.59151
60	ENVEQ MIN	0.00000	-327.47446	0.00000	-63.34961
60	ENVEQ MIN	0.25000	-331.94172	0.00000	-90.47341
60	ENVEQ MIN	0.50000	-336.40899	0.00000	-124.79509
60	ENVEQ MIN	0.75000	-340.87625	0.00000	-162.39341
60	ENVEQ MIN	1.00000	-345.34351	0.00000	-210.48209
61	ENVEQ MAX	0.00000	0.00000	219.80290	138.59151
61	ENVEQ MAX	0.25000	0.00000	236.16600	115.69590
61	ENVEQ MAX	0.50000	0.00000	252.52910	99.14142
61	ENVEQ MAX	0.75000	0.00000	268.89220	87.30247
61	ENVEQ MAX	1.00000	0.00000	285.25530	74.66909
61	ENVEQ MIN	0.00000	-334.42753	0.00000	-210.48209
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
61	ENVEQ MIN	1.00000	-352.27983	0.00000	-464.05780
62	ENVEQ MAX	0.00000	0.00000	285.26273	74.66878
62	ENVEQ MAX	0.25000	0.00000	287.05868	73.26132
62	ENVEQ MAX	0.50000	0.00000	288.85463	71.83654
62	ENVEQ MAX	0.75000	0.00000	290.65058	70.39443
62	ENVEQ MAX	1.00000	0.00000	292.44653	68.93500
62	ENVEQ MIN	0.00000	-341.43493	0.00000	-464.05780
62	ENVEQ MIN	0.25000	-341.92477	0.00000	-472.39993
62	ENVEQ MIN	0.50000	-342.41462	0.00000	-480.79459
62	ENVEQ MIN	0.75000	-342.90447	0.00000	-489.24178
62	ENVEQ MIN	1.00000	-343.39432	0.00000	-497.74150
63	ENVEQ MAX	0.00000	0.00000	292.44642	68.93519
63	ENVEQ MAX	0.22500	0.00000	299.56486	63.19817
63	ENVEQ MAX	0.45000	0.00000	307.10517	57.16927
63	ENVEQ MAX	0.67500	0.00000	315.06736	50.81289
63	ENVEQ MAX	0.90000	0.00000	323.45142	44.09343
63	ENVEQ MIN	0.00000	-343.39435	0.00000	-497.74150
63	ENVEQ MIN	0.22500	-345.27839	0.00000	-530.93020
63	ENVEQ MIN	0.45000	-347.16243	0.00000	-564.94345
63	ENVEQ MIN	0.67500	-349.04646	0.00000	-599.82872
63	ENVEQ MIN	0.90000	-350.93050	0.00000	-635.63347
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.10000	0.00000	0.00000	45.53969
66	ENVEQ MAX	0.32500	0.00000	0.00000	51.49170
66	ENVEQ MAX	0.55000	0.00000	0.00000	56.67132
66	ENVEQ MAX	0.77500	0.00000	0.00000	61.08866
66	ENVEQ MAX	1.00000	0.00000	0.00000	64.75383
66	ENVEQ MIN	0.10000	-377.38206	-303.39915	-658.42729
66	ENVEQ MIN	0.32500	-380.70925	-306.30904	-624.12918
66	ENVEQ MIN	0.55000	-383.61456	-309.00246	-589.51587
66	ENVEQ MIN	0.77500	-386.09800	-311.47941	-554.61174
66	ENVEQ MIN	1.00000	-388.15956	-313.73988	-523.40378
67	ENVEQ MAX	0.00000	0.00000	0.00000	64.75398
67	ENVEQ MAX	0.25000	0.00000	0.00000	66.32796
67	ENVEQ MAX	0.50000	0.00000	0.00000	67.71782
67	ENVEQ MAX	0.75000	0.00000	0.00000	68.92495
67	ENVEQ MAX	1.00000	0.00000	0.00000	69.95074
67	ENVEQ MIN	0.00000	-388.15947	-313.73988	-523.40378
67	ENVEQ MIN	0.25000	-389.08478	-314.78781	-508.50182
67	ENVEQ MIN	0.50000	-390.01009	-315.77934	-493.47913
67	ENVEQ MIN	0.75000	-390.93541	-316.71448	-478.33798
67	ENVEQ MIN	1.00000	-391.86072	-317.59323	-463.08066
68	ENVEQ MAX	0.00000	0.00000	0.00000	69.94934
68	ENVEQ MAX	0.25000	0.00000	0.00000	72.60273
68	ENVEQ MAX	0.50000	0.00000	14.62508	70.57324
68	ENVEQ MAX	0.75000	0.00000	29.42064	82.60152
68	ENVEQ MAX	1.00000	0.00000	43.45209	92.91331
68	ENVEQ MIN	0.00000	-317.81537	-240.87625	-463.08066
68	ENVEQ MIN	0.25000	-322.64755	-244.50454	-404.55722
68	ENVEQ MIN	0.50000	-327.47974	-246.50582	-344.53187
68	ENVEQ MIN	0.75000	-332.31193	-246.88009	-282.61170
68	ENVEQ MIN	1.00000	-337.14412	-245.62736	-218.63906
69	ENVEQ MAX	0.00000	0.00000	42.62579	92.91399
69	ENVEQ MAX	0.25000	0.00000	55.80801	95.45971
69	ENVEQ MAX	0.50000	0.00000	68.05588	89.87504
69	ENVEQ MAX	0.75000	0.00000	79.36940	76.18096
69	ENVEQ MAX	1.00000	0.00000	89.74858	83.93159
69	ENVEQ MIN	0.00000	-263.28499	-183.23573	-218.63906
69	ENVEQ MIN	0.25000	-274.12475	-180.27088	-171.96101
69	ENVEQ MIN	0.50000	-285.15506	-175.50879	-123.98289
69	ENVEQ MIN	0.75000	-296.18537	-172.47290	-75.24935
69	ENVEQ MIN	1.00000	-307.21569	-173.48421	-74.27331
70	ENVEQ MAX	0.00000	0.00000	89.74858	83.93159
70	ENVEQ MAX	0.25000	0.00000	114.46539	109.45898
70	ENVEQ MAX	0.50000	0.00000	141.58285	132.16753
70	ENVEQ MAX	0.75000	0.00000	168.46957	152.96853
70	ENVEQ MAX	1.00000	0.00000	195.12554	173.59026

61	ENVEQ MIN	0.25000	-338.89060	0.00000	-262.10764
61	ENVEQ MIN	0.50000	-343.35368	0.00000	-321.25003
61	ENVEQ MIN	0.75000	-347.81675	0.00000	-390.47354
FRAME	LOAD	DIST	P	V2	M3
70	ENVEQ MIN	0.75000	-271.88800	-128.43855	-149.73557
70	ENVEQ MIN	1.00000	-282.91831	-133.71503	-179.68836
71	ENVEQ MAX	0.00000	0.00000	195.12554	173.59026
71	ENVEQ MAX	0.25000	0.00000	209.19283	178.31694
71	ENVEQ MAX	0.50000	0.00000	223.16000	181.66691
71	ENVEQ MAX	0.75000	0.00000	237.02705	188.24215
71	ENVEQ MAX	1.00000	0.00000	250.79398	205.12038
71	ENVEQ MIN	0.00000	-214.64817	-106.10260	-179.68836
71	ENVEQ MIN	0.25000	-220.51535	-108.44625	-196.39862
71	ENVEQ MIN	0.50000	-226.38254	-110.44564	-213.58246
71	ENVEQ MIN	0.75000	-232.24973	-112.10078	-235.58425
71	ENVEQ MIN	1.00000	-238.11692	-113.41166	-271.26747
72	ENVEQ MAX	0.00000	0.00000	250.79398	205.12038
72	ENVEQ MAX	0.10227	0.00000	255.72407	211.25932
72	ENVEQ MAX	0.20455	0.00000	260.63818	217.42734
72	ENVEQ MAX	0.30682	0.00000	265.53632	223.62176
72	ENVEQ MAX	0.40909	0.00000	270.41848	229.83991
72	ENVEQ MIN	0.00000	-238.11678	-113.41168	-271.26747
72	ENVEQ MIN	0.10227	-240.22897	-113.79782	-284.67177
72	ENVEQ MIN	0.20455	-242.34116	-114.13634	-298.37033
72	ENVEQ MIN	0.30682	-244.45335	-114.42725	-312.36226
72	ENVEQ MIN	0.40909	-246.56553	-114.67055	-326.64667
73	ENVEQ MAX	0.11915	0.00000	68.38217	170.73252
73	ENVEQ MAX	0.32128	0.00000	69.63707	88.78119
73	ENVEQ MAX	0.52340	0.00000	70.86773	5.38725
73	ENVEQ MAX	0.72553	0.00000	72.07415	79.55607
73	ENVEQ MAX	0.92766	0.00000	73.25632	165.81244
73	ENVEQ MIN	0.11915	-568.07435	-68.38217	-170.73252
73	ENVEQ MIN	0.32128	-585.88685	-69.63707	-88.78119
73	ENVEQ MIN	0.52340	-603.69935	-70.86773	-5.38725
73	ENVEQ MIN	0.72553	-621.51185	-72.07415	-79.55607
73	ENVEQ MIN	0.92766	-639.32435	-73.25632	-165.81244

70	ENVEQ MIN	0.00000	-238.79706	-126.81299	-74.27331
70	ENVEQ MIN	0.25000	-249.82737	-126.37887	-96.70679
70	ENVEQ MIN	0.50000	-260.85768	-124.41966	-121.96796

20. OUTPUT DATA (붕괴방지)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.38889	211.59410	0.00000	523.43674
1	ENVEQ MAX	0.54167	210.59365	0.00000	534.05572
1	ENVEQ MAX	0.69444	209.59320	0.00000	544.83067
1	ENVEQ MAX	0.84722	208.59275	0.00000	555.76160
1	ENVEQ MAX	1.00000	207.59230	0.00000	566.84851
1	ENVEQ MIN	0.38889	-295.47373	-306.73854	-446.05720
1	ENVEQ MIN	0.54167	-294.47328	-309.00729	-429.94101
1	ENVEQ MIN	0.69444	-293.47283	-311.27604	-413.70785
1	ENVEQ MIN	0.84722	-292.47238	-313.54479	-397.35770
1	ENVEQ MIN	1.00000	-291.47193	-315.81354	-380.89057
2	ENVEQ MAX	0.00000	207.59235	0.00000	566.84851
2	ENVEQ MAX	0.25000	205.34771	0.00000	592.29102
2	ENVEQ MAX	0.50000	203.10306	0.00000	619.60832
2	ENVEQ MAX	0.75000	200.85842	0.00000	649.96608
2	ENVEQ MAX	1.00000	198.61377	0.00000	681.10942
2	ENVEQ MIN	0.00000	-291.12064	-315.81349	-380.89057
2	ENVEQ MIN	0.25000	-288.87599	-320.90374	-344.63131
2	ENVEQ MIN	0.50000	-286.63135	-325.99399	-308.35942
2	ENVEQ MIN	0.75000	-284.38670	-331.08424	-271.49865
2	ENVEQ MIN	1.00000	-282.14205	-336.17449	-234.04900
3	ENVEQ MAX	0.00000	192.77871	0.00000	681.10942
3	ENVEQ MAX	0.25000	191.02155	0.00000	690.01958
3	ENVEQ MAX	0.50000	189.26440	0.00000	699.41090
3	ENVEQ MAX	0.75000	187.50724	0.00000	709.28338
3	ENVEQ MAX	1.00000	185.75009	0.00000	719.63702
3	ENVEQ MIN	0.00000	-275.75022	-209.20821	-234.04901
3	ENVEQ MIN	0.25000	-273.99306	-213.19296	-214.41997
3	ENVEQ MIN	0.50000	-272.23591	-217.17771	-194.43006
3	ENVEQ MIN	0.75000	-270.47875	-221.16246	-174.07928
3	ENVEQ MIN	1.00000	-268.72160	-225.14721	-153.36762
4	ENVEQ MAX	0.00000	185.75013	0.00000	719.63702
4	ENVEQ MAX	0.25000	184.65873	0.00000	726.28899
4	ENVEQ MAX	0.50000	183.56733	0.00000	733.08441
4	ENVEQ MAX	0.75000	182.47593	0.00000	740.02326
4	ENVEQ MAX	1.00000	181.38453	0.00000	747.10554
4	ENVEQ MIN	0.00000	-268.49623	-225.14718	-153.36751
4	ENVEQ MIN	0.25000	-267.40483	-227.05968	-140.43472
4	ENVEQ MIN	0.50000	-266.31343	-228.97218	-127.39434
4	ENVEQ MIN	0.75000	-265.22203	-230.88468	-114.24640
4	ENVEQ MIN	1.00000	-264.13063	-232.79718	-100.99087
5	ENVEQ MAX	0.00000	181.38456	0.00000	747.10554
5	ENVEQ MAX	0.25000	180.35500	0.00000	753.93675
5	ENVEQ MAX	0.50000	179.32545	0.00000	760.93313
5	ENVEQ MAX	0.75000	178.29589	0.00000	768.09471
5	ENVEQ MAX	1.00000	177.26634	0.00000	775.42146
5	ENVEQ MIN	0.00000	-263.97075	-232.79716	-100.99100
5	ENVEQ MIN	0.25000	-262.94119	-235.13191	-88.43987
5	ENVEQ MIN	0.50000	-261.91164	-237.46666	-75.76486
5	ENVEQ MIN	0.75000	-260.88209	-239.80141	-62.96596
5	ENVEQ MIN	1.00000	-259.85253	-242.13616	-50.04317
6	ENVEQ MAX	0.00000	171.44452	35.69624	775.42146
6	ENVEQ MAX	0.25000	167.56277	29.09418	769.81093
6	ENVEQ MAX	0.50000	163.68102	22.49211	766.54853
6	ENVEQ MAX	0.75000	159.79928	15.89005	765.63427
6	ENVEQ MAX	1.00000	155.91753	9.28799	767.06814
6	ENVEQ MIN	0.00000	-253.41746	-114.33429	-50.04306
6	ENVEQ MIN	0.25000	-249.53571	-123.13704	-23.02112
6	ENVEQ MIN	0.50000	-245.65396	-131.93979	0.00000
6	ENVEQ MIN	0.75000	-241.77222	-140.74254	0.00000
6	ENVEQ MIN	1.00000	-237.89047	-149.54529	0.00000
7	ENVEQ MAX	0.00000	150.10658	121.37414	767.06814
7	ENVEQ MAX	0.25000	146.22483	112.57139	736.27642
7	ENVEQ MAX	0.50000	142.34308	103.76864	707.83284
7	ENVEQ MAX	0.75000	138.46134	94.96589	681.73739
7	ENVEQ MAX	1.00000	134.57959	86.16314	657.99007
7	ENVEQ MIN	0.00000	-231.25433	-36.18773	0.00000
7	ENVEQ MIN	0.25000	-227.37258	-42.78979	0.00000
7	ENVEQ MIN	0.50000	-223.49084	-49.39185	0.00000
7	ENVEQ MIN	0.75000	-219.60909	-55.99392	0.00000
7	ENVEQ MIN	1.00000	-215.72734	-62.59598	0.00000
8	ENVEQ MAX	0.00000	128.77805	215.30616	657.99007
8	ENVEQ MAX	0.25000	124.89994	206.51166	601.78284
8	ENVEQ MAX	0.50000	121.02183	197.71716	547.91935
8	ENVEQ MAX	0.75000	117.14372	188.92266	496.39960
8	ENVEQ MAX	1.00000	113.26562	180.12816	447.22357
8	ENVEQ MIN	0.00000	-209.12872	0.00000	0.00000
8	ENVEQ MIN	0.25000	-205.25061	0.00000	0.00000
8	ENVEQ MIN	0.50000	-201.37250	0.00000	0.00000
8	ENVEQ MIN	0.75000	-197.49439	0.00000	0.00000
8	ENVEQ MIN	1.00000	-193.61629	0.00000	0.00000
9	ENVEQ MAX	0.00000	107.47207	313.27247	447.22357
9	ENVEQ MAX	0.25000	103.59033	304.46972	367.27145
9	ENVEQ MAX	0.50000	99.70858	295.66697	289.99072
9	ENVEQ MAX	0.75000	95.82683	286.86422	215.05811
9	ENVEQ MAX	1.00000	91.94509	278.06147	142.79867
9	ENVEQ MIN	0.00000	-187.05144	0.00000	0.00000
9	ENVEQ MIN	0.25000	-183.16970	0.00000	0.00000
9	ENVEQ MIN	0.50000	-179.28795	0.00000	0.00000
9	ENVEQ MIN	0.75000	-175.40620	0.00000	0.00000
9	ENVEQ MIN	1.00000	-171.52446	0.00000	0.00000
10	ENVEQ MAX	0.00000	86.15814	414.61910	142.79867
10	ENVEQ MAX	0.25000	82.27639	405.81635	38.64954
10	ENVEQ MAX	0.50000	78.39464	397.01360	0.00000
10	ENVEQ MAX	0.75000	81.29927	388.21085	0.00000
10	ENVEQ MAX	1.00000	85.18102	379.40810	0.00000
10	ENVEQ MIN	0.00000	-164.98975	0.00000	0.00000
10	ENVEQ MIN	0.25000	-161.10800	0.00000	-38.23986
10	ENVEQ MIN	0.50000	-157.22626	0.00000	-110.00706
10	ENVEQ MIN	0.75000	-160.72430	0.00000	-195.36724
10	ENVEQ MIN	1.00000	-164.60604	0.00000	-293.70127
11	ENVEQ MAX	0.00000	91.39375	519.79482	0.00000
11	ENVEQ MAX	0.25000	95.27186	511.00032	0.00000
11	ENVEQ MAX	0.50000	99.14997	502.20582	0.00000
11	ENVEQ MAX	0.75000	103.02808	493.41132	0.00000
11	ENVEQ MAX	1.00000	106.90619	484.61682	0.00000
11	ENVEQ MIN	0.00000	-171.13490	0.00000	-293.70127
11	ENVEQ MIN	0.25000	-175.01301	0.00000	-429.18613
11	ENVEQ MIN	0.50000	-178.89112	0.00000	-564.16193
11	ENVEQ MIN	0.75000	-182.76922	0.00000	-696.79400
11	ENVEQ MIN	1.00000	-186.64733	0.00000	-827.08234
12	ENVEQ MAX	0.00000	113.12553	629.87881	0.00000
12	ENVEQ MAX	0.25000	113.73308	628.50106	0.00000
12	ENVEQ MAX	0.50000	114.34062	627.12331	0.00000
12	ENVEQ MAX	0.75000	114.94817	625.74556	0.00000
12	ENVEQ MAX	1.00000	115.55572	624.36781	0.00000
12	ENVEQ MIN	0.00000	-193.18801	0.00000	-827.08234
12	ENVEQ MIN	0.25000	-193.79555	0.00000	-853.26625
12	ENVEQ MIN	0.50000	-194.40310	0.00000	-879.39264
12	ENVEQ MIN	0.75000	-195.01064	0.00000	-905.46150
12	ENVEQ MIN	1.00000	-195.61819	0.00000	-931.47285
13	ENVEQ MAX	0.00000	115.55569	624.36784	0.00000
13	ENVEQ MAX	0.25000	116.64709	621.89284	0.00000
13	ENVEQ MAX	0.50000	117.73849	619.41784	0.00000
13	ENVEQ MAX	0.75000	118.82989	616.94284	0.00000
13	ENVEQ MAX	1.00000	119.92129	614.46784	0.00000
13	ENVEQ MIN	0.00000	-195.61819	0.00000	-931.47285
13	ENVEQ MIN	0.25000	-196.70959	0.00000	-978.05534
13	ENVEQ MIN	0.50000	-197.80099	0.00000	-1024.45200
13	ENVEQ MIN	0.75000	-198.89239	0.00000	-1070.66300
13	ENVEQ MIN	1.00000	-199.98379	0.00000	-1116.68900
14	ENVEQ MAX	0.00000	119.92125	614.46787	0.00000
14	ENVEQ MAX	0.25000	121.19455	611.58037	0.00000
14	ENVEQ MAX	0.50000	122.46785	608.69287	0.00000
14	ENVEQ MAX	0.75000	123.74115	605.80537	0.00000
14	ENVEQ MAX	1.00000	125.01445	602.91787	0.00000
14	ENVEQ MIN	0.00000	-199.98379	0.00000	-1116.68900
14	ENVEQ MIN	0.25000	-201.25709	0.00000	-1170.15100
14	ENVEQ MIN	0.50000	-202.53039	0.00000	-1223.36000
14	ENVEQ MIN	0.75000	-203.80369	0.00000	-1276.31700
14	ENVEQ MIN	1.00000	-205.07699	0.00000	-1329.02100
15	ENVEQ MAX	0.00000	125.01441	602.91791	0.00000
15	ENVEQ MAX	0.25000	125.92391	600.85541	0.00000
15	ENVEQ MAX	0.50000	126.83341	598.79291	0.00000
15	ENVEQ MAX	0.75000	127.74291	596.73041	0.00000
15	ENVEQ MAX	1.00000	128.65241	594.66791	0.00000
15	ENVEQ MIN	0.00000	-205.07699	0.00000	-1329.02100
15	ENVEQ MIN	0.25000	-205.98649	0.00000	-1366.51200
15	ENVEQ MIN	0.50000	-206.89599	0.00000	-1403.87400
15	ENVEQ MIN	0.75000	-207.80549	0.00000	-1441.10700
15	ENVEQ MIN	1.00000	-208.71499	0.00000	-1478.29100
16	ENVEQ MAX	0.00000	128.65241	0.00000	0.00000
16	ENVEQ MAX	0.25000	127.74291	0.00000	0.00000
16	ENVEQ MAX	0.50000	126.83341	0.00000	0.00000
16	ENVEQ MAX	0.75000	125.92391	0.00000	0.00000
16	ENVEQ MAX	1.00000	125.01441	0.00000	0.00000
16	ENVEQ MIN	0.00000	-208.71499	-594.66791	-1478.29100
16	ENVEQ MIN	0.25000	-207.80549	-596.73041	-1441.10700
16	ENVEQ MIN	0.50000	-206.89599	-598.79291	-1403.87400
16	ENVEQ MIN	0.75000	-205.98649	-600.85541	-1366.51200
16	ENVEQ MIN	1.00000	-205.07699	-602.91791	-1329.02100
17	ENVEQ MAX	0.00000	125.01445	0.00000	0.00000
17	ENVEQ MAX	0.25000	123.74115	0.00000	0.00000
17	ENVEQ MAX	0.50000	122.46785	0.00000	0.00000
17	ENVEQ MAX	0.75000	121.19455	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	119.92125	0.00000	0.00000
17	ENVEQ MIN	0.00000	-205.07699	-602.91787	-1329.02100
17	ENVEQ MIN	0.25000	-203.80369	-605.80537	-1276.31700
17	ENVEQ MIN	0.50000	-202.53039	-608.69287	-1223.36000
17	ENVEQ MIN	0.75000	-201.25709	-611.58037	-1170.15100
17	ENVEQ MIN	1.00000	-199.98379	-614.46787	-1116.68900
18	ENVEQ MAX	0.00000	119.92129	0.00000	0.00000
18	ENVEQ MAX	0.25000	118.82989	0.00000	0.00000
18	ENVEQ MAX	0.50000	117.73849	0.00000	0.00000
18	ENVEQ MAX	0.75000	116.64709	0.00000	0.00000
18	ENVEQ MAX	1.00000	115.55569	0.00000	0.00000
18	ENVEQ MIN	0.00000	-199.98379	-614.46784	-1116.68900
18	ENVEQ MIN	0.25000	-198.89239	-616.94284	-1070.66300
18	ENVEQ MIN	0.50000	-197.80099	-619.41784	-1024.45200
18	ENVEQ MIN	0.75000	-196.70959	-621.89284	-978.05534
18	ENVEQ MIN	1.00000	-195.61819	-624.36784	-931.47285
19	ENVEQ MAX	0.00000	115.55572	0.00000	0.00000
19	ENVEQ MAX	0.25000	114.94817	0.00000	0.00000
19	ENVEQ MAX	0.50000	114.34062	0.00000	0.00000
19	ENVEQ MAX	0.75000	113.73308	0.00000	0.00000
19	ENVEQ MAX	1.00000	113.12553	0.00000	0.00000
19	ENVEQ MIN	0.00000	-195.61819	-624.36781	-931.47285
19	ENVEQ MIN	0.25000	-195.01064	-625.74556	-905.46150
19	ENVEQ MIN	0.50000	-194.40310	-627.12331	-879.39264
19	ENVEQ MIN	0.75000	-193.79555	-628.50106	-853.26625
19	ENVEQ MIN	1.00000	-193.18801	-629.87881	-827.08234
20	ENVEQ MAX	0.00000	106.90619	0.00000	0.00000
20	ENVEQ MAX	0.25000	103.02808	0.00000	0.00000
20	ENVEQ MAX	0.50000	99.14997	0.00000	0.00000
20	ENVEQ MAX	0.75000	95.27186	0.00000	0.00000
20	ENVEQ MAX	1.00000	91.39375	0.00000	0.00000
20	ENVEQ MIN	0.00000	-186.64733	-484.61682	-827.08234
20	ENVEQ MIN	0.25000	-182.76922	-493.41132	-696.79400
20	ENVEQ MIN	0.50000	-178.89112	-502.20582	-564.16193
20	ENVEQ MIN	0.75000	-175.01301	-511.00032	-429.18613
20	ENVEQ MIN	1.00000	-171.13490	-519.79482	-293.70127
21	ENVEQ MAX	0.00000	85.18102	0.00000	0.00000
21	ENVEQ MAX	0.25000	81.29927	0.00000	0.00000
21	ENVEQ MAX	0.50000	78.39464	0.00000	0.00000
21	ENVEQ MAX	0.75000	82.27639	0.00000	38.64954
21	ENVEQ MAX	1.00000	86.15814	0.00000	142.79867
21	ENVEQ MIN	0.00000	-164.60604	-379.40810	-293.70127
21	ENVEQ MIN	0.25000	-160.72430	-388.21085	-195.36724
21	ENVEQ MIN	0.50000	-157.22616	-397.01360	-110.00706
21	ENVEQ MIN	0.75000	-161.10790	-405.81635	-38.23986
21	ENVEQ MIN	1.00000	-164.98965	-414.61910	0.00000
22	ENVEQ MAX	0.00000	91.94509	0.00000	142.79867
22	ENVEQ MAX	0.25000	95.82683	0.00000	215.05811
22	ENVEQ MAX	0.50000	99.70858	0.00000	289.99072
22	ENVEQ MAX	0.75000	103.59033	0.00000	367.27145
22	ENVEQ MAX	1.00000	107.47207	0.00000	447.22357
22	ENVEQ MIN	0.00000	-171.52438	-278.06147	0.00000
22	ENVEQ MIN	0.25000	-175.40613	-286.86422	0.00000
22	ENVEQ MIN	0.50000	-179.28788	-295.66697	0.00000
22	ENVEQ MIN	0.75000	-183.16962	-304.46972	0.00000
22	ENVEQ MIN	1.00000	-187.05137	-313.27247	0.00000
23	ENVEQ MAX	0.00000	113.26562	0.00000	447.22357
23	ENVEQ MAX	0.25000	117.14372	0.00000	496.39960
23	ENVEQ MAX	0.50000	121.02183	0.00000	547.91935
23	ENVEQ MAX	0.75000	124.89994	0.00000	601.78284
23	ENVEQ MAX	1.00000	128.77805	0.00000	657.99007
23	ENVEQ MIN	0.00000	-193.61628	-180.12816	0.00000
23	ENVEQ MIN	0.25000	-197.49439	-188.92266	0.00000
23	ENVEQ MIN	0.50000	-201.37249	-197.71716	0.00000
23	ENVEQ MIN	0.75000	-205.25060	-206.51166	0.00000
23	ENVEQ MIN	1.00000	-209.12871	-215.30616	0.00000
24	ENVEQ MAX	0.00000	134.57959	62.59597	657.99007
24	ENVEQ MAX	0.25000	138.46134	55.99390	681.73739
24	ENVEQ MAX	0.50000	142.34308	49.39184	707.83284
24	ENVEQ MAX	0.75000	146.22483	42.78978	736.27642
24	ENVEQ MAX	1.00000	150.10658	36.18772	767.06814
24	ENVEQ MIN	0.00000	-215.72741	-86.16314	0.00000
24	ENVEQ MIN	0.25000	-219.60915	-94.96589	0.00000
24	ENVEQ MIN	0.50000	-223.49090	-103.76864	0.00000
24	ENVEQ MIN	0.75000	-227.37265	-112.57139	0.00000
24	ENVEQ MIN	1.00000	-231.25439	-121.37414	0.00000
25	ENVEQ MAX	0.00000	155.91753	149.54529	767.06814
25	ENVEQ MAX	0.25000	159.79928	140.74254	765.63427
25	ENVEQ MAX	0.50000	163.68102	131.93979	766.54853
25	ENVEQ MAX	0.75000	167.56277	123.13704	769.81093
25	ENVEQ MAX	1.00000	171.44452	114.33429	775.42146
25	ENVEQ MIN	0.00000	-237.89058	-9.28799	0.00000
25	ENVEQ MIN	0.25000	-241.77233	-15.89005	0.00000
25	ENVEQ MIN	0.50000	-245.65407	-22.49211	0.00000
25	ENVEQ MIN	0.75000	-249.53582	-29.09417	-23.02115
25	ENVEQ MIN	1.00000	-253.41756	-35.69624	-50.04308
26	ENVEQ MAX	0.00000	177.26634	242.13616	775.42146
26	ENVEQ MAX	0.25000	178.29589	239.80141	768.09471
26	ENVEQ MAX	0.75000	180.35500	235.13191	753.93675
26	ENVEQ MAX	1.00000	181.38456	232.79716	747.10554
26	ENVEQ MIN	0.00000	-259.85263	0.00000	-50.04304
26	ENVEQ MIN	0.25000	-260.88218	0.00000	-62.96583
26	ENVEQ MIN	0.50000	-261.91174	0.00000	-75.76473
26	ENVEQ MIN	0.75000	-262.94129	0.00000	-88.43974
26	ENVEQ MIN	1.00000	-263.97084	0.00000	-100.99087
27	ENVEQ MAX	0.00000	181.38453	232.79718	747.10554
27	ENVEQ MAX	0.25000	182.47593	230.88468	740.02326
27	ENVEQ MAX	0.50000	183.56733	228.97218	733.08441
27	ENVEQ MAX	0.75000	184.65873	227.05968	726.28899
27	ENVEQ MAX	1.00000	185.75013	225.14718	719.63702
27	ENVEQ MIN	0.00000	-264.13069	0.00000	-100.99097
27	ENVEQ MIN	0.25000	-265.22209	0.00000	-114.24650
27	ENVEQ MIN	0.50000	-266.31349	0.00000	-127.39445
27	ENVEQ MIN	0.75000	-267.40489	0.00000	-140.43482
27	ENVEQ MIN	1.00000	-268.49629	0.00000	-153.36762
28	ENVEQ MAX	0.00000	185.75009	225.14721	719.63702
28	ENVEQ MAX	0.25000	187.50724	221.16246	709.28338
28	ENVEQ MAX	0.50000	189.26440	217.17771	699.41090
28	ENVEQ MAX	0.75000	191.02155	213.19296	690.01958
28	ENVEQ MAX	1.00000	192.77871	209.20821	681.10942
28	ENVEQ MIN	0.00000	-268.72161	0.00000	-153.36752
28	ENVEQ MIN	0.25000	-270.47876	0.00000	-174.07918
28	ENVEQ MIN	0.50000	-272.23592	0.00000	-194.42998
28	ENVEQ MIN	0.75000	-273.99307	0.00000	-214.41990
28	ENVEQ MIN	1.00000	-275.75023	0.00000	-234.04896
29	ENVEQ MAX	0.00000	198.61377	336.17449	681.10942
29	ENVEQ MAX	0.25000	200.85842	331.08424	649.96608
29	ENVEQ MAX	0.50000	203.10306	325.99399	619.60832
29	ENVEQ MAX	0.75000	205.34771	320.90374	592.29102
29	ENVEQ MAX	1.00000	207.59235	315.81349	566.84851
29	ENVEQ MIN	0.00000	-282.14200	0.00000	-234.04896
29	ENVEQ MIN	0.25000	-284.38665	0.00000	-271.49860
29	ENVEQ MIN	0.50000	-286.63129	0.00000	-308.35937
29	ENVEQ MIN	0.75000	-288.87594	0.00000	-344.63125
29	ENVEQ MIN	1.00000	-291.12059	0.00000	-380.89057
30	ENVEQ MAX	0.00000	207.59230	315.81354	566.84851
30	ENVEQ MAX	0.15278	208.59275	313.54479	555.76160
30	ENVEQ MAX	0.30556	209.59320	311.27604	544.83067
30	ENVEQ MAX	0.45833	210.59365	309.00729	534.05572
30	ENVEQ MAX	0.61111	211.59410	306.73854	523.43674
30	ENVEQ MIN	0.00000	-291.47178	0.00000	-380.89057
30	ENVEQ MIN	0.15278	-292.47223	0.00000	-397.35770
30	ENVEQ MIN	0.30556	-293.47268	0.00000	-413.70785
30	ENVEQ MIN	0.45833	-294.47313	0.00000	-429.94101
30	ENVEQ MIN	0.61111	-295.47358	0.00000	-446.05720
31	ENVEQ MAX	0.59091	0.00000	258.28084	414.41383
31	ENVEQ MAX	0.69318	0.00000	257.81042	400.19589
31	ENVEQ MAX	0.79545	0.00000	257.27926	386.01482
31	ENVEQ MAX	0.89773	0.00000	256.68737	371.87403
31	ENVEQ MAX	1.00000	0.00000	256.03475	357.77695
31	ENVEQ MIN	0.59091	-403.81916	-269.44709	-394.56163
31	ENVEQ MIN	0.69318	-401.54385	-264.33780	-381.46879
31	ENVEQ MIN	0.79545	-399.26853	-259.19942	-368.95661
31	ENVEQ MIN	0.89773	-396.99322	-254.03195	-356.75169
31	ENVEQ MIN	1.00000	-394.71791	-248.83538	-344.85565
32	ENVEQ MAX	0.00000	0.00000	256.03471	357.77695
32	ENVEQ MAX	0.25000	0.00000	253.91762	318.87550
32	ENVEQ MAX	0.50000	0.00000	251.36073	297.45120
32	ENVEQ MAX	0.75000	0.00000	248.36403	276.88207
32	ENVEQ MAX	1.00000	0.00000	244.92752	255.09981
32	ENVEQ MIN	0.00000	-394.71796	-249.28276	-344.85565
32	ENVEQ MIN	0.25000	-388.39764	-234.70961	-313.44477
32	ENVEQ MIN	0.50000	-382.07733	-219.94081	-302.33712
32	ENVEQ MIN	0.75000	-375.75702	-204.97633	-294.15775
32	ENVEQ MIN	1.00000	-369.43671	-189.81620	-286.61633
33	ENVEQ MAX	0.00000	0.00000	305.62921	255.09981
33	ENVEQ MAX	0.25000	0.00000	298.05509	200.10292
33	ENVEQ MAX	0.50000	0.00000	289.08081	147.54207
33	ENVEQ MAX	0.75000	0.00000	278.70637	92.39765
33	ENVEQ MAX	1.00000	0.00000	266.93176	35.90922
33	ENVEQ MIN	0.00000	-474.26109	-190.75710	-286.61633
33	ENVEQ MIN	0.25000	-462.37890	-161.80348	-274.39345
33	ENVEQ MIN	0.50000	-450.49672	-132.31260	-265.07571
33	ENVEQ MIN	0.75000	-438.61453	-102.28445	-259.07440
33	ENVEQ MIN	1.00000	-426.73234	-71.71903	-256.80083
34	ENVEQ MAX	0.00000	0.00000	343.16905	35.90915
34	ENVEQ MAX	0.25000	0.00000	331.48522	0.00000
34	ENVEQ MAX	0.50000	0.00000	331.29284	0.00000
34	ENVEQ MAX	0.75000	0.00000	332.03985	0.00000
34	ENVEQ MAX	1.00000	0.00000	330.73178	0.00000
34	ENVEQ MIN	0.00000	-531.65688	-73.41597	-256.80083
34	ENVEQ MIN	0.25000	-519.77469	-42.41727	-265.23370
34	ENVEQ MIN	0.50000	-510.11242	-25.77701	-357.98899
34	ENVEQ MIN	0.75000	-506.13211	-9.51406	-446.37943
34	ENVEQ MIN	1.00000	-502.15179	0.00000	-530.05483
35	ENVEQ MAX	0.00000	0.00000	418.26810	0.00000

26	ENVEQ MAX	0.50000	179.32545	237.46666	760.93313
FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	409.90973	0.00000
35	ENVEQ MAX	0.75000	0.00000	402.96519	0.00000
35	ENVEQ MAX	1.00000	0.00000	394.17707	0.00000
35	ENVEQ MIN	0.00000	-617.03694	0.00000	-530.05483
35	ENVEQ MIN	0.25000	-613.05663	0.00000	-634.77848
35	ENVEQ MIN	0.50000	-609.07631	0.00000	-735.02665
35	ENVEQ MIN	0.75000	-605.09600	0.00000	-831.20480
35	ENVEQ MIN	1.00000	-601.11569	0.00000	-921.91759
36	ENVEQ MAX	0.00000	0.00000	490.56256	0.00000
36	ENVEQ MAX	0.25000	0.00000	488.67177	0.00000
36	ENVEQ MAX	0.50000	0.00000	486.71810	0.00000
36	ENVEQ MAX	0.75000	0.00000	484.70154	0.00000
36	ENVEQ MAX	1.00000	0.00000	482.62209	0.00000
36	ENVEQ MIN	0.00000	-716.15655	0.00000	-921.91759
36	ENVEQ MIN	0.25000	-715.39436	0.00000	-946.69225
36	ENVEQ MIN	0.50000	-714.63217	0.00000	-971.29362
36	ENVEQ MIN	0.75000	-713.86999	0.00000	-995.71906
36	ENVEQ MIN	1.00000	-713.10780	0.00000	-1019.96600
37	ENVEQ MAX	0.00000	0.00000	482.62208	0.00000
37	ENVEQ MAX	0.22500	0.00000	478.27939	0.00000
37	ENVEQ MAX	0.45000	0.00000	473.69489	0.00000
37	ENVEQ MAX	0.67500	0.00000	468.86858	0.00000
37	ENVEQ MAX	0.90000	0.00000	463.80045	0.00000
37	ENVEQ MIN	0.00000	-713.10783	0.00000	-1019.96600
37	ENVEQ MIN	0.22500	-711.37252	0.00000	-1070.42100
37	ENVEQ MIN	0.45000	-709.21533	0.00000	-1123.97200
37	ENVEQ MIN	0.67500	-706.63627	0.00000	-1176.99300
37	ENVEQ MIN	0.90000	-703.63533	0.00000	-1229.45800
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
40	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
40	ENVEQ MIN	0.10000	-512.35966	-620.21240	-1127.81800
40	ENVEQ MIN	0.32500	-509.69712	-604.86571	-1058.91100
40	ENVEQ MIN	0.55000	-507.03458	-589.94090	-991.70739
40	ENVEQ MIN	0.77500	-504.37205	-575.43796	-926.15879
40	ENVEQ MIN	1.00000	-501.70951	-561.35690	-862.21803
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
41	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	-501.70951	-561.35694	-862.21803
41	ENVEQ MIN	0.25000	-501.01725	-557.75071	-845.85108
41	ENVEQ MIN	0.50000	-500.32499	-554.14447	-829.58961
41	ENVEQ MIN	0.75000	-499.63273	-550.53824	-813.43363
41	ENVEQ MIN	1.00000	-498.94047	-546.93201	-797.38313
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.25000	0.00000	0.00000	54.96887
42	ENVEQ MAX	0.50000	0.00000	0.00000	114.95829
42	ENVEQ MAX	0.75000	0.00000	0.00000	171.35888
42	ENVEQ MAX	1.00000	0.00000	0.00000	253.17723
42	ENVEQ MIN	0.00000	-511.93342	-546.92851	-797.38313
42	ENVEQ MIN	0.25000	-505.62617	-514.07172	-656.00485
42	ENVEQ MIN	0.50000	-499.31891	-481.21494	-523.38290
42	ENVEQ MIN	0.75000	-493.01166	-448.35815	-407.61944
42	ENVEQ MIN	1.00000	-486.70440	-415.50137	-301.30468
43	ENVEQ MAX	0.00000	0.00000	0.00000	253.17723
43	ENVEQ MAX	0.25000	0.00000	0.00000	326.46951
43	ENVEQ MAX	0.50000	0.00000	0.00000	391.15553
43	ENVEQ MAX	0.75000	0.00000	0.00000	447.23528
43	ENVEQ MAX	1.00000	0.00000	0.00000	494.70956
43	ENVEQ MIN	0.00000	-499.73769	-415.49773	-301.30468
43	ENVEQ MIN	0.25000	-493.42451	-382.61012	-215.17583
43	ENVEQ MIN	0.50000	-487.11134	-349.72252	-142.26667
43	ENVEQ MIN	0.75000	-480.79817	-316.83491	-75.35005

35	ENVEQ MAX	0.25000	0.00000	415.01070	0.00000
FRAME	LOAD	DIST	P	V2	M3
44	ENVEQ MAX	0.25000	0.00000	0.00000	533.57662
44	ENVEQ MAX	0.50000	0.00000	0.00000	563.83742
44	ENVEQ MAX	0.75000	0.00000	0.00000	585.49195
44	ENVEQ MAX	1.00000	0.00000	0.00000	598.54022
44	ENVEQ MIN	0.00000	-487.55772	-283.94349	-17.06277
44	ENVEQ MIN	0.25000	-481.24455	-251.05588	0.00000
44	ENVEQ MIN	0.50000	-474.93138	-218.16827	0.00000
44	ENVEQ MIN	0.75000	-468.61820	-185.28066	0.00000
44	ENVEQ MIN	1.00000	-462.30503	-152.39306	0.00000
45	ENVEQ MAX	0.00000	0.00000	0.00000	598.54022
45	ENVEQ MAX	0.25000	0.00000	13.78631	602.98102
45	ENVEQ MAX	0.50000	0.00000	35.76257	598.83169
45	ENVEQ MAX	0.75000	0.00000	65.37920	586.26461
45	ENVEQ MAX	1.00000	0.00000	97.61238	566.91623
45	ENVEQ MIN	0.00000	-475.41615	-152.38940	0.00000
45	ENVEQ MIN	0.25000	-469.10889	-119.53261	0.00000
45	ENVEQ MIN	0.50000	-462.80163	-86.67583	0.00000
45	ENVEQ MIN	0.75000	-457.05136	-59.96943	0.00000
45	ENVEQ MIN	1.00000	-463.35862	-37.52547	0.00000
46	ENVEQ MAX	0.00000	0.00000	96.93965	566.91623
46	ENVEQ MAX	0.25000	0.00000	129.20306	538.78000
46	ENVEQ MAX	0.50000	0.00000	161.46648	501.87099
46	ENVEQ MAX	0.75000	0.00000	193.72989	456.18921
46	ENVEQ MAX	1.00000	0.00000	225.99330	402.99226
46	ENVEQ MIN	0.00000	-463.33561	-38.64426	0.00000
46	ENVEQ MIN	0.25000	-457.02244	-16.17924	0.00000
46	ENVEQ MIN	0.50000	-462.54126	0.00000	0.00000
46	ENVEQ MIN	0.75000	-468.85443	0.00000	0.00000
46	ENVEQ MIN	1.00000	-475.16760	0.00000	0.00000
47	ENVEQ MAX	0.00000	0.00000	225.99733	402.99226
47	ENVEQ MAX	0.25000	0.00000	258.26074	350.83098
47	ENVEQ MAX	0.50000	0.00000	290.52416	308.16503
47	ENVEQ MAX	0.75000	0.00000	322.78757	256.72632
47	ENVEQ MAX	1.00000	0.00000	355.05098	196.51483
47	ENVEQ MIN	0.00000	-461.76130	0.00000	0.00000
47	ENVEQ MIN	0.25000	-468.07447	0.00000	0.00000
47	ENVEQ MIN	0.50000	-474.38764	0.00000	0.00000
47	ENVEQ MIN	0.75000	-480.70082	0.00000	0.00000
47	ENVEQ MIN	1.00000	-487.01399	0.00000	0.00000
48	ENVEQ MAX	0.00000	0.00000	355.05493	196.51483
48	ENVEQ MAX	0.25000	0.00000	387.28811	127.59990
48	ENVEQ MAX	0.50000	0.00000	419.52128	57.76313
48	ENVEQ MAX	0.75000	0.00000	451.75446	4.96943
48	ENVEQ MAX	1.00000	0.00000	484.35330	0.00000
48	ENVEQ MIN	0.00000	-473.64603	0.00000	0.00000
48	ENVEQ MIN	0.25000	-479.95329	0.00000	-58.33323
48	ENVEQ MIN	0.50000	-486.26054	0.00000	-154.91335
48	ENVEQ MIN	0.75000	-492.56780	0.00000	-261.79578
48	ENVEQ MIN	1.00000	-498.87505	0.00000	-382.90418
49	ENVEQ MAX	0.00000	0.00000	484.35725	0.00000
49	ENVEQ MAX	0.25000	0.00000	494.12799	0.00000
49	ENVEQ MAX	0.50000	0.00000	503.89872	0.00000
49	ENVEQ MAX	0.75000	0.00000	513.66945	0.00000
49	ENVEQ MAX	1.00000	0.00000	523.44018	0.00000
49	ENVEQ MIN	0.00000	-485.54638	0.00000	-382.90418
49	ENVEQ MIN	0.25000	-487.42199	0.00000	-421.64033
49	ENVEQ MIN	0.50000	-489.29760	0.00000	-461.13611
49	ENVEQ MIN	0.75000	-491.17321	0.00000	-501.39152
49	ENVEQ MIN	1.00000	-493.04882	0.00000	-542.40657
50	ENVEQ MAX	0.00000	0.00000	523.44014	0.00000
50	ENVEQ MAX	0.22500	0.00000	537.31026	0.00000
50	ENVEQ MAX	0.45000	0.00000	551.18039	0.00000
50	ENVEQ MAX	0.67500	0.00000	565.05051	0.00000
50	ENVEQ MAX	0.90000	0.00000	578.92064	0.00000
50	ENVEQ MIN	0.00000	-493.04882	0.00000	-542.40657
50	ENVEQ MIN	0.22500	-495.71136	0.00000	-601.93438
50	ENVEQ MIN	0.45000	-498.37390	0.00000	-662.99296
50	ENVEQ MIN	0.67500	-501.03643	0.00000	-725.58232
50	ENVEQ MIN	0.90000	-503.69897	0.00000	-789.70245
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000

43	ENVEQ MIN	1.00000	-474.48500	-283.94730	-17.06276
44	ENVEQ MAX	0.00000	0.00000	0.00000	494.70956
FRAME	LOAD	DIST	P	V2	M3
53	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
53	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
53	ENVEQ MIN	0.10000	-503.69897	-578.92064	-789.70245
53	ENVEQ MIN	0.32500	-501.03643	-565.05051	-725.58232
53	ENVEQ MIN	0.55000	-498.37390	-551.18039	-662.99296
53	ENVEQ MIN	0.77500	-495.71136	-537.31026	-601.93438
53	ENVEQ MIN	1.00000	-493.04882	-523.44014	-542.40657
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
54	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	-493.04882	-523.44018	-542.40657
54	ENVEQ MIN	0.25000	-491.17321	-513.66945	-501.39152
54	ENVEQ MIN	0.50000	-489.29760	-503.89872	-461.13611
54	ENVEQ MIN	0.75000	-487.42199	-494.12799	-421.64033
54	ENVEQ MIN	1.00000	-485.54638	-484.35725	-382.90418
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.25000	0.00000	0.00000	4.96935
55	ENVEQ MAX	0.50000	0.00000	0.00000	57.76313
55	ENVEQ MAX	0.75000	0.00000	0.00000	127.59990
55	ENVEQ MAX	1.00000	0.00000	0.00000	196.51483
55	ENVEQ MIN	0.00000	-498.87505	-484.35330	-382.90418
55	ENVEQ MIN	0.25000	-492.56780	-451.75446	-261.79578
55	ENVEQ MIN	0.50000	-486.26054	-419.52128	-154.91335
55	ENVEQ MIN	0.75000	-479.95329	-387.28811	-58.33318
55	ENVEQ MIN	1.00000	-473.64603	-355.05493	0.00000
56	ENVEQ MAX	0.00000	0.00000	0.00000	196.51483
56	ENVEQ MAX	0.25000	0.00000	0.00000	256.72632
56	ENVEQ MAX	0.50000	0.00000	0.00000	308.16503
56	ENVEQ MAX	0.75000	0.00000	0.00000	350.83098
56	ENVEQ MAX	1.00000	0.00000	0.00000	402.99226
56	ENVEQ MIN	0.00000	-487.01399	-355.05098	0.00000
56	ENVEQ MIN	0.25000	-480.70082	-322.78757	0.00000
56	ENVEQ MIN	0.50000	-474.38764	-290.52416	0.00000
56	ENVEQ MIN	0.75000	-468.07447	-258.26074	0.00000
56	ENVEQ MIN	1.00000	-461.76130	-225.99733	0.00000
57	ENVEQ MAX	0.00000	0.00000	0.00000	402.99226
57	ENVEQ MAX	0.25000	0.00000	0.00000	456.18921
57	ENVEQ MAX	0.50000	0.00000	0.00000	501.87099
57	ENVEQ MAX	0.75000	0.00000	16.17925	538.78000
57	ENVEQ MAX	1.00000	0.00000	38.64427	566.91623
57	ENVEQ MIN	0.00000	-475.16760	-225.99330	0.00000
57	ENVEQ MIN	0.25000	-468.85443	-193.72989	0.00000
57	ENVEQ MIN	0.50000	-462.54126	-161.46648	0.00000
57	ENVEQ MIN	0.75000	-457.02244	-129.20306	0.00000
57	ENVEQ MIN	1.00000	-463.33561	-96.93965	0.00000
58	ENVEQ MAX	0.00000	0.00000	37.52547	566.91623
58	ENVEQ MAX	0.25000	0.00000	59.96943	586.26461
58	ENVEQ MAX	0.50000	0.00000	86.67583	598.83169
58	ENVEQ MAX	0.75000	0.00000	119.53261	602.98102
58	ENVEQ MAX	1.00000	0.00000	152.38940	598.54022
58	ENVEQ MIN	0.00000	-463.35862	-97.61237	0.00000
58	ENVEQ MIN	0.25000	-457.05136	-65.37920	0.00000
58	ENVEQ MIN	0.50000	-462.80163	-35.76257	0.00000
58	ENVEQ MIN	0.75000	-469.10889	-13.78631	0.00000
58	ENVEQ MIN	1.00000	-475.41615	0.00000	0.00000
59	ENVEQ MAX	0.00000	0.00000	152.39306	598.54022
59	ENVEQ MAX	0.25000	0.00000	185.28066	585.49195
59	ENVEQ MAX	0.50000	0.00000	218.16827	563.83742
59	ENVEQ MAX	0.75000	0.00000	251.05588	533.57662
59	ENVEQ MAX	1.00000	0.00000	283.94349	494.70956
59	ENVEQ MIN	0.00000	-462.30503	0.00000	0.00000
59	ENVEQ MIN	0.25000	-468.61820	0.00000	0.00000
59	ENVEQ MIN	0.50000	-474.93138	0.00000	0.00000
59	ENVEQ MIN	0.75000	-481.24455	0.00000	0.00000
59	ENVEQ MIN	1.00000	-487.55772	0.00000	-17.06277
60	ENVEQ MAX	0.00000	0.00000	283.94730	494.70956
60	ENVEQ MAX	0.25000	0.00000	316.83491	447.23528
60	ENVEQ MAX	0.50000	0.00000	349.72252	391.15553
60	ENVEQ MAX	0.75000	0.00000	382.61012	326.46951
60	ENVEQ MAX	1.00000	0.00000	415.49773	253.17723
60	ENVEQ MIN	0.00000	-474.48500	0.00000	-17.06276
60	ENVEQ MIN	0.25000	-480.79817	0.00000	-75.35005
60	ENVEQ MIN	0.50000	-487.11134	0.00000	-142.26667
60	ENVEQ MIN	0.75000	-493.42451	0.00000	-215.17583
60	ENVEQ MIN	1.00000	-499.73769	0.00000	-301.30468
61	ENVEQ MAX	0.00000	0.00000	415.50137	253.17723
61	ENVEQ MAX	0.25000	0.00000	448.35815	171.35888
61	ENVEQ MAX	0.50000	0.00000	481.21494	114.95826
61	ENVEQ MAX	0.75000	0.00000	514.07172	54.96882
61	ENVEQ MAX	1.00000	0.00000	546.92851	0.00000
61	ENVEQ MIN	0.00000	-486.70440	0.00000	-301.30468
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
61	ENVEQ MIN	1.00000	-511.93342	0.00000	-797.38313
62	ENVEQ MAX	0.00000	0.00000	546.93201	0.00000
62	ENVEQ MAX	0.25000	0.00000	550.53824	0.00000
62	ENVEQ MAX	0.50000	0.00000	554.14447	0.00000
62	ENVEQ MAX	0.75000	0.00000	557.75071	0.00000
62	ENVEQ MAX	1.00000	0.00000	561.35694	0.00000
62	ENVEQ MIN	0.00000	-498.94047	0.00000	-797.38313
62	ENVEQ MIN	0.25000	-499.63273	0.00000	-813.43363
62	ENVEQ MIN	0.50000	-500.32499	0.00000	-829.58961
62	ENVEQ MIN	0.75000	-501.01725	0.00000	-845.85108
62	ENVEQ MIN	1.00000	-501.70951	0.00000	-862.21803
63	ENVEQ MAX	0.00000	0.00000	561.35690	0.00000
63	ENVEQ MAX	0.22500	0.00000	575.43796	0.00000
63	ENVEQ MAX	0.45000	0.00000	589.94090	0.00000
63	ENVEQ MAX	0.67500	0.00000	604.86571	0.00000
63	ENVEQ MAX	0.90000	0.00000	620.21240	0.00000
63	ENVEQ MIN	0.00000	-501.70951	0.00000	-862.21803
63	ENVEQ MIN	0.22500	-504.37205	0.00000	-926.15879
63	ENVEQ MIN	0.45000	-507.03458	0.00000	-991.70739
63	ENVEQ MIN	0.67500	-509.69712	0.00000	-1058.91100
63	ENVEQ MIN	0.90000	-512.35966	0.00000	-1127.81800
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
66	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
66	ENVEQ MIN	0.10000	-703.63533	-463.80045	-1229.45800
66	ENVEQ MIN	0.32500	-706.63627	-468.86858	-1176.99300
66	ENVEQ MIN	0.55000	-709.21533	-473.69489	-1123.97200
66	ENVEQ MIN	0.77500	-711.37252	-478.27939	-1070.42100
66	ENVEQ MIN	1.00000	-713.10783	-482.62208	-1019.96600
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
67	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	-713.10780	-482.62209	-1019.96600
67	ENVEQ MIN	0.25000	-713.86999	-484.70154	-995.71906
67	ENVEQ MIN	0.50000	-714.63217	-486.71810	-971.29362
67	ENVEQ MIN	0.75000	-715.39436	-488.67177	-946.69225
67	ENVEQ MIN	1.00000	-716.15655	-490.56256	-921.91759
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
68	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	-601.11569	-394.17707	-921.91759
68	ENVEQ MIN	0.25000	-605.09600	-402.96519	-831.20480
68	ENVEQ MIN	0.50000	-609.07631	-409.90973	-735.02665
68	ENVEQ MIN	0.75000	-613.05663	-415.01070	-634.77848
68	ENVEQ MIN	1.00000	-617.03694	-418.26810	-530.05483
69	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
69	ENVEQ MAX	0.25000	0.00000	9.51464	0.00000
69	ENVEQ MAX	0.50000	0.00000	25.77759	0.00000
69	ENVEQ MAX	0.75000	0.00000	42.41801	0.00000
69	ENVEQ MAX	1.00000	0.00000	73.41671	35.90929
69	ENVEQ MIN	0.00000	-502.15179	-330.73178	-530.05483
69	ENVEQ MIN	0.25000	-506.13211	-332.03985	-446.37943
69	ENVEQ MIN	0.50000	-510.11242	-331.29284	-357.98899
69	ENVEQ MIN	0.75000	-519.77469	-331.48522	-265.23370
69	ENVEQ MIN	1.00000	-531.65688	-343.16905	-256.80083
70	ENVEQ MAX	0.00000	0.00000	71.71959	35.90909
70	ENVEQ MAX	0.25000	0.00000	102.28502	92.39765
70	ENVEQ MAX	0.50000	0.00000	132.31317	147.54207
70	ENVEQ MAX	0.75000	0.00000	161.80405	200.10292
70	ENVEQ MAX	1.00000	0.00000	190.75767	255.09981

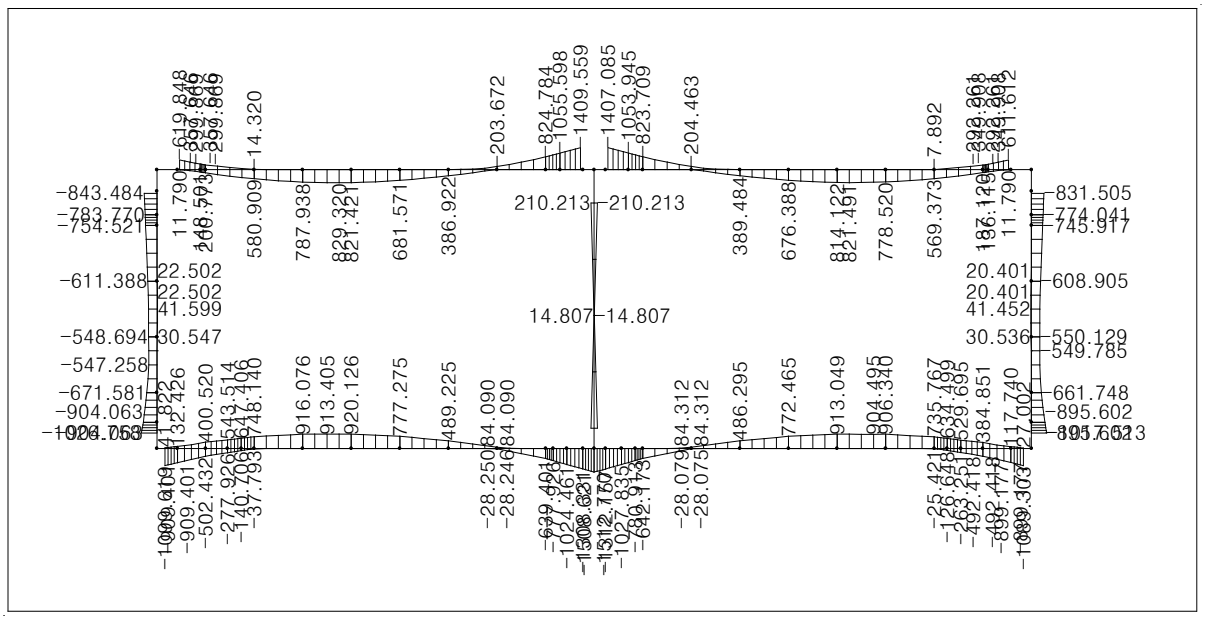
61	ENVEQ MIN	0.25000	-493.01166	0.00000	-407.61944
61	ENVEQ MIN	0.50000	-499.31891	0.00000	-523.38290
61	ENVEQ MIN	0.75000	-505.62617	0.00000	-656.00485
FRAME	LOAD	DIST	P	V2	M3
70	ENVEQ MIN	0.75000	-462.37890	-298.05509	-274.39345
70	ENVEQ MIN	1.00000	-474.26109	-305.62921	-286.61633
71	ENVEQ MAX	0.00000	0.00000	189.81640	255.09981
71	ENVEQ MAX	0.25000	0.00000	204.97654	276.88207
71	ENVEQ MAX	0.50000	0.00000	219.94101	297.45120
71	ENVEQ MAX	0.75000	0.00000	234.70982	318.87550
71	ENVEQ MAX	1.00000	0.00000	249.28297	357.77695
71	ENVEQ MIN	0.00000	-369.43671	-244.92752	-286.61633
71	ENVEQ MIN	0.25000	-375.75702	-248.36403	-294.15775
71	ENVEQ MIN	0.50000	-382.07733	-251.36073	-302.33712
71	ENVEQ MIN	0.75000	-388.39764	-253.91762	-313.44477
71	ENVEQ MIN	1.00000	-394.71796	-256.03471	-344.85565
72	ENVEQ MAX	0.00000	0.00000	248.83500	357.77695
72	ENVEQ MAX	0.10227	0.00000	254.03157	371.87403
72	ENVEQ MAX	0.20455	0.00000	259.19904	386.01482
72	ENVEQ MAX	0.30682	0.00000	264.33743	400.19589
72	ENVEQ MAX	0.40909	0.00000	269.44672	414.41383
72	ENVEQ MIN	0.00000	-394.71791	-256.03475	-344.85565
72	ENVEQ MIN	0.10227	-396.99322	-256.68737	-356.75169
72	ENVEQ MIN	0.20455	-399.26853	-257.27926	-368.95661
72	ENVEQ MIN	0.30682	-401.54385	-257.81042	-381.46879
72	ENVEQ MIN	0.40909	-403.81916	-258.28084	-394.56163
73	ENVEQ MAX	0.11915	0.00000	106.79442	267.07385
73	ENVEQ MAX	0.32128	0.00000	109.88264	138.41597
73	ENVEQ MAX	0.52340	0.00000	112.91158	6.12604
73	ENVEQ MAX	0.72553	0.00000	115.88123	129.77976
73	ENVEQ MAX	0.92766	0.00000	118.79159	269.07696
73	ENVEQ MIN	0.11915	-1140.46900	-106.79442	-267.07385
73	ENVEQ MIN	0.32128	-1158.28200	-109.88264	-138.41597
73	ENVEQ MIN	0.52340	-1176.09400	-112.91158	-6.12604
73	ENVEQ MIN	0.72553	-1193.90700	-115.88123	-129.77976
73	ENVEQ MIN	0.92766	-1211.71900	-118.79159	-269.07696

70	ENVEQ MIN	0.00000	-426.73234	-266.93176	-256.80083
70	ENVEQ MIN	0.25000	-438.61453	-278.70637	-259.07440
70	ENVEQ MIN	0.50000	-450.49672	-289.08081	-265.07571

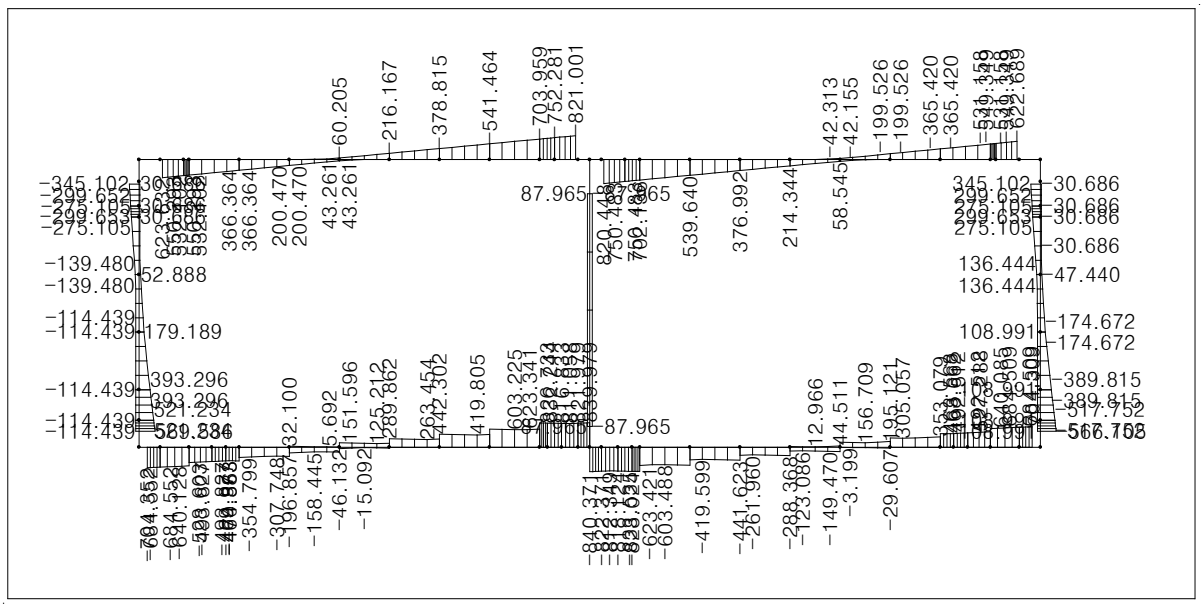
21. 단면력정리

21.1 상시

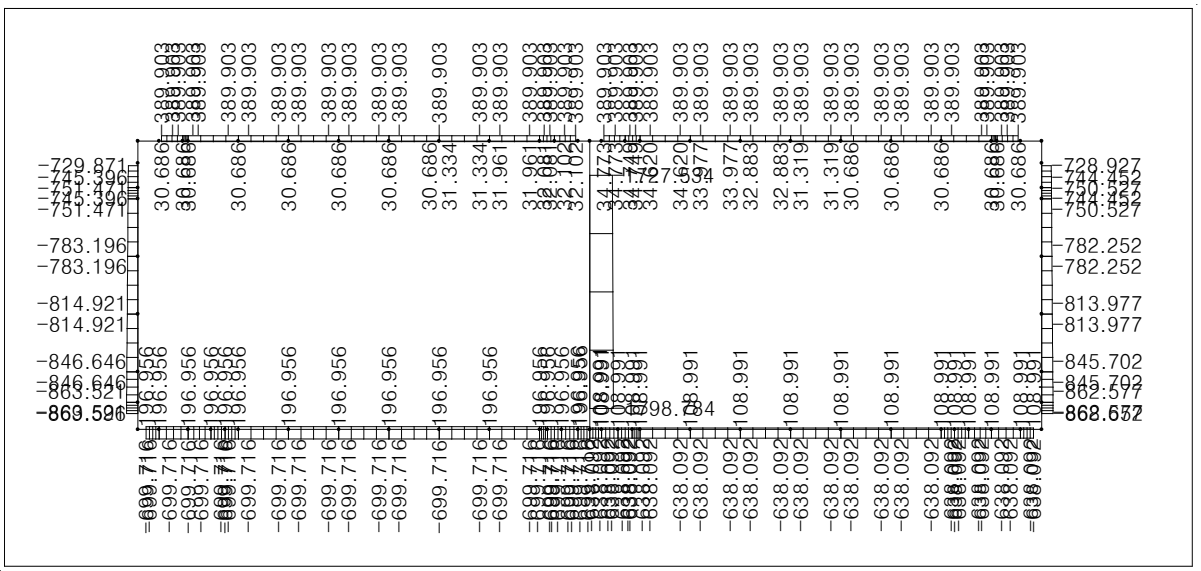
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



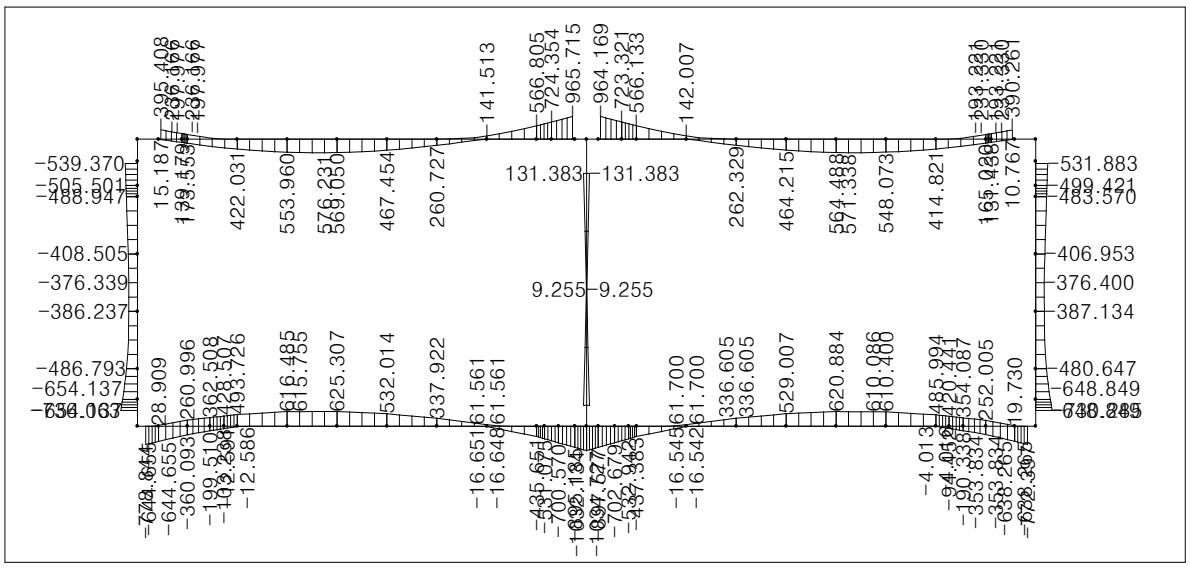
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

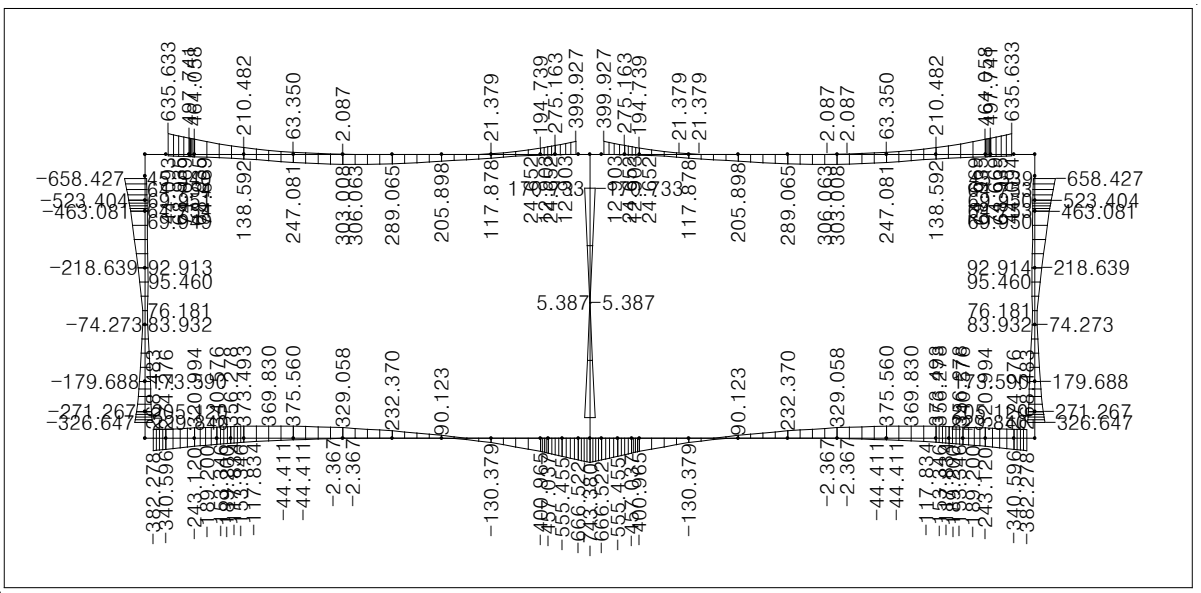


5) 단면력 정리

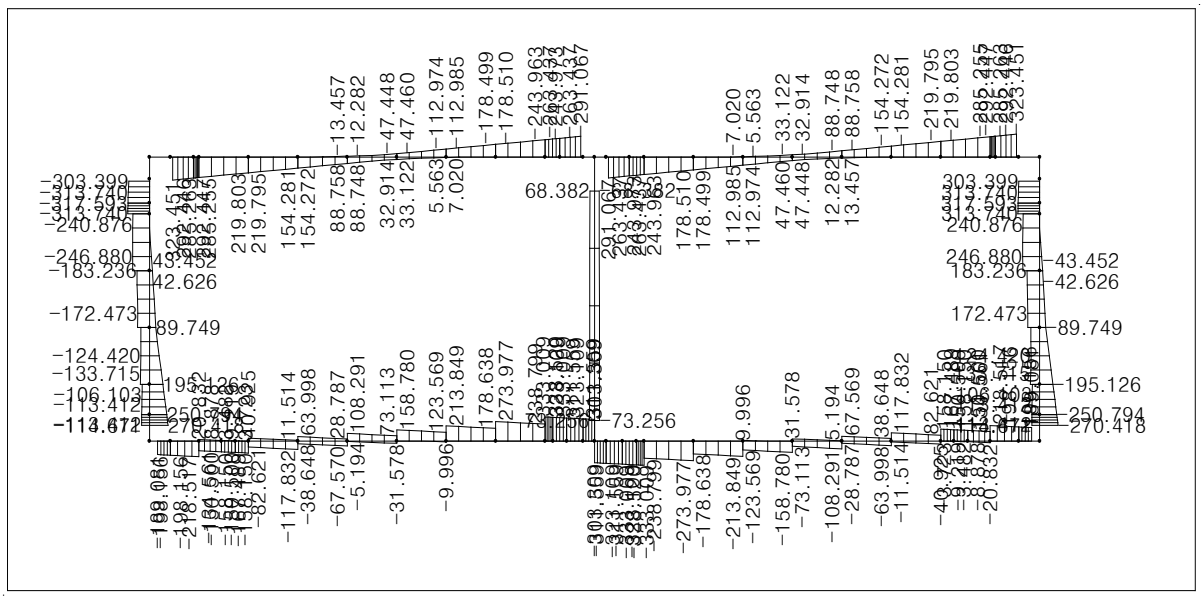
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	619.85	503.62	389.90	395.41	1000.00	1050.00	
		중앙부	2	829.32	76.05	389.90	576.23	1000.00	900.00	
		우측	3	1409.56	706.50	389.90	965.72	1000.00	1050.00	
	2 경간	좌측	4	1407.09	704.68	389.90	964.17	1000.00	1050.00	
		중앙부	5	821.49	75.11	389.90	571.34	1000.00	900.00	
		우측	6	611.61	502.67	389.90	390.26	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	909.40	501.02	699.72	644.66	1000.00	1100.00	
		측구부	8	277.93	501.05	699.72	199.51	1000.00	1100.00	
		중앙부	9	920.13	171.25	699.72	625.31	1000.00	1100.00	
		우측	10	1308.33	610.15	699.72	895.19	1000.00	1100.00	
	2 경간	좌측	11	1312.16	610.23	638.09	897.58	1000.00	1100.00	
		중앙부	12	913.05	168.54	638.09	620.88	1000.00	1100.00	
		측구부	13	263.25	499.71	638.09	190.34	1000.00	1100.00	
		우측	14	899.18	499.71	638.09	638.27	1000.00	1100.00	
좌측 벽체	1 층	상부	15	843.48	272.22	729.87	539.37	1000.00	1050.00	
		중앙부	16	0.00	393.30	846.65	0.00	1000.00	900.00	
		하부	17	904.06	325.91	863.52	654.14	1000.00	900.00	
우측 벽체	1 층	상부	18	831.51	272.22	728.93	531.88	1000.00	1050.00	
		중앙부	19	0.00	389.82	845.70	0.00	1000.00	900.00	
		하부	20	895.60	322.43	862.58	648.85	1000.00	900.00	
중간 벽체	1 련	상부	21	210.21	87.97	1727.53	131.38	1000.00	500.00	
		중앙부	22	105.75	87.97	1745.35	66.10	1000.00	500.00	
		하부	23	207.62	87.97	1798.78	129.77	1000.00	500.00	

21.2 지진시(기능수행)

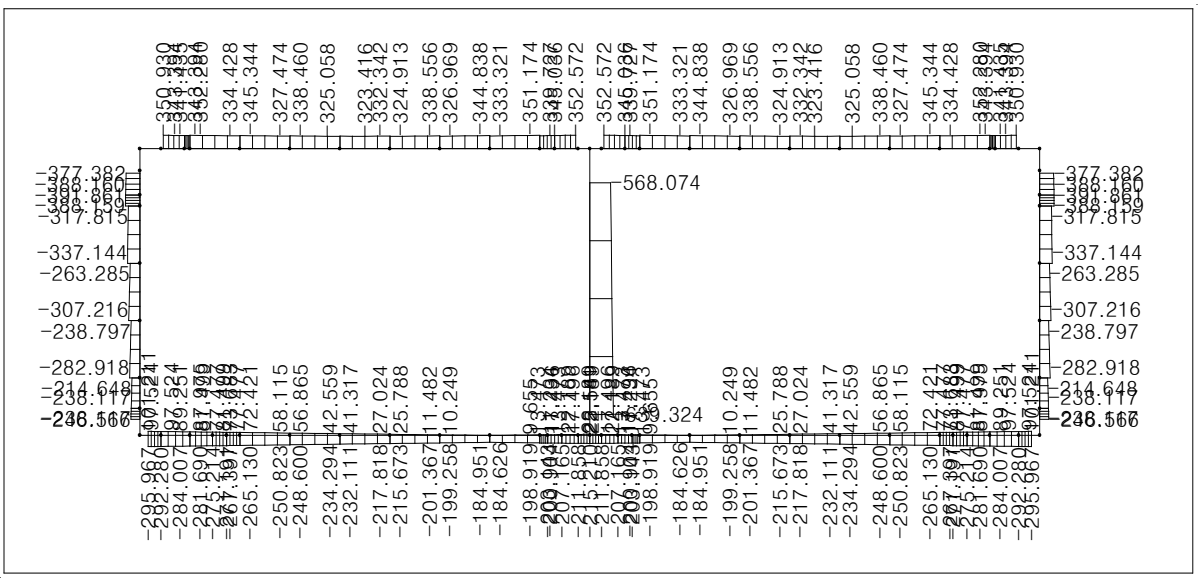
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

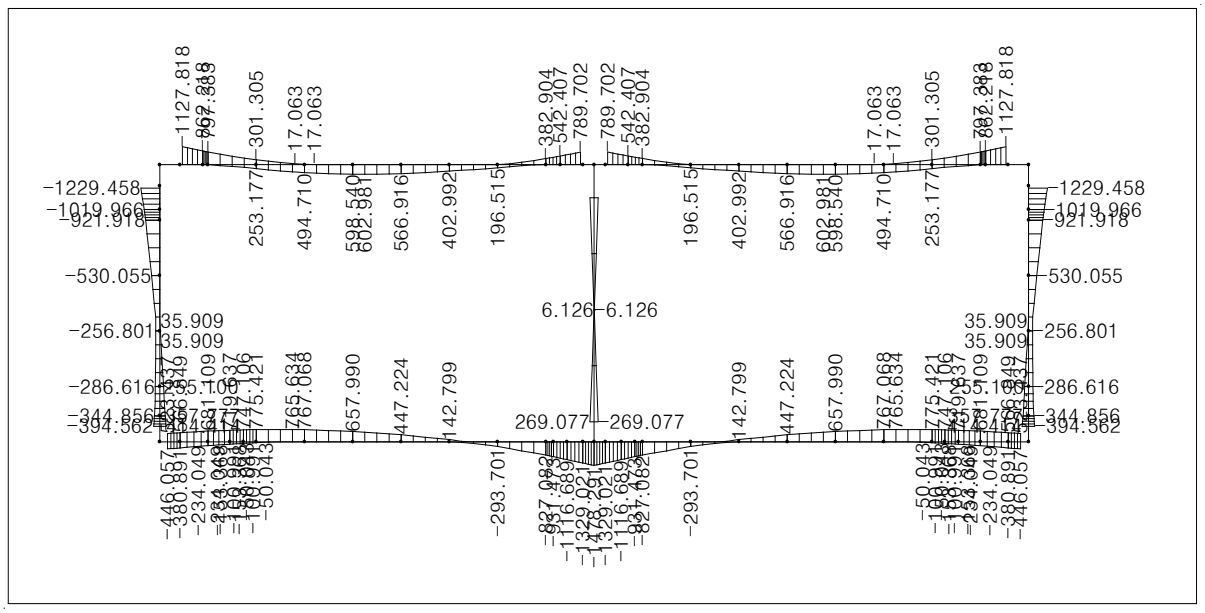


4) 단면력 정리

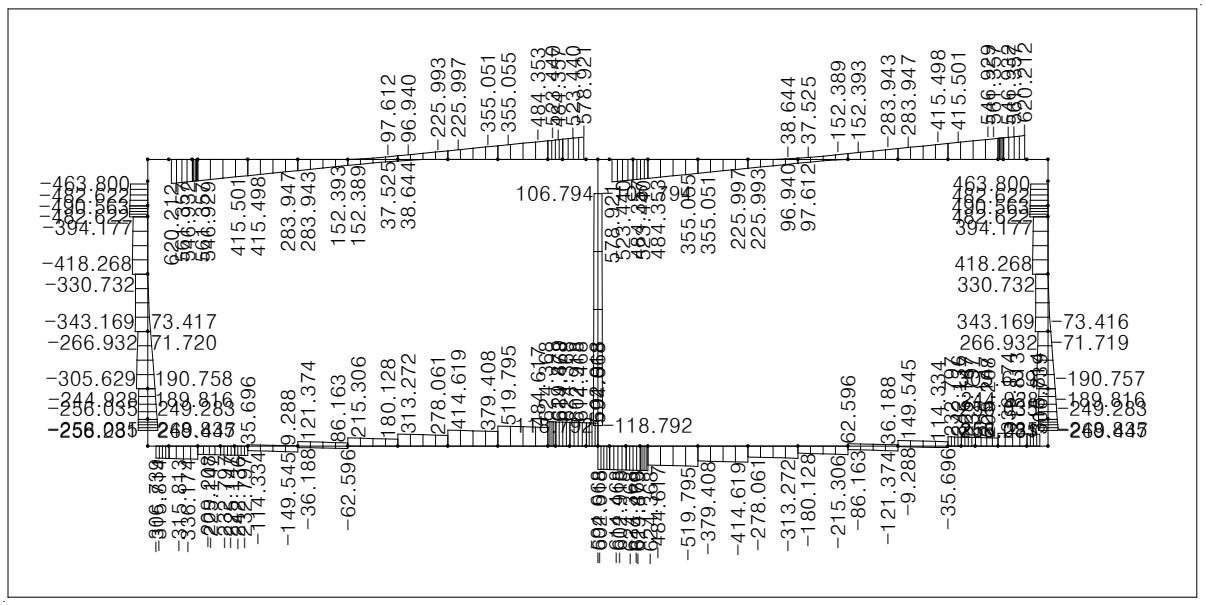
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	635.63	274.01	350.93	1000.00	1050.00	
		중앙부	2	295.58	105.14	325.06	1000.00	900.00	
		우측	3	399.93	245.00	352.57	1000.00	1050.00	
	2 경간	좌측	4	399.93	245.00	352.57	1000.00	1050.00	
		중앙부	5	295.58	105.14	325.06	1000.00	900.00	
		우측	6	635.63	274.01	350.93	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	340.60	147.20	292.28	1000.00	1100.00	
		측구부	8	189.20	147.19	295.97	1000.00	1100.00	
		중앙부	9	329.06	108.29	234.29	1000.00	1100.00	
		우측	10	666.52	244.85	211.86	1000.00	1100.00	
	2 경간	좌측	11	666.52	244.85	211.86	1000.00	1100.00	
		중앙부	12	329.06	108.29	232.11	1000.00	1100.00	
		측구부	13	189.20	147.20	275.21	1000.00	1100.00	
		우측	14	340.60	147.20	292.28	1000.00	1100.00	
좌측 벽체	1 층	상부	15	658.43	241.19	377.38	1000.00	1050.00	
		중앙부	16	173.59	195.13	282.92	1000.00	900.00	
		하부	17	271.27	163.32	238.12	1000.00	900.00	
우측 벽체	1 층	상부	18	658.43	241.19	377.38	1000.00	1050.00	
		중앙부	19	173.59	195.13	214.65	1000.00	900.00	
		하부	20	271.27	163.32	238.12	1000.00	900.00	
중간 벽체	1 련	상부	21	170.73	68.93	568.07	1000.00	500.00	
		중앙부	22	88.78	69.64	585.89	1000.00	500.00	
		하부	23	165.81	72.14	639.32	1000.00	500.00	

21.3 지진시(붕괴방지)

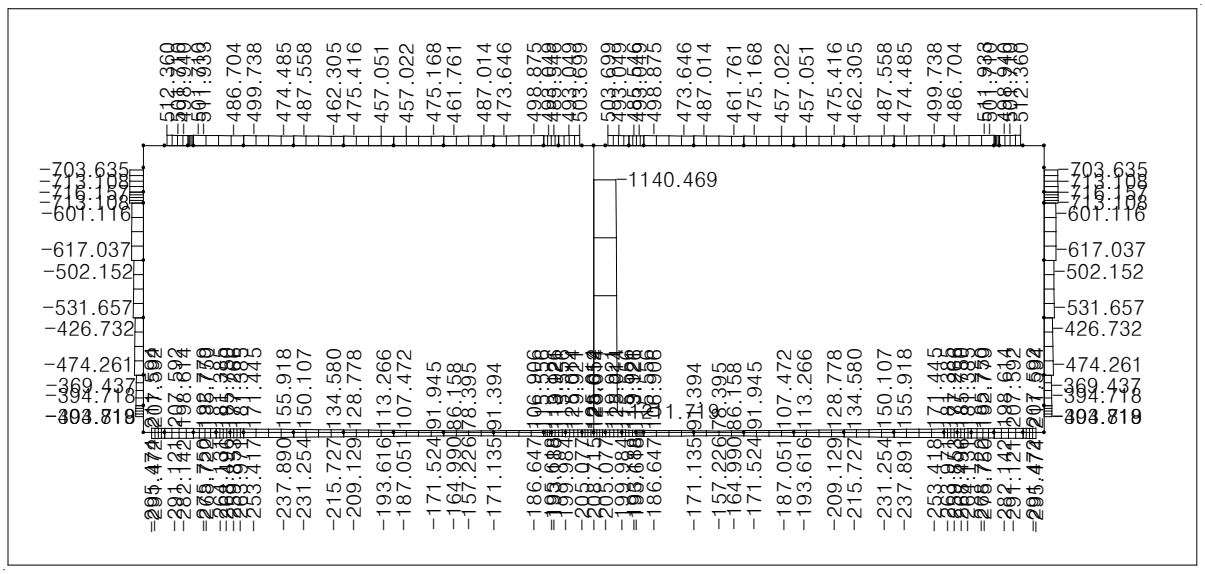
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	1127.82	524.34	512.36	1000.00	1050.00	
		중앙부	2	585.49	185.28	468.62	1000.00	900.00	
		우측	3	789.70	486.42	503.70	1000.00	1050.00	
	2 경간	좌측	4	789.70	486.42	503.70	1000.00	1050.00	
		중앙부	5	585.49	185.28	468.62	1000.00	900.00	
		우측	6	1127.82	524.34	512.36	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	380.89	221.85	291.12	1000.00	1100.00	
		측구부	8	153.37	221.84	295.47	1000.00	1100.00	
		중앙부	9	657.99	215.31	215.73	1000.00	1100.00	
		우측	10	1329.02	490.66	205.08	1000.00	1100.00	
	2 경간	좌측	11	1329.02	490.66	205.08	1000.00	1100.00	
		중앙부	12	657.99	215.31	209.13	1000.00	1100.00	
		측구부	13	153.37	221.85	268.50	1000.00	1100.00	
		우측	14	380.89	221.85	291.12	1000.00	1100.00	
좌측 벽체	1 층	상부	15	1229.46	394.93	703.64	1000.00	1050.00	
		중앙부	16	255.10	305.63	474.26	1000.00	900.00	
		하부	17	344.86	296.34	394.72	1000.00	900.00	
우측 벽체	1 층	상부	18	1229.46	394.93	703.64	1000.00	1050.00	
		중앙부	19	255.10	305.63	369.44	1000.00	900.00	
		하부	20	344.86	296.34	394.72	1000.00	900.00	
중간 벽체	1 련	상부	21	267.07	108.15	1140.47	1000.00	500.00	
		중앙부	22	138.42	109.88	1158.28	1000.00	500.00	
		하부	23	269.08	116.05	1211.72	1000.00	500.00	

21.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-619.85	-	-1127.82	-635.63	-1127.82	
		중앙부	2	829.32	-	585.49	295.58	829.32	
		우측	3	-1409.56	-	-789.70	-399.93	-1409.56	
	2 경간	좌측	4	-1407.09	-	-789.70	-399.93	-1407.09	
		중앙부	5	821.49	-	585.49	295.58	821.49	
		우측	6	-611.61	-	-1127.82	-635.63	-1127.82	
하부 슬래브	1 경간	좌측	7	-909.40	-	-380.89	-340.60	-909.40	
		측구부	8	-277.93	-	-153.37	-189.20	-277.93	
		중앙부	9	920.13	-	657.99	329.06	920.13	
		우측	10	-1308.33	-	-1329.02	-666.52	-1329.02	
	2 경간	좌측	11	-1312.16	-	-1329.02	-666.52	-1329.02	
		중앙부	12	913.05	-	657.99	329.06	913.05	
		측구부	13	-263.25	-	-153.37	-189.20	-263.25	
		우측	14	-899.18	-	-380.89	-340.60	-899.18	
좌측 벽체	1 층	상부	15	-843.48	-	-1229.46	-658.43	-1229.46	
		중앙부	16	-	-	255.10	173.59	255.10	
		하부	17	-904.06	-	-344.86	-271.27	-904.06	
우측 벽체	1 층	상부	18	-831.51	-	-1229.46	-658.43	-1229.46	
		중앙부	19	-	-	255.10	173.59	255.10	
		하부	20	-895.60	-	-344.86	-271.27	-895.60	
중간 벽체	1 련	상부	21	-210.21	-	-267.07	-170.73	-267.07	
		중앙부	22	105.75	-	138.42	88.78	138.42	
		하부	23	-207.62	-	-269.08	-165.81	-269.08	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	503.62	-	524.34	274.01	524.34	
		중앙부	2	76.05	-	185.28	105.14	185.28	
		우측	3	-706.50	-	-486.42	-245.00	-706.50	
	2 경간	좌측	4	704.68	-	486.42	245.00	704.68	
		중앙부	5	-75.11	-	-185.28	-105.14	-185.28	
		우측	6	-502.67	-	-524.34	-274.01	-524.34	
하부 슬래브	1 경간	좌측	7	-501.02	-	-221.85	-147.20	-501.02	
		측구부	8	-501.05	-	-221.84	-147.19	-501.05	
		중앙부	9	-171.25	-	215.31	108.29	215.31	
		우측	10	610.15	-	490.66	244.85	610.15	
	2 경간	좌측	11	-610.23	-	-490.66	-244.85	-610.23	
		중앙부	12	168.54	-	-215.31	-108.29	-215.31	
		측구부	13	499.71	-	221.85	147.20	499.71	
		우측	14	499.71	-	221.85	147.20	499.71	
좌측 벽체	1 층	상부	15	-272.22	-	-394.93	-241.19	-394.93	
		중앙부	16	393.30	-	-305.63	195.13	393.30	
		하부	17	325.91	-	-296.34	163.32	325.91	
우측 벽체	1 층	상부	18	272.22	-	394.93	241.19	394.93	
		중앙부	19	-389.82	-	305.63	-195.13	-389.82	
		하부	20	-322.43	-	296.34	-163.32	-322.43	
중간 벽체	1 련	상부	21	-87.97	-	-108.15	-68.93	-108.15	
		중앙부	22	-87.97	-	-109.88	-69.64	-109.88	
		하부	23	-87.97	-	-116.05	-72.14	-116.05	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-389.90	-	-512.36	-350.93	-512.36	
		중앙부	2	-389.90	-	-468.62	-325.06	-468.62	
		우측	3	-389.90	-	-503.70	-352.57	-503.70	
	2 경간	좌측	4	-389.90	-	-503.70	-352.57	-503.70	
		중앙부	5	-389.90	-	-468.62	-325.06	-468.62	
		우측	6	-389.90	-	-512.36	-350.93	-512.36	
하부 슬래브	1 경간	좌측	7	-699.72	-	-291.12	-292.28	-699.72	
		측구부	8	-699.72	-	-295.47	-295.97	-699.72	
		중앙부	9	-699.72	-	-215.73	-234.29	-699.72	
		우측	10	-699.72	-	-205.08	-211.86	-699.72	
	2 경간	좌측	11	-638.09	-	-205.08	-211.86	-638.09	
		중앙부	12	-638.09	-	-209.13	-232.11	-638.09	
		측구부	13	-638.09	-	-268.50	-275.21	-638.09	
		우측	14	-638.09	-	-291.12	-292.28	-638.09	
좌측 벽체	1 층	상부	15	-729.87	-	-703.64	-377.38	-729.87	
		중앙부	16	-846.65	-	-474.26	-282.92	-846.65	
		하부	17	-863.52	-	-394.72	-238.12	-863.52	
우측 벽체	1 층	상부	18	-728.93	-	-703.64	-377.38	-728.93	
		중앙부	19	-845.70	-	-369.44	-214.65	-845.70	
		하부	20	-862.58	-	-394.72	-238.12	-862.58	
중간 벽체	1 련	상부	21	-1727.53	-	-1140.47	-568.07	-1727.53	
		중앙부	22	-1745.35	-	-1158.28	-585.89	-1745.35	
		하부	23	-1798.78	-	-1211.72	-639.32	-1798.78	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-395.41	-	-	-	-395.41	
		중앙부	2	576.23	-	-	-	576.23	
		우측	3	-965.72	-	-	-	-965.72	
	2 경간	좌측	4	-964.17	-	-	-	-964.17	
		중앙부	5	571.34	-	-	-	571.34	
		우측	6	-390.26	-	-	-	-390.26	
하부 슬래브	1 경간	좌측	7	-644.66	-	-	-	-644.66	
		측구부	8	-199.51	-	-	-	-199.51	
		중앙부	9	625.31	-	-	-	625.31	
		우측	10	-895.19	-	-	-	-895.19	
	2 경간	좌측	11	-897.58	-	-	-	-897.58	
		중앙부	12	620.88	-	-	-	620.88	
		측구부	13	-190.34	-	-	-	-190.34	
		우측	14	-638.27	-	-	-	-638.27	
좌측 벽체	1 층	상부	15	-539.37	-	-	-	-539.37	
		중앙부	16	-	-	-	-	-	
		하부	17	-654.14	-	-	-	-654.14	
우측 벽체	1 층	상부	18	-531.88	-	-	-	-531.88	
		중앙부	19	-	-	-	-	-	
		하부	20	-648.85	-	-	-	-648.85	
중간 벽체	1 련	상부	21	-131.38	-	-	-	-131.38	
		중앙부	22	66.10	-	-	-	66.10	
		하부	23	-129.77	-	-	-	-129.77	

22. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	950	1127.82	1581.71	3611.33	H29 - 8.0EA	5139.20	1.40
		중앙부	2	1000	820	829.32	1081.46	3075.10	H25 - 8.0EA	4053.60	1.30
		우측	3	1000	950	1409.56	1581.71	4554.22	H29 - 8.0EA	5139.20	1.12
	2경간	좌측	4	1000	950	1407.09	1581.71	4545.86	H29 - 8.0EA	5139.20	1.12
		중앙부	5	1000	820	821.49	1081.46	3045.07	H25 - 8.0EA	4053.60	1.32
		우측	6	1000	950	1127.82	1581.71	3611.33	H29 - 8.0EA	5139.20	1.40
하부슬래브	1경간	좌측	7	1000	1000	909.40	1329.54	2740.14	H25 - 8.0EA	4053.60	1.46
		측구부	8	1000	750	277.93	984.98	1104.07	H25 - 8.0EA	4053.60	3.54
		중앙부	9	1000	1020	920.13	1357.10	2716.22	H25 - 8.0EA	4053.60	1.47
		우측	10	1000	1000	1329.02	1669.07	4051.97	H29 - 8.0EA	5139.20	1.26
	2경간	좌측	11	1000	1000	1329.02	1669.07	4051.97	H29 - 8.0EA	5139.20	1.26
		중앙부	12	1000	1020	913.05	1357.10	2694.83	H25 - 8.0EA	4053.60	1.49
		측구부	13	1000	750	263.25	984.98	1045.05	H25 - 8.0EA	4053.60	3.74
		우측	14	1000	1000	899.18	1329.54	2708.57	H25 - 8.0EA	4053.60	1.48
좌측벽체	1층	상부	15	1000	950	1229.46	1581.71	3949.46	H29 - 8.0EA	5139.20	1.29
		중앙부	16	1000	820	255.10	623.44	924.07	H19 - 8.0EA	2292.00	2.44
		하부	17	1000	800	904.06	1053.89	3453.70	H25 - 8.0EA	4053.60	1.17
우측벽체	1층	상부	18	1000	950	1229.46	1581.71	3949.46	H29 - 8.0EA	5139.20	1.29
		중앙부	19	1000	820	255.10	623.44	924.07	H19 - 8.0EA	2292.00	2.44
		하부	20	1000	800	895.60	1053.89	3420.07	H25 - 8.0EA	4053.60	1.18

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	519.6	524.3	925.06	2.00	2.95	H13	150	253.40	O.K
		중앙부	2	532.6	185.3	740.39	2.00	-	H13	300	253.40	O.K
		우측	3	519.6	706.5	925.06	2.00	116.80	H13	150	253.40	O.K
	2경간	좌측	4	519.6	704.7	925.06	2.00	115.67	H13	150	253.40	O.K
		중앙부	5	532.6	185.3	740.39	2.00	-	H13	300	253.40	O.K
		우측	6	519.6	524.3	925.06	2.00	2.95	H13	150	253.40	O.K
하부슬래브	1경간	좌측	7	649.5	501.0	1156.32	2.00	131.25	H13	150	253.40	O.K
		측구부	8	487.1	501.0	867.24	2.00	9.27	H13	150	253.40	O.K
		중앙부	9	662.5	215.3	920.98	2.00	-	H13	300	253.40	O.K
		우측	10	649.5	610.2	1156.32	2.00	131.25	H13	150	253.40	O.K
	2경간	좌측	11	649.5	610.2	1156.32	2.00	131.25	H13	150	253.40	O.K
		중앙부	12	662.5	215.3	920.98	2.00	-	H13	300	253.40	O.K
		측구부	13	487.1	499.7	867.24	2.00	8.38	H13	150	253.40	O.K
		우측	14	649.5	499.7	1156.32	2.00	131.25	H13	150	253.40	O.K
좌측벽체	1층	상부	15	519.6	394.9	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	16	532.6	393.3	948.18	2.00	-	H13	150	253.40	O.K
		하부	17	519.6	325.9	925.06	2.00	-	H13	150	253.40	O.K
우측벽체	1층	상부	18	519.6	394.9	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	19	532.6	389.8	948.18	2.00	-	H13	150	253.40	O.K
		하부	20	519.6	322.4	925.06	2.00	-	H13	150	253.40	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1127.82	524.34

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3611.332 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.423]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1127.818 kN.m) ∴ O.K [안전률 1.402]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 524.340 kN) , 전단보강 필요.

Av_req = (524.340-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 2.953 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 524.340 kN ∴ O.K

▣ TITLE : 상부슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	829.32	185.28

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 83.119) / 83.119 = 0.02660

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3075.102 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.318]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00494

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (820.00 - a/2) = 1081.457 kN.m

≥ Mu (= 829.320 kN.m) ∴ O.K [안전률 1.304]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

ΦVc/2 ≥ Vu (= 185.281 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1409.56	706.50

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4554.222 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.128]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1409.559 kN.m) ∴ O.K [안전률 1.122]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 706.503 kN) , 전단보강 필요.

Av_req = (706.503-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 116.805 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 706.503 kN ∴ O.K

▣ TITLE : 상부슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1407.09	704.68

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4545.865 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.131]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1407.085 kN.m) ∴ O.K [안전률 1.124]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 704.680 kN) , 전단보강 필요.

Av_req = (704.680-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 115.665 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 704.680 kN ∴ O.K

▣ TITLE : 상부슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	821.49	185.28

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 83.119) / 83.119 = 0.02660

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3045.068 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.331]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00494

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (820.00 - a/2) = 1081.457 kN.m

≥ Mu (= 821.491 kN.m) ∴ O.K [안전률 1.316]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

ΦVc/2 ≥ Vu (= 185.281 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1127.82	524.34

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3611.332 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.423]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1127.818 kN.m) ∴ O.K [안전률 1.402]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 524.340 kN) , 전단보강 필요.

Av_req = (524.340-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 2.953 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 524.340 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1100.00	1000.00	100.00	909.40	501.02

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1000.00 - 83.119) / 83.119 = 0.03309

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2740.140 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.479]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00405

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1000.00 - a/2) = 1329.538 kN.m

≥ Mu (= 909.401 kN.m) ∴ O.K [안전률 1.462]

* 전단에 대한 검토 (d = 1000.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1000.00 = 649.519 kN

ΦVc/2 < Vu (= 501.022 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 1경간(측구)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	850.00	750.00	100.00	277.93	501.05

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (750.00 - 83.119) / 83.119 = 0.02407

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1104.068 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm), [사용률 = 3.672]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00540

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (750.00 - a/2) = 984.982 kN.m

≥ Mu (= 277.926 kN.m) ∴ O.K [안전률 3.544]

* 전단에 대한 검토 (d = 750.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 750.00 = 487.139 kN

< Vu (= 501.046 kN) , 전단보강 필요.

Av_req = (501.046-487.139) x 150.00 / (400x750.00xΦ) x 1000 = 9.271 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 750.00 / 150.00 x 1000 = 506.800 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 750.00 / 1000 = 2598.076 kN ≥ 506.800 kN ∴ O.K

s = 150.000 ≤ 375.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (649.519 + 506.800) = 867.239 kN ≥ 501.046 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1100.00	1020.00	80.00	920.13	215.31

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1020.00 - 83.119) / 83.119 = 0.03381

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2716.223 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.492]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00397

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1020.00 - a/2) = 1357.102 kN.m

≥ Mu (= 920.126 kN.m) ∴ O.K [안전률 1.475]

* 전단에 대한 검토 (d = 1020.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1020.00 = 662.509 kN

ΦVc/2 ≥ Vu (= 215.306 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1100.00	1000.00	100.00	1329.02	610.15

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1000.00 - 105.379) / 105.379 = 0.02547

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4051.965 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.268]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00514

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1000.00 - a/2) = 1669.072 kN.m

≥ Mu (= 1329.021 kN.m) ∴ O.K [안전률 1.256]

* 전단에 대한 검토 (d = 1000.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1000.00 = 649.519 kN

ΦVc/2 < Vu (= 610.150 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1100.00	1000.00	100.00	1329.02	610.23

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1000.00 - 105.379) / 105.379 = 0.02547

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4051.965 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.268]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00514

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1000.00 - a/2) = 1669.072 kN.m

≥ Mu (= 1329.021 kN.m) ∴ O.K [안전률 1.256]

* 전단에 대한 검토 (d = 1000.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1000.00 = 649.519 kN

ΦVc/2 < Vu (= 610.230 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1100.00	1020.00	80.00	913.05	215.31

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1020.00 - 83.119) / 83.119 = 0.03381

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2694.828 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.504]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00397

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1020.00 - a/2) = 1357.102 kN.m

≥ Mu (= 913.049 kN.m) ∴ O.K [안전률 1.486]

* 전단에 대한 검토 (d = 1020.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1020.00 = 662.509 kN

ΦVc/2 ≥ Vu (= 215.306 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 2경간(측구)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	850.00	750.00	100.00	263.25	499.71

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (750.00 - 83.119) / 83.119 = 0.02407

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1045.045 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm), [사용률 = 3.879]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00540

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (750.00 - a/2) = 984.982 kN.m

≥ Mu (= 263.251 kN.m) ∴ O.K [안전률 3.742]

* 전단에 대한 검토 (d = 750.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 750.00 = 487.139 kN

< Vu (= 499.708 kN) , 전단보강 필요.

Av_req = (499.708-487.139) x 150.00 / (400x750.00xΦ) x 1000 = 8.379 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 750.00 / 150.00 x 1000 = 506.800 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 750.00 / 1000 = 2598.076 kN ≥ 506.800 kN ∴ O.K

s = 150.000 ≤ 375.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (649.519 + 506.800) = 867.239 kN ≥ 499.708 kN ∴ O.K

▣ TITLE : 하부슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1100.00	1000.00	100.00	899.18	499.71

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1000.00 - 83.119) / 83.119 = 0.03309

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2708.572 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.497]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00405

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1000.00 - a/2) = 1329.538 kN.m

≥ Mu (= 899.177 kN.m) ∴ O.K [안전률 1.479]

* 전단에 대한 검토 (d = 1000.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1000.00 = 649.519 kN

ΦVc/2 < Vu (= 499.708 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 좌측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1229.46	394.93

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3949.458 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.301]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1229.458 kN.m) ∴ O.K [안전률 1.287]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 394.925 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	255.10	393.30

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 46.997) / 46.997 = 0.04934

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 924.067 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm), [사용률 = 2.480]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00280

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (820.00 - a/2) = 623.444 kN.m

≥ Mu (= 255.100 kN.m) ∴ O.K [안전률 2.444]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

≥ Vu (= 393.296 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	800.00	100.00	904.06	325.91

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (800.00 - 83.119) / 83.119 = 0.02587

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3453.696 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.174]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00507

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (800.00 - a/2) = 1053.893 kN.m

≥ Mu (= 904.063 kN.m) ∴ O.K [안전률 1.166]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 325.907 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1229.46	394.93

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3949.458 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.301]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1229.458 kN.m) ∴ O.K [안전률 1.287]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 394.925 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	255.10	389.82

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 46.997) / 46.997 = 0.04934

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 924.067 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm), [사용률 = 2.480]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00280

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (820.00 - a/2) = 623.444 kN.m

≥ Mu (= 255.100 kN.m) ∴ O.K [안전률 2.444]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

≥ Vu (= 389.815 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	800.00	100.00	895.60	322.43

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (800.00 - 83.119) / 83.119 = 0.02587

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3420.073 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.185]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00507

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (800.00 - a/2) = 1053.893 kN.m

≥ Mu (= 895.602 kN.m) ∴ O.K [안전률 1.177]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 322.425 kN) , 전단보강 불필요.

23. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

2) 상부슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

4) 상부슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

5) 상부슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

6) 상부슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

7) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1100 × 0.0020 = 2200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

8) 하부슬래브 : 1경간(측구)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1100 × 0.0020 = 2200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

9) 하부슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1100 × 0.0020 = 2200.00 ㎟

∴ Used As = H16 - 10EA = 3310.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 6.7EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 2648.662 ㎟ ≥ 810.720 ∴ O.K
H16 - 6.7EA

10) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1100 × 0.0020 = 2200.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

11) 하부슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1100 × 0.0020 = 2200.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

12) 하부슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1100 × 0.0020 = 2200.00 ㎟

∴ Used As = H16 - 10EA = 3310.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 6.7EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 2648.662 ㎟ ≥ 810.720 ∴ O.K
H16 - 6.7EA

13) 하부슬래브 : 2경간(측구)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1100 × 0.0020 = 2200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

14) 하부슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1100 × 0.0020 = 2200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

15) 좌측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

16) 좌측벽체 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 2292.000 × 0.20 = 458.40 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 458.400 ∴ O.K

17) 좌측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

18) 우측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

19) 우측벽체 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 2292.000 × 0.20 = 458.40 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 458.400 ∴ O.K

20) 우측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

24. 거더,기둥검토,내측벽체 검토

24.1 내측벽체 검토

(단위 : kN,m)

부재	폭	두께	높이	CTC	축력	모멘트	축력×CTC	모멘트×CTC	해석모델	조합
W1	1.00	0.50	4.25	-	1798.78	53.77	1798.78	53.77	상시	68
					1081.60	269.08	1081.60	269.08	지진(붕괴)	3

* 벽체와 기둥의 판별 (W1)

$0.4Agfck = 0.4 \times 1000 \times 500 \times 27$

$= 5400000\ N = 5400.00\ kN \quad \geq 1798.78\ kN$

∴ 벽체로 검토한다

(1) 벽체 1

1) 축력최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	80	420	1798.784	53.768	29.9

* 철근비 검토

As = 2292.000 mm² (인장중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0092) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 252.00 mm, ab = k1 x cb = 214.20 mm

Cc = 0.85 x 27.0 x 214200.000 = 4915.890 kN, ∑Csi = 864.199 kN, ∑Tsi = 916.800 kN

Pb = 4915.890 + 864.199 - 916.800 = 4863.289 kN

Mb = Cc x 142.900 + ∑(Csi*di) + ∑(Tsi*di) = 1005.250 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 206.702 mm, e = Mu/Pu = 29.891 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 534.32 mm, a = k1 x c = 454.18 mm 를 사용.

Cc = 0.85 x 27.0 x 454175.949 = 10423.338 kN

∑Csi = 1105.836 kN, ∑Tsi = 0.000 kN

Pn = 10423.338 + 1105.836 - 0.000 = 11529.174 kN

Mn = Cc x 22.912 + ∑(Csi*di) + ∑(Tsi*di) = 344.655 kN.m

- 편심오차 : |e - Mn/Pn(=29.894)| = 0.0030 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 500.00 - 80.00 = 420.000 mm

c = 534.325 mm, a = k1 x c = 454.176 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (420.00-534.32) / 534.32 = -0.00064

εt ≤ εy 이므로 압축지배단면이며, Φ = 0.65 를 적용한다.

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10562.718 kN < Pn = 11529.174 kN

ΦPn = 0.65 x 10562.718 = 6865.767 kN ≥ Pu = 1798.784 kN ∴ O.K

ΦMn = ΦPn x 0.030 = 205.226 kN.m ≥ Mu = 53.768 kN.m ∴ O.K

* 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 420.00 = 342.899 kN

≥ Vu (= 118.792 kN) , 전단보강 불필요.

2) 모멘트최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	80	420	1081.604	269.077	248.8

* 철근비 검토

As = 2292.000 mm² (인장중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0092) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 252.00 mm, ab = k1 x cb = 214.20 mm

Cc = 0.85 x 27.0 x 214200.000 = 4915.890 kN, ∑Csi = 864.199 kN, ∑Tsi = 916.800 kN

Pb = 4915.890 + 864.199 - 916.800 = 4863.289 kN

Mb = Cc x 142.900 + ∑(Csi*di) + ∑(Tsi*di) = 1005.250 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 206.702 mm, e = Mu/Pu = 248.776 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 198.93 mm, a = k1 x c = 169.09 mm 를 사용.

Cc = 0.85 x 27.0 x 169086.914 = 3880.545 kN

∑Csi = 769.548 kN, ∑Tsi = 916.800 kN

Pn = 3880.545 + 769.548 - 916.800 = 3733.293 kN

Mn = Cc x 165.457 + ∑(Csi*di) + ∑(Tsi*di) = 928.741 kN.m

- 편심오차 : |e - Mn/Pn(=248.773)| = 0.0033 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 500.00 - 80.00 = 420.000 mm

c = 198.926 mm, a = k1 x c = 169.087 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (420.00-198.93) / 198.93 = 0.00333

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10562.718 kN ≥ Pn = 3733.293 kN

ΦPn = 0.78 x 3733.293 = 2924.413 kN ≥ Pu = 1081.604 kN ∴ O.K

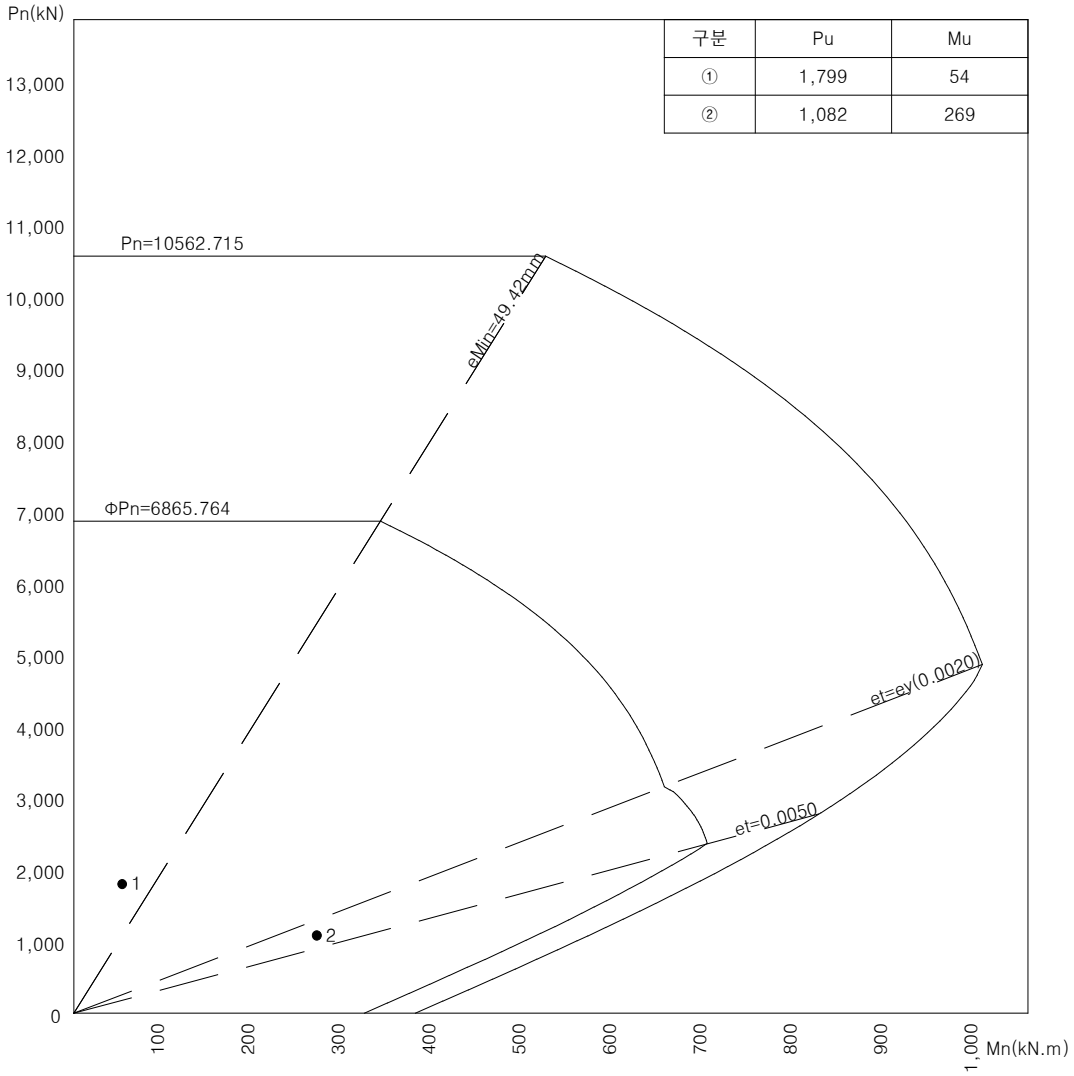
ΦMn = ΦPn x 0.249 = 727.523 kN.m ≥ Mu = 269.077 kN.m ∴ O.K

* 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 420.00 = 314.949 kN

≥ Vu (= 118.792 kN) , 전단보강 불필요.

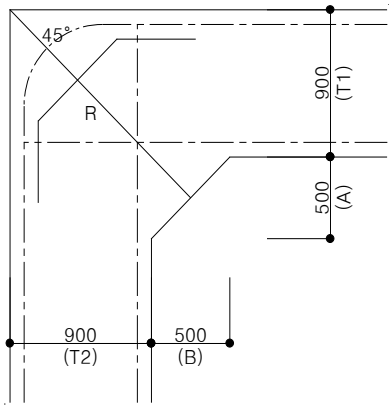
4) PM 상관도



구분	Pu	Mu
①	1,799	54
②	1,082	269

25. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 539.370 kN.m
- 절점부 휨모멘트 : Mo = 539.370 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 1626.346 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 539.37 \times 10^6}{1626.346^2 \times 1000} = 1.020 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 539.37 \times 10^6}{1626.346 \times 180} = 3684.948 \text{ mm}^2$$

Asb = 2569.600 mm²

Req'd As = As - Asb

= 3684.948 mm² - 2569.600 mm²

= 1115.348 mm²

- 사용보강철근

Use'd As = H19 - 4EA

∴ Total As = 1146.000 mm² > Req'd As (= 1115.348 mm²) ----------> O.K !!!

② 내측인장 휨모멘트 보강검토

- 수평부재 내측에 배근된 주철근량 : 2026.8 ㎟

  k = -np + √(2 x np + (np)²) [∵ n = 7]

  = - 7 x 0.0024717 + √(2 x 0.0173 + (0.0173)²) = 0.170

  j = 1 - k / 3 = 1 - 0.170 /3 = 0.943

  fs = Mo / (As x d x j) = 15187056.000 / (2026.800 x 820.000 x 0.943)

  = 9.685 MPa

  인장력 Th1 = fs x As = 9.685 x 2026.800 = 19630.043 N

- 연직부재 내측에 배근된 주철근량 : 1146 ㎟

  k = -np + √(2 x np + (np)²) [∵ n = 7]

  = - 7 x 0.0013976 + √(2 x 0.0098 + (0.0098)²) = 0.130

  j = 1 - k / 3 = 1 - 0.130 /3 = 0.957

  fs = Mo / (As x d x j) = 15187056.000 / (1146.000 x 820.000 x 0.957)

  = 16.896 MPa

  인장력 Th2 = fs x As = 16.896 x 1146.000 = 19362.668 N

- 보강철근량 산정

  T = √(Th1² + Th2²) = fsa x As T : 대각선 방향의 인장력

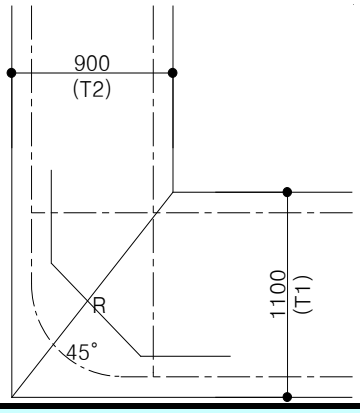
  Th : 수평부재 또는 연직부재에 작용하는 인장력

  As = √(Th1² + Th2²) / fsa = √(19630.043² + 19362.668²) / 180.0

  As = 153.181 ㎟

  사용철근량 : H13 @ 500, 2EA = 506.800 ㎟ ∴ O.K

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 778.844 kN.m
- 절점부 휨모멘트 : Mo = 778.844 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 1421.267$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H25 @250 - 4EA = 2026.800 mm²

∴ Total Asb = 2026.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 778.84 \times 10^6}{1421.267^2 \times 1000} = 1.928 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 778.84 \times 10^6}{1421.267 \times 180} = 6088.812 \text{ mm}^2$$

Asb = 2026.800 mm²

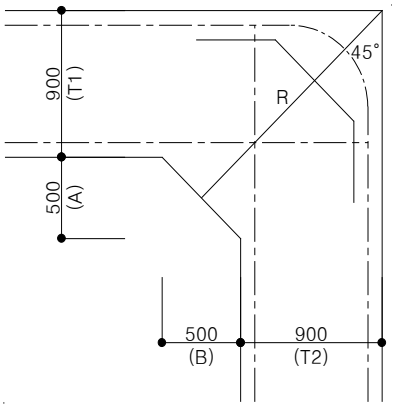
Req'd As = As - Asb
= 6088.812 mm² - 2026.800 mm²
= 4062.012 mm²

- 사용보강철근

Use'd As = H29 - 4EA , H25 - 4EA

∴ Total As = 4596.400 mm² > Req'd As (= 4062.012 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 531.883 kN.m
- 절점부 휨모멘트 : Mo = 531.883 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

= 1626.346 mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 531.88 \times 10^6}{1626.346^2 \times 1000} = 1.005 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 531.88 \times 10^6}{1626.346 \times 180} = 3633.796 \text{ mm}^2$$

Asb = 2569.600 mm²

Req'd As = As - Asb
= 3633.796 mm² - 2569.600 mm²
= 1064.196 mm²

- 사용보강철근

Use'd As = H19 - 4EA

∴ Total As = 1146.000 mm² > Req'd As (= 1064.196 mm²) ----------> O.K !!!

② 내측인장 휨모멘트 보강검토

- 수평부재 내측에 배근된 주철근량 : 2026.8 ㎟

  k = -np + √(2 x np + (np)²) [∵ n = 7]

  = - 7 x 0.0024717 + √(2 x 0.0173 + (0.0173)²) = 0.170

  j = 1 - k / 3 = 1 - 0.170 /3 = 0.943

  fs = Mo / (As x d x j) = 10766696.000 / (2026.800 x 820.000 x 0.943)

  = 6.866 MPa

  인장력 Th1 = fs x As = 6.866 x 2026.800 = 13916.502 N

- 연직부재 내측에 배근된 주철근량 : 1146 ㎟

  k = -np + √(2 x np + (np)²) [∵ n = 7]

  = - 7 x 0.0013976 + √(2 x 0.0098 + (0.0098)²) = 0.130

  j = 1 - k / 3 = 1 - 0.130 /3 = 0.957

  fs = Mo / (As x d x j) = 10766696.000 / (1146.000 x 820.000 x 0.957)

  = 11.978 MPa

  인장력 Th2 = fs x As = 11.978 x 1146.000 = 13726.950 N

- 보강철근량 산정

  T = √(Th1² + Th2²) = fsa x As T : 대각선 방향의 인장력

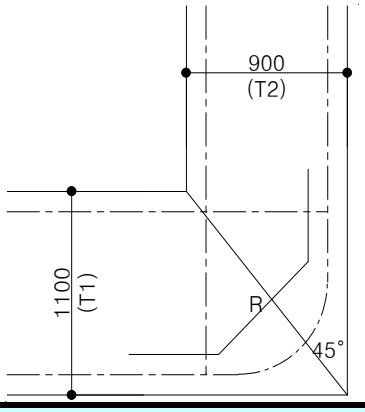
  Th : 수평부재 또는 연직부재에 작용하는 인장력

  As = √(Th1² + Th2²) / fsa = √(13916.502² + 13726.950²) / 180.0

  As = 108.596 ㎟

  사용철근량 : H13 @ 500, 2EA = 506.800 ㎟ ∴ O.K

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 772.397 kN.m
- 절점부 휨모멘트 : Mo = 772.397 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 1421.267$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H25 @250 - 4EA = 2026.800 mm²

∴ Total Asb = 2026.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 772.40 \times 10^6}{1421.267^2 \times 1000} = 1.912 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 772.40 \times 10^6}{1421.267 \times 180} = 6038.404 \text{ mm}^2$$

Asb = 2026.800 mm²

Req'd As = As - Asb
= 6038.404 mm² - 2026.800 mm²
= 4011.604 mm²

- 사용보강철근

Use'd As = H29 - 4EA , H25 - 4EA

∴ Total As = 4596.400 mm² > Req'd As (= 4011.604 mm²) ----------> O.K !!!

26. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	950	H29 - 8.0EA	125	680.838	O.K	5.447
		중앙부	2	820	H25 - 8.0EA	125	250.576	O.K	2.005
		우측	3	950	H29 - 8.0EA	125	152.536	O.K	1.220
	2경간	좌측	4	950	H29 - 8.0EA	125	153.123	O.K	1.225
		중앙부	5	820	H25 - 8.0EA	125	254.167	O.K	2.033
		우측	6	950	H29 - 8.0EA	125	692.637	O.K	5.541
하부슬래브	1경간	좌측	7	1000	H25 - 8.0EA	125	241.516	O.K	1.932
		측구부	8	750	H25 - 8.0EA	125	883.269	O.K	7.066
		중앙부	9	1020	H25 - 8.0EA	125	315.566	O.K	2.525
		우측	10	1000	H29 - 8.0EA	125	202.985	O.K	1.624
	2경간	좌측	11	1000	H29 - 8.0EA	125	201.875	O.K	1.615
		중앙부	12	1020	H25 - 8.0EA	125	319.016	O.K	2.552
		측구부	13	750	H25 - 8.0EA	125	925.832	O.K	7.407
		우측	14	1000	H25 - 8.0EA	125	246.123	O.K	1.969
좌측벽체	1층	상부	15	950	H29 - 8.0EA	125	442.067	O.K	3.537
		중앙부	16	820	H19 - 8.0EA	-	-	-	-
		하부	17	800	H25 - 8.0EA	125	141.302	O.K	1.130
우측벽체	1층	상부	18	950	H29 - 8.0EA	125	451.298	O.K	3.610
		중앙부	19	820	H19 - 8.0EA	-	-	-	-
		하부	20	800	H25 - 8.0EA	125	144.237	O.K	1.154

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 395.408 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 88.029 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 88.03) - 2.5 x 85.50 = 680.84 mm
300 x (Kcr / fs) = 300 x (210 / 88.03) = 715.67 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 680.84 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 680.84 mm) ∴ O.K

2) 상부슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 576.231 x 1000000 / [4053.600 x (820.000 - 189.203/3)]
= 187.801 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x820.0/(7x4053.600)]
= 189.203 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 187.80) - 2.5 x 67.50 = 250.58 mm
300 x (Kcr / fs) = 300 x (210 / 187.80) = 335.46 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 250.58 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 250.58 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 965.715 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 214.996 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 215.00) - 2.5 x 85.50 = 152.54 mm
300 x (Kcr / fs) = 300 x (210 / 215.00) = 293.03 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 152.54 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 152.54 mm) ∴ O.K

4) 상부슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 964.169 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 214.652 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 214.65) - 2.5 x 85.50 = 153.12 mm
300 x (Kcr / fs) = 300 x (210 / 214.65) = 293.50 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 153.12 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 153.12 mm) ∴ O.K

5) 상부슬래브 2경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 571.338 x 1000000 / [4053.600 x (820.000 - 189.203/3)]
= 186.207 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x820.0/(7x4053.600)]
= 189.203 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 186.21) - 2.5 x 67.50 = 254.17 mm
300 x (Kcr / fs) = 300 x (210 / 186.21) = 338.33 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 254.17 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 254.17 mm) ∴ O.K

6) 상부슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 390.261 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 86.883 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 86.88) - 2.5 x 85.50 = 692.64 mm
300 x (Kcr / fs) = 300 x (210 / 86.88) = 725.11 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 692.64 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 692.64 mm) ∴ O.K

7) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 644.655 x 1000000 / [4053.600 x (1000.000 - 211.532/3)]
= 171.097 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1000.0/(7x4053.600)]
= 211.532 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 171.10) - 2.5 x 87.50 = 241.52 mm
300 x (Kcr / fs) = 300 x (210 / 171.10) = 368.21 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 241.52 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 241.52 mm) ∴ O.K

8) 하부슬래브 1경간(측구)

① 응력 산정

fs = M / [As x (d - χ/3)] = 199.510 x 1000000 / [4053.600 x (750.000 - 179.875/3)]
= 71.326 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x750.0/(7x4053.600)]
= 179.875 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 71.33) - 2.5 x 87.50 = 885.34 mm
300 x (Kcr / fs) = 300 x (210 / 71.33) = 883.27 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 883.27 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 883.27 mm) ∴ O.K

9) 하부슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 625.307 x 1000000 / [4053.600 x (1020.000 - 213.886/3)]
= 162.600 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1020.0/(7x4053.600)]
= 213.886 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 162.60) - 2.5 x 67.50 = 315.57 mm
300 x (Kcr / fs) = 300 x (210 / 162.60) = 387.45 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 315.57 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 315.57 mm) ∴ O.K

10) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 895.185 x 1000000 / [5139.200 x (1000.000 - 234.660/3)]
= 188.969 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1000.0/(7x5139.200)]
= 234.660 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 188.97) - 2.5 x 85.50 = 202.99 mm
300 x (Kcr / fs) = 300 x (210 / 188.97) = 333.39 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 202.99 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 202.99 mm) ∴ O.K

11) 하부슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 897.577 x 1000000 / [5139.200 x (1000.000 - 234.660/3)]
= 189.474 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1000.0/(7x5139.200)]
= 234.660 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 189.47) - 2.5 x 85.50 = 201.88 mm
300 x (Kcr / fs) = 300 x (210 / 189.47) = 332.50 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 201.88 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 201.88 mm) ∴ O.K

12) 하부슬래브 2경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 620.884 x 1000000 / [4053.600 x (1020.000 - 213.886/3)]
= 161.450 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1020.0/(7x4053.600)]
= 213.886 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 161.45) - 2.5 x 67.50 = 319.02 mm
300 x (Kcr / fs) = 300 x (210 / 161.45) = 390.21 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 319.02 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 319.02 mm) ∴ O.K

13) 하부슬래브 2경간(측구)

① 응력 산정

fs = M / [As x (d - χ/3)] = 190.338 x 1000000 / [4053.600 x (750.000 - 179.875/3)]
= 68.047 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x750.0/(7x4053.600)]
= 179.875 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 68.05) - 2.5 x 87.50 = 938.54 mm
300 x (Kcr / fs) = 300 x (210 / 68.05) = 925.83 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 925.83 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 925.83 mm) ∴ O.K

14) 하부슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 638.265 x 1000000 / [4053.600 x (1000.000 - 211.532/3)]
= 169.401 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1000.0/(7x4053.600)]
= 211.532 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 169.40) - 2.5 x 87.50 = 246.12 mm
300 x (Kcr / fs) = 300 x (210 / 169.40) = 371.90 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 246.12 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 246.12 mm) ∴ O.K

15) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 539.370 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 120.079 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 120.08) - 2.5 x 85.50 = 442.07 mm
300 x (Kcr / fs) = 300 x (210 / 120.08) = 524.65 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 442.07 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 442.07 mm) ∴ O.K

16) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 654.137 x 1000000 / [4053.600 x (800.000 - 186.579/3)]
= 218.718 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x800.0/(7x4053.600)]
= 186.579 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 218.72) - 2.5 x 87.50 = 141.30 mm
300 x (Kcr / fs) = 300 x (210 / 218.72) = 288.04 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 141.30 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 141.30 mm) ∴ O.K

17) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 531.883 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 118.412 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 118.41) - 2.5 x 85.50 = 451.30 mm
300 x (Kcr / fs) = 300 x (210 / 118.41) = 532.04 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 451.30 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 451.30 mm) ∴ O.K

18) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 648.849 x 1000000 / [4053.600 x (800.000 - 186.579/3)]
= 216.950 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x800.0/(7x4053.600)]
= 186.579 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 216.95) - 2.5 x 87.50 = 144.24 mm
300 x (Kcr / fs) = 300 x (210 / 216.95) = 290.39 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 144.24 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 144.24 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 9.600 m
- fy = 400 MPa
- 부재두께(T) = 0.90 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28

T = 9.600 / 28

T = 0.343 m < 0.900 m ----------> O.K

27. 기초 지지력 검토

(1) 하중산정

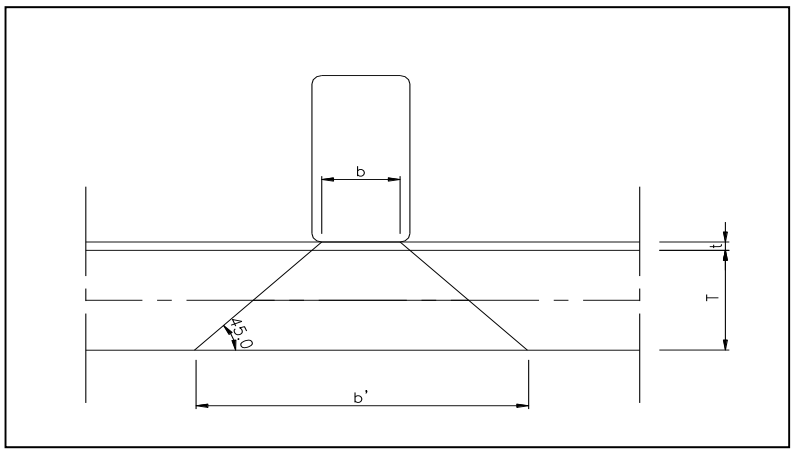
1) 고정하중

- 구체자중 = 1290.625 / 20.100 = 64.210 kN/m²
- 상부연직하중 = 59.125 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.08 × 23.00 = 1.840 kN/m²

2) 활하중

- 도로 노면 활하중 = 11.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중

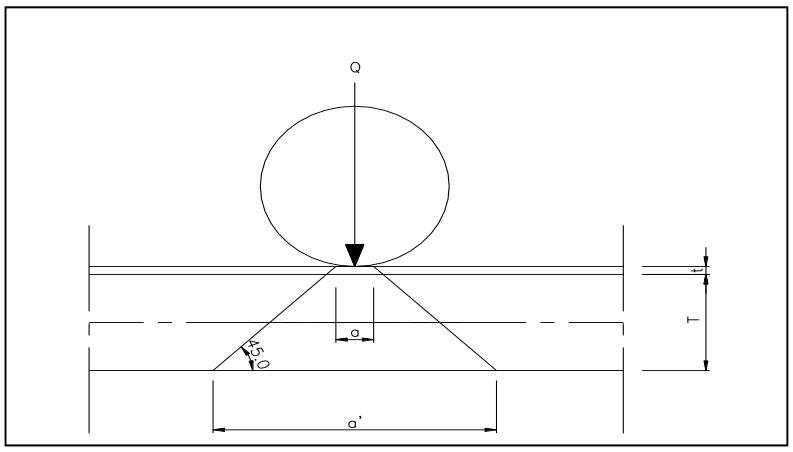


t = 80 mm (암거내부 포장두께)

T = 1100 mm (하부 슬래브 두께)

b' = 0.500 + 2 × (1.100 + 0.080) × cot 45°

= 2.860 m



a' = 0.200 + 2 × (1.100 + 0.080) × cot 45°

= 2.560 m

Qz = 96.0 / (2.860 × 2.560)= 13.112 kN/m²

3) 내부 고정하중

- 암거내부 고정하중 = 10.000 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 64.21 + 59.13 + 11.00 + 1.84 + 13.11 + 10.00

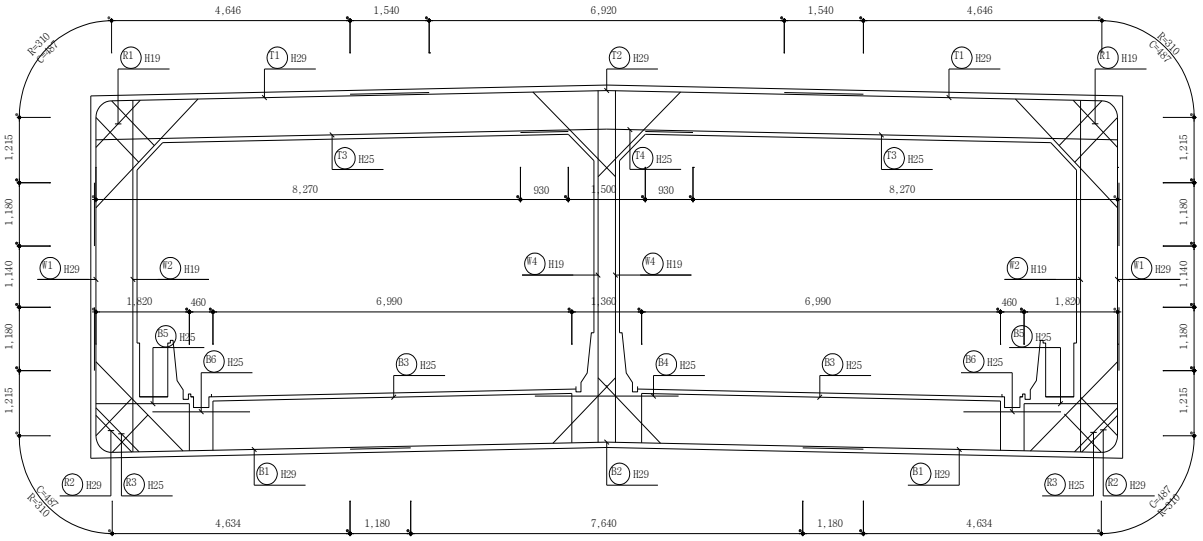
= 159.287 kN/m²

2) 지반의 허용연직지지력

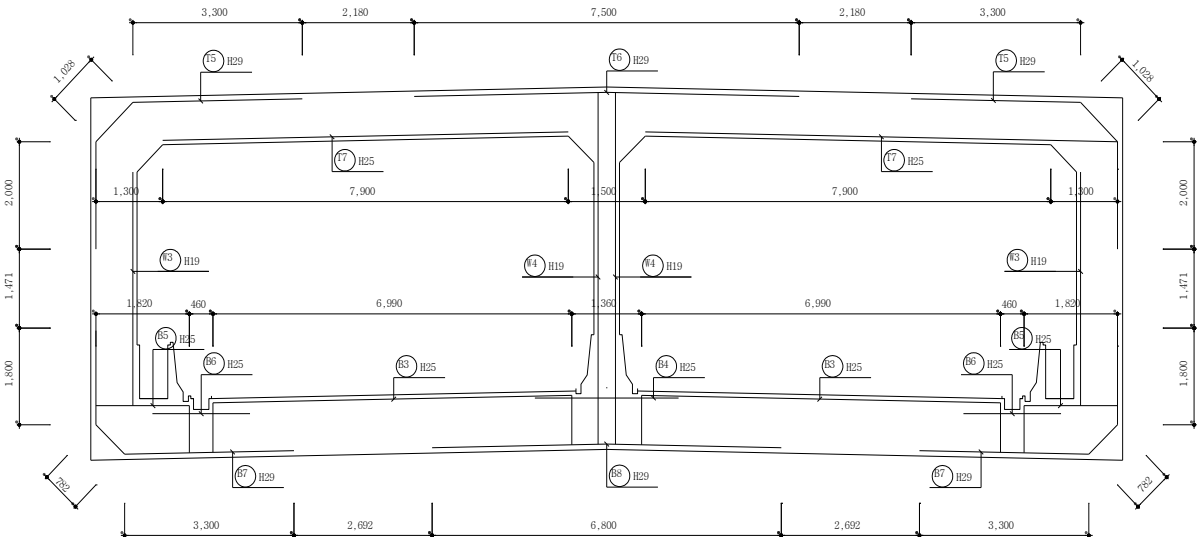
Qa = 400.000 kN/m² ≥ Qmax = 159.287 kN/m² ..... O.K

28. 주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



1.18 B6-1(STA.0+700.0)

- 램 프 -

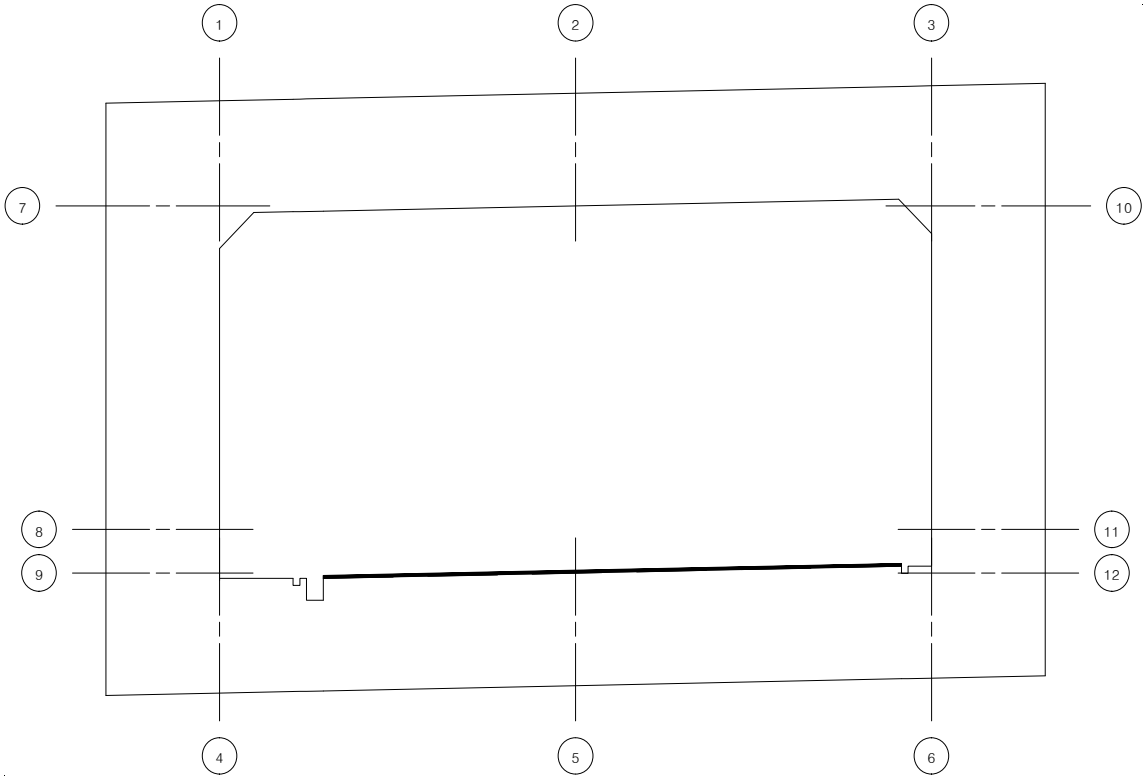
지하차도 구조계산서

▣ STA. 0K+699.000 (BLOCK1 : 단면 A-A)
▣ 토 피(FH) = 10.81 m ▣ 선 형 = ∞
▣ 지반 조건 : 토사
▣ 구조형식 : 지중 1 련
(내공 : 10.65M × 5.22M, 사각 : 90°)

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. INPUT DATA(상시)
16. INPUT DATA(기능수행)
17. INPUT DATA(붕괴방지)
18. OUTPUT DATA(상시)
19. OUTPUT DATA(기능수행)
20. OUTPUT DATA(붕괴방지)
21. 단면력정리
22. 단면검토 및 철근량 산정
23. 수평철근 검토
24. 절점부 검토
25. 사용성 검토
26. STM-우각부
27. 기초 지지력 검토
28. 주철근 조립도
29. 신축이음부

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qa(kN)	비 고
직접기초	338.29	700.000	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	2560.753	4871.803	1.902	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1638	3582.04	4733.19	6669.03	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.32
		중앙부	2	1000	1491	3726.23	4288.22	7695.53	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.15
		우측	3	1000	1638	3582.02	4733.19	6669.00	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.32
하부슬래브	1경간	좌측	4	1000	1467	2309.14	3668.05	4765.57	H29 - 8.0EA + H29 - 4.0EA	7708.80	1.59
		측구부	5	1000	1210	1548.38	2036.01	3871.63	H29 - 8.0EA	5139.20	1.31
		중앙부	6	1000	1496	3290.15	4053.99	6733.47	H32 - 8.0EA + H25 - 4.0EA	8380.40	1.23
		우측	7	1000	1467	2309.17	3668.05	4765.63	H29 - 8.0EA + H29 - 4.0EA	7708.80	1.59
좌측벽체	1층	상부	8	1000	1738	4596.83	5036.58	8109.46	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.10
		중앙부	9	1000	1620	694.66	2184.04	1269.85	H25 - 8.0EA	4053.60	3.14
		하부	10	1000	1567	3640.16	3930.14	7115.47	H29 - 8.0EA + H29 - 4.0EA	7708.80	1.08
우측벽체	1층	상부	11	1000	1727	4596.80	5002.20	8167.41	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.09
		중앙부	12	1000	1620	694.67	2184.04	1269.87	H25 - 8.0EA	4053.60	3.14
		하부	13	1000	1567	3640.16	3930.14	7115.46	H29 - 8.0EA + H29 - 4.0EA	7708.80	1.08

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부슬래브	1경간	좌측	1	1800.0	3972.0	O.K	1784.6	2647.3	O.K
		중앙부	2	1800.0	3310.7	O.K	1784.6	2647.3	O.K
		우측	3	1800.0	3972.0	O.K	1784.6	2647.3	O.K
하부슬래브	1경간	좌측	4	1800.0	3310.7	O.K	1541.8	2647.3	O.K
		중앙부	6	1800.0	3308.7	O.K	1676.1	2647.3	O.K
		우측	7	1800.0	4635.3	O.K	1541.8	2647.3	O.K
좌측벽체	1층	상부	8	1800.0	2865.0	O.K	1784.6	1911.0	O.K
		중앙부	9	1800.0	2865.0	O.K	810.7	954.0	O.K
		하부	10	1800.0	2865.0	O.K	1541.8	1911.0	O.K
우측벽체	1층	상부	11	1800.0	2865.0	O.K	1784.6	1911.0	O.K
		중앙부	12	1800.0	2865.0	O.K	810.7	954.0	O.K
		하부	13	1800.0	2865.0	O.K	1541.8	1911.0	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	㎟		㎜	㎟	
상부 슬래브	1 경간	좌측	1	955.6	1514.5	1701.18	2.00	189.95	H13	150	253.40	0.K
		중앙부	2	968.6	318.5	1346.44	2.00	-	H13	300	253.40	0.K
		우측	3	955.6	1514.4	1701.18	2.00	189.91	H13	150	253.40	0.K
하부 슬래브	1 경간	좌측	4	952.6	1294.4	1695.93	2.00	116.50	H13	150	253.40	0.K
		중앙부	6	971.6	350.3	1350.60	2.00	-	H13	300	253.40	0.K
		우측	7	952.6	1294.3	1695.93	2.00	116.48	H13	150	253.40	0.K
좌측 벽체	1 층	상부	8	1020.5	1048.5	1644.61	2.00	17.78	H16	300	397.20	0.K
		중앙부	9	1052.2	634.9	1695.68	2.00	-	H16	300	397.20	0.K
		하부	10	1017.6	1086.0	1639.86	2.00	43.66	H16	300	397.20	0.K
우측 벽체	1 층	상부	11	1020.5	1048.5	1644.61	2.00	17.78	H16	300	397.20	0.K
		중앙부	12	1052.2	634.9	1695.68	2.00	-	H16	300	397.20	0.K
		하부	13	1017.6	1086.0	1639.86	2.00	43.66	H16	300	397.20	0.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 ㎜)

구분	부재 위치			유효높이 (㎜)	인장사용철근량	철근 간격(㎜)	최대 간격 (㎜)	검토 결과	S.F
상부슬래브	1경간	좌측	1	1638	H32 - 8.0EA + H29 - 4.0EA	125	485.909	0.K	3.887
		중앙부	2	1491	H32 - 8.0EA + H29 - 4.0EA	125	222.097	0.K	1.777
		우측	3	1638	H32 - 8.0EA + H29 - 4.0EA	125	485.910	0.K	3.887
하부슬래브	1경간	좌측	4	1467	H29 - 8.0EA + H29 - 4.0EA	125	294.717	0.K	2.358
		측구부	5	1210	H29 - 8.0EA	125	763.050	0.K	6.104
		중앙부	6	1496	H32 - 8.0EA + H25 - 4.0EA	125	252.231	0.K	2.018
		우측	7	1467	H29 - 8.0EA + H29 - 4.0EA	125	294.710	0.K	2.358
좌측벽체	1층	상부	8	1738	H32 - 8.0EA + H29 - 4.0EA	125	243.225	0.K	1.946
		중앙부	9	1620	H25 - 8.0EA	-	-	-	-
		하부	10	1567	H29 - 8.0EA + H29 - 4.0EA	125	136.897	0.K	1.095
우측벽체	1층	상부	11	1727	H32 - 8.0EA + H29 - 4.0EA	125	240.161	0.K	1.921
		중앙부	12	1620	H25 - 8.0EA	-	-	-	-
		하부	13	1567	H29 - 8.0EA + H29 - 4.0EA	125	136.897	0.K	1.095

2. 설 계 조 건

1) 구조형식

- 지중 1 련 지하차도 (내공 : 10.65M × 5.22M, 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (ω_c) = 25.00 kN/m³
- Mortar (γ_{mot}) = 21.50 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sd
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 10.000 kN/m² (∵ 토피 : 10.806 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

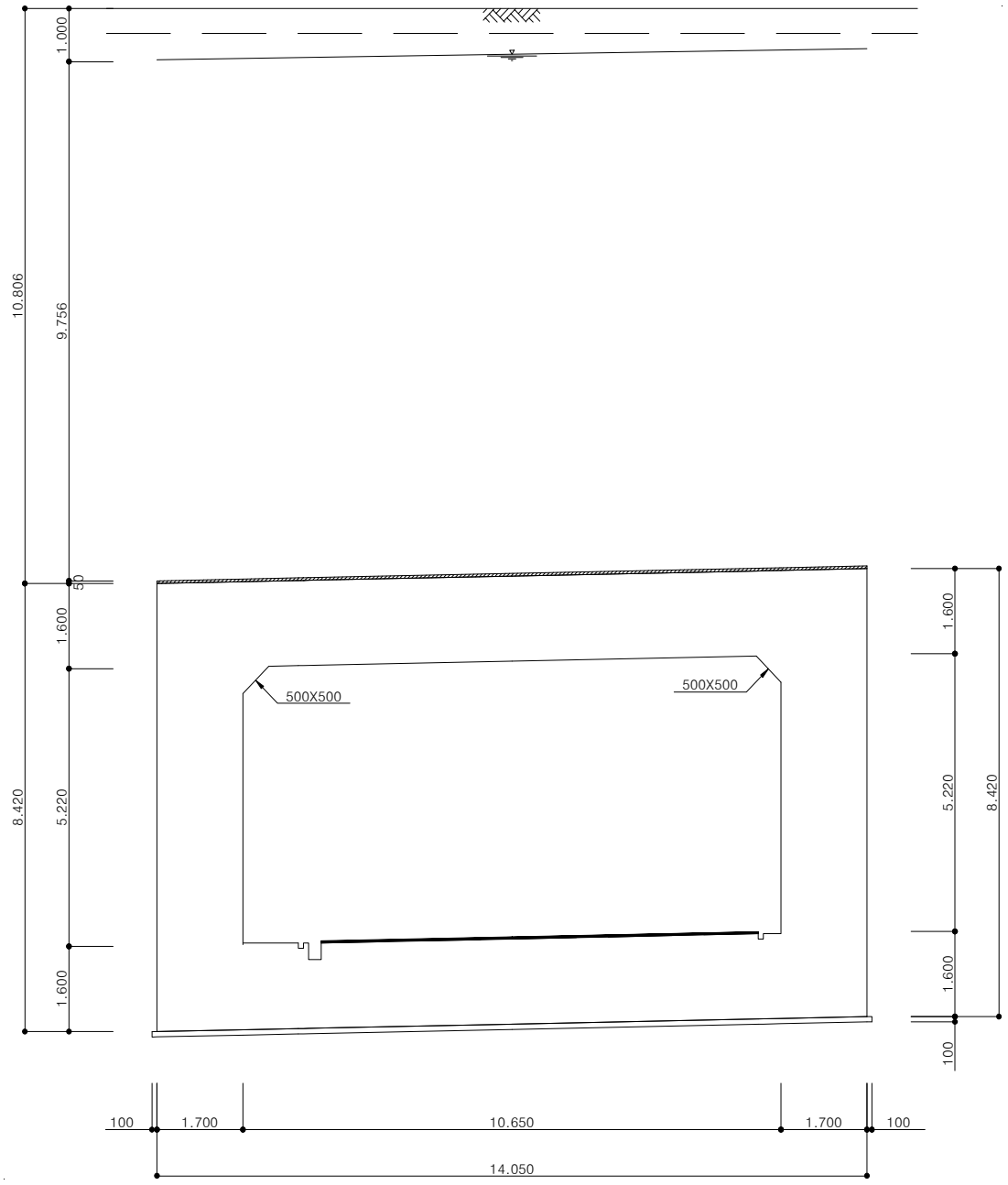
10) 사용프로그램 : SAP2000

11) 참고문헌

- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정

1) 단 면 가 정


1.000
10.806
9.756
50
1.600
8.420
5.220
1.600
500X500
500X500
1.600
5.220
8.420
1.600
100
100
1.700
10.650
1.700
100
14.050

4. 부 력 검 토

4.1 시공중 부력검토 (지하수위:G.L -9.6m) -상부슬래브 폐합전

: 부력에 대한 안전률 Fs = 1.10 (R/B)

1) 구체자중

- 하부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
		∴ Σ	=	1005.700	kN/m

2) 상재 하중

∴ Σ	=	0.000	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 0.000^2 \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$

$= 0.500 \times (2 \times 0.000 \times 0.000 \times 19.000 + 0.000^2 \times 10.000) \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

∴ Σ = 0.000 + 0.000 = 0.000 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 14.050 \times 9.626 \times 10.000$

$= 1352.453$ kN/m

6) 안정검토

$R = 1005.700 + 0.000 + 0.000 = 1005.700$ kN/m

$Fs = R / U$

$= 1005.700 / 1352.453$

$\geq 1.100 \Rightarrow H \leq 0.676$ m

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 0.676m이하로 유지.

4.2 완공후 부력검토 (지하수위:G.L -9.6m)

: 부력에 대한 안전률 Fs = 1.20 (R/B)

부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려

(최소토피 H = 10.806 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	: 14.050 × 1.600 × 25.0	=	562.000	kN/m
- 하부슬래브	: 14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	: 1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	: 1.700 × 5.220 × 25.0	=	221.850	kN/m
- 헌치 1	: 0.500 × 0.500 × 1/2 × 2EA × 25.0	=	6.250	kN/m
	∴ Σ	=	1573.950	kN/m

2) 상재 하중

- ASPHALT 포장하중	: 0.500 × 14.050 × 23.0	=	161.575	kN/m
- 흙의 자중(지하수위 이상	: 9.100 × 14.050 × 19.0	=	2429.245	kN/m
- 흙의 자중(지하수위 이하	: 1.156 × 14.050 × 10.0	=	162.418	kN/m
- 지하수 자중	: 1.156 × 14.050 × 10.0	=	162.418	kN/m
- 방수 Mortal	: 0.050 × 14.050 × 21.5	=	15.104	kN/m
	∴ Σ	=	2930.760	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 9.600^2 \times \tan(30.0 \times 2/3)$

$= 318.663$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$

$= 0.500 \times (2 \times 9.600 \times 1.156 \times 19.000 + 1.156^2 \times 10.000) \times \tan(30.0 \times 2/3)$

$= 79.177$ kN/m

∴ Σ = 318.663 + 79.177 = 397.840 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반편,p.170)]

5) 부력

U = B × hs × γw (여기서,hs=구조물높이+토피고-지하수위)

= 14.050 × 9.626 × 10.000

= 1352.453 kN/m

6) 안정검토

R = 1573.950 + 2930.760 + 397.840 = 4902.550 kN/m

Fs = R / U

= 4902.550 / 1352.453

= 3.625 > 1.200 ∴O.K

4.3 완공후 부력검토 (극한수위:G.L -1.0m)

: 부력에 대한 안전률 Fs = 1.05 (R/B)
부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려
(최소토피 H = 10.806 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 하부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 2EA × 25.0	=	6.250	kN/m
		∴ Σ	=	1573.950	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 14.050 × 23.0	=	161.575	kN/m
- 흙의 자중(지하수위 이상	:	0.500 × 14.050 × 19.0	=	133.475	kN/m
- 흙의 자중(지하수위 이하	:	9.756 × 14.050 × 10.0	=	1370.718	kN/m
- 지하수 자중	:	9.756 × 14.050 × 10.0	=	1370.718	kN/m
- 방수 Mortal	:	0.050 × 14.050 × 21.5	=	15.104	kN/m
		∴ Σ	=	3051.590	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$
$= 0.500 \times 19.000 \times 1.000^2 \times \tan(30.0 \times 2/3)$
$= 3.458$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$
$= 0.500 \times (2 \times 1.000 \times 9.806 \times 19.000 + 9.806^2 \times 10.000) \times \tan(30.0 \times 2/3)$
$= 242.805$ kN/m

∴ ∑ = 3.458 + 242.805 = 246.263 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)
$= 14.050 \times 18.226 \times 10.000$
$= 2560.753$ kN/m

6) 안정검토

$R = 1573.950 + 3051.590 + 246.263 = 4871.803$ kN/m
$Fs = R / U$
$= 4871.803 / 2560.753$
$= 1.902 > 1.050$ ∴O.K

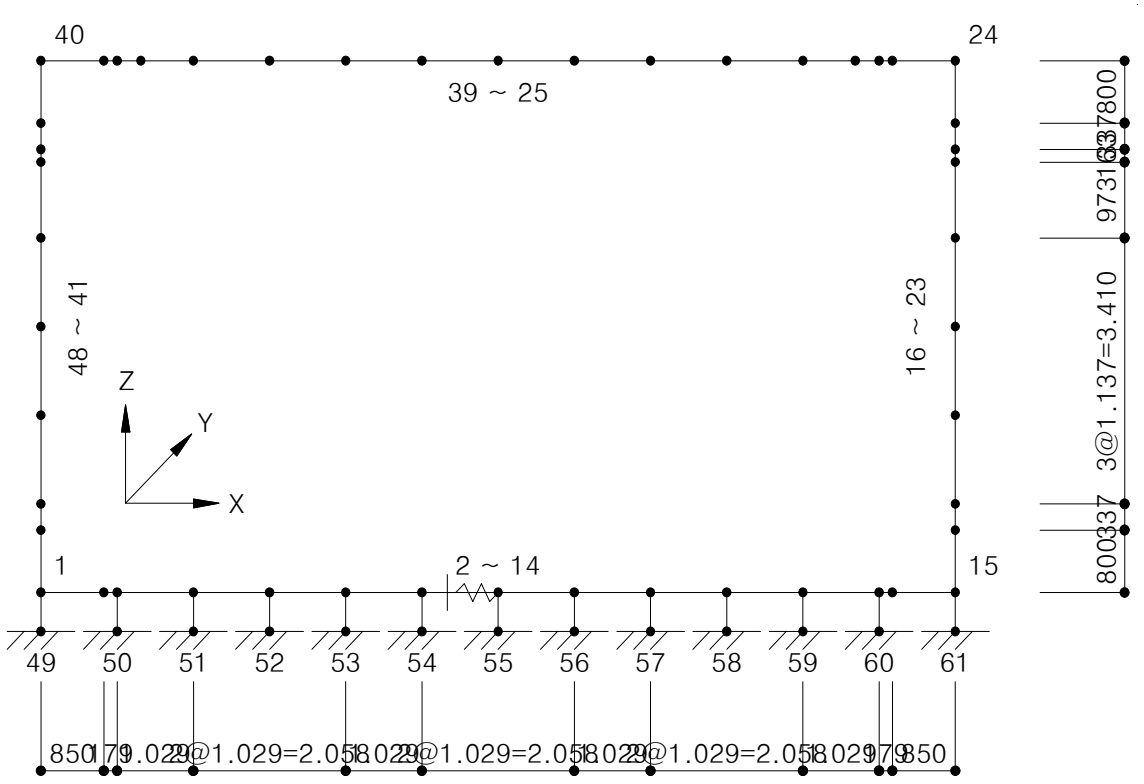
5. 해석모델 및 단면제원 (상시)

1) Modeling

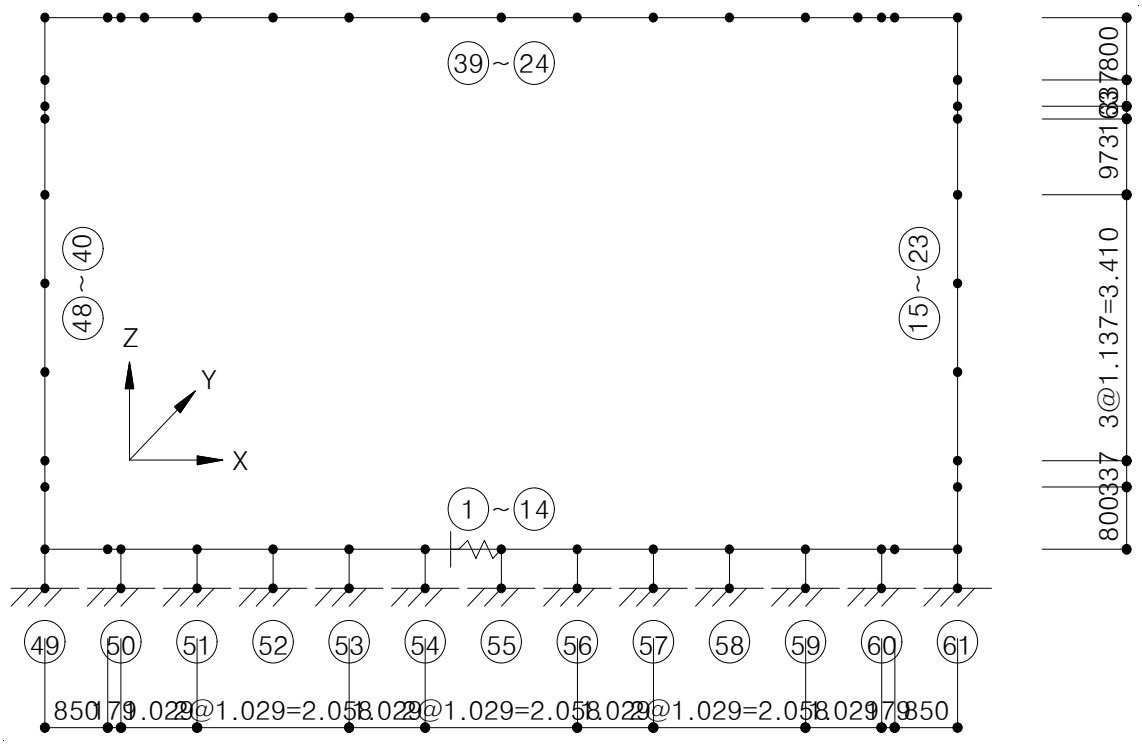
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.600 × 1.000	= 1.600	0.34133	1~14,27~36
2	1.700 × 1.000	= 1.700	0.40942	15~20,43~48
4	2.200 × 1.000	= 2.200	0.88733	23,40
5	2.100 × 1.000	= 2.100	0.77175	24,39

NO	A (m²)		I (m⁴)	절 점
3	1.863 × 1.000	= 1.863	0.53913	22,42
6	1.921 × 1.000	= 1.921	0.59059	26,38

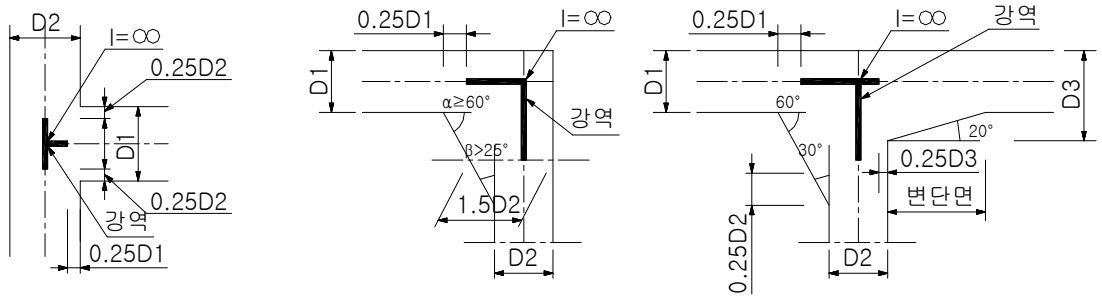
NO	Section(Tapper)	부 재
7	SEC 2 ~ 3	21
8	SEC 3 ~ 4	22
9	SEC 5 ~ 6	25
10	SEC 6 ~ 1	26
11	SEC 1 ~ 6	37
12	SEC 6 ~ 5	38
13	SEC 4 ~ 3	41
14	SEC 3 ~ 2	42

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	32	6.175	7.320
2	0.850	0.500	33	5.146	7.320
3	1.029	0.500	34	4.117	7.320
4	2.058	0.500	35	3.087	7.320
5	3.087	0.500	36	2.058	7.320
6	4.117	0.500	37	1.350	7.320
7	5.146	0.500	38	1.029	7.320
8	6.175	0.500	39	0.850	7.320
9	7.204	0.500	40	0.000	7.320
10	8.233	0.500	41	0.000	6.520
11	9.262	0.500	42	0.000	6.183
12	10.292	0.500	43	0.000	6.020
13	11.321	0.500	44	0.000	5.047
14	11.500	0.500	45	0.000	3.910
15	12.350	0.500	46	0.000	2.773
16	12.350	1.300	47	0.000	1.637
17	12.350	1.637	48	0.000	1.300
18	12.350	2.773	49	0.000	0.000
19	12.350	3.910	50	1.029	0.000
20	12.350	5.047	51	2.058	0.000
21	12.350	6.020	52	3.087	0.000
22	12.350	6.183	53	4.117	0.000
23	12.350	6.520	54	5.146	0.000
24	12.350	7.320	55	6.175	0.000
25	11.500	7.320	56	7.204	0.000
26	11.321	7.320	57	8.233	0.000
27	11.000	7.320	58	9.262	0.000
28	10.292	7.320	59	10.292	0.000
29	9.262	7.320	60	11.321	0.000
30	8.233	7.320	61	12.350	0.000
31	7.204	7.320			

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 40 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(2) 40 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(3) 24 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(4) 24 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

(7) 15 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(8) 15 지점 - 슬래브 벽체 연결부

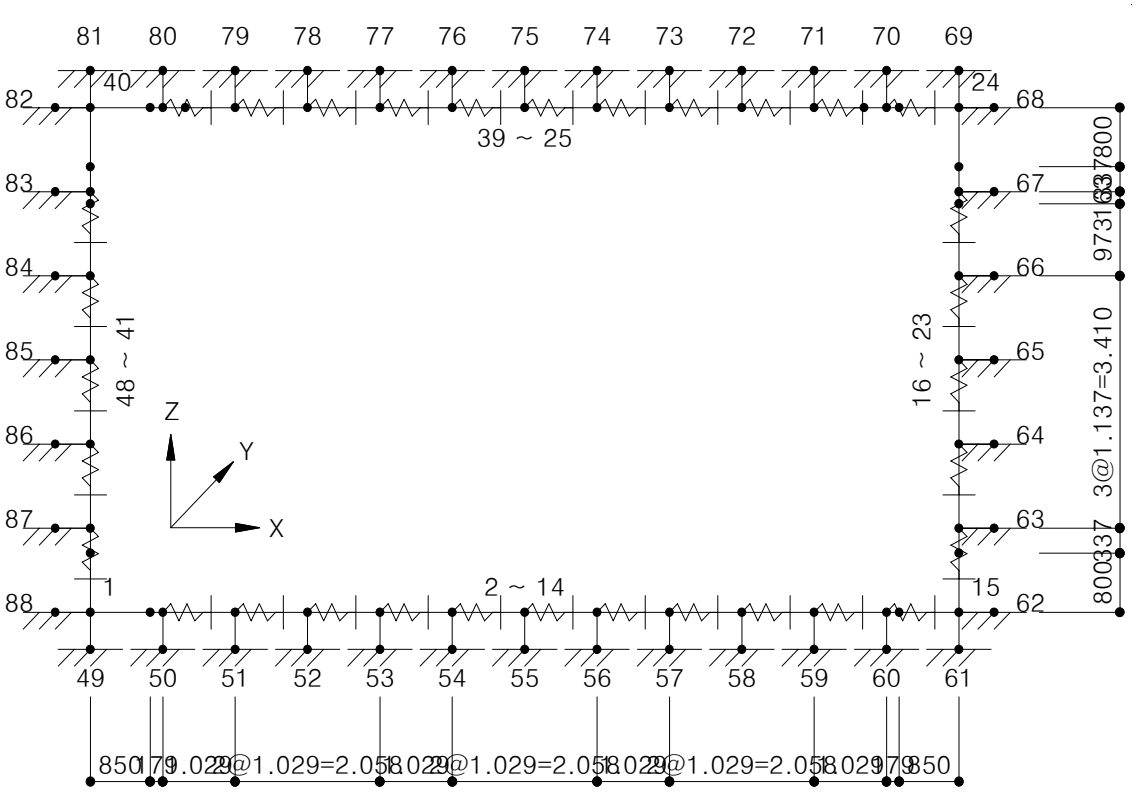
D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

6. 해석모델 및 단면제원 (지진시)

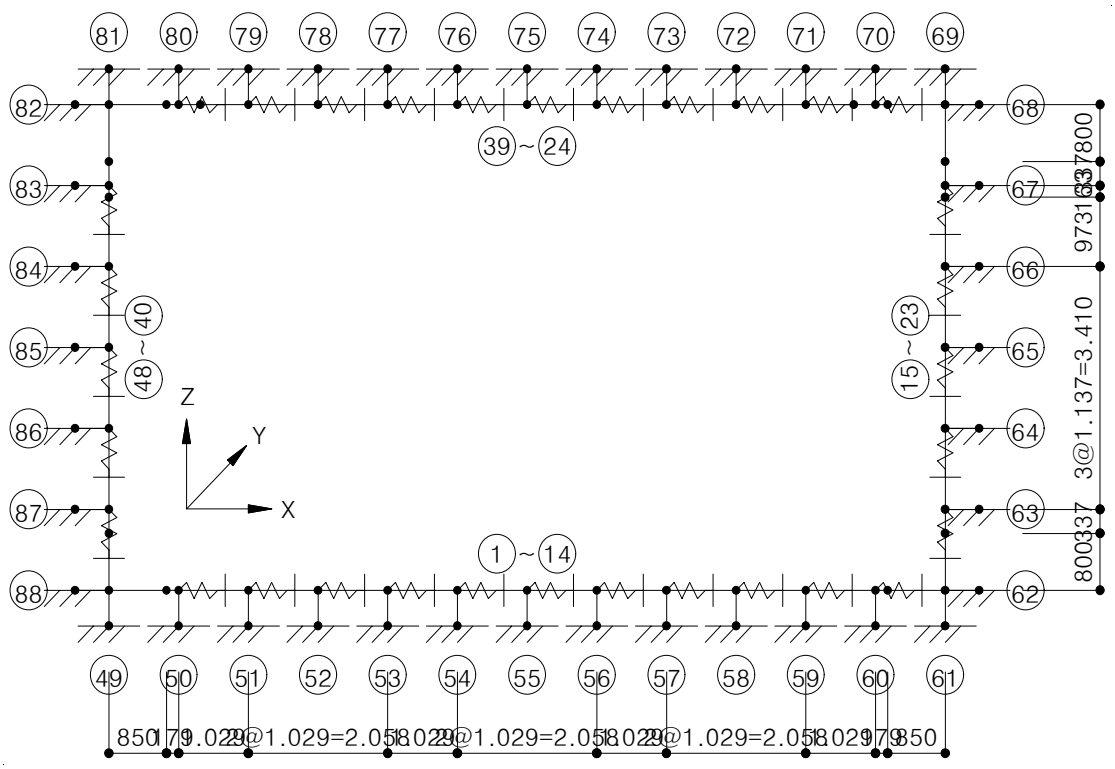
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.600 × 1.000	= 1.600	0.34133	1~14,27~36
2	1.700 × 1.000	= 1.700	0.40942	15~20,43~48
4	2.200 × 1.000	= 2.200	0.88733	23,40
5	2.100 × 1.000	= 2.100	0.77175	24,39

NO	A (m²)		I (m⁴)	절 점
3	1.863 × 1.000	= 1.863	0.53913	22,42
6	1.921 × 1.000	= 1.921	0.59059	26,38

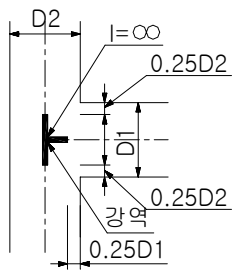
NO	Section(Tapper)	부 재
7	SEC 2 ~ 3	21
8	SEC 3 ~ 4	22
9	SEC 5 ~ 6	25
10	SEC 6 ~ 1	26
11	SEC 1 ~ 6	37
12	SEC 6 ~ 5	38
13	SEC 4 ~ 3	41
14	SEC 3 ~ 2	42

3) 단면좌표

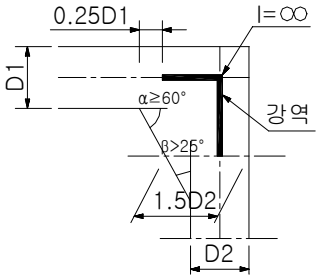
(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.500	0.500	45	0.500	3.910
2	1.350	0.500	46	0.500	2.773
3	1.529	0.500	47	0.500	1.637
4	2.558	0.500	48	0.500	1.300
5	3.587	0.500	49	0.500	0.000
6	4.617	0.500	50	1.529	0.000
7	5.646	0.500	51	2.558	0.000
8	6.675	0.500	52	3.587	0.000
9	7.704	0.500	53	4.617	0.000
10	8.733	0.500	54	5.646	0.000
11	9.762	0.500	55	6.675	0.000
12	10.792	0.500	56	7.704	0.000
13	11.821	0.500	57	8.733	0.000
14	12.000	0.500	58	9.762	0.000
15	12.850	0.500	59	10.792	0.000
16	12.850	1.300	60	11.821	0.000
17	12.850	1.637	61	12.850	0.000
18	12.850	2.773	62	13.350	0.500
19	12.850	3.910	63	13.350	1.637
20	12.850	5.047	64	13.350	2.773
21	12.850	6.020	65	13.350	3.910
22	12.850	6.183	66	13.350	5.047
23	12.850	6.520	67	13.350	6.183
24	12.850	7.320	68	13.350	7.320
25	12.000	7.320	69	12.850	7.820
26	11.821	7.320	70	11.821	7.820
27	11.500	7.320	71	10.792	7.820
28	10.792	7.320	72	9.762	7.820
29	9.762	7.320	73	8.733	7.820
30	8.733	7.320	74	7.704	7.820
31	7.704	7.320	75	6.675	7.820
32	6.675	7.320	76	5.646	7.820
33	5.646	7.320	77	4.617	7.820
34	4.617	7.320	78	3.587	7.820
35	3.587	7.320	79	2.558	7.820
36	2.558	7.320	80	1.529	7.820
37	1.850	7.320	81	0.500	7.820
38	1.529	7.320	82	0.000	7.320
39	1.350	7.320	83	0.000	6.183
40	0.500	7.320	84	0.000	5.047
41	0.500	6.520	85	0.000	3.910
42	0.500	6.183	86	0.000	2.773
43	0.500	6.020	87	0.000	1.637
44	0.500	5.047	88	0.000	0.500

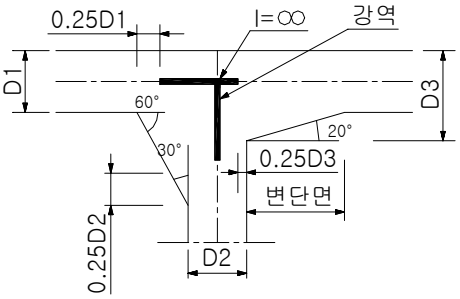
8) 강역설정



(가) 등단면의 경우



(나) 변단면의 경우(1)



(다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 40 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(2) 40 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(3) 24 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(4) 24 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

(7) 15 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(8) 15 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 2800 x N = 2800 x 50 = 140000.000 kN/m²

Bv = √(B × B) = √(14.050 × 14.050) = 14.05 m (L > B)

Kvo = 1 / 0.3 × 1 × 140000 = 466670.00 kN/m³

Kv = 466670.000 × (14.050 / 0.3) $^{-3 / 4}$ = 26067.15 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 35571 kN/m	1,15
Kv2	Kv x (1.029/2 + 1.029/2) = 26828 kN/m	3~13
Kh	1E10 kN/m (무한강성)	8

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 점토 (EL. : 9.786 ~ -2.900, N=5)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8² = 31753.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0² = 12404.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m²

(2) 실트질 모래 (EL. : -2.900 ~ -6.000, N=50)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 289.0 = 231.2 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 231.2² = 108977.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 108977.0 = 316033.3 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 289.0 = 144.5 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 144.5² = 42569.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 42569.0 = 123450.1 kN/m²

(3) 풍화암 (EL. : -6.000 ~ -13.000, N=50)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 631.0 = 504.8 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 504.8² = 519517.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 519517.0 = 1506599.3 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 631.0 = 315.5 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 315.5^2 = 202936.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 202936.0 = 588514.4 kN/m^2

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제2토층 ,점토

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m^3

Kv = 306945.670 × (14.050 / 0.3)$^{-3/4}$ = 17145.30 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 17145.300 = 5715.10 kN/m^3

(2) 하부슬래브 : 제4토층 , 풍화암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 1506599.3 = 5021997.67 kN/m^3

Kv = 5021997.670 × (14.050 / 0.3)$^{-3/4}$ = 280517.66 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 280517.660 = 93505.89 kN/m^3

(3) 측벽 : 제2토층 , 점토

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m^3

Kh = 306945.670 × (8.420 / 0.3)$^{-3/4}$ = 25172.04 kN/m^3

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 25172.040 = 8390.68 kN/m^3

(4) 측벽 : 제3토층 , 실트질 모래

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 316033.3 = 1053444.33 kN/m^3

Kh = 1053444.330 × (8.420 / 0.3)$^{-3/4}$ = 86390.99 kN/m^3

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 86390.990 = 28797.00 kN/m^3

(5) 측벽 : 제4토층 , 풍화암

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 1506599.3 = 5021997.67 kN/m³

Kh = 5021997.670 × (8.420 / 0.3)$^{-3/4}$ = 411844.60 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 411844.600 = 137281.53 kN/m³

(6) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 17645 kN/m	26,28~36,38
Ksb1	Ksb x (1.029/2 + 1.029/2) = 5882 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.137/2 + 1.137/2) = 468131 kN/m	17~18,46,47
Kss1	Kss x (1.137/2 + 1.137/2) = 156044 kN/m	
Kh2	Kh x (1.137/2 + 1.137/2) = 98198 kN/m	19~20,22,42,44,45
Kss2	Kss x (1.137/2 + 1.137/2) = 32733 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 288700 kN/m	3~13
Ksb1	Ksb x (1.029/2 + 1.029/2) = 96233 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 382790 kN/m	1,15
Ksb1	Kh x (1.137/2 + 1.600/2) = 563541 kN/m	
Kv2	Kv x (1.029/2 + 1.700/2) = 23396 kN/m	24,40
Ksb2	Kh x (1.137/2 + 1.600/2) = 34444 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제2토층 ,점토

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kv = 119905.330 × (14.050 / 0.3)$^{-3/4}$ = 6697.65 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 6697.650 = 2232.55 kN/m³

(2) 하부슬래브 : 제4토층 , 풍화암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 588514.4 = 1961714.67 kN/m³

Kv = 1961714.670 × (14.050 / 0.3) $^{-3 / 4}$ = 109577.03 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 109577.030 = 36525.68 kN/m³

(3) 측벽 : 제2토층 , 점토

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kh = 119905.330 × (8.420 / 0.3) $^{-3 / 4}$ = 9833.21 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 9833.210 = 3277.74 kN/m³

(4) 측벽 : 제3토층 , 실트질 모래

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 123450.1 = 411500.33 kN/m³

Kh = 411500.330 × (8.420 / 0.3) $^{-3 / 4}$ = 33746.37 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 33746.370 = 11248.79 kN/m³

(5) 측벽 : 제4토층 , 풍화암

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 588514.4 = 1961714.67 kN/m³

Kh = 1961714.670 × (8.420 / 0.3) $^{-3 / 4}$ = 160876.54 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 160876.540 = 53625.51 kN/m³

(6) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 6893 kN/m	26,28~36,38
Ksb1	Ksb x (1.029/2 + 1.029/2) = 2298 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.137/2 + 1.137/2) = 182864 kN/m	17~18,46,47
Kss1	Kss x (1.137/2 + 1.137/2) = 60955 kN/m	
Kh2	Kh x (1.137/2 + 1.137/2) = 38358 kN/m	19~20,22,42,44,45
Kss2	Kss x (1.137/2 + 1.137/2) = 12786 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 112773 kN/m	3~13
Ksb1	Ksb x (1.029/2 + 1.029/2) = 37591 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 149527 kN/m	1,15
Ksb1	Kh x (1.137/2 + 1.600/2) = 220133 kN/m	
Kv2	Kv x (1.029/2 + 1.700/2) = 9140 kN/m	24,40
Ksb2	Kh x (1.137/2 + 1.600/2) = 13455 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

설계지진	성능기준 / 재현주기	기 능 수 행	붕 괴 방 지
	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.16 = 0.091
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.16 = 0.224

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00		= 11.500	kN/m²
- 토 사	: 10.256 × 19.00		= 194.864	kN/m²
- 방 수	: 0.050 × 21.50		= 1.075	kN/m²
		∴ Total Wd1	= 207.439	kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00		= 11.500	kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00		= 9.500	kN/m²
- 흙(지하수위 이하)	: 9.756 × 10.00		= 97.560	kN/m²
- 방수	: 0.050 × 21.50		= 1.075	kN/m²
		∴ Total Wd2	= 119.635	kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

토피고(D,m)	도로면의 활하중 (kN/m²)	토피고(D,m)	도로면의 활하중 (kN/m²)
1.0	39.0	1.5	25.0
2.0	18.0	2.5	14.0
3.0	11.0	3.5	10.0
4.0	10.0	5.0	10.0
6.0	10.0	7.0	10.0
8.0	10.0	9.0	10.0
10.0	10.0		

주) 중간토피에 대한 것은 그 상위의 것을 취한다.

① 상부 슬래브에 작용하는 하중 (WI1) - 토피 4m 이상

- WI1 = 10.000 kN/m²

② 측벽에 작용하는 하중 (WI2)

- WI2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 11.106 × 19.000) × 0.500 = 111.257 kN/m²
Wh2 = 111.257 + 0.800 × 19.000 × 0.500 = 118.857 kN/m²
Wh3 = 118.857 + 0.337 × 19.000 × 0.500 = 122.056 kN/m²
Wh4 = 122.056 + 0.163 × 19.000 × 0.500 = 123.607 kN/m²
Wh5 = 123.607 + 0.973 × 19.000 × 0.500 = 132.853 kN/m²
Wh6 = 132.853 + 1.137 × 19.000 × 0.500 = 143.652 kN/m²
Wh7 = 143.652 + 1.137 × 19.000 × 0.500 = 154.451 kN/m²
Wh8 = 154.451 + 1.137 × 19.000 × 0.500 = 165.248 kN/m²
Wh9 = 165.248 + 0.337 × 19.000 × 0.500 = 168.447 kN/m²
Wh10 = 168.447 + 0.800 × 19.000 × 0.500 = 176.047 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 10.606 × 10.00 = 63.530 kN/m²
Wh2 = 63.530 + 0.800 × 10.000 × 0.500 = 67.530 kN/m²
Wh3 = 67.530 + 0.337 × 10.000 × 0.500 = 69.213 kN/m²
Wh4 = 69.213 + 0.163 × 10.000 × 0.500 = 70.030 kN/m²
Wh5 = 70.030 + 0.973 × 10.000 × 0.500 = 74.897 kN/m²
Wh6 = 74.897 + 1.137 × 10.000 × 0.500 = 80.580 kN/m²
Wh7 = 80.580 + 1.137 × 10.000 × 0.500 = 86.263 kN/m²
Wh8 = 86.263 + 1.137 × 10.000 × 0.500 = 91.947 kN/m²
Wh9 = 91.947 + 0.337 × 10.000 × 0.500 = 93.630 kN/m²
Wh10 = 93.630 + 0.800 × 10.000 × 0.500 = 97.630 kN/m²

6) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

7) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 15 \times 10^{-5}$
- 온도선팽창 계수 $\alpha = 1.0 \times 10^{-5}$
- $\Delta T = -\frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
성토재	1.786	248.600	248.600	19.000	0.029	0.029
실트질 자갈	2.200	156.000	156.000	20.000	0.056	0.056
점토	8.700	156.000	156.000	20.000	0.223	0.223
실트질 모래	3.100	289.000	289.000	20.000	0.043	0.043
풍화암	14.214	631.000	631.000	20.000	0.090	0.090
계					0.441	0.441

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.441 = 0.551	1.25 Tg' = 1.25 × 0.441 = 0.551

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575
To(sec)	To = 0.2 × Ts = 0.2 × 0.575 = 0.115	To = 0.2 × Ts = 0.2 × 0.575 = 0.115

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $C_d = \frac{1.5}{40h+1} + 0.5$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa)

- 붕괴방지수준시(재현주기 1000년적용)

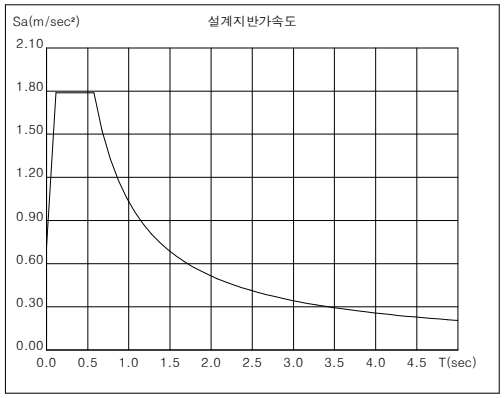
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 1.789 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 3.664 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg

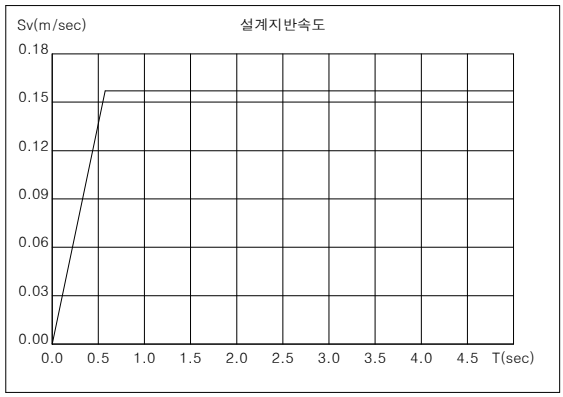
5) 속도 응답스펙트럼(Sv) - 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.551 / 2π × 1.789 = 0.157 m/s	Sv = Tg/2π × Sa = 0.551 / 2π × 3.664 = 0.321 m/s

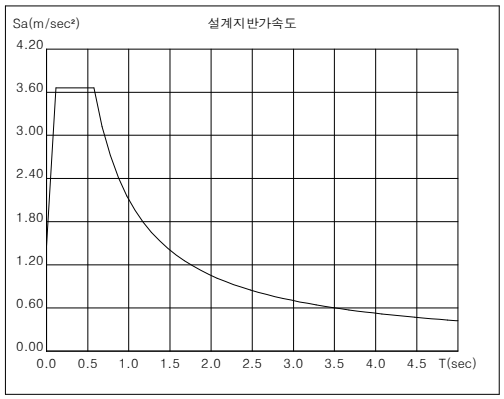
6) 설계응답 응답스펙트럼

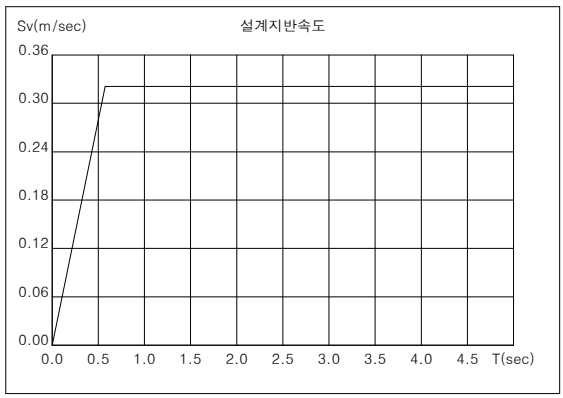
(1) 기능수행수준





(2) 붕괴방지수준





7) 층별 변위값 정리

- 제 1층의 두께(H1) = 15.786 m
- 제 2층의 두께(H2) = 14.214 m
- 제 1층의 습윤단위 체적중량(γ1) = 17.740 kN/m³
- 제 2층의 습윤단위 체적중량(γ2) = 20.000 kN/m³
- 제 1층의 평균전단파속도(Vsod1) = 164.469 m/sec
- 제 2층의 평균전단파속도(Vsod2) = 631.000 m/sec
- 제 1층과 제2층의 임피던스비(α)

  (γ1×Vsod1) / (γ2×Vsod2) = (17.740 × 164.469) / (20.000 × 631.000)

  = 0.231
- 지반의 설계 고유 진동수(Wo)

  (1+α)×cos[Wo×(H1/Vsod1 + H2/Vsod2)] + (1-α)×cos[Wo×(H1/Vsod1 - H2/Vsod2)] = 0

  (1 + 0.231) × cos[Wo × (15.786 / 164.469 + 14.214 / 631.000)] +

  (1 - 0.231) × cos[Wo × (15.786 / 164.469 - 14.214 / 631.000)] = 0

  에서 시행착오법으로 산정, Wo = 15.492

- 각 층별 변위 계산식
  - 제1층 변위 계산식

    $Uh1 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times x1/Vsod1)$

  - 제2층 변위 계산식

    $Uh2 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times H1/Vsod1) \times$
    $[\cos(Wo \times x2/Vsod2) - \sin(Wo \times x2/Vsod2) / \tan(Wo \times H2/Vsod2)]$

8) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 11.606 m
- 하부슬래브 EL. = 18.426 m
- 기반암 심도(H) = 30.000 m

$Po = Ksb,top \times (U(Zu) - U(Zb))$

기능수행수준	붕괴방지수준
$Po = 5715.100 \times (0.008057 - 0.001204)$ $= 39.166\ kN/m^2$	$Po = 2232.550 \times (0.016474 - 0.002461)$ $= 31.285\ kN/m^2$

9) 측벽 지반변위 하중

$P(z) = Kh \times (Uh(z) - Uh(b))$

(1) 기능수행수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
11.606	25172.040	0.008057	0.006853	172.504
12.406	25172.040	0.006862	0.005658	142.423
12.743	86390.990	0.006347	0.005143	444.309
12.906	86390.990	0.006095	0.004891	422.538
13.879	86390.990	0.004565	0.003361	290.360
15.016	86390.990	0.002730	0.001526	131.833
16.153	411844.600	0.001432	0.000228	93.901
17.289	411844.600	0.001318	0.000114	46.950
17.626	411844.600	0.001284	0.000080	32.948
18.426	411844.600	0.001204	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
11.606	9833.210	0.016474	0.014013	137.793
12.406	9833.210	0.014031	0.011570	113.770
12.743	33746.370	0.012977	0.010516	354.877
12.906	33746.370	0.012462	0.010001	337.497
13.879	33746.370	0.009335	0.006874	231.973
15.016	33746.370	0.005582	0.003121	105.322
16.153	160876.540	0.002927	0.000466	74.968
17.289	160876.540	0.002695	0.000234	37.645
17.626	160876.540	0.002626	0.000165	26.545
18.426	160876.540	0.002461	0.000000	0.000

10) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

구분	기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
Vu	31753.000 × 0.001405 = 44.610	12404.000 × 0.002873 = 35.640
Vb	519517.000 × 0.000101 = 52.470	202936.000 × 0.000206 = 41.800
Vs	(44.610 + 52.470) / 2 = 48.540	(35.640 + 41.800) / 2 = 38.720

11) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fu = 1.600×25.000×0.091×(1 - 0.015×11.606) = 3.006	fu = 1.600×25.000×0.224×(1 - 0.015×11.606) = 7.400

② 하부슬래브

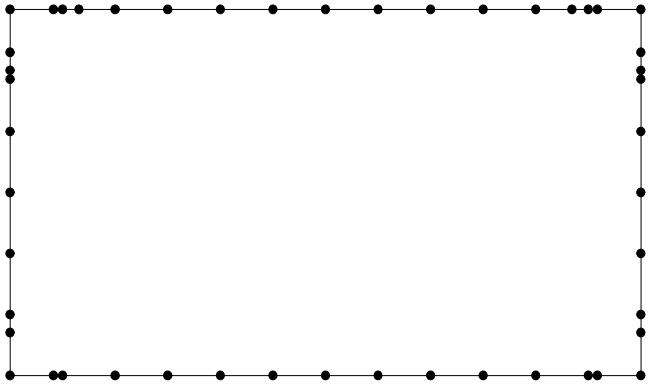
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fb = 1.600×25.000×0.091×(1 - 0.015×18.426) = 2.634	fb = 1.600×25.000×0.224×(1 - 0.015×18.426) = 6.484

③ 측벽

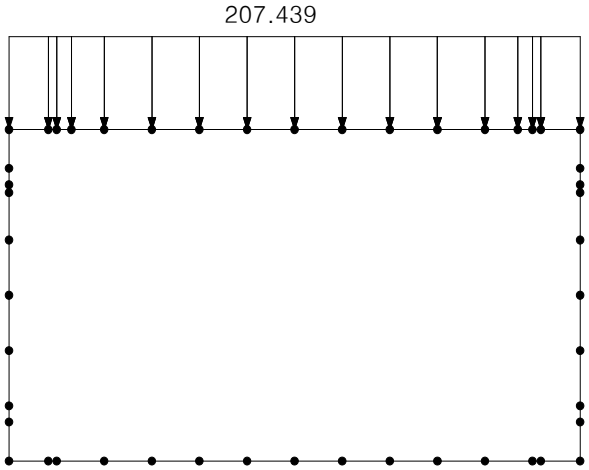
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
f1 = 1.700×25.000×0.091×(1-0.015×11.606) = 3.194	f1 = 1.700×25.000×0.224×(1-0.015×11.606) = 7.863
f2 = 1.700×25.000×0.091×(1-0.015×12.406) = 3.148	f2 = 1.700×25.000×0.224×(1-0.015×12.406) = 7.748
f3 = 1.700×25.000×0.091×(1-0.015×12.743) = 3.128	f3 = 1.700×25.000×0.224×(1-0.015×12.743) = 7.700
f4 = 1.700×25.000×0.091×(1-0.015×12.906) = 3.119	f4 = 1.700×25.000×0.224×(1-0.015×12.906) = 7.677
f5 = 1.700×25.000×0.091×(1-0.015×13.879) = 3.062	f5 = 1.700×25.000×0.224×(1-0.015×13.879) = 7.538
f6 = 1.700×25.000×0.091×(1-0.015×15.016) = 2.996	f6 = 1.700×25.000×0.224×(1-0.015×15.016) = 7.376
f7 = 1.700×25.000×0.091×(1-0.015×16.153) = 2.930	f7 = 1.700×25.000×0.224×(1-0.015×16.153) = 7.213
f8 = 1.700×25.000×0.091×(1-0.015×17.289) = 2.865	f8 = 1.700×25.000×0.224×(1-0.015×17.289) = 7.051
f9 = 1.700×25.000×0.091×(1-0.015×17.626) = 2.845	f9 = 1.700×25.000×0.224×(1-0.015×17.626) = 7.003
f10 = 1.700×25.000×0.091×(1-0.015×18.426) = 2.799	f10 = 1.700×25.000×0.224×(1-0.015×18.426) = 6.889

11. 하 중 재 하 (상시)

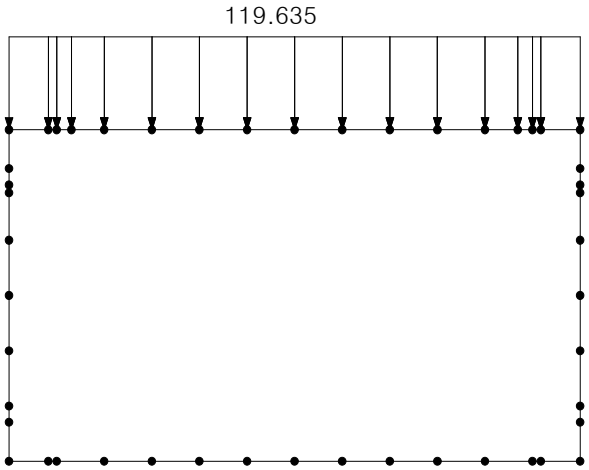
1) CASE1 - 구체자중(SW)



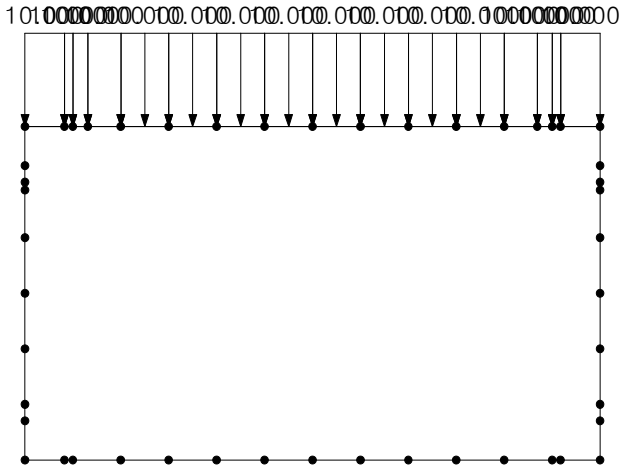
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



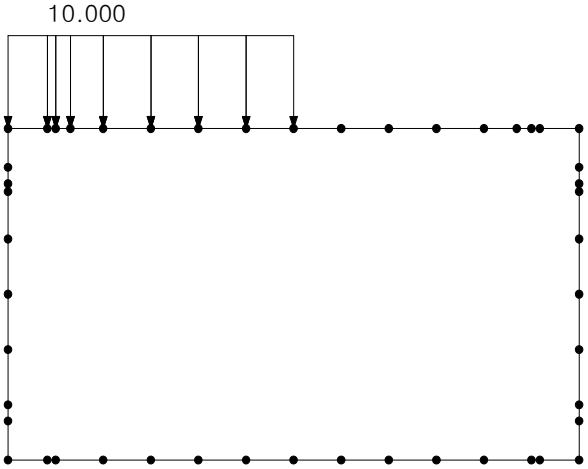
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



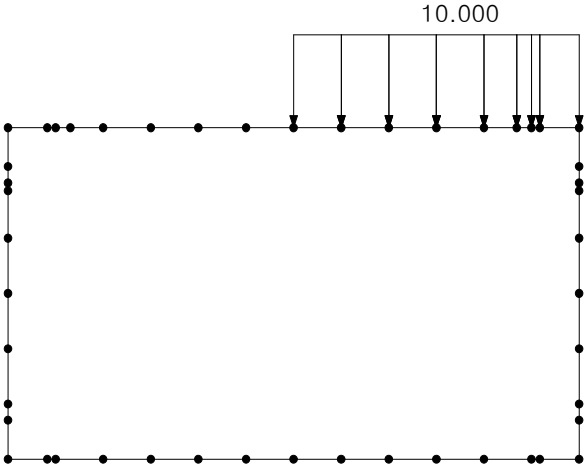
4) CASE4 - 만재활하중(LIVEFU)



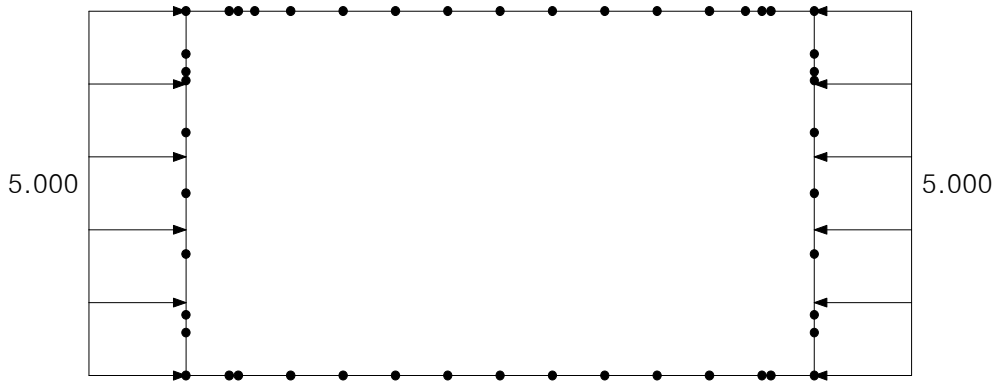
5) CASE5 - 편재활하중(좌측)(LIVELE)



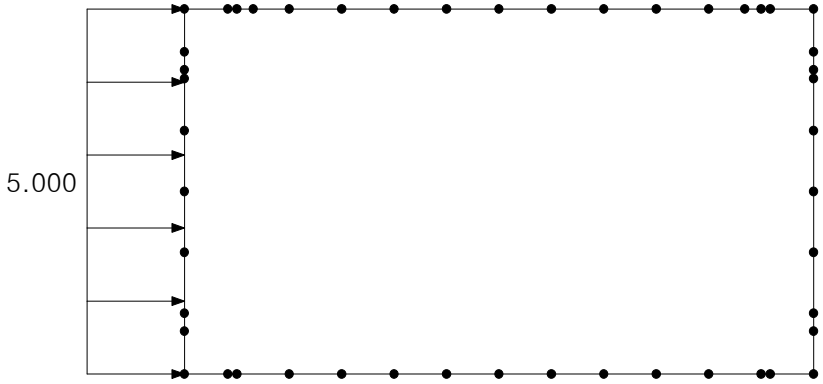
6) CASE6 - 편재활하중(우측)(LIVERI)



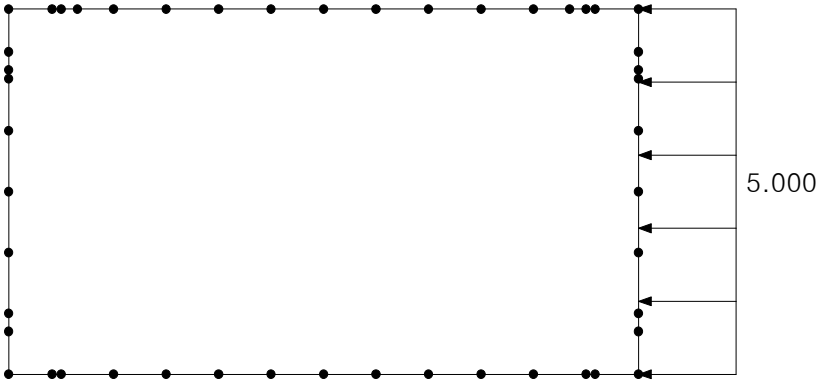
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



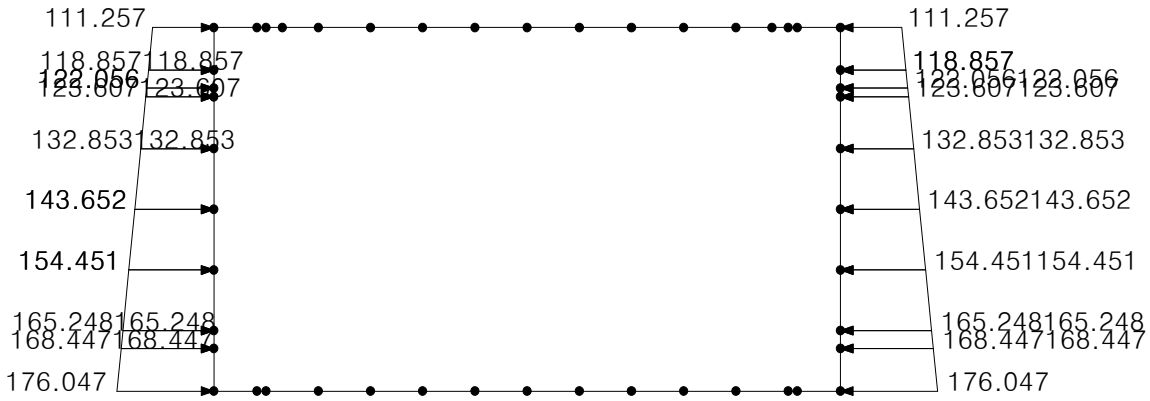
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



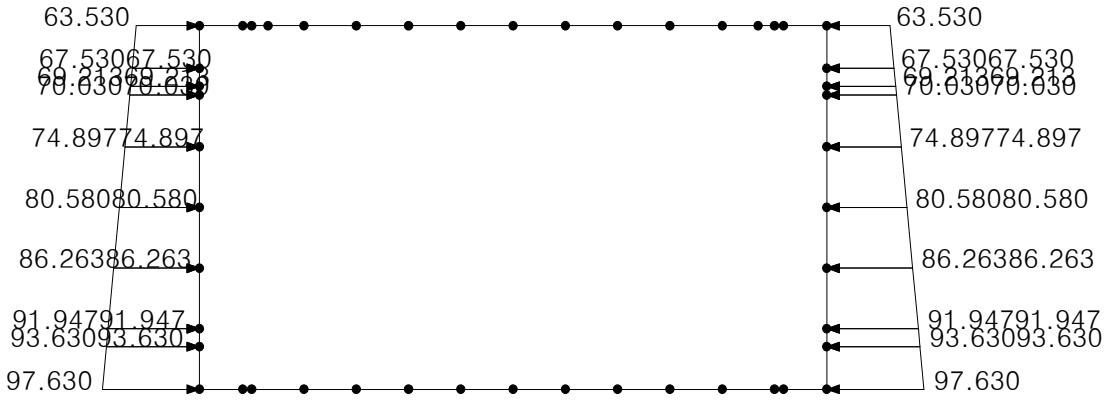
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



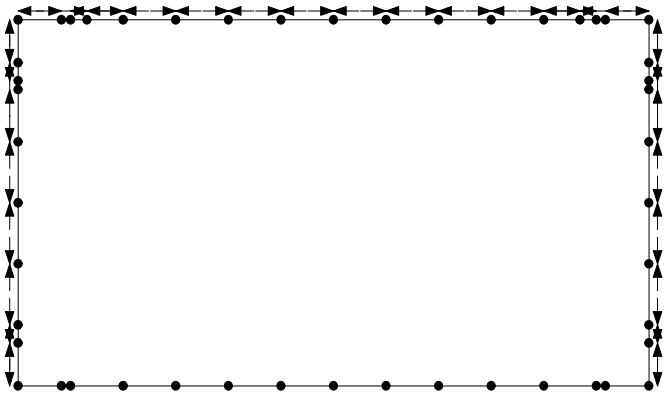
10) CASE10 - 양토압 : 지하수無(SOILB)



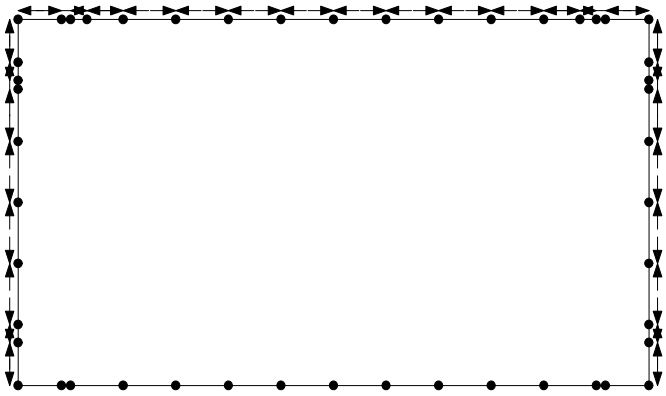
11) CASE11 - 양토압 : 지하수有(SOILBW)



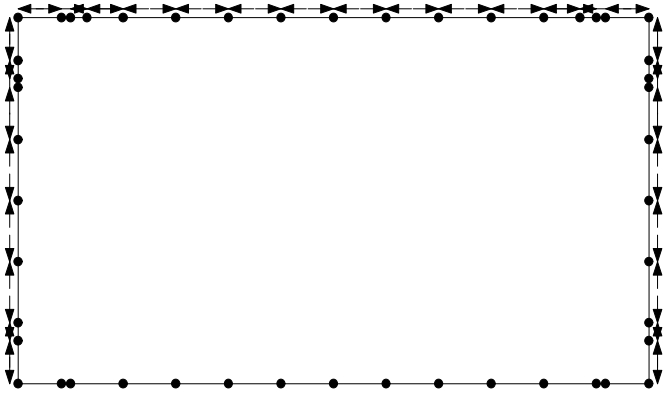
12) CASE12 - 온도변화(+) +10° C(TEMPPLUS)



13) CASE13 - 온도변화(-) -10° C(TEMPMINU)

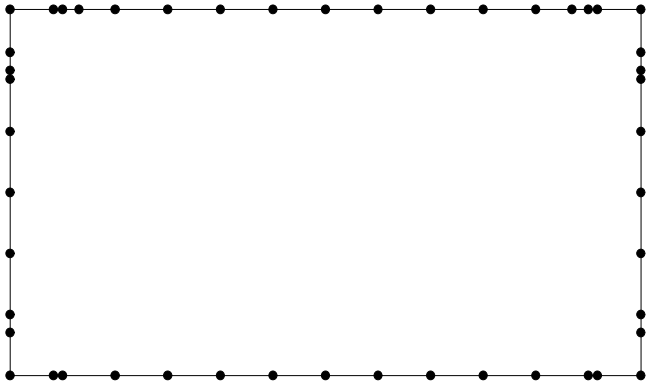


14) CASE14 - 건조수축 -15° C(SHRINK)

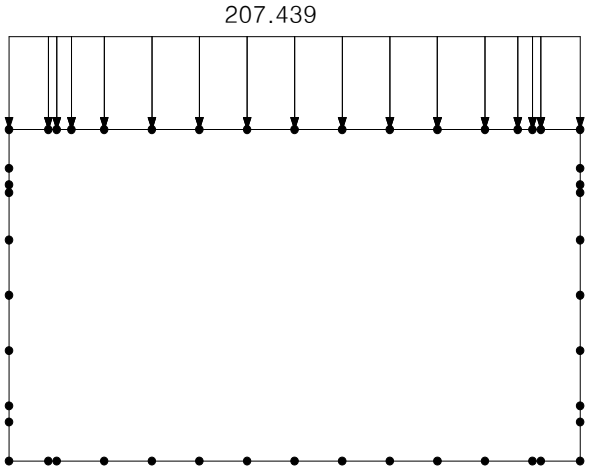


12. 하중 재하 (기능수행)

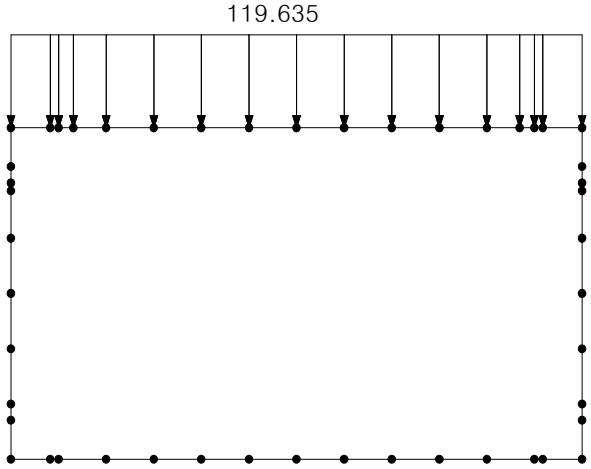
1) CASE1 - 구체자중(SW)



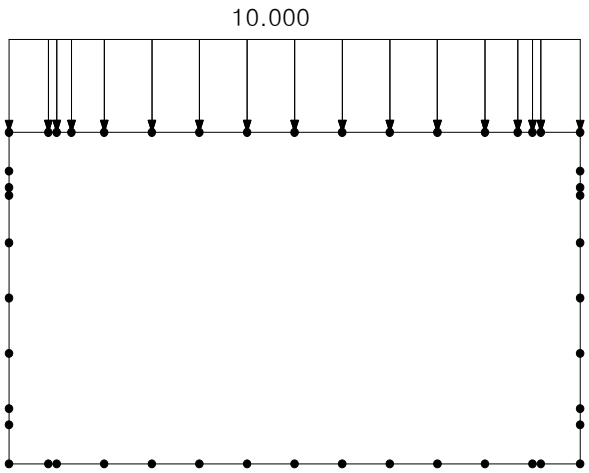
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



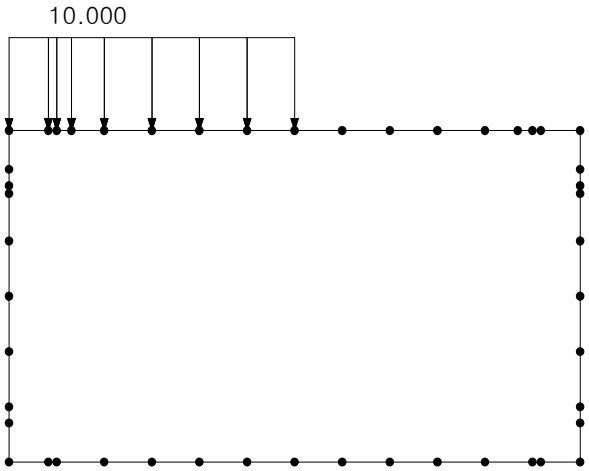
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



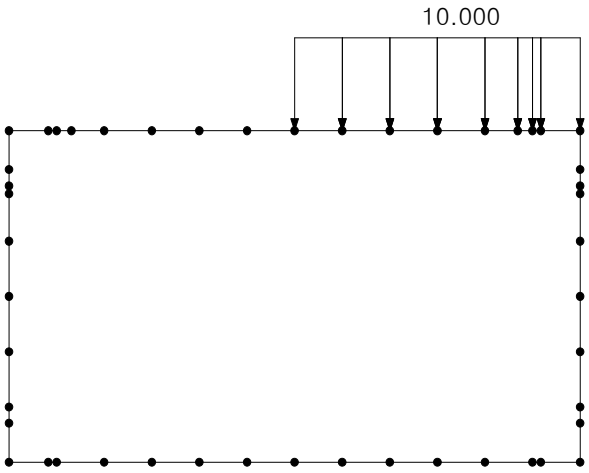
4) CASE4 - 지진시 만재활하중(LIVEFUE)



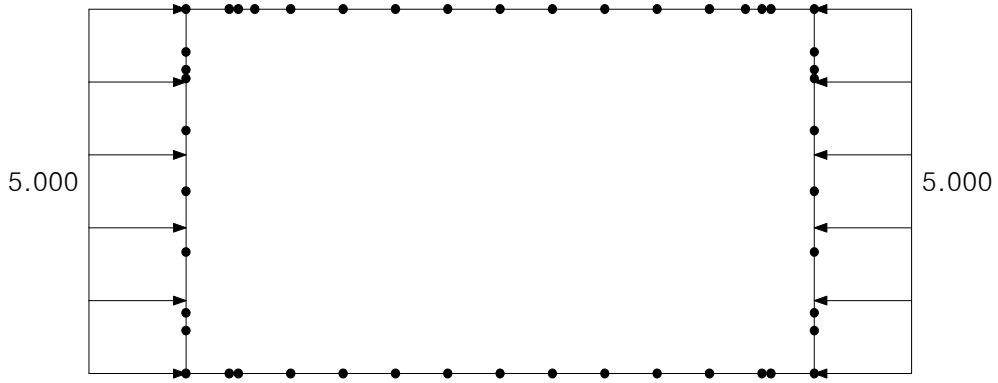
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



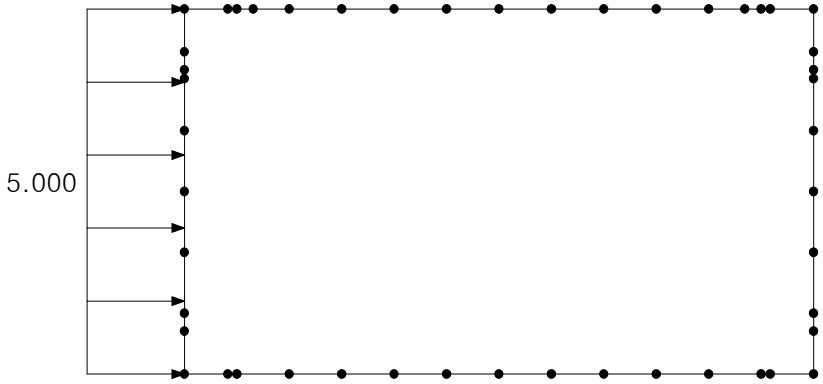
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



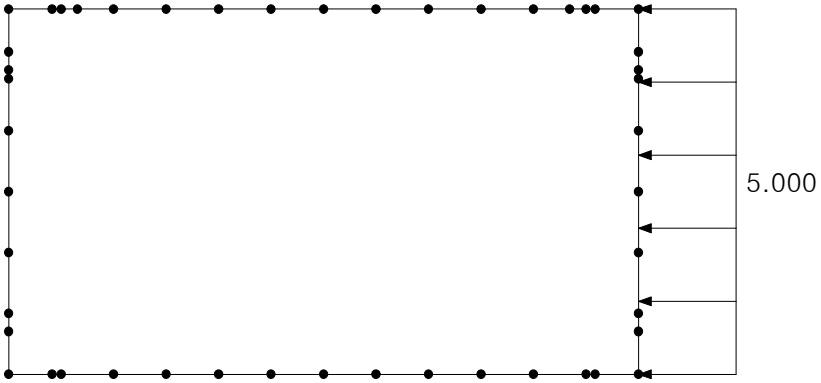
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)

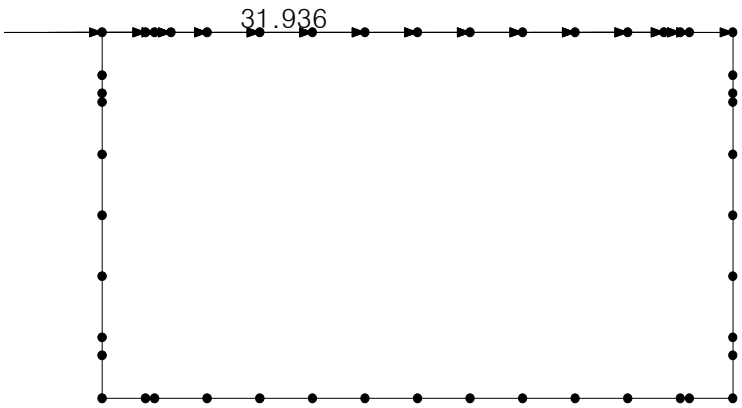


9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)

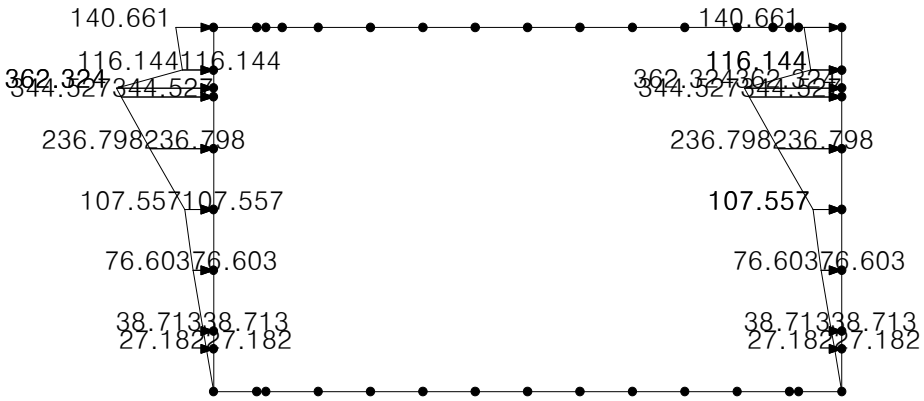


- 지진재하방향(좌측에서 우측으로)

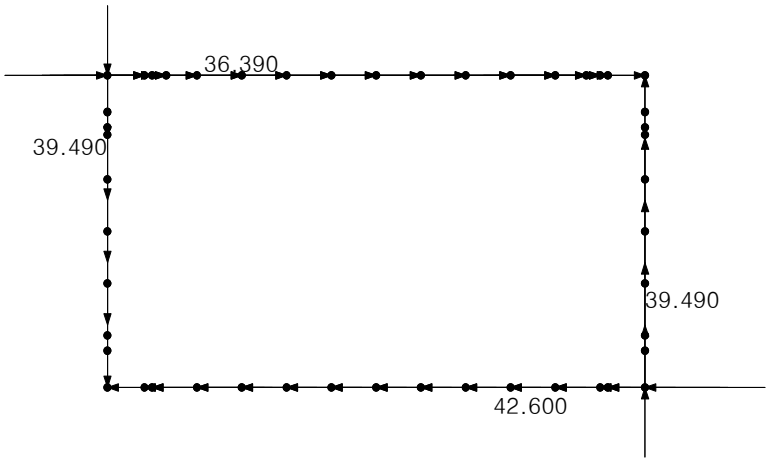
10) CASE10 - 슬래브 지반변위(기능수행)(FUNSLAB)



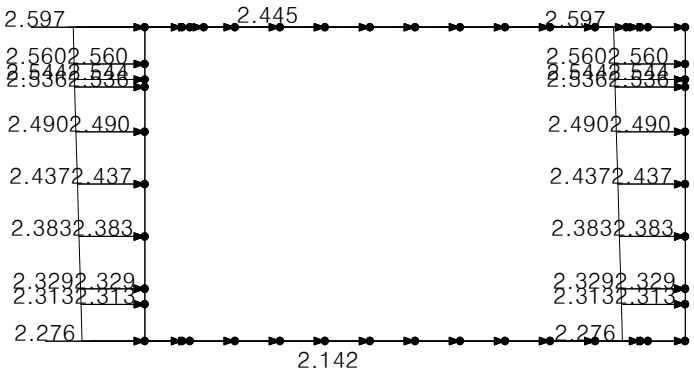
11) CASE11 - 벽체 지반변위(기능수행)(FUNWALL)



12) CASE12 - 주면전단력(기능수행)(FUNMS)

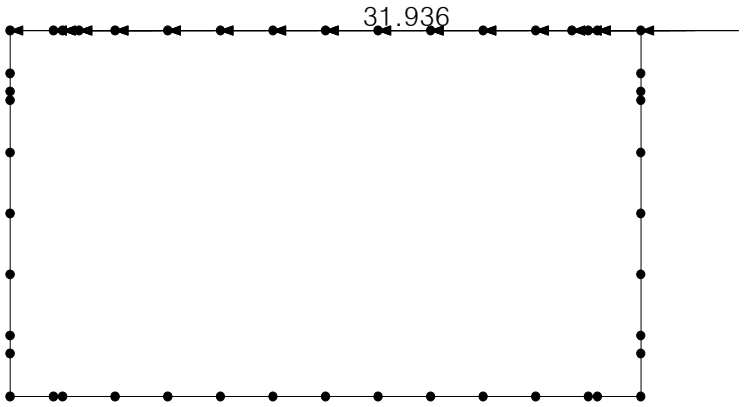


13) CASE13 - 구체 관성력(기능수행)(FUNINER)

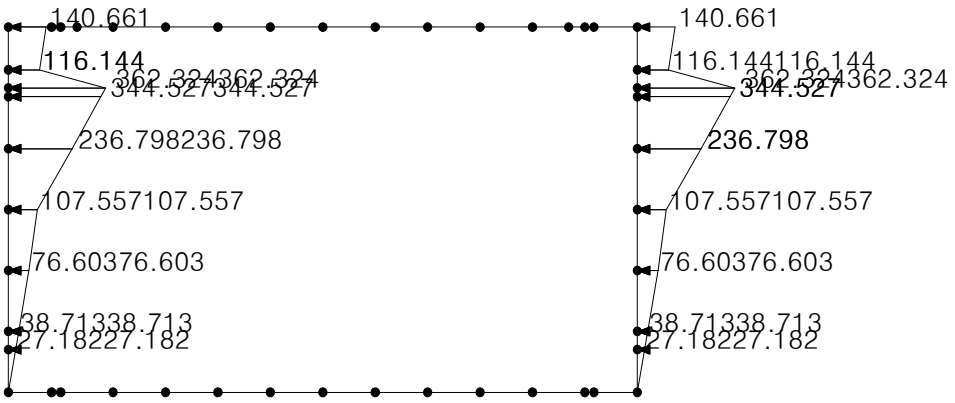


- 지진재하방향(우측에서 좌측으로)

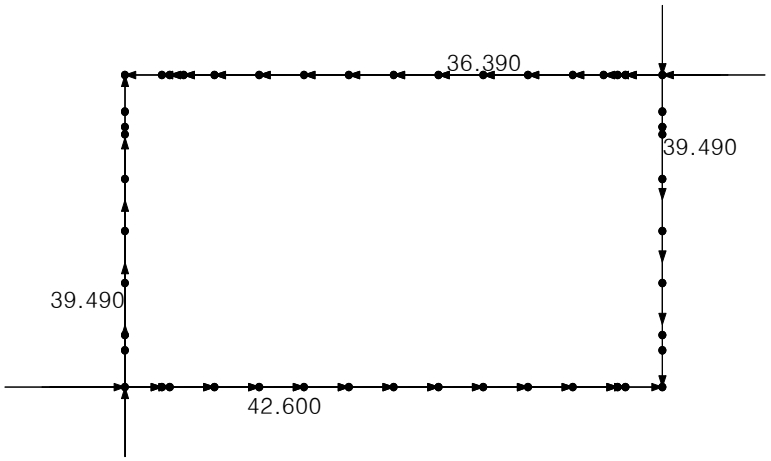
14) CASE14 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



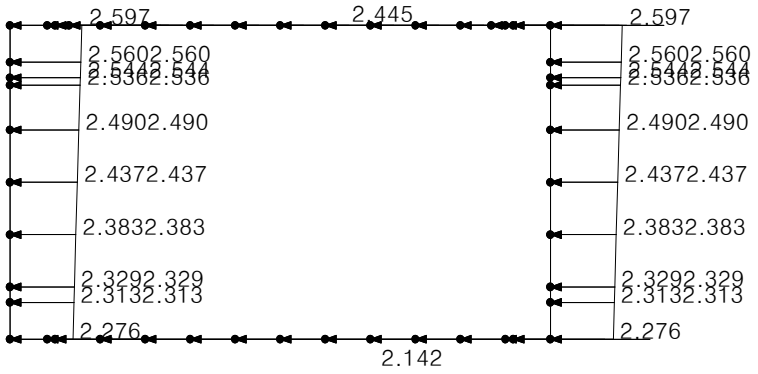
15) CASE15 - 벽체 지반변위(기능수행)2(FUNWALL2)



16) CASE16 - 주면전단력(기능수행)2(FUNMS2)

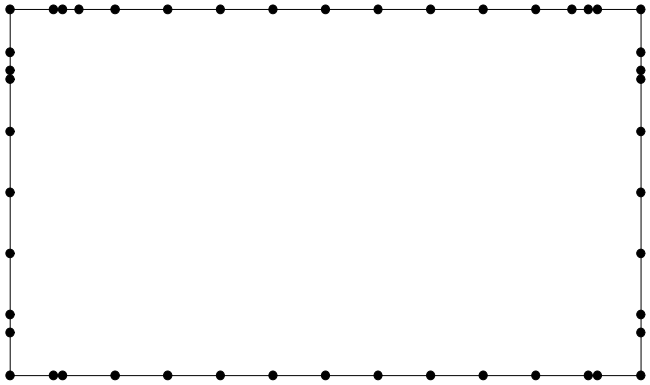


17) CASE17 - 구체 관성력(기능수행)2(FUNINER2)

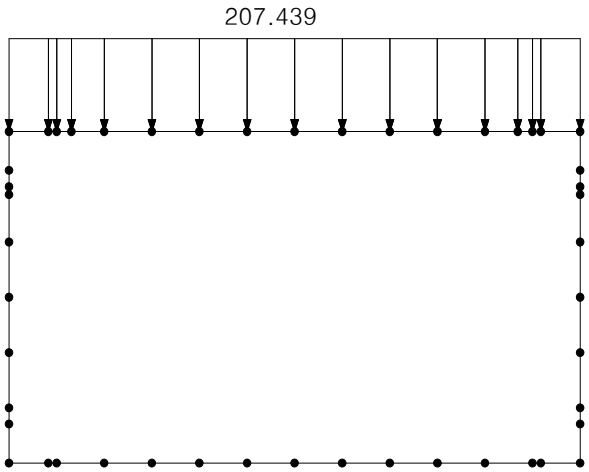


13. 하중 재하 (붕괴방지)

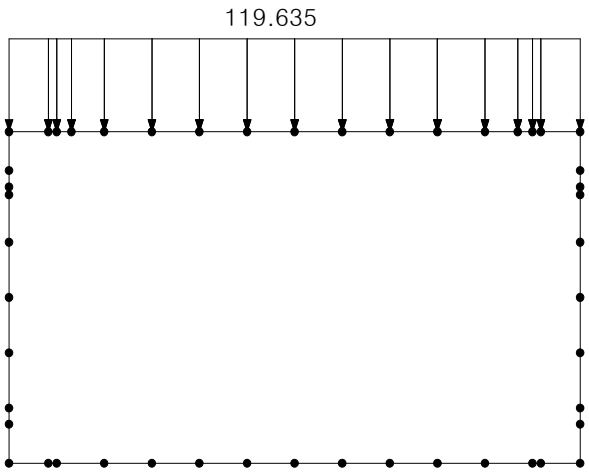
1) CASE1 - 구체자중(SW)



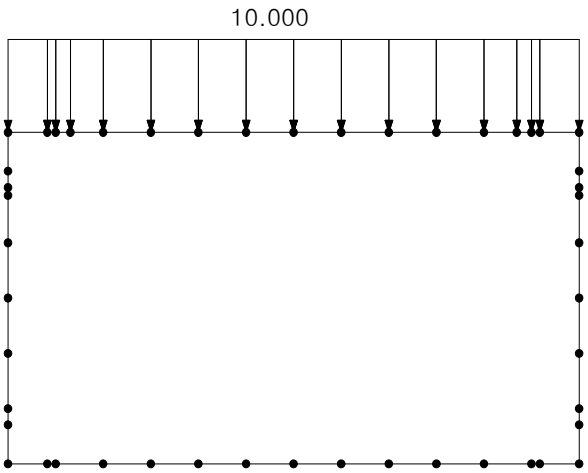
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



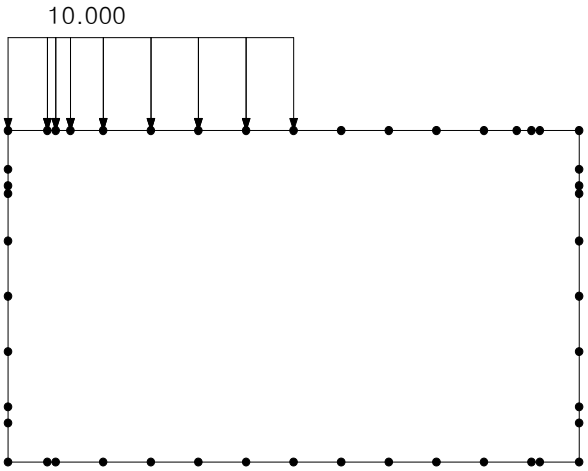
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



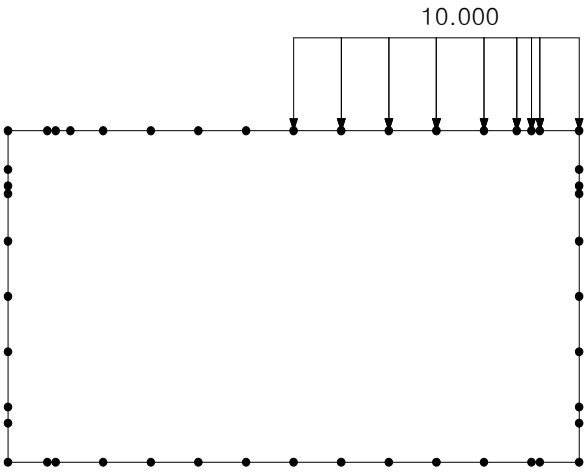
4) CASE4 - 지진시 만재활하중(LIVEFUE)



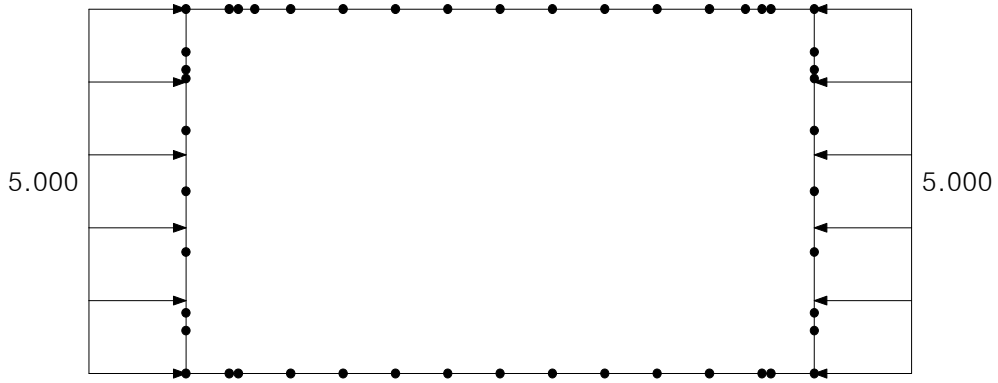
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



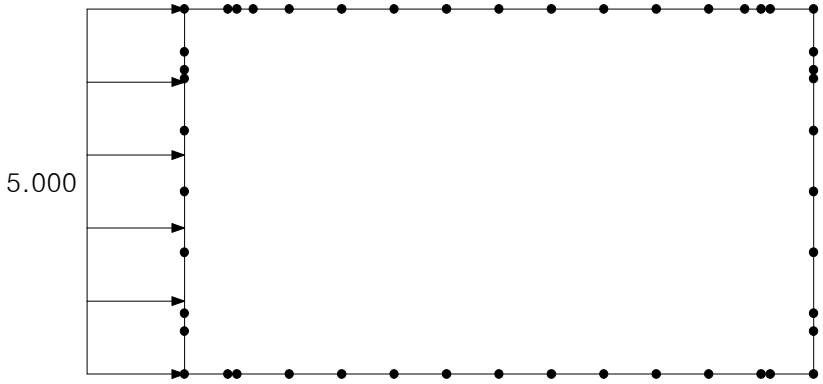
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



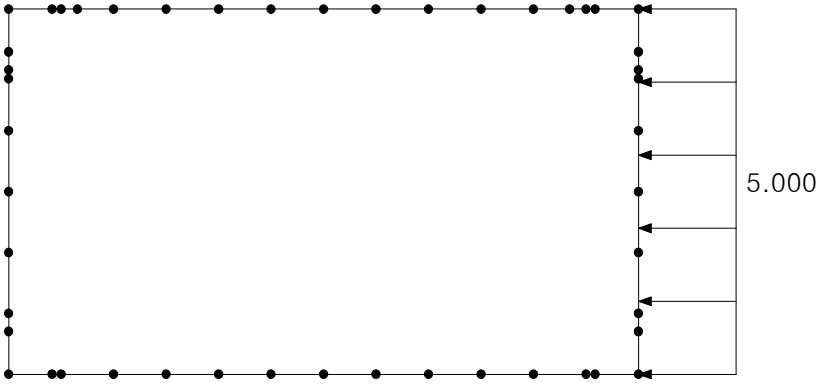
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)

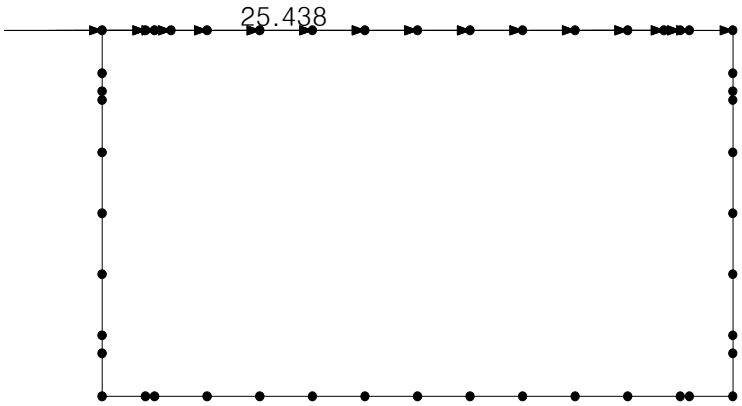


9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)

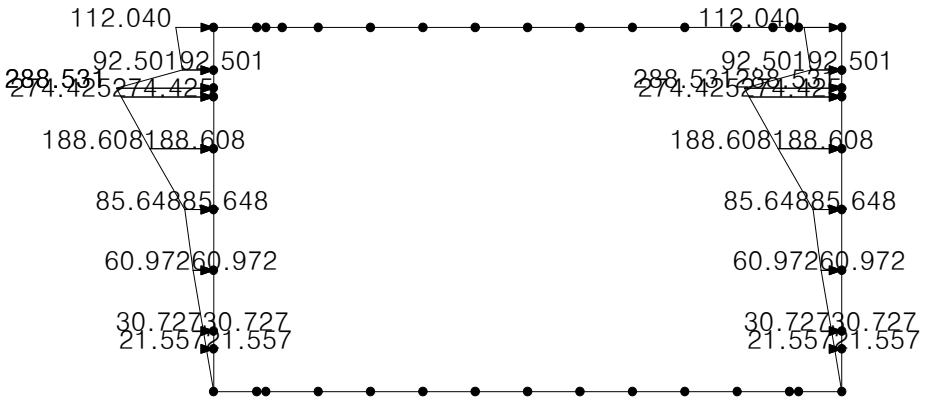


- 지진재하방향(좌측에서 우측으로)

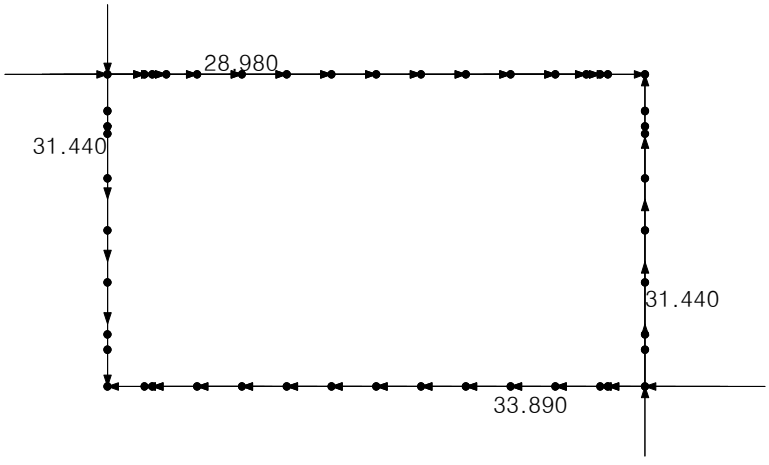
10) CASE10 - 슬래브 지반변위(붕괴방지)(COLSLAB)



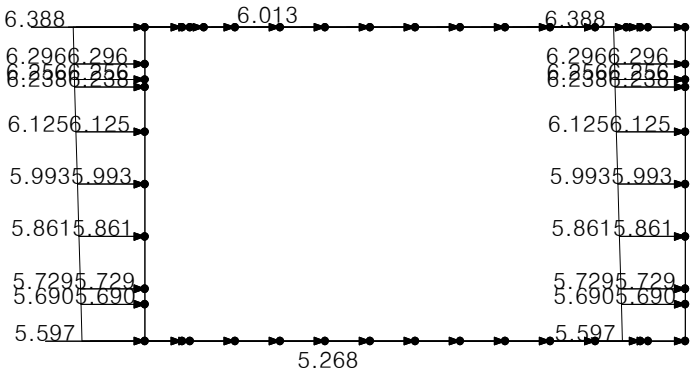
11) CASE11 - 벽체 지반변위(붕괴방지)(COLWALL)



12) CASE12 - 주면전단력(붕괴방지)(COLMS)

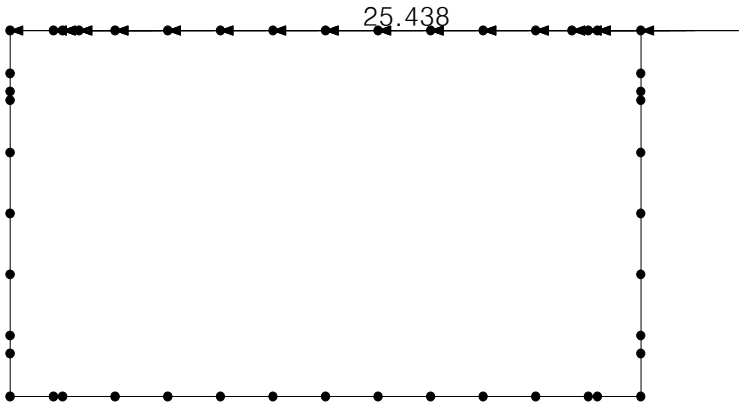


13) CASE13 - 구체 관성력(붕괴방지)(COLINER)

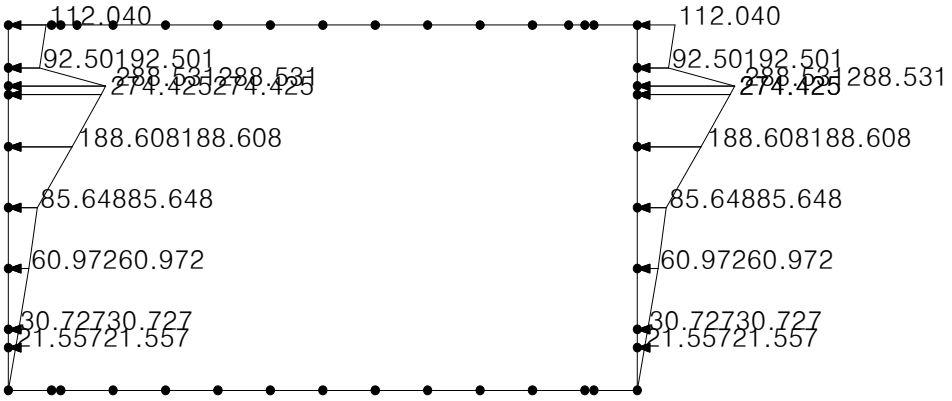


- 지진재하방향(우측에서 좌측으로)

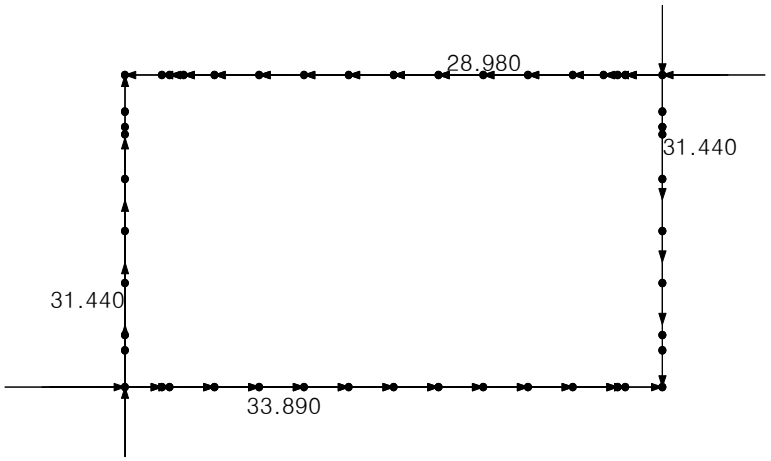
14) CASE14 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



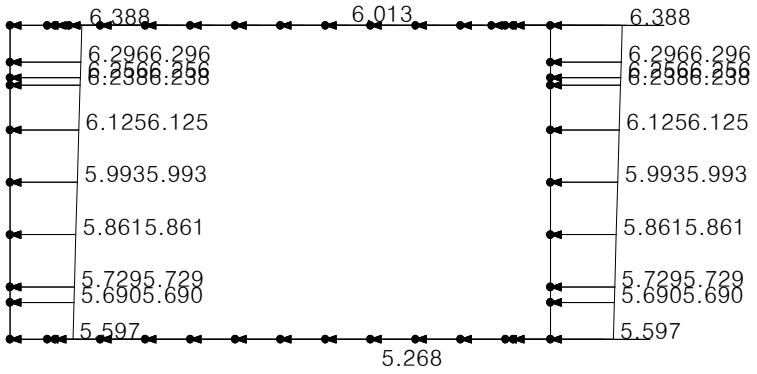
15) CASE15 - 벽체 지반변위(붕괴방지)2(COLWALL2)



16) CASE16 - 주면전단력(붕괴방지)2(COLMS2)



17) CASE17 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 1.000, h = 10.806 m

1) 계수하중

구 분	D	Hv	L	Hh	T	지하수 고려
LC1	1.200	1.600	1.600	1.600	1.200	
LC2	1.200	1.600	1.600	0.800	1.200	
LC3	0.900	1.600		1.600		
LC4	0.900	1.600		0.800		
LC5	1.200	1.600	1.600	1.600	1.200	●
LC6	1.200	1.600	1.600	0.800	1.200	●
LC7	0.900	1.600		1.600		●
LC8	0.900	1.600		0.800		●

2) 사용하중

구 분	D	Hv	L	Hh	T	지하수 고려
LC1	1.000	1.000	1.000	1.000	1.000	
LC2	1.000	1.000	1.000	0.500	1.000	
LC3	1.000	1.000		1.000		
LC4	1.000	1.000		0.500		
LC5	1.000	1.000	1.000	1.000	1.000	●
LC6	1.000	1.000	1.000	0.500	1.000	●
LC7	1.000	1.000		1.000		●
LC8	1.000	1.000		0.500		●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	E	지하수 고려
LC1	1.200	1.200	1.000	1.000		1.000	
LC2	1.200	1.200	1.000	0.500		1.000	
LC3	0.900	0.900		1.000		1.000	
LC4	0.900	0.900		0.500		1.000	
LC5	1.200	1.200	1.000	1.000		1.000	●
LC6	1.200	1.200	1.000	0.500		1.000	●
LC7	0.900	0.900		1.000		1.000	●
LC8	0.900	0.900		0.500		1.000	●

4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	E	지하수 고려
LC1	1.200	1.200	1.000	1.000		1.000	
LC2	1.200	1.200	1.000	0.500		1.000	
LC3	0.900	0.900		1.000		1.000	
LC4	0.900	0.900		0.500		1.000	
LC5	1.200	1.200	1.000	1.000		1.000	●
LC6	1.200	1.200	1.000	0.500		1.000	●
LC7	0.900	0.900		1.000		1.000	●
LC8	0.900	0.900		0.500		1.000	●

15. INPUT DATA (상시)

```
; ACulvert SAP2000 데이터파일 : 평상시
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.000 Y=     0.000 Z=     0.500
  2    X=     0.850 Y=     0.000 Z=     0.500
  3    X=     1.029 Y=     0.000 Z=     0.500
  4    X=     2.058 Y=     0.000 Z=     0.500
  5    X=     3.087 Y=     0.000 Z=     0.500
  6    X=     4.117 Y=     0.000 Z=     0.500
  7    X=     5.146 Y=     0.000 Z=     0.500
  8    X=     6.175 Y=     0.000 Z=     0.500
  9    X=     7.204 Y=     0.000 Z=     0.500
  10   X=     8.233 Y=     0.000 Z=     0.500
  11   X=     9.262 Y=     0.000 Z=     0.500
  12   X=    10.292 Y=     0.000 Z=     0.500
  13   X=    11.321 Y=     0.000 Z=     0.500
  14   X=    11.500 Y=     0.000 Z=     0.500
  15   X=    12.350 Y=     0.000 Z=     0.500
  16   X=    12.350 Y=     0.000 Z=     1.300
  17   X=    12.350 Y=     0.000 Z=     1.637
  18   X=    12.350 Y=     0.000 Z=     2.773
  19   X=    12.350 Y=     0.000 Z=     3.910
  20   X=    12.350 Y=     0.000 Z=     5.047
  21   X=    12.350 Y=     0.000 Z=     6.020
  22   X=    12.350 Y=     0.000 Z=     6.183
  23   X=    12.350 Y=     0.000 Z=     6.520
  24   X=    12.350 Y=     0.000 Z=     7.320
  25   X=    11.500 Y=     0.000 Z=     7.320
  26   X=    11.321 Y=     0.000 Z=     7.320
  27   X=    11.000 Y=     0.000 Z=     7.320
  28   X=    10.292 Y=     0.000 Z=     7.320
  29   X=     9.262 Y=     0.000 Z=     7.320
  30   X=     8.233 Y=     0.000 Z=     7.320
  31   X=     7.204 Y=     0.000 Z=     7.320
  32   X=     6.175 Y=     0.000 Z=     7.320
  33   X=     5.146 Y=     0.000 Z=     7.320
  34   X=     4.117 Y=     0.000 Z=     7.320
  35   X=     3.087 Y=     0.000 Z=     7.320
  36   X=     2.058 Y=     0.000 Z=     7.320
  37   X=     1.350 Y=     0.000 Z=     7.320
  38   X=     1.029 Y=     0.000 Z=     7.320
  39   X=     0.850 Y=     0.000 Z=     7.320
  40   X=     0.000 Y=     0.000 Z=     7.320
  41   X=     0.000 Y=     0.000 Z=     6.520
  42   X=     0.000 Y=     0.000 Z=     6.183
  43   X=     0.000 Y=     0.000 Z=     6.020
  44   X=     0.000 Y=     0.000 Z=     5.047
  45   X=     0.000 Y=     0.000 Z=     3.910
  46   X=     0.000 Y=     0.000 Z=     2.773
  47   X=     0.000 Y=     0.000 Z=     1.637
  48   X=     0.000 Y=     0.000 Z=     1.300
  49   X=     0.000 Y=     0.000 Z=     0.000
  50   X=     1.029 Y=     0.000 Z=     0.000
  51   X=     2.058 Y=     0.000 Z=     0.000
  52   X=     3.087 Y=     0.000 Z=     0.000
  53   X=     4.117 Y=     0.000 Z=     0.000
  54   X=     5.146 Y=     0.000 Z=     0.000
  55   X=     6.175 Y=     0.000 Z=     0.000
  56   X=     7.204 Y=     0.000 Z=     0.000
  57   X=     8.233 Y=     0.000 Z=     0.000
  58   X=     9.262 Y=     0.000 Z=     0.000
  59   X=    10.292 Y=     0.000 Z=     0.000
  60   X=    11.321 Y=     0.000 Z=     0.000
  61   X=    12.350 Y=     0.000 Z=     0.000
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=8 UX=1e+010
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=35570.8 CE=0.99999 K=35570.8 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=26827.5 CE=0.99999 K=26827.5 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-207.439, -207.439
      ADD=25 RD=0,1 UZ=-207.439, -207.439
      ADD=26 RD=0,1 UZ=-207.439, -207.439
      ADD=27 RD=0,1 UZ=-207.439, -207.439
```

```
      ADD=28 RD=0,1 UZ=-207.439, -207.439
      ADD=29 RD=0,1 UZ=-207.439, -207.439
      ADD=30 RD=0,1 UZ=-207.439, -207.439
      ADD=31 RD=0,1 UZ=-207.439, -207.439
      ADD=32 RD=0,1 UZ=-207.439, -207.439
      ADD=33 RD=0,1 UZ=-207.439, -207.439
      ADD=34 RD=0,1 UZ=-207.439, -207.439
      ADD=35 RD=0,1 UZ=-207.439, -207.439
      ADD=36 RD=0,1 UZ=-207.439, -207.439
      ADD=37 RD=0,1 UZ=-207.439, -207.439
      ADD=38 RD=0,1 UZ=-207.439, -207.439
      ADD=39 RD=0,1 UZ=-207.439, -207.439
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-119.635, -119.635
      ADD=25 RD=0,1 UZ=-119.635, -119.635
      ADD=26 RD=0,1 UZ=-119.635, -119.635
      ADD=27 RD=0,1 UZ=-119.635, -119.635
      ADD=28 RD=0,1 UZ=-119.635, -119.635
      ADD=29 RD=0,1 UZ=-119.635, -119.635
      ADD=30 RD=0,1 UZ=-119.635, -119.635
      ADD=31 RD=0,1 UZ=-119.635, -119.635
      ADD=32 RD=0,1 UZ=-119.635, -119.635
      ADD=33 RD=0,1 UZ=-119.635, -119.635
      ADD=34 RD=0,1 UZ=-119.635, -119.635
      ADD=35 RD=0,1 UZ=-119.635, -119.635
      ADD=36 RD=0,1 UZ=-119.635, -119.635
      ADD=37 RD=0,1 UZ=-119.635, -119.635
      ADD=38 RD=0,1 UZ=-119.635, -119.635
      ADD=39 RD=0,1 UZ=-119.635, -119.635
NAME=LIVEFU  ; 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELE  ; 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERI  ; 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUH  ; 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEH  ; 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIH  ; 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=SOILB  ; 양토압 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=111.257, 118.857
      ADD=41 RD=0,1 UX=118.857, 122.056
      ADD=42 RD=0,1 UX=122.056, 123.607
      ADD=43 RD=0,1 UX=123.607, 132.853
      ADD=44 RD=0,1 UX=132.853, 143.652
      ADD=45 RD=0,1 UX=143.652, 154.451
      ADD=46 RD=0,1 UX=154.451, 165.248
      ADD=47 RD=0,1 UX=165.248, 168.447
      ADD=48 RD=0,1 UX=168.447, 176.047
      ADD=15 RD=0,1 UX=-176.047, -168.447
      ADD=16 RD=0,1 UX=-168.447, -165.248
      ADD=17 RD=0,1 UX=-165.248, -154.451
      ADD=18 RD=0,1 UX=-154.451, -143.652
      ADD=19 RD=0,1 UX=-143.652, -132.853
      ADD=20 RD=0,1 UX=-132.853, -123.607
      ADD=21 RD=0,1 UX=-123.607, -122.056
      ADD=22 RD=0,1 UX=-122.056, -118.857
      ADD=23 RD=0,1 UX=-118.857, -111.257
NAME=SOILBW  ; 양토압 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=63.53, 67.53
      ADD=41 RD=0,1 UX=67.53, 69.213
      ADD=42 RD=0,1 UX=69.213, 70.03
      ADD=43 RD=0,1 UX=70.03, 74.897
      ADD=44 RD=0,1 UX=74.897, 80.58
      ADD=45 RD=0,1 UX=80.58, 86.263
      ADD=46 RD=0,1 UX=86.263, 91.947
      ADD=47 RD=0,1 UX=91.947, 93.63
      ADD=48 RD=0,1 UX=93.63, 97.63
      ADD=15 RD=0,1 UX=-97.63, -93.63
      ADD=16 RD=0,1 UX=-93.63, -91.947
      ADD=17 RD=0,1 UX=-91.947, -86.263
      ADD=18 RD=0,1 UX=-86.263, -80.58
      ADD=19 RD=0,1 UX=-80.58, -74.897
      ADD=20 RD=0,1 UX=-74.897, -70.03
      ADD=21 RD=0,1 UX=-70.03, -69.213
      ADD=22 RD=0,1 UX=-69.213, -67.53
      ADD=23 RD=0,1 UX=-67.53, -63.53
NAME=TEMPPLUS  ; 온도변화(+)
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=10
      ADD=16 T=10
      ADD=17 T=10
      ADD=18 T=10
      ADD=19 T=10
      ADD=20 T=10
      ADD=21 T=10
      ADD=22 T=10
      ADD=23 T=10
      ADD=24 T=10
      ADD=25 T=10
      ADD=26 T=10
      ADD=27 T=10
      ADD=28 T=10
      ADD=29 T=10
      ADD=30 T=10
      ADD=31 T=10
      ADD=32 T=10
      ADD=33 T=10
      ADD=34 T=10
      ADD=35 T=10
      ADD=36 T=10
      ADD=37 T=10
      ADD=38 T=10
      ADD=39 T=10
      ADD=40 T=10
      ADD=41 T=10
      ADD=42 T=10
```

```
      ADD=43 T=10
      ADD=44 T=10
      ADD=45 T=10
      ADD=46 T=10
      ADD=47 T=10
      ADD=48 T=10
NAME=TEMPMINU  ; 온도변화(-)
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=-10
      ADD=16 T=-10
      ADD=17 T=-10
      ADD=18 T=-10
      ADD=19 T=-10
      ADD=20 T=-10
      ADD=21 T=-10
      ADD=22 T=-10
      ADD=23 T=-10
      ADD=24 T=-10
      ADD=25 T=-10
      ADD=26 T=-10
      ADD=27 T=-10
      ADD=28 T=-10
      ADD=29 T=-10
      ADD=30 T=-10
      ADD=31 T=-10
      ADD=32 T=-10
      ADD=33 T=-10
      ADD=34 T=-10
      ADD=35 T=-10
      ADD=36 T=-10
      ADD=37 T=-10
      ADD=38 T=-10
      ADD=39 T=-10
      ADD=40 T=-10
      ADD=41 T=-10
      ADD=42 T=-10
      ADD=43 T=-10
      ADD=44 T=-10
      ADD=45 T=-10
      ADD=46 T=-10
      ADD=47 T=-10
      ADD=48 T=-10
NAME=SHRINK  ; 건조수축
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=-15
      ADD=16 T=-15
      ADD=17 T=-15
      ADD=18 T=-15
      ADD=19 T=-15
      ADD=20 T=-15
      ADD=21 T=-15
      ADD=22 T=-15
      ADD=23 T=-15
      ADD=24 T=-15
      ADD=25 T=-15
      ADD=26 T=-15
      ADD=27 T=-15
      ADD=28 T=-15
      ADD=29 T=-15
      ADD=30 T=-15
      ADD=31 T=-15
      ADD=32 T=-15
      ADD=33 T=-15
      ADD=34 T=-15
      ADD=35 T=-15
      ADD=36 T=-15
      ADD=37 T=-15
      ADD=38 T=-15
      ADD=39 T=-15
      ADD=40 T=-15
      ADD=41 T=-15
      ADD=42 T=-15
      ADD=43 T=-15
      ADD=44 T=-15
      ADD=45 T=-15
      ADD=46 T=-15
      ADD=47 T=-15
      ADD=48 T=-15
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFU
      LOAD=LIVELE
      LOAD=LIVERI
      LOAD=LIVEFUH
      LOAD=LIVELEH
      LOAD=LIVERIH
      LOAD=SOILB
      LOAD=SOILBW
      LOAD=TEMPPLUS
      LOAD=TEMPMINU
      LOAD=SHRINK
      NLLINK=*
HISTORY
   NAME=UL01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
      LOAD= LIVERIH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
      LOAD= LIVERIH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
```

```
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.600   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
NAME=UL14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=1.600   AT=1
   LOAD= SOILB         SF=0.800   AT=1
NAME=UL15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
NAME=UL28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=1.600   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
NAME=SV01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
```

```
NAME=SV08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= SOILB           SF=1.000   AT=1
NAME=SV14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= SOILB           SF=0.500   AT=1
NAME=SV15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
NAME=SV28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
COMBO
  NAME=ENVUSE  TYPE=ENVE
    HIST=SV01 SF=1
    HIST=SV02 SF=1
    HIST=SV03 SF=1
    HIST=SV04 SF=1
    HIST=SV05 SF=1
    HIST=SV06 SF=1
    HIST=SV07 SF=1
    HIST=SV08 SF=1
    HIST=SV09 SF=1
    HIST=SV10 SF=1
    HIST=SV11 SF=1
    HIST=SV12 SF=1
    HIST=SV13 SF=1
    HIST=SV14 SF=1
    HIST=SV15 SF=1
    HIST=SV16 SF=1
    HIST=SV17 SF=1
    HIST=SV18 SF=1
    HIST=SV19 SF=1
    HIST=SV20 SF=1
    HIST=SV21 SF=1
    HIST=SV22 SF=1
    HIST=SV23 SF=1
    HIST=SV24 SF=1
    HIST=SV25 SF=1
    HIST=SV26 SF=1
```

```
      HIST=SV27 SF=1
      HIST=SV28 SF=1
   NAME=ENVULT  TYPE=ENVE
      HIST=UL01 SF=1
      HIST=UL02 SF=1
      HIST=UL03 SF=1
      HIST=UL04 SF=1
      HIST=UL05 SF=1
      HIST=UL06 SF=1
      HIST=UL07 SF=1
      HIST=UL08 SF=1
      HIST=UL09 SF=1
      HIST=UL10 SF=1
      HIST=UL11 SF=1
      HIST=UL12 SF=1
      HIST=UL13 SF=1
      HIST=UL14 SF=1
      HIST=UL15 SF=1
      HIST=UL16 SF=1
      HIST=UL17 SF=1
      HIST=UL18 SF=1
      HIST=UL19 SF=1
      HIST=UL20 SF=1
      HIST=UL21 SF=1
      HIST=UL22 SF=1
      HIST=UL23 SF=1
      HIST=UL24 SF=1
      HIST=UL25 SF=1
      HIST=UL26 SF=1
      HIST=UL27 SF=1
      HIST=UL28 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

16. INPUT DATA (기능수행)

```
; ACulvert SAP2000 데이터파일 : 내진(기능)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     1.350 Y=     0.000 Z=     0.500
  3    X=     1.529 Y=     0.000 Z=     0.500
  4    X=     2.558 Y=     0.000 Z=     0.500
  5    X=     3.587 Y=     0.000 Z=     0.500
  6    X=     4.617 Y=     0.000 Z=     0.500
  7    X=     5.646 Y=     0.000 Z=     0.500
  8    X=     6.675 Y=     0.000 Z=     0.500
  9    X=     7.704 Y=     0.000 Z=     0.500
  10   X=     8.733 Y=     0.000 Z=     0.500
  11   X=     9.762 Y=     0.000 Z=     0.500
  12   X=    10.792 Y=     0.000 Z=     0.500
  13   X=    11.821 Y=     0.000 Z=     0.500
  14   X=    12.000 Y=     0.000 Z=     0.500
  15   X=    12.850 Y=     0.000 Z=     0.500
  16   X=    12.850 Y=     0.000 Z=     1.300
  17   X=    12.850 Y=     0.000 Z=     1.637
  18   X=    12.850 Y=     0.000 Z=     2.773
  19   X=    12.850 Y=     0.000 Z=     3.910
  20   X=    12.850 Y=     0.000 Z=     5.047
  21   X=    12.850 Y=     0.000 Z=     6.020
  22   X=    12.850 Y=     0.000 Z=     6.183
  23   X=    12.850 Y=     0.000 Z=     6.520
  24   X=    12.850 Y=     0.000 Z=     7.320
  25   X=    12.000 Y=     0.000 Z=     7.320
  26   X=    11.821 Y=     0.000 Z=     7.320
  27   X=    11.500 Y=     0.000 Z=     7.320
  28   X=    10.792 Y=     0.000 Z=     7.320
  29   X=     9.762 Y=     0.000 Z=     7.320
  30   X=     8.733 Y=     0.000 Z=     7.320
  31   X=     7.704 Y=     0.000 Z=     7.320
  32   X=     6.675 Y=     0.000 Z=     7.320
  33   X=     5.646 Y=     0.000 Z=     7.320
  34   X=     4.617 Y=     0.000 Z=     7.320
  35   X=     3.587 Y=     0.000 Z=     7.320
  36   X=     2.558 Y=     0.000 Z=     7.320
  37   X=     1.850 Y=     0.000 Z=     7.320
  38   X=     1.529 Y=     0.000 Z=     7.320
  39   X=     1.350 Y=     0.000 Z=     7.320
  40   X=     0.500 Y=     0.000 Z=     7.320
  41   X=     0.500 Y=     0.000 Z=     6.520
  42   X=     0.500 Y=     0.000 Z=     6.183
  43   X=     0.500 Y=     0.000 Z=     6.020
  44   X=     0.500 Y=     0.000 Z=     5.047
  45   X=     0.500 Y=     0.000 Z=     3.910
  46   X=     0.500 Y=     0.000 Z=     2.773
  47   X=     0.500 Y=     0.000 Z=     1.637
  48   X=     0.500 Y=     0.000 Z=     1.300
  49   X=     0.500 Y=     0.000 Z=     0.000
  50   X=     1.529 Y=     0.000 Z=     0.000
  51   X=     2.558 Y=     0.000 Z=     0.000
  52   X=     3.587 Y=     0.000 Z=     0.000
  53   X=     4.617 Y=     0.000 Z=     0.000
  54   X=     5.646 Y=     0.000 Z=     0.000
  55   X=     6.675 Y=     0.000 Z=     0.000
  56   X=     7.704 Y=     0.000 Z=     0.000
  57   X=     8.733 Y=     0.000 Z=     0.000
  58   X=     9.762 Y=     0.000 Z=     0.000
  59   X=    10.792 Y=     0.000 Z=     0.000
  60   X=    11.821 Y=     0.000 Z=     0.000
  61   X=    12.850 Y=     0.000 Z=     0.000
  62   X=    13.350 Y=     0.000 Z=     0.500
  63   X=    13.350 Y=     0.000 Z=     1.637
  64   X=    13.350 Y=     0.000 Z=     2.773
  65   X=    13.350 Y=     0.000 Z=     3.910
  66   X=    13.350 Y=     0.000 Z=     5.047
  67   X=    13.350 Y=     0.000 Z=     6.183
  68   X=    13.350 Y=     0.000 Z=     7.320
  69   X=    12.850 Y=     0.000 Z=     7.820
  70   X=    11.821 Y=     0.000 Z=     7.820
  71   X=    10.792 Y=     0.000 Z=     7.820
  72   X=     9.762 Y=     0.000 Z=     7.820
  73   X=     8.733 Y=     0.000 Z=     7.820
  74   X=     7.704 Y=     0.000 Z=     7.820
  75   X=     6.675 Y=     0.000 Z=     7.820
  76   X=     5.646 Y=     0.000 Z=     7.820
  77   X=     4.617 Y=     0.000 Z=     7.820
  78   X=     3.587 Y=     0.000 Z=     7.820
  79   X=     2.558 Y=     0.000 Z=     7.820
  80   X=     1.529 Y=     0.000 Z=     7.820
  81   X=     0.500 Y=     0.000 Z=     7.820
  82   X=     0.000 Y=     0.000 Z=     7.320
  83   X=     0.000 Y=     0.000 Z=     6.183
  84   X=     0.000 Y=     0.000 Z=     5.047
  85   X=     0.000 Y=     0.000 Z=     3.910
  86   X=     0.000 Y=     0.000 Z=     2.773
  87   X=     0.000 Y=     0.000 Z=     1.637
  88   X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=62 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=63 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=64 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=65 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=66 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=67 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=68 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=69 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=70 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=71 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=72 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=96233.5
  ADD=4 UX=96233.5
  ADD=5 UX=96233.5
  ADD=6 UX=96233.5
  ADD=7 UX=96233.5
  ADD=8 UX=96233.5
  ADD=9 UX=96233.5
  ADD=10 UX=96233.5
  ADD=11 UX=96233.5
  ADD=12 UX=96233.5
  ADD=13 UX=96233.5
  ADD=17 UZ=156044
  ADD=18 UZ=156044
  ADD=19 UZ=32732.7
  ADD=20 UZ=32732.7
  ADD=22 UZ=32732.7
  ADD=26 UX=5881.81
  ADD=28 UX=5881.81
  ADD=29 UX=5881.81
  ADD=30 UX=5881.81
  ADD=31 UX=5881.81
  ADD=32 UX=5881.81
  ADD=33 UX=5881.81
  ADD=34 UX=5881.81
  ADD=35 UX=5881.81
  ADD=36 UX=5881.81
  ADD=38 UX=5881.81
  ADD=42 UZ=32732.7
  ADD=44 UZ=32732.7
  ADD=45 UZ=32732.7
  ADD=46 UZ=156044
  ADD=47 UZ=156044
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=382790. CE=0.99999 K=382790. OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=288700. CE=0.99999 K=288700. OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
```

```
      DOF=U1 KE=563541. CE=0.99999 K=563541. OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=468131. CE=0.99999 K=468131. OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=98198. CE=0.99999 K=98198. OPEN=0
  NAME=6 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=34443.8 CE=0.99999 K=34443.8 OPEN=0
  NAME=7 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=23396.2 CE=0.99999 K=23396.2 OPEN=0
  NAME=8 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=17645.4 CE=0.99999 K=17645.4 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
    14 J=15,62 NLP=3 ANG=0
    15 J=17,63 NLP=4 ANG=0
    16 J=18,64 NLP=4 ANG=0
    17 J=19,65 NLP=5 ANG=0
    18 J=20,66 NLP=5 ANG=0
    19 J=22,67 NLP=5 ANG=0
    20 J=24,68 NLP=6 ANG=0
    21 J=24,69 NLP=7 ANG=0
    22 J=26,70 NLP=8 ANG=0
    23 J=28,71 NLP=8 ANG=0
    24 J=29,72 NLP=8 ANG=0
    25 J=30,73 NLP=8 ANG=0
    26 J=31,74 NLP=8 ANG=0
    27 J=32,75 NLP=8 ANG=0
    28 J=33,76 NLP=8 ANG=0
    29 J=34,77 NLP=8 ANG=0
    30 J=35,78 NLP=8 ANG=0
    31 J=36,79 NLP=8 ANG=0
    32 J=38,80 NLP=8 ANG=0
    33 J=40,81 NLP=7 ANG=0
    34 J=40,82 NLP=6 ANG=0
    35 J=42,83 NLP=5 ANG=0
    36 J=44,84 NLP=5 ANG=0
    37 J=45,85 NLP=5 ANG=0
    38 J=46,86 NLP=4 ANG=0
    39 J=47,87 NLP=4 ANG=0
    40 J= 1,88 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-207.439, -207.439
      ADD=25 RD=0,1 UZ=-207.439, -207.439
      ADD=26 RD=0,1 UZ=-207.439, -207.439
      ADD=27 RD=0,1 UZ=-207.439, -207.439
      ADD=28 RD=0,1 UZ=-207.439, -207.439
      ADD=29 RD=0,1 UZ=-207.439, -207.439
      ADD=30 RD=0,1 UZ=-207.439, -207.439
      ADD=31 RD=0,1 UZ=-207.439, -207.439
      ADD=32 RD=0,1 UZ=-207.439, -207.439
      ADD=33 RD=0,1 UZ=-207.439, -207.439
      ADD=34 RD=0,1 UZ=-207.439, -207.439
      ADD=35 RD=0,1 UZ=-207.439, -207.439
      ADD=36 RD=0,1 UZ=-207.439, -207.439
      ADD=37 RD=0,1 UZ=-207.439, -207.439
      ADD=38 RD=0,1 UZ=-207.439, -207.439
      ADD=39 RD=0,1 UZ=-207.439, -207.439
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-119.635, -119.635
      ADD=25 RD=0,1 UZ=-119.635, -119.635
      ADD=26 RD=0,1 UZ=-119.635, -119.635
      ADD=27 RD=0,1 UZ=-119.635, -119.635
      ADD=28 RD=0,1 UZ=-119.635, -119.635
      ADD=29 RD=0,1 UZ=-119.635, -119.635
      ADD=30 RD=0,1 UZ=-119.635, -119.635
      ADD=31 RD=0,1 UZ=-119.635, -119.635
      ADD=32 RD=0,1 UZ=-119.635, -119.635
      ADD=33 RD=0,1 UZ=-119.635, -119.635
      ADD=34 RD=0,1 UZ=-119.635, -119.635
      ADD=35 RD=0,1 UZ=-119.635, -119.635
      ADD=36 RD=0,1 UZ=-119.635, -119.635
      ADD=37 RD=0,1 UZ=-119.635, -119.635
      ADD=38 RD=0,1 UZ=-119.635, -119.635
      ADD=39 RD=0,1 UZ=-119.635, -119.635
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
```

```
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=FUNSLAB  ; 슬래브 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=31.936, 31.936
      ADD=25 RD=0,1 UX=31.936, 31.936
      ADD=26 RD=0,1 UX=31.936, 31.936
      ADD=27 RD=0,1 UX=31.936, 31.936
      ADD=28 RD=0,1 UX=31.936, 31.936
      ADD=29 RD=0,1 UX=31.936, 31.936
      ADD=30 RD=0,1 UX=31.936, 31.936
      ADD=31 RD=0,1 UX=31.936, 31.936
      ADD=32 RD=0,1 UX=31.936, 31.936
      ADD=33 RD=0,1 UX=31.936, 31.936
      ADD=34 RD=0,1 UX=31.936, 31.936
      ADD=35 RD=0,1 UX=31.936, 31.936
      ADD=36 RD=0,1 UX=31.936, 31.936
      ADD=37 RD=0,1 UX=31.936, 31.936
      ADD=38 RD=0,1 UX=31.936, 31.936
      ADD=39 RD=0,1 UX=31.936, 31.936
NAME=FUNWALL  ; 벽체 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=140.661, 116.144
      ADD=41 RD=0,1 UX=116.144, 362.324
      ADD=42 RD=0,1 UX=362.324, 344.527
      ADD=43 RD=0,1 UX=344.527, 236.798
      ADD=44 RD=0,1 UX=236.798, 107.557
      ADD=45 RD=0,1 UX=107.557, 76.603
      ADD=46 RD=0,1 UX=76.603, 38.713
      ADD=47 RD=0,1 UX=38.713, 27.182
      ADD=48 RD=0,1 UX=27.182, 0
      ADD=15 RD=0,1 UX=0, 27.182
      ADD=16 RD=0,1 UX=27.182, 38.713
      ADD=17 RD=0,1 UX=38.713, 76.603
      ADD=18 RD=0,1 UX=76.603, 107.557
      ADD=19 RD=0,1 UX=107.557, 236.798
      ADD=20 RD=0,1 UX=236.798, 344.527
      ADD=21 RD=0,1 UX=344.527, 362.324
      ADD=22 RD=0,1 UX=362.324, 116.144
      ADD=23 RD=0,1 UX=116.144, 140.661
NAME=FUNMS  ; 주면전단력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=36.39, 36.39
      ADD=25 RD=0,1 UX=36.39, 36.39
      ADD=26 RD=0,1 UX=36.39, 36.39
      ADD=27 RD=0,1 UX=36.39, 36.39
      ADD=28 RD=0,1 UX=36.39, 36.39
      ADD=29 RD=0,1 UX=36.39, 36.39
      ADD=30 RD=0,1 UX=36.39, 36.39
      ADD=31 RD=0,1 UX=36.39, 36.39
      ADD=32 RD=0,1 UX=36.39, 36.39
      ADD=33 RD=0,1 UX=36.39, 36.39
      ADD=34 RD=0,1 UX=36.39, 36.39
      ADD=35 RD=0,1 UX=36.39, 36.39
      ADD=36 RD=0,1 UX=36.39, 36.39
      ADD=37 RD=0,1 UX=36.39, 36.39
      ADD=38 RD=0,1 UX=36.39, 36.39
      ADD=39 RD=0,1 UX=36.39, 36.39
      ADD=40 RD=0,1 UZ=-39.49, -39.49
      ADD=41 RD=0,1 UZ=-39.49, -39.49
      ADD=42 RD=0,1 UZ=-39.49, -39.49
      ADD=43 RD=0,1 UZ=-39.49, -39.49
      ADD=44 RD=0,1 UZ=-39.49, -39.49
      ADD=45 RD=0,1 UZ=-39.49, -39.49
      ADD=46 RD=0,1 UZ=-39.49, -39.49
      ADD=47 RD=0,1 UZ=-39.49, -39.49
      ADD=48 RD=0,1 UZ=-39.49, -39.49
      ADD=15 RD=0,1 UZ=39.49, 39.49
      ADD=16 RD=0,1 UZ=39.49, 39.49
      ADD=17 RD=0,1 UZ=39.49, 39.49
      ADD=18 RD=0,1 UZ=39.49, 39.49
      ADD=19 RD=0,1 UZ=39.49, 39.49
      ADD=20 RD=0,1 UZ=39.49, 39.49
      ADD=21 RD=0,1 UZ=39.49, 39.49
      ADD=22 RD=0,1 UZ=39.49, 39.49
      ADD=23 RD=0,1 UZ=39.49, 39.49
      ADD=1 RD=0,1 UX=-42.6, -42.6
      ADD=2 RD=0,1 UX=-42.6, -42.6
      ADD=3 RD=0,1 UX=-42.6, -42.6
      ADD=4 RD=0,1 UX=-42.6, -42.6
      ADD=5 RD=0,1 UX=-42.6, -42.6
      ADD=6 RD=0,1 UX=-42.6, -42.6
      ADD=7 RD=0,1 UX=-42.6, -42.6
      ADD=8 RD=0,1 UX=-42.6, -42.6
      ADD=9 RD=0,1 UX=-42.6, -42.6
      ADD=10 RD=0,1 UX=-42.6, -42.6
      ADD=11 RD=0,1 UX=-42.6, -42.6
      ADD=12 RD=0,1 UX=-42.6, -42.6
      ADD=13 RD=0,1 UX=-42.6, -42.6
      ADD=14 RD=0,1 UX=-42.6, -42.6
NAME=FUNINER  ; 구체 관성력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=2.445, 2.445
      ADD=25 RD=0,1 UX=2.445, 2.445
      ADD=26 RD=0,1 UX=2.445, 2.445
      ADD=27 RD=0,1 UX=2.445, 2.445
      ADD=28 RD=0,1 UX=2.445, 2.445
      ADD=29 RD=0,1 UX=2.445, 2.445
      ADD=30 RD=0,1 UX=2.445, 2.445
      ADD=31 RD=0,1 UX=2.445, 2.445
      ADD=32 RD=0,1 UX=2.445, 2.445
      ADD=33 RD=0,1 UX=2.445, 2.445
      ADD=34 RD=0,1 UX=2.445, 2.445
      ADD=35 RD=0,1 UX=2.445, 2.445
      ADD=36 RD=0,1 UX=2.445, 2.445
      ADD=37 RD=0,1 UX=2.445, 2.445
      ADD=38 RD=0,1 UX=2.445, 2.445
      ADD=39 RD=0,1 UX=2.445, 2.445
      ADD=40 RD=0,1 UX=2.597, 2.56
      ADD=41 RD=0,1 UX=2.56, 2.544
      ADD=42 RD=0,1 UX=2.544, 2.536
      ADD=43 RD=0,1 UX=2.536, 2.49
      ADD=44 RD=0,1 UX=2.49, 2.437
      ADD=45 RD=0,1 UX=2.437, 2.383
      ADD=46 RD=0,1 UX=2.383, 2.329
      ADD=47 RD=0,1 UX=2.329, 2.313
      ADD=48 RD=0,1 UX=2.313, 2.276
      ADD=15 RD=0,1 UX=2.276, 2.313
      ADD=16 RD=0,1 UX=2.313, 2.329
      ADD=17 RD=0,1 UX=2.329, 2.383
      ADD=18 RD=0,1 UX=2.383, 2.437
      ADD=19 RD=0,1 UX=2.437, 2.49
      ADD=20 RD=0,1 UX=2.49, 2.536
      ADD=21 RD=0,1 UX=2.536, 2.544
      ADD=22 RD=0,1 UX=2.544, 2.56
      ADD=23 RD=0,1 UX=2.56, 2.597
      ADD=1 RD=0,1 UX=2.142, 2.142
      ADD=2 RD=0,1 UX=2.142, 2.142
```

```
      ADD=3 RD=0,1 UX=2.142, 2.142
      ADD=4 RD=0,1 UX=2.142, 2.142
      ADD=5 RD=0,1 UX=2.142, 2.142
      ADD=6 RD=0,1 UX=2.142, 2.142
      ADD=7 RD=0,1 UX=2.142, 2.142
      ADD=8 RD=0,1 UX=2.142, 2.142
      ADD=9 RD=0,1 UX=2.142, 2.142
      ADD=10 RD=0,1 UX=2.142, 2.142
      ADD=11 RD=0,1 UX=2.142, 2.142
      ADD=12 RD=0,1 UX=2.142, 2.142
      ADD=13 RD=0,1 UX=2.142, 2.142
      ADD=14 RD=0,1 UX=2.142, 2.142
NAME=FUNSLAB2  ; 슬래브 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-31.936, -31.936
      ADD=25 RD=0,1 UX=-31.936, -31.936
      ADD=26 RD=0,1 UX=-31.936, -31.936
      ADD=27 RD=0,1 UX=-31.936, -31.936
      ADD=28 RD=0,1 UX=-31.936, -31.936
      ADD=29 RD=0,1 UX=-31.936, -31.936
      ADD=30 RD=0,1 UX=-31.936, -31.936
      ADD=31 RD=0,1 UX=-31.936, -31.936
      ADD=32 RD=0,1 UX=-31.936, -31.936
      ADD=33 RD=0,1 UX=-31.936, -31.936
      ADD=34 RD=0,1 UX=-31.936, -31.936
      ADD=35 RD=0,1 UX=-31.936, -31.936
      ADD=36 RD=0,1 UX=-31.936, -31.936
      ADD=37 RD=0,1 UX=-31.936, -31.936
      ADD=38 RD=0,1 UX=-31.936, -31.936
      ADD=39 RD=0,1 UX=-31.936, -31.936
NAME=FUNWALL2  ; 벽체 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=-140.661, -116.144
      ADD=41 RD=0,1 UX=-116.144, -362.324
      ADD=42 RD=0,1 UX=-362.324, -344.527
      ADD=43 RD=0,1 UX=-344.527, -236.798
      ADD=44 RD=0,1 UX=-236.798, -107.557
      ADD=45 RD=0,1 UX=-107.557, -76.603
      ADD=46 RD=0,1 UX=-76.603, -38.713
      ADD=47 RD=0,1 UX=-38.713, -27.182
      ADD=48 RD=0,1 UX=-27.182, -0
      ADD=15 RD=0,1 UX=-0, -27.182
      ADD=16 RD=0,1 UX=-27.182, -38.713
      ADD=17 RD=0,1 UX=-38.713, -76.603
      ADD=18 RD=0,1 UX=-76.603, -107.557
      ADD=19 RD=0,1 UX=-107.557, -236.798
      ADD=20 RD=0,1 UX=-236.798, -344.527
      ADD=21 RD=0,1 UX=-344.527, -362.324
      ADD=22 RD=0,1 UX=-362.324, -116.144
      ADD=23 RD=0,1 UX=-116.144, -140.661
NAME=FUNMS2  ; 주면전단력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-36.39, -36.39
      ADD=25 RD=0,1 UX=-36.39, -36.39
      ADD=26 RD=0,1 UX=-36.39, -36.39
      ADD=27 RD=0,1 UX=-36.39, -36.39
      ADD=28 RD=0,1 UX=-36.39, -36.39
      ADD=29 RD=0,1 UX=-36.39, -36.39
      ADD=30 RD=0,1 UX=-36.39, -36.39
      ADD=31 RD=0,1 UX=-36.39, -36.39
      ADD=32 RD=0,1 UX=-36.39, -36.39
      ADD=33 RD=0,1 UX=-36.39, -36.39
      ADD=34 RD=0,1 UX=-36.39, -36.39
      ADD=35 RD=0,1 UX=-36.39, -36.39
      ADD=36 RD=0,1 UX=-36.39, -36.39
      ADD=37 RD=0,1 UX=-36.39, -36.39
      ADD=38 RD=0,1 UX=-36.39, -36.39
      ADD=39 RD=0,1 UX=-36.39, -36.39
      ADD=40 RD=0,1 UZ=39.49, 39.49
      ADD=41 RD=0,1 UZ=39.49, 39.49
      ADD=42 RD=0,1 UZ=39.49, 39.49
      ADD=43 RD=0,1 UZ=39.49, 39.49
      ADD=44 RD=0,1 UZ=39.49, 39.49
      ADD=45 RD=0,1 UZ=39.49, 39.49
      ADD=46 RD=0,1 UZ=39.49, 39.49
      ADD=47 RD=0,1 UZ=39.49, 39.49
      ADD=48 RD=0,1 UZ=39.49, 39.49
      ADD=15 RD=0,1 UZ=-39.49, -39.49
      ADD=16 RD=0,1 UZ=-39.49, -39.49
      ADD=17 RD=0,1 UZ=-39.49, -39.49
      ADD=18 RD=0,1 UZ=-39.49, -39.49
      ADD=19 RD=0,1 UZ=-39.49, -39.49
      ADD=20 RD=0,1 UZ=-39.49, -39.49
      ADD=21 RD=0,1 UZ=-39.49, -39.49
      ADD=22 RD=0,1 UZ=-39.49, -39.49
      ADD=23 RD=0,1 UZ=-39.49, -39.49
      ADD=1 RD=0,1 UX=42.6, 42.6
      ADD=2 RD=0,1 UX=42.6, 42.6
      ADD=3 RD=0,1 UX=42.6, 42.6
      ADD=4 RD=0,1 UX=42.6, 42.6
      ADD=5 RD=0,1 UX=42.6, 42.6
      ADD=6 RD=0,1 UX=42.6, 42.6
      ADD=7 RD=0,1 UX=42.6, 42.6
      ADD=8 RD=0,1 UX=42.6, 42.6
      ADD=9 RD=0,1 UX=42.6, 42.6
      ADD=10 RD=0,1 UX=42.6, 42.6
      ADD=11 RD=0,1 UX=42.6, 42.6
      ADD=12 RD=0,1 UX=42.6, 42.6
      ADD=13 RD=0,1 UX=42.6, 42.6
      ADD=14 RD=0,1 UX=42.6, 42.6
NAME=FUNINER2  ; 구체 관성력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-2.445, -2.445
      ADD=25 RD=0,1 UX=-2.445, -2.445
      ADD=26 RD=0,1 UX=-2.445, -2.445
      ADD=27 RD=0,1 UX=-2.445, -2.445
      ADD=28 RD=0,1 UX=-2.445, -2.445
      ADD=29 RD=0,1 UX=-2.445, -2.445
      ADD=30 RD=0,1 UX=-2.445, -2.445
      ADD=31 RD=0,1 UX=-2.445, -2.445
      ADD=32 RD=0,1 UX=-2.445, -2.445
      ADD=33 RD=0,1 UX=-2.445, -2.445
      ADD=34 RD=0,1 UX=-2.445, -2.445
      ADD=35 RD=0,1 UX=-2.445, -2.445
      ADD=36 RD=0,1 UX=-2.445, -2.445
      ADD=37 RD=0,1 UX=-2.445, -2.445
      ADD=38 RD=0,1 UX=-2.445, -2.445
      ADD=39 RD=0,1 UX=-2.445, -2.445
      ADD=40 RD=0,1 UX=-2.597, -2.56
      ADD=41 RD=0,1 UX=-2.56, -2.544
      ADD=42 RD=0,1 UX=-2.544, -2.536
      ADD=43 RD=0,1 UX=-2.536, -2.49
      ADD=44 RD=0,1 UX=-2.49, -2.437
      ADD=45 RD=0,1 UX=-2.437, -2.383
      ADD=46 RD=0,1 UX=-2.383, -2.329
      ADD=47 RD=0,1 UX=-2.329, -2.313
      ADD=48 RD=0,1 UX=-2.313, -2.276
      ADD=15 RD=0,1 UX=-2.276, -2.313
      ADD=16 RD=0,1 UX=-2.313, -2.329
      ADD=17 RD=0,1 UX=-2.329, -2.383
      ADD=18 RD=0,1 UX=-2.383, -2.437
      ADD=19 RD=0,1 UX=-2.437, -2.49
      ADD=20 RD=0,1 UX=-2.49, -2.536
      ADD=21 RD=0,1 UX=-2.536, -2.544
      ADD=22 RD=0,1 UX=-2.544, -2.56
      ADD=23 RD=0,1 UX=-2.56, -2.597
      ADD=1 RD=0,1 UX=-2.142, -2.142
      ADD=2 RD=0,1 UX=-2.142, -2.142
      ADD=3 RD=0,1 UX=-2.142, -2.142
      ADD=4 RD=0,1 UX=-2.142, -2.142
      ADD=5 RD=0,1 UX=-2.142, -2.142
      ADD=6 RD=0,1 UX=-2.142, -2.142
      ADD=7 RD=0,1 UX=-2.142, -2.142
      ADD=8 RD=0,1 UX=-2.142, -2.142
      ADD=9 RD=0,1 UX=-2.142, -2.142
      ADD=10 RD=0,1 UX=-2.142, -2.142
      ADD=11 RD=0,1 UX=-2.142, -2.142
      ADD=12 RD=0,1 UX=-2.142, -2.142
      ADD=13 RD=0,1 UX=-2.142, -2.142
      ADD=14 RD=0,1 UX=-2.142, -2.142
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=FUNSLAB
      LOAD=FUNWALL
      LOAD=FUNMS
      LOAD=FUNINER
      LOAD=FUNSLAB2
      LOAD=FUNWALL2
      LOAD=FUNMS2
      LOAD=FUNINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
```

```
NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=0.500   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=0.500   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=0.500   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=0.500   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=0.500   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=0.500   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
```

```
      LOAD= FUNINER2       SF=1.000   AT=1                                  HIST=UE06 SF=1
   NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE07 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE08 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE09 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                  HIST=UE10 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                  HIST=UE11 SF=1
      LOAD= FUNSLAB        SF=1.000   AT=1                                  HIST=UE12 SF=1
      LOAD= FUNWALL        SF=1.000   AT=1                                  HIST=UE13 SF=1
      LOAD= FUNMS          SF=1.000   AT=1                                  HIST=UE14 SF=1
      LOAD= FUNINER        SF=1.000   AT=1                                  HIST=UE15 SF=1
   NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE16 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE17 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE18 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                  HIST=UE19 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                  HIST=UE20 SF=1
      LOAD= FUNSLAB2       SF=1.000   AT=1                                  HIST=UE21 SF=1
      LOAD= FUNWALL2       SF=1.000   AT=1                                  HIST=UE22 SF=1
      LOAD= FUNMS2         SF=1.000   AT=1                                  HIST=UE23 SF=1
      LOAD= FUNINER2       SF=1.000   AT=1                                  HIST=UE24 SF=1
   NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE25 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE26 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE27 SF=1
      LOAD= LIVELEE        SF=1.000   AT=1                                  HIST=UE28 SF=1
      LOAD= LIVELEHE       SF=0.500   AT=1                                  HIST=UE29 SF=1
      LOAD= FUNSLAB        SF=1.000   AT=1                                  HIST=UE30 SF=1
      LOAD= FUNWALL        SF=1.000   AT=1                                  HIST=UE31 SF=1
      LOAD= FUNMS          SF=1.000   AT=1                                  HIST=UE32 SF=1
      LOAD= FUNINER        SF=1.000   AT=1                            OUTPUT
   NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= SW             SF=1.200   AT=1                                 ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVELEE        SF=1.000   AT=1
      LOAD= LIVELEHE       SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
```

17. INPUT DATA (붕괴방지)

```
; ACulvert SAP2000 데이터파일 : 내진(붕괴)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     1.350 Y=     0.000 Z=     0.500
  3    X=     1.529 Y=     0.000 Z=     0.500
  4    X=     2.558 Y=     0.000 Z=     0.500
  5    X=     3.587 Y=     0.000 Z=     0.500
  6    X=     4.617 Y=     0.000 Z=     0.500
  7    X=     5.646 Y=     0.000 Z=     0.500
  8    X=     6.675 Y=     0.000 Z=     0.500
  9    X=     7.704 Y=     0.000 Z=     0.500
  10   X=     8.733 Y=     0.000 Z=     0.500
  11   X=     9.762 Y=     0.000 Z=     0.500
  12   X=    10.792 Y=     0.000 Z=     0.500
  13   X=    11.821 Y=     0.000 Z=     0.500
  14   X=    12.000 Y=     0.000 Z=     0.500
  15   X=    12.850 Y=     0.000 Z=     0.500
  16   X=    12.850 Y=     0.000 Z=     1.300
  17   X=    12.850 Y=     0.000 Z=     1.637
  18   X=    12.850 Y=     0.000 Z=     2.773
  19   X=    12.850 Y=     0.000 Z=     3.910
  20   X=    12.850 Y=     0.000 Z=     5.047
  21   X=    12.850 Y=     0.000 Z=     6.020
  22   X=    12.850 Y=     0.000 Z=     6.183
  23   X=    12.850 Y=     0.000 Z=     6.520
  24   X=    12.850 Y=     0.000 Z=     7.320
  25   X=    12.000 Y=     0.000 Z=     7.320
  26   X=    11.821 Y=     0.000 Z=     7.320
  27   X=    11.500 Y=     0.000 Z=     7.320
  28   X=    10.792 Y=     0.000 Z=     7.320
  29   X=     9.762 Y=     0.000 Z=     7.320
  30   X=     8.733 Y=     0.000 Z=     7.320
  31   X=     7.704 Y=     0.000 Z=     7.320
  32   X=     6.675 Y=     0.000 Z=     7.320
  33   X=     5.646 Y=     0.000 Z=     7.320
  34   X=     4.617 Y=     0.000 Z=     7.320
  35   X=     3.587 Y=     0.000 Z=     7.320
  36   X=     2.558 Y=     0.000 Z=     7.320
  37   X=     1.850 Y=     0.000 Z=     7.320
  38   X=     1.529 Y=     0.000 Z=     7.320
  39   X=     1.350 Y=     0.000 Z=     7.320
  40   X=     0.500 Y=     0.000 Z=     7.320
  41   X=     0.500 Y=     0.000 Z=     6.520
  42   X=     0.500 Y=     0.000 Z=     6.183
  43   X=     0.500 Y=     0.000 Z=     6.020
  44   X=     0.500 Y=     0.000 Z=     5.047
  45   X=     0.500 Y=     0.000 Z=     3.910
  46   X=     0.500 Y=     0.000 Z=     2.773
  47   X=     0.500 Y=     0.000 Z=     1.637
  48   X=     0.500 Y=     0.000 Z=     1.300
  49   X=     0.500 Y=     0.000 Z=     0.000
  50   X=     1.529 Y=     0.000 Z=     0.000
  51   X=     2.558 Y=     0.000 Z=     0.000
  52   X=     3.587 Y=     0.000 Z=     0.000
  53   X=     4.617 Y=     0.000 Z=     0.000
  54   X=     5.646 Y=     0.000 Z=     0.000
  55   X=     6.675 Y=     0.000 Z=     0.000
  56   X=     7.704 Y=     0.000 Z=     0.000
  57   X=     8.733 Y=     0.000 Z=     0.000
  58   X=     9.762 Y=     0.000 Z=     0.000
  59   X=    10.792 Y=     0.000 Z=     0.000
  60   X=    11.821 Y=     0.000 Z=     0.000
  61   X=    12.850 Y=     0.000 Z=     0.000
  62   X=    13.350 Y=     0.000 Z=     0.500
  63   X=    13.350 Y=     0.000 Z=     1.637
  64   X=    13.350 Y=     0.000 Z=     2.773
  65   X=    13.350 Y=     0.000 Z=     3.910
  66   X=    13.350 Y=     0.000 Z=     5.047
  67   X=    13.350 Y=     0.000 Z=     6.183
  68   X=    13.350 Y=     0.000 Z=     7.320
  69   X=    12.850 Y=     0.000 Z=     7.820
  70   X=    11.821 Y=     0.000 Z=     7.820
  71   X=    10.792 Y=     0.000 Z=     7.820
  72   X=     9.762 Y=     0.000 Z=     7.820
  73   X=     8.733 Y=     0.000 Z=     7.820
  74   X=     7.704 Y=     0.000 Z=     7.820
  75   X=     6.675 Y=     0.000 Z=     7.820
  76   X=     5.646 Y=     0.000 Z=     7.820
  77   X=     4.617 Y=     0.000 Z=     7.820
  78   X=     3.587 Y=     0.000 Z=     7.820
  79   X=     2.558 Y=     0.000 Z=     7.820
  80   X=     1.529 Y=     0.000 Z=     7.820
  81   X=     0.500 Y=     0.000 Z=     7.820
  82   X=     0.000 Y=     0.000 Z=     7.320
  83   X=     0.000 Y=     0.000 Z=     6.183
  84   X=     0.000 Y=     0.000 Z=     5.047
  85   X=     0.000 Y=     0.000 Z=     3.910
  86   X=     0.000 Y=     0.000 Z=     2.773
  87   X=     0.000 Y=     0.000 Z=     1.637
  88   X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=62 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=63 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=64 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=65 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=66 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=67 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=68 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=69 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=70 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=71 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=72 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=37591.1
  ADD=4 UX=37591.1
  ADD=5 UX=37591.1
  ADD=6 UX=37591.1
  ADD=7 UX=37591.1
  ADD=8 UX=37591.1
  ADD=9 UX=37591.1
  ADD=10 UX=37591.1
  ADD=11 UX=37591.1
  ADD=12 UX=37591.1
  ADD=13 UX=37591.1
  ADD=17 UZ=60954.5
  ADD=18 UZ=60954.5
  ADD=19 UZ=12786.2
  ADD=20 UZ=12786.2
  ADD=22 UZ=12786.2
  ADD=26 UX=2297.67
  ADD=28 UX=2297.67
  ADD=29 UX=2297.67
  ADD=30 UX=2297.67
  ADD=31 UX=2297.67
  ADD=32 UX=2297.67
  ADD=33 UX=2297.67
  ADD=34 UX=2297.67
  ADD=35 UX=2297.67
  ADD=36 UX=2297.67
  ADD=38 UX=2297.67
  ADD=42 UZ=12786.2
  ADD=44 UZ=12786.2
  ADD=45 UZ=12786.2
  ADD=46 UZ=60954.5
  ADD=47 UZ=60954.5
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=149527. CE=0.99999 K=149527. OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=112773. CE=0.99999 K=112773. OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
```

```
      DOF=U1 KE=220133. CE=0.99999 K=220133. OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=182864. CE=0.99999 K=182864. OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=38358.5 CE=0.99999 K=38358.5 OPEN=0
  NAME=6 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=13455.1 CE=0.99999 K=13455.1 OPEN=0
  NAME=7 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=9139.51 CE=0.99999 K=9139.51 OPEN=0
  NAME=8 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
      DOF=U1 KE=6893.02 CE=0.99999 K=6893.02 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
    14 J=15,62 NLP=3 ANG=0
    15 J=17,63 NLP=4 ANG=0
    16 J=18,64 NLP=4 ANG=0
    17 J=19,65 NLP=5 ANG=0
    18 J=20,66 NLP=5 ANG=0
    19 J=22,67 NLP=5 ANG=0
    20 J=24,68 NLP=6 ANG=0
    21 J=24,69 NLP=7 ANG=0
    22 J=26,70 NLP=8 ANG=0
    23 J=28,71 NLP=8 ANG=0
    24 J=29,72 NLP=8 ANG=0
    25 J=30,73 NLP=8 ANG=0
    26 J=31,74 NLP=8 ANG=0
    27 J=32,75 NLP=8 ANG=0
    28 J=33,76 NLP=8 ANG=0
    29 J=34,77 NLP=8 ANG=0
    30 J=35,78 NLP=8 ANG=0
    31 J=36,79 NLP=8 ANG=0
    32 J=38,80 NLP=8 ANG=0
    33 J=40,81 NLP=7 ANG=0
    34 J=40,82 NLP=6 ANG=0
    35 J=42,83 NLP=5 ANG=0
    36 J=44,84 NLP=5 ANG=0
    37 J=45,85 NLP=5 ANG=0
    38 J=46,86 NLP=4 ANG=0
    39 J=47,87 NLP=4 ANG=0
    40 J= 1,88 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-207.439, -207.439
      ADD=25 RD=0,1 UZ=-207.439, -207.439
      ADD=26 RD=0,1 UZ=-207.439, -207.439
      ADD=27 RD=0,1 UZ=-207.439, -207.439
      ADD=28 RD=0,1 UZ=-207.439, -207.439
      ADD=29 RD=0,1 UZ=-207.439, -207.439
      ADD=30 RD=0,1 UZ=-207.439, -207.439
      ADD=31 RD=0,1 UZ=-207.439, -207.439
      ADD=32 RD=0,1 UZ=-207.439, -207.439
      ADD=33 RD=0,1 UZ=-207.439, -207.439
      ADD=34 RD=0,1 UZ=-207.439, -207.439
      ADD=35 RD=0,1 UZ=-207.439, -207.439
      ADD=36 RD=0,1 UZ=-207.439, -207.439
      ADD=37 RD=0,1 UZ=-207.439, -207.439
      ADD=38 RD=0,1 UZ=-207.439, -207.439
      ADD=39 RD=0,1 UZ=-207.439, -207.439
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-119.635, -119.635
      ADD=25 RD=0,1 UZ=-119.635, -119.635
      ADD=26 RD=0,1 UZ=-119.635, -119.635
      ADD=27 RD=0,1 UZ=-119.635, -119.635
      ADD=28 RD=0,1 UZ=-119.635, -119.635
      ADD=29 RD=0,1 UZ=-119.635, -119.635
      ADD=30 RD=0,1 UZ=-119.635, -119.635
      ADD=31 RD=0,1 UZ=-119.635, -119.635
      ADD=32 RD=0,1 UZ=-119.635, -119.635
      ADD=33 RD=0,1 UZ=-119.635, -119.635
      ADD=34 RD=0,1 UZ=-119.635, -119.635
      ADD=35 RD=0,1 UZ=-119.635, -119.635
      ADD=36 RD=0,1 UZ=-119.635, -119.635
      ADD=37 RD=0,1 UZ=-119.635, -119.635
      ADD=38 RD=0,1 UZ=-119.635, -119.635
      ADD=39 RD=0,1 UZ=-119.635, -119.635
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
```

```
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=COLSLAB  ; 슬래브 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=25.438, 25.438
      ADD=25 RD=0,1 UX=25.438, 25.438
      ADD=26 RD=0,1 UX=25.438, 25.438
      ADD=27 RD=0,1 UX=25.438, 25.438
      ADD=28 RD=0,1 UX=25.438, 25.438
      ADD=29 RD=0,1 UX=25.438, 25.438
      ADD=30 RD=0,1 UX=25.438, 25.438
      ADD=31 RD=0,1 UX=25.438, 25.438
      ADD=32 RD=0,1 UX=25.438, 25.438
      ADD=33 RD=0,1 UX=25.438, 25.438
      ADD=34 RD=0,1 UX=25.438, 25.438
      ADD=35 RD=0,1 UX=25.438, 25.438
      ADD=36 RD=0,1 UX=25.438, 25.438
      ADD=37 RD=0,1 UX=25.438, 25.438
      ADD=38 RD=0,1 UX=25.438, 25.438
      ADD=39 RD=0,1 UX=25.438, 25.438
NAME=COLWALL  ; 벽체 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=112.04, 92.501
      ADD=41 RD=0,1 UX=92.501, 288.531
      ADD=42 RD=0,1 UX=288.531, 274.425
      ADD=43 RD=0,1 UX=274.425, 188.608
      ADD=44 RD=0,1 UX=188.608, 85.648
      ADD=45 RD=0,1 UX=85.648, 60.972
      ADD=46 RD=0,1 UX=60.972, 30.727
      ADD=47 RD=0,1 UX=30.727, 21.557
      ADD=48 RD=0,1 UX=21.557, 0
      ADD=15 RD=0,1 UX=0, 21.557
      ADD=16 RD=0,1 UX=21.557, 30.727
      ADD=17 RD=0,1 UX=30.727, 60.972
      ADD=18 RD=0,1 UX=60.972, 85.648
      ADD=19 RD=0,1 UX=85.648, 188.608
      ADD=20 RD=0,1 UX=188.608, 274.425
      ADD=21 RD=0,1 UX=274.425, 288.531
      ADD=22 RD=0,1 UX=288.531, 92.501
      ADD=23 RD=0,1 UX=92.501, 112.04
NAME=COLMS  ; 주면전단력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=28.98, 28.98
      ADD=25 RD=0,1 UX=28.98, 28.98
      ADD=26 RD=0,1 UX=28.98, 28.98
      ADD=27 RD=0,1 UX=28.98, 28.98
      ADD=28 RD=0,1 UX=28.98, 28.98
      ADD=29 RD=0,1 UX=28.98, 28.98
      ADD=30 RD=0,1 UX=28.98, 28.98
      ADD=31 RD=0,1 UX=28.98, 28.98
      ADD=32 RD=0,1 UX=28.98, 28.98
      ADD=33 RD=0,1 UX=28.98, 28.98
      ADD=34 RD=0,1 UX=28.98, 28.98
      ADD=35 RD=0,1 UX=28.98, 28.98
      ADD=36 RD=0,1 UX=28.98, 28.98
      ADD=37 RD=0,1 UX=28.98, 28.98
      ADD=38 RD=0,1 UX=28.98, 28.98
      ADD=39 RD=0,1 UX=28.98, 28.98
      ADD=40 RD=0,1 UZ=-31.44, -31.44
      ADD=41 RD=0,1 UZ=-31.44, -31.44
      ADD=42 RD=0,1 UZ=-31.44, -31.44
      ADD=43 RD=0,1 UZ=-31.44, -31.44
      ADD=44 RD=0,1 UZ=-31.44, -31.44
      ADD=45 RD=0,1 UZ=-31.44, -31.44
      ADD=46 RD=0,1 UZ=-31.44, -31.44
      ADD=47 RD=0,1 UZ=-31.44, -31.44
      ADD=48 RD=0,1 UZ=-31.44, -31.44
      ADD=15 RD=0,1 UZ=31.44, 31.44
      ADD=16 RD=0,1 UZ=31.44, 31.44
      ADD=17 RD=0,1 UZ=31.44, 31.44
      ADD=18 RD=0,1 UZ=31.44, 31.44
      ADD=19 RD=0,1 UZ=31.44, 31.44
      ADD=20 RD=0,1 UZ=31.44, 31.44
      ADD=21 RD=0,1 UZ=31.44, 31.44
      ADD=22 RD=0,1 UZ=31.44, 31.44
      ADD=23 RD=0,1 UZ=31.44, 31.44
      ADD=1 RD=0,1 UX=-33.89, -33.89
      ADD=2 RD=0,1 UX=-33.89, -33.89
      ADD=3 RD=0,1 UX=-33.89, -33.89
      ADD=4 RD=0,1 UX=-33.89, -33.89
      ADD=5 RD=0,1 UX=-33.89, -33.89
      ADD=6 RD=0,1 UX=-33.89, -33.89
      ADD=7 RD=0,1 UX=-33.89, -33.89
      ADD=8 RD=0,1 UX=-33.89, -33.89
      ADD=9 RD=0,1 UX=-33.89, -33.89
      ADD=10 RD=0,1 UX=-33.89, -33.89
      ADD=11 RD=0,1 UX=-33.89, -33.89
      ADD=12 RD=0,1 UX=-33.89, -33.89
      ADD=13 RD=0,1 UX=-33.89, -33.89
      ADD=14 RD=0,1 UX=-33.89, -33.89
NAME=COLINER  ; 구체 관성력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=6.013, 6.013
      ADD=25 RD=0,1 UX=6.013, 6.013
      ADD=26 RD=0,1 UX=6.013, 6.013
      ADD=27 RD=0,1 UX=6.013, 6.013
      ADD=28 RD=0,1 UX=6.013, 6.013
      ADD=29 RD=0,1 UX=6.013, 6.013
      ADD=30 RD=0,1 UX=6.013, 6.013
      ADD=31 RD=0,1 UX=6.013, 6.013
      ADD=32 RD=0,1 UX=6.013, 6.013
      ADD=33 RD=0,1 UX=6.013, 6.013
      ADD=34 RD=0,1 UX=6.013, 6.013
      ADD=35 RD=0,1 UX=6.013, 6.013
      ADD=36 RD=0,1 UX=6.013, 6.013
      ADD=37 RD=0,1 UX=6.013, 6.013
      ADD=38 RD=0,1 UX=6.013, 6.013
      ADD=39 RD=0,1 UX=6.013, 6.013
      ADD=40 RD=0,1 UX=6.388, 6.296
      ADD=41 RD=0,1 UX=6.296, 6.256
      ADD=42 RD=0,1 UX=6.256, 6.238
      ADD=43 RD=0,1 UX=6.238, 6.125
      ADD=44 RD=0,1 UX=6.125, 5.993
      ADD=45 RD=0,1 UX=5.993, 5.861
      ADD=46 RD=0,1 UX=5.861, 5.729
      ADD=47 RD=0,1 UX=5.729, 5.69
      ADD=48 RD=0,1 UX=5.69, 5.597
      ADD=15 RD=0,1 UX=5.597, 5.69
      ADD=16 RD=0,1 UX=5.69, 5.729
      ADD=17 RD=0,1 UX=5.729, 5.861
      ADD=18 RD=0,1 UX=5.861, 5.993
      ADD=19 RD=0,1 UX=5.993, 6.125
      ADD=20 RD=0,1 UX=6.125, 6.238
      ADD=21 RD=0,1 UX=6.238, 6.256
      ADD=22 RD=0,1 UX=6.256, 6.296
      ADD=23 RD=0,1 UX=6.296, 6.388
      ADD=1 RD=0,1 UX=5.268, 5.268
      ADD=2 RD=0,1 UX=5.268, 5.268
```

```
      ADD=3 RD=0,1 UX=5.268, 5.268
      ADD=4 RD=0,1 UX=5.268, 5.268
      ADD=5 RD=0,1 UX=5.268, 5.268
      ADD=6 RD=0,1 UX=5.268, 5.268
      ADD=7 RD=0,1 UX=5.268, 5.268
      ADD=8 RD=0,1 UX=5.268, 5.268
      ADD=9 RD=0,1 UX=5.268, 5.268
      ADD=10 RD=0,1 UX=5.268, 5.268
      ADD=11 RD=0,1 UX=5.268, 5.268
      ADD=12 RD=0,1 UX=5.268, 5.268
      ADD=13 RD=0,1 UX=5.268, 5.268
      ADD=14 RD=0,1 UX=5.268, 5.268
NAME=COLSLAB2  ; 슬래브 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-25.438, -25.438
      ADD=25 RD=0,1 UX=-25.438, -25.438
      ADD=26 RD=0,1 UX=-25.438, -25.438
      ADD=27 RD=0,1 UX=-25.438, -25.438
      ADD=28 RD=0,1 UX=-25.438, -25.438
      ADD=29 RD=0,1 UX=-25.438, -25.438
      ADD=30 RD=0,1 UX=-25.438, -25.438
      ADD=31 RD=0,1 UX=-25.438, -25.438
      ADD=32 RD=0,1 UX=-25.438, -25.438
      ADD=33 RD=0,1 UX=-25.438, -25.438
      ADD=34 RD=0,1 UX=-25.438, -25.438
      ADD=35 RD=0,1 UX=-25.438, -25.438
      ADD=36 RD=0,1 UX=-25.438, -25.438
      ADD=37 RD=0,1 UX=-25.438, -25.438
      ADD=38 RD=0,1 UX=-25.438, -25.438
      ADD=39 RD=0,1 UX=-25.438, -25.438
NAME=COLWALL2  ; 벽체 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=-112.04, -92.501
      ADD=41 RD=0,1 UX=-92.501, -288.531
      ADD=42 RD=0,1 UX=-288.531, -274.425
      ADD=43 RD=0,1 UX=-274.425, -188.608
      ADD=44 RD=0,1 UX=-188.608, -85.648
      ADD=45 RD=0,1 UX=-85.648, -60.972
      ADD=46 RD=0,1 UX=-60.972, -30.727
      ADD=47 RD=0,1 UX=-30.727, -21.557
      ADD=48 RD=0,1 UX=-21.557, -0
      ADD=15 RD=0,1 UX=-0, -21.557
      ADD=16 RD=0,1 UX=-21.557, -30.727
      ADD=17 RD=0,1 UX=-30.727, -60.972
      ADD=18 RD=0,1 UX=-60.972, -85.648
      ADD=19 RD=0,1 UX=-85.648, -188.608
      ADD=20 RD=0,1 UX=-188.608, -274.425
      ADD=21 RD=0,1 UX=-274.425, -288.531
      ADD=22 RD=0,1 UX=-288.531, -92.501
      ADD=23 RD=0,1 UX=-92.501, -112.04
NAME=COLMS2  ; 주면전단력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-28.98, -28.98
      ADD=25 RD=0,1 UX=-28.98, -28.98
      ADD=26 RD=0,1 UX=-28.98, -28.98
      ADD=27 RD=0,1 UX=-28.98, -28.98
      ADD=28 RD=0,1 UX=-28.98, -28.98
      ADD=29 RD=0,1 UX=-28.98, -28.98
      ADD=30 RD=0,1 UX=-28.98, -28.98
      ADD=31 RD=0,1 UX=-28.98, -28.98
      ADD=32 RD=0,1 UX=-28.98, -28.98
      ADD=33 RD=0,1 UX=-28.98, -28.98
      ADD=34 RD=0,1 UX=-28.98, -28.98
      ADD=35 RD=0,1 UX=-28.98, -28.98
      ADD=36 RD=0,1 UX=-28.98, -28.98
      ADD=37 RD=0,1 UX=-28.98, -28.98
      ADD=38 RD=0,1 UX=-28.98, -28.98
      ADD=39 RD=0,1 UX=-28.98, -28.98
      ADD=40 RD=0,1 UZ=31.44, 31.44
      ADD=41 RD=0,1 UZ=31.44, 31.44
      ADD=42 RD=0,1 UZ=31.44, 31.44
      ADD=43 RD=0,1 UZ=31.44, 31.44
      ADD=44 RD=0,1 UZ=31.44, 31.44
      ADD=45 RD=0,1 UZ=31.44, 31.44
      ADD=46 RD=0,1 UZ=31.44, 31.44
      ADD=47 RD=0,1 UZ=31.44, 31.44
      ADD=48 RD=0,1 UZ=31.44, 31.44
      ADD=15 RD=0,1 UZ=-31.44, -31.44
      ADD=16 RD=0,1 UZ=-31.44, -31.44
      ADD=17 RD=0,1 UZ=-31.44, -31.44
      ADD=18 RD=0,1 UZ=-31.44, -31.44
      ADD=19 RD=0,1 UZ=-31.44, -31.44
      ADD=20 RD=0,1 UZ=-31.44, -31.44
      ADD=21 RD=0,1 UZ=-31.44, -31.44
      ADD=22 RD=0,1 UZ=-31.44, -31.44
      ADD=23 RD=0,1 UZ=-31.44, -31.44
      ADD=1 RD=0,1 UX=33.89, 33.89
      ADD=2 RD=0,1 UX=33.89, 33.89
      ADD=3 RD=0,1 UX=33.89, 33.89
      ADD=4 RD=0,1 UX=33.89, 33.89
      ADD=5 RD=0,1 UX=33.89, 33.89
      ADD=6 RD=0,1 UX=33.89, 33.89
      ADD=7 RD=0,1 UX=33.89, 33.89
      ADD=8 RD=0,1 UX=33.89, 33.89
      ADD=9 RD=0,1 UX=33.89, 33.89
      ADD=10 RD=0,1 UX=33.89, 33.89
      ADD=11 RD=0,1 UX=33.89, 33.89
      ADD=12 RD=0,1 UX=33.89, 33.89
      ADD=13 RD=0,1 UX=33.89, 33.89
      ADD=14 RD=0,1 UX=33.89, 33.89
NAME=COLINER2  ; 구체 관성력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-6.013, -6.013
      ADD=25 RD=0,1 UX=-6.013, -6.013
      ADD=26 RD=0,1 UX=-6.013, -6.013
      ADD=27 RD=0,1 UX=-6.013, -6.013
      ADD=28 RD=0,1 UX=-6.013, -6.013
      ADD=29 RD=0,1 UX=-6.013, -6.013
      ADD=30 RD=0,1 UX=-6.013, -6.013
      ADD=31 RD=0,1 UX=-6.013, -6.013
      ADD=32 RD=0,1 UX=-6.013, -6.013
      ADD=33 RD=0,1 UX=-6.013, -6.013
      ADD=34 RD=0,1 UX=-6.013, -6.013
      ADD=35 RD=0,1 UX=-6.013, -6.013
      ADD=36 RD=0,1 UX=-6.013, -6.013
      ADD=37 RD=0,1 UX=-6.013, -6.013
      ADD=38 RD=0,1 UX=-6.013, -6.013
      ADD=39 RD=0,1 UX=-6.013, -6.013
      ADD=40 RD=0,1 UX=-6.388, -6.296
      ADD=41 RD=0,1 UX=-6.296, -6.256
      ADD=42 RD=0,1 UX=-6.256, -6.238
      ADD=43 RD=0,1 UX=-6.238, -6.125
      ADD=44 RD=0,1 UX=-6.125, -5.993
      ADD=45 RD=0,1 UX=-5.993, -5.861
      ADD=46 RD=0,1 UX=-5.861, -5.729
      ADD=47 RD=0,1 UX=-5.729, -5.69
      ADD=48 RD=0,1 UX=-5.69, -5.597
      ADD=15 RD=0,1 UX=-5.597, -5.69
      ADD=16 RD=0,1 UX=-5.69, -5.729
      ADD=17 RD=0,1 UX=-5.729, -5.861
      ADD=18 RD=0,1 UX=-5.861, -5.993
      ADD=19 RD=0,1 UX=-5.993, -6.125
      ADD=20 RD=0,1 UX=-6.125, -6.238
      ADD=21 RD=0,1 UX=-6.238, -6.256
      ADD=22 RD=0,1 UX=-6.256, -6.296
      ADD=23 RD=0,1 UX=-6.296, -6.388
      ADD=1 RD=0,1 UX=-5.268, -5.268
      ADD=2 RD=0,1 UX=-5.268, -5.268
      ADD=3 RD=0,1 UX=-5.268, -5.268
      ADD=4 RD=0,1 UX=-5.268, -5.268
      ADD=5 RD=0,1 UX=-5.268, -5.268
      ADD=6 RD=0,1 UX=-5.268, -5.268
      ADD=7 RD=0,1 UX=-5.268, -5.268
      ADD=8 RD=0,1 UX=-5.268, -5.268
      ADD=9 RD=0,1 UX=-5.268, -5.268
      ADD=10 RD=0,1 UX=-5.268, -5.268
      ADD=11 RD=0,1 UX=-5.268, -5.268
      ADD=12 RD=0,1 UX=-5.268, -5.268
      ADD=13 RD=0,1 UX=-5.268, -5.268
      ADD=14 RD=0,1 UX=-5.268, -5.268
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=COLSLAB
      LOAD=COLWALL
      LOAD=COLMS
      LOAD=COLINER
      LOAD=COLSLAB2
      LOAD=COLWALL2
      LOAD=COLMS2
      LOAD=COLINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
```

```
NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=0.500   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=0.500   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=0.500   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=0.500   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=0.500   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=0.500   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
```

```
      LOAD= COLINER2       SF=1.000   AT=1                                HIST=UE06 SF=1
   NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     HIST=UE07 SF=1
      LOAD= SW             SF=1.200   AT=1                                HIST=UE08 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                HIST=UE09 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                HIST=UE10 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                HIST=UE11 SF=1
      LOAD= COLSLAB        SF=1.000   AT=1                                HIST=UE12 SF=1
      LOAD= COLWALL        SF=1.000   AT=1                                HIST=UE13 SF=1
      LOAD= COLMS          SF=1.000   AT=1                                HIST=UE14 SF=1
      LOAD= COLINER        SF=1.000   AT=1                                HIST=UE15 SF=1
   NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     HIST=UE16 SF=1
      LOAD= SW             SF=1.200   AT=1                                HIST=UE17 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                HIST=UE18 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                HIST=UE19 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                HIST=UE20 SF=1
      LOAD= COLSLAB2       SF=1.000   AT=1                                HIST=UE21 SF=1
      LOAD= COLWALL2       SF=1.000   AT=1                                HIST=UE22 SF=1
      LOAD= COLMS2         SF=1.000   AT=1                                HIST=UE23 SF=1
      LOAD= COLINER2       SF=1.000   AT=1                                HIST=UE24 SF=1
   NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     HIST=UE25 SF=1
      LOAD= SW             SF=1.200   AT=1                                HIST=UE26 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                HIST=UE27 SF=1
      LOAD= LIVELEE        SF=1.000   AT=1                                HIST=UE28 SF=1
      LOAD= LIVELEHE       SF=0.500   AT=1                                HIST=UE29 SF=1
      LOAD= COLSLAB        SF=1.000   AT=1                                HIST=UE30 SF=1
      LOAD= COLWALL        SF=1.000   AT=1                                HIST=UE31 SF=1
      LOAD= COLMS          SF=1.000   AT=1                                HIST=UE32 SF=1
      LOAD= COLINER        SF=1.000   AT=1                          OUTPUT
   NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= SW             SF=1.200   AT=1                                ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVELEE        SF=1.000   AT=1
      LOAD= LIVELEHE       SF=0.500   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
```

18. OUTPUT DATA (상시)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVULT MAX	0.52941	0.00000	0.00000	0.00000
1	ENVULT MAX	0.64706	0.00000	0.00000	0.00000
1	ENVULT MAX	0.76471	0.00000	0.00000	0.00000
1	ENVULT MAX	0.88235	0.00000	0.00000	0.00000
1	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
1	ENVULT MIN	0.52941	-907.58258	-2165.92100	-3170.44500
1	ENVULT MIN	0.64706	-907.58258	-2170.72100	-2955.83800
1	ENVULT MIN	0.76471	-907.58258	-2175.52100	-2740.75200
1	ENVULT MIN	0.88235	-907.58258	-2180.32100	-2525.18500
1	ENVULT MIN	1.00000	-907.58258	-2185.12100	-2309.13800
2	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
2	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
2	ENVULT MIN	0.00000	-907.58258	-2185.12100	-2309.13800
2	ENVULT MIN	0.25000	-907.58258	-2187.26900	-2212.30200
2	ENVULT MIN	0.50000	-907.58258	-2189.41700	-2115.36900
2	ENVULT MIN	0.75000	-907.58258	-2191.56500	-2018.34100
2	ENVULT MIN	1.00000	-907.58258	-2193.71300	-1921.21600
3	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
3	ENVULT MAX	1.00000	0.00000	0.00000	378.57304
3	ENVULT MIN	0.00000	-907.58258	-1699.72400	-1921.21600
3	ENVULT MIN	0.25000	-907.58258	-1712.07200	-1486.77200
3	ENVULT MIN	0.50000	-907.58258	-1724.42000	-1049.15200
3	ENVULT MIN	0.75000	-907.58258	-1736.76800	-608.35502
3	ENVULT MIN	1.00000	-907.58258	-1749.11600	-239.09610
4	ENVULT MAX	0.00000	0.00000	0.00000	378.57304
4	ENVULT MAX	0.25000	0.00000	0.00000	672.80230
4	ENVULT MAX	0.50000	0.00000	0.00000	992.34030
4	ENVULT MAX	0.75000	0.00000	0.00000	1323.19400
4	ENVULT MAX	1.00000	0.00000	0.00000	1657.22400
4	ENVULT MIN	0.00000	-907.58258	-1280.36200	-239.09609
4	ENVULT MIN	0.25000	-907.58258	-1292.71000	-24.20887
4	ENVULT MIN	0.50000	-907.58258	-1305.05800	0.00000
4	ENVULT MIN	0.75000	-907.58258	-1317.40600	0.00000
4	ENVULT MIN	1.00000	-907.58258	-1329.75400	0.00000
5	ENVULT MAX	0.00000	0.00000	0.00000	1657.22400
5	ENVULT MAX	0.25000	0.00000	0.00000	1881.56100
5	ENVULT MAX	0.50000	0.00000	0.00000	2109.08000
5	ENVULT MAX	0.75000	0.00000	0.00000	2339.78100
5	ENVULT MAX	1.00000	0.00000	0.00000	2573.66600
5	ENVULT MIN	0.00000	-907.58258	-886.09904	0.00000
5	ENVULT MIN	0.25000	-907.58258	-898.45904	0.00000
5	ENVULT MIN	0.50000	-907.58258	-910.81904	0.00000
5	ENVULT MIN	0.75000	-907.58258	-923.17904	0.00000
5	ENVULT MIN	1.00000	-907.58258	-935.53904	0.00000
6	ENVULT MAX	0.00000	0.00000	0.00000	2573.66600
6	ENVULT MAX	0.25000	0.00000	0.00000	2703.57900
6	ENVULT MAX	0.50000	0.00000	0.00000	2836.66900
6	ENVULT MAX	0.75000	0.00000	0.00000	2972.93500
6	ENVULT MAX	1.00000	0.00000	0.00000	3112.37800
6	ENVULT MIN	0.00000	-907.58258	-512.71119	0.00000
6	ENVULT MIN	0.25000	-907.58258	-525.05919	0.00000
6	ENVULT MIN	0.50000	-907.58258	-537.40719	0.00000
6	ENVULT MIN	0.75000	-907.58258	-549.75519	0.00000
6	ENVULT MIN	1.00000	-907.58258	-562.10319	0.00000
7	ENVULT MAX	0.00000	0.00000	0.00000	3112.37800
7	ENVULT MAX	0.25000	0.00000	0.00000	3152.05600
7	ENVULT MAX	0.50000	0.00000	0.00000	3194.91000
7	ENVULT MAX	0.75000	0.00000	0.00000	3240.94000
7	ENVULT MAX	1.00000	0.00000	0.00000	3290.14700
7	ENVULT MIN	0.00000	-907.58258	-156.59630	0.00000
7	ENVULT MIN	0.25000	-907.58258	-168.94430	0.00000
7	ENVULT MIN	0.50000	-907.58258	-181.29230	0.00000
7	ENVULT MIN	0.75000	-907.58258	-193.64030	0.00000
7	ENVULT MIN	1.00000	-907.58258	-205.98830	0.00000
8	ENVULT MAX	0.00000	0.00000	205.90165	3290.14700
8	ENVULT MAX	0.25000	0.00000	193.55365	3240.96200
8	ENVULT MAX	0.50000	0.00000	181.20565	3194.95400
8	ENVULT MAX	0.75000	0.00000	168.85765	3152.12200
8	ENVULT MAX	1.00000	0.00000	156.50965	3112.46700
8	ENVULT MIN	0.00000	-907.58266	0.00000	0.00000
8	ENVULT MIN	0.25000	-907.58266	0.00000	0.00000
8	ENVULT MIN	0.50000	-907.58266	0.00000	0.00000
8	ENVULT MIN	0.75000	-907.58266	0.00000	0.00000
8	ENVULT MIN	1.00000	-907.58266	0.00000	0.00000
9	ENVULT MAX	0.00000	0.00000	562.01939	3112.46700
9	ENVULT MAX	0.25000	0.00000	549.67139	2973.04500
9	ENVULT MAX	0.50000	0.00000	537.32339	2836.80000
9	ENVULT MAX	0.75000	0.00000	524.97539	2703.73100
9	ENVULT MAX	1.00000	0.00000	512.62739	2573.83900
9	ENVULT MIN	0.00000	-907.58266	0.00000	0.00000
9	ENVULT MIN	0.25000	-907.58266	0.00000	0.00000
9	ENVULT MIN	0.50000	-907.58266	0.00000	0.00000
9	ENVULT MIN	0.75000	-907.58266	0.00000	0.00000
9	ENVULT MIN	1.00000	-907.58266	0.00000	0.00000
10	ENVULT MAX	0.00000	0.00000	935.46395	2573.83900
10	ENVULT MAX	0.25000	0.00000	923.11595	2340.19800
10	ENVULT MAX	0.50000	0.00000	910.76795	2109.73500
10	ENVULT MAX	0.75000	0.00000	898.41995	1882.44800
10	ENVULT MAX	1.00000	0.00000	886.07195	1658.33700
10	ENVULT MIN	0.00000	-907.58266	0.00000	0.00000
10	ENVULT MIN	0.25000	-907.58266	0.00000	0.00000
10	ENVULT MIN	0.50000	-907.58266	0.00000	0.00000
10	ENVULT MIN	0.75000	-907.58266	0.00000	0.00000
10	ENVULT MIN	1.00000	-907.58266	0.00000	0.00000
11	ENVULT MAX	0.00000	0.00000	1329.71800	1658.33700
11	ENVULT MAX	0.25000	0.00000	1317.35800	1323.99300
11	ENVULT MAX	0.50000	0.00000	1304.99800	992.83223
11	ENVULT MAX	0.75000	0.00000	1292.63800	672.97667
11	ENVULT MAX	1.00000	0.00000	1280.27800	378.47992
11	ENVULT MIN	0.00000	-907.58266	0.00000	0.00000
11	ENVULT MIN	0.25000	-907.58266	0.00000	0.00000
11	ENVULT MIN	0.50000	-907.58266	0.00000	0.00000
11	ENVULT MIN	0.75000	-907.58266	0.00000	-24.08622
11	ENVULT MIN	1.00000	-907.58266	0.00000	-239.16921
12	ENVULT MAX	0.00000	0.00000	1749.05200	378.47992
12	ENVULT MAX	0.25000	0.00000	1736.70400	0.00000
12	ENVULT MAX	0.50000	0.00000	1724.35600	0.00000
12	ENVULT MAX	0.75000	0.00000	1712.00800	0.00000
12	ENVULT MAX	1.00000	0.00000	1699.66000	0.00000
12	ENVULT MIN	0.00000	-907.58266	0.00000	-239.16922
12	ENVULT MIN	0.25000	-907.58266	0.00000	-608.44121
12	ENVULT MIN	0.50000	-907.58266	0.00000	-1049.22200
12	ENVULT MIN	0.75000	-907.58266	0.00000	-1486.82600
12	ENVULT MIN	1.00000	-907.58266	0.00000	-1921.25300
13	ENVULT MAX	0.00000	0.00000	2193.67300	0.00000
13	ENVULT MAX	0.25000	0.00000	2191.52500	0.00000
13	ENVULT MAX	0.50000	0.00000	2189.37700	0.00000
13	ENVULT MAX	0.75000	0.00000	2187.22900	0.00000
13	ENVULT MAX	1.00000	0.00000	2185.08100	0.00000
13	ENVULT MIN	0.00000	-907.58266	0.00000	-1921.25300
13	ENVULT MIN	0.25000	-907.58266	0.00000	-2018.37600
13	ENVULT MIN	0.50000	-907.58266	0.00000	-2115.40300
13	ENVULT MIN	0.75000	-907.58266	0.00000	-2212.33400
13	ENVULT MIN	1.00000	-907.58266	0.00000	-2309.16900
14	ENVULT MAX	0.00000	0.00000	2185.08100	0.00000
14	ENVULT MAX	0.11765	0.00000	2180.28100	0.00000
14	ENVULT MAX	0.23529	0.00000	2175.48100	0.00000
14	ENVULT MAX	0.35294	0.00000	2170.68100	0.00000
14	ENVULT MAX	0.47059	0.00000	2165.88100	0.00000
14	ENVULT MIN	0.00000	-907.58266	0.00000	-2309.16900
14	ENVULT MIN	0.11765	-907.58266	0.00000	-2525.21100
14	ENVULT MIN	0.23529	-907.58266	0.00000	-2740.77400
14	ENVULT MIN	0.35294	-907.58266	0.00000	-2955.85700
14	ENVULT MIN	0.47059	-907.58266	0.00000	-3170.46000
15	ENVULT MAX	0.46875	0.00000	0.00000	0.00000
15	ENVULT MAX	0.60156	0.00000	0.00000	0.00000
15	ENVULT MAX	0.73438	0.00000	0.00000	0.00000
15	ENVULT MAX	0.86719	0.00000	0.00000	0.00000
15	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
15	ENVULT MIN	0.46875	-2805.64300	-800.02321	-3816.51000
15	ENVULT MIN	0.60156	-2800.22500	-769.93664	-3755.63900
15	ENVULT MIN	0.73438	-2794.80600	-740.02167	-3715.56300
15	ENVULT MIN	0.86719	-2789.38700	-710.27829	-3677.07200
15	ENVULT MIN	1.00000	-2783.96800	-680.70650	-3640.15600
16	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
16	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
16	ENVULT MIN	0.00000	-2783.96800	-680.70650	-3640.15600
16	ENVULT MIN	0.25000	-2779.67200	-657.37975	-3611.99800
16	ENVULT MIN	0.50000	-2775.37500	-634.16080	-3584.82100
16	ENVULT MIN	0.75000	-2771.07800	-611.04966	-3558.61900
16	ENVULT MIN	1.00000	-2766.78100	-588.04633	-3533.38900
17	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.75000	0.00000	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
17	ENVULT MIN	0.00000	-2766.78100	-588.04633	-3533.38900
17	ENVULT MIN	0.25000	-2752.29700	-511.29891	-3455.43500
17	ENVULT MIN	0.50000	-2737.81300	-435.77803	-3388.29100
17	ENVULT MIN	0.75000	-2723.32900	-361.48368	-3331.78500
17	ENVULT MIN	1.00000	-2708.84500	-288.41588	-3285.74200
18	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
18	ENVULT MAX	0.25000	0.00000	29.05701	0.00000
18	ENVULT MAX	0.50000	0.00000	63.25828	0.00000
18	ENVULT MAX	0.75000	0.00000	96.84563	0.00000
18	ENVULT MAX	1.00000	0.00000	143.15933	0.00000
18	ENVULT MIN	0.00000	-2708.84500	-288.41588	-3285.74200
18	ENVULT MIN	0.25000	-2694.34900	-216.51149	-3249.96000
18	ENVULT MIN	0.50000	-2679.85200	-164.06398	-3224.31000
18	ENVULT MIN	0.75000	-2665.35500	-124.17296	-3208.61800
18	ENVULT MIN	1.00000	-2650.85800	-84.92810	-3202.70900
19	ENVULT MAX	0.00000	0.00000	142.74001	0.00000
19	ENVULT MAX	0.25000	0.00000	207.45902	0.00000
19	ENVULT MAX	0.50000	0.00000	270.95018	0.00000
19	ENVULT MAX	0.75000	0.00000	333.21350	0.00000
19	ENVULT MAX	1.00000	0.00000	394.24896	0.00000
19	ENVULT MIN	0.00000	-2650.85800	-84.92812	-3202.70900
19	ENVULT MIN	0.25000	-2636.36200	-65.53454	-3232.81800
19	ENVULT MIN	0.50000	-2621.86500	-46.55827	-3273.77600
19	ENVULT MIN	0.75000	-2607.36800	-27.90507	-3323.99500
19	ENVULT MIN	1.00000	-2592.87100	-9.57495	-3383.29800
20	ENVULT MAX	0.00000	0.00000	394.01101	0.00000
20	ENVULT MAX	0.25000	0.00000	445.26758	0.00000
20	ENVULT MAX	0.50000	0.00000	495.62452	0.00000
20	ENVULT MAX	0.75000	0.00000	545.08181	0.00000
20	ENVULT MAX	1.00000	0.00000	593.63948	0.00000
20	ENVULT MIN	0.00000	-2592.87100	-10.79454	-3383.29800
20	ENVULT MIN	0.25000	-2580.46600	0.00000	-3441.12900
20	ENVULT MIN	0.50000	-2568.06000	0.00000	-3505.37700
20	ENVULT MIN	0.75000	-2555.65400	0.00000	-3575.93100
20	ENVULT MIN	1.00000	-2543.24800	0.00000	-3652.68200
21	ENVULT MAX	0.00000	0.00000	593.54659	0.00000
21	ENVULT MAX	0.25000	0.00000	601.59313	0.00000
21	ENVULT MAX	0.50000	0.00000	609.61438	0.00000
21	ENVULT MAX	0.75000	0.00000	617.61035	0.00000
21	ENVULT MAX	1.00000	0.00000	625.58105	0.00000
21	ENVULT MIN	0.00000	-2543.24800	0.00000	-3652.68200
21	ENVULT MIN	0.25000	-2541.14500	0.00000	-3666.13800
21	ENVULT MIN	0.50000	-2538.99200	0.00000	-3679.76500
21	ENVULT MIN	0.75000	-2536.78900	0.00000	-3693.56100
21	ENVULT MIN	1.00000	-2534.53600	0.00000	-3707.52600
22	ENVULT MAX	0.00000	0.00000	625.53594	0.00000
22	ENVULT MAX	0.25000	0.00000	641.93519	0.00000
22	ENVULT MAX	0.50000	0.00000	658.22663	0.00000
22	ENVULT MAX	0.75000	0.00000	674.41026	0.00000
22	ENVULT MAX	1.00000	0.00000	690.48609	0.00000
22	ENVULT MIN	0.00000	-2534.53600	0.00000	-3707.52600
22	ENVULT MIN	0.25000	-2529.72000	0.00000	-3736.93400
22	ENVULT MIN	0.50000	-2524.69100	0.00000	-3767.05900
22	ENVULT MIN	0.75000	-2519.45000	0.00000	-3797.89600
22	ENVULT MIN	1.00000	-2513.99600	0.00000	-3829.44100
23	ENVULT MAX	0.00000	0.00000	690.35664	0.00000
23	ENVULT MAX	0.10937	0.00000	706.93843	0.00000
23	ENVULT MAX	0.21875	0.00000	723.40385	0.00000
23	ENVULT MAX	0.32812	0.00000	739.75289	0.00000
23	ENVULT MAX	0.43750	0.00000	755.98556	0.00000
23	ENVULT MIN	0.00000	-2513.99600	0.00000	-3829.44100
23	ENVULT MIN	0.10937	-2508.22100	0.00000	-3862.94800
23	ENVULT MIN	0.21875	-2502.44600	0.00000	-3897.20800
23	ENVULT MIN	0.32812	-2496.67100	0.00000	-3932.21600
23	ENVULT MIN	0.43750	-2490.89600	0.00000	-3969.36400
24	ENVULT MAX	0.64706	0.00000	0.00000	0.00000
24	ENVULT MAX	0.73529	0.00000	0.00000	0.00000
24	ENVULT MAX	0.82353	0.00000	0.00000	0.00000
24	ENVULT MAX	0.91176	0.00000	0.00000	0.00000
24	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
24	ENVULT MIN	0.64706	-837.14378	-2235.19900	-3032.13500
24	ENVULT MIN	0.73529	-837.14378	-2204.38200	-2865.65100
24	ENVULT MIN	0.82353	-837.14378	-2173.56400	-2701.47800
24	ENVULT MIN	0.91176	-837.14378	-2142.74600	-2539.61700
24	ENVULT MIN	1.00000	-837.14378	-2111.92900	-2380.06600
25	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
25	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
25	ENVULT MIN	0.00000	-836.91312	-2111.92900	-2380.06600
25	ENVULT MIN	0.25000	-836.91312	-2093.57100	-2285.96800
25	ENVULT MIN	0.50000	-836.91312	-2075.27300	-2192.69100
25	ENVULT MIN	0.75000	-836.91312	-2057.03600	-2100.58800
25	ENVULT MIN	1.00000	-836.91312	-2038.85800	-2011.33000
26	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
26	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
26	ENVULT MIN	0.00000	-836.81691	-2038.85800	-2011.33000
26	ENVULT MIN	0.25000	-836.81691	-2006.41100	-1853.21600
26	ENVULT MIN	0.50000	-836.81691	-1974.15700	-1697.59500
26	ENVULT MIN	0.75000	-836.81691	-1942.09700	-1544.45200
26	ENVULT MIN	1.00000	-836.81691	-1910.22900	-1393.77000
27	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
27	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
27	ENVULT MAX	0.50000	0.00000	0.00000	89.27814
27	ENVULT MAX	0.75000	0.00000	0.00000	275.47598
27	ENVULT MAX	1.00000	0.00000	0.00000	458.14628
27	ENVULT MIN	0.00000	-836.65827	-1910.22900	-1393.77000
27	ENVULT MIN	0.25000	-836.65827	-1840.15400	-1070.08100
27	ENVULT MIN	0.50000	-836.65827	-1770.07900	-771.34935
27	ENVULT MIN	0.75000	-836.65827	-1700.00500	-485.96659
27	ENVULT MIN	1.00000	-836.65827	-1629.93000	-218.44245
28	ENVULT MAX	0.00000	0.00000	0.00000	458.14629
28	ENVULT MAX	0.25000	0.00000	0.00000	811.33190
28	ENVULT MAX	0.50000	0.00000	0.00000	1184.98900
28	ENVULT MAX	0.75000	0.00000	0.00000	1532.39500
28	ENVULT MAX	1.00000	0.00000	0.00000	1853.55000
28	ENVULT MIN	0.00000	-836.44401	-1629.93000	-218.44245
28	ENVULT MIN	0.25000	-836.44401	-1527.98500	0.00000
28	ENVULT MIN	0.50000	-836.44401	-1426.04000	0.00000
28	ENVULT MIN	0.75000	-836.44401	-1324.09500	0.00000
28	ENVULT MIN	1.00000	-836.44401	-1222.15000	0.00000
29	ENVULT MAX	0.00000	0.00000	0.00000	1853.55000
29	ENVULT MAX	0.25000	0.00000	0.00000	2148.18100
29	ENVULT MAX	0.50000	0.00000	0.00000	2416.61200
29	ENVULT MAX	0.75000	0.00000	0.00000	2665.13800
29	ENVULT MAX	1.00000	0.00000	0.00000	2887.83700
29	ENVULT MIN	0.00000	-836.26153	-1222.15000	0.00000
29	ENVULT MIN	0.25000	-836.26153	-1120.30500	0.00000
29	ENVULT MIN	0.50000	-836.26153	-1018.45900	0.00000
29	ENVULT MIN	0.75000	-836.26153	-916.61277	0.00000
29	ENVULT MIN	1.00000	-836.26153	-814.76687	0.00000
30	ENVULT MAX	0.00000	0.00000	0.00000	2887.83700
30	ENVULT MAX	0.25000	0.00000	0.00000	3084.33600
30	ENVULT MAX	0.50000	0.00000	0.00000	3254.63500
30	ENVULT MAX	0.75000	0.00000	0.00000	3398.73400
30	ENVULT MAX	1.00000	0.00000	0.00000	3516.63300
30	ENVULT MIN	0.00000	-836.14316	-814.76687	0.00000
30	ENVULT MIN	0.25000	-836.14316	-713.45247	0.00000
30	ENVULT MIN	0.50000	-836.14316	-615.72258	0.00000
30	ENVULT MIN	0.75000	-836.14316	-517.99269	0.00000
30	ENVULT MIN	1.00000	-836.14316	-420.26280	0.00000
31	ENVULT MAX	0.00000	0.00000	0.00000	3516.63300
31	ENVULT MAX	0.25000	0.00000	0.00000	3608.33200
31	ENVULT MAX	0.50000	0.00000	0.00000	3673.83200
31	ENVULT MAX	0.75000	0.00000	0.00000	3713.13200
31	ENVULT MAX	1.00000	0.00000	35.31324	3726.23200
31	ENVULT MIN	0.00000	-836.08488	-420.26280	0.00000
31	ENVULT MIN	0.25000	-836.08488	-322.53290	0.00000
31	ENVULT MIN	0.50000	-836.08488	-224.80301	0.00000
31	ENVULT MIN	0.75000	-836.08488	-127.07312	0.00000
31	ENVULT MIN	1.00000	-836.08488	-29.34333	0.00000
32	ENVULT MAX	0.00000	0.00000	29.34379	3726.23200
32	ENVULT MAX	0.25000	0.00000	127.07368	3713.13200
32	ENVULT MAX	0.50000	0.00000	224.80357	3673.83200
32	ENVULT MAX	0.75000	0.00000	322.53346	3608.33200
32	ENVULT MAX	1.00000	0.00000	420.26336	3516.63200
32	ENVULT MIN	0.00000	-836.08495	-35.31207	0.00000
32	ENVULT MIN	0.25000	-836.08495	0.00000	0.00000
32	ENVULT MIN	0.50000	-836.08495	0.00000	0.00000
32	ENVULT MIN	0.75000	-836.08495	0.00000	0.00000
32	ENVULT MIN	1.00000	-836.08495	0.00000	0.00000
33	ENVULT MAX	0.00000	0.00000	420.26336	3516.63200
33	ENVULT MAX	0.25000	0.00000	517.99325	3398.73300
33	ENVULT MAX	0.50000	0.00000	615.72314	3254.63400
33	ENVULT MAX	0.75000	0.00000	713.45303	3084.33500
33	ENVULT MAX	1.00000	0.00000	814.76746	2887.83600
33	ENVULT MIN	0.00000	-836.14336	0.00000	0.00000
33	ENVULT MIN	0.25000	-836.14336	0.00000	0.00000
33	ENVULT MIN	0.50000	-836.14336	0.00000	0.00000
33	ENVULT MIN	0.75000	-836.14336	0.00000	0.00000
33	ENVULT MIN	1.00000	-836.14336	0.00000	0.00000
34	ENVULT MAX	0.00000	0.00000	814.76746	2887.83600
34	ENVULT MAX	0.25000	0.00000	916.71233	2664.90800
34	ENVULT MAX	0.50000	0.00000	1018.65700	2416.11400
34	ENVULT MAX	0.75000	0.00000	1120.60200	2147.35900
34	ENVULT MAX	1.00000	0.00000	1222.54700	1852.35200
34	ENVULT MIN	0.00000	-836.26193	0.00000	0.00000
34	ENVULT MIN	0.25000	-836.26193	0.00000	0.00000
34	ENVULT MIN	0.50000	-836.26193	0.00000	0.00000
34	ENVULT MIN	0.75000	-836.26193	0.00000	0.00000
34	ENVULT MIN	1.00000	-836.26193	0.00000	0.00000
35	ENVULT MAX	0.00000	0.00000	1222.54700	1852.35200
35	ENVULT MAX	0.25000	0.00000	1324.39300	1531.41900

FRAME	LOAD	DIST	P	V2	M3
35	ENVULT MAX	0.50000	0.00000	1426.23900	1184.28700
35	ENVULT MAX	0.75000	0.00000	1528.08500	810.95413
35	ENVULT MAX	1.00000	0.00000	1629.93100	458.14478
35	ENVULT MIN	0.00000	-836.44461	0.00000	0.00000
35	ENVULT MIN	0.25000	-836.44461	0.00000	0.00000
35	ENVULT MIN	0.50000	-836.44461	0.00000	0.00000
35	ENVULT MIN	0.75000	-836.44461	0.00000	0.00000
35	ENVULT MIN	1.00000	-836.44461	0.00000	-218.44762
36	ENVULT MAX	0.00000	0.00000	1629.93100	458.14477
36	ENVULT MAX	0.25000	0.00000	1700.00500	275.47229
36	ENVULT MAX	0.50000	0.00000	1770.08000	89.27426
36	ENVULT MAX	0.75000	0.00000	1840.15500	0.00000
36	ENVULT MAX	1.00000	0.00000	1910.22900	0.00000
36	ENVULT MIN	0.00000	-836.65886	0.00000	-218.44762
36	ENVULT MIN	0.25000	-836.65886	0.00000	-485.96904
36	ENVULT MIN	0.50000	-836.65886	0.00000	-771.35190
36	ENVULT MIN	0.75000	-836.65886	0.00000	-1070.08400
36	ENVULT MIN	1.00000	-836.65886	0.00000	-1393.77300
37	ENVULT MAX	0.00000	0.00000	1910.22900	0.00000
37	ENVULT MAX	0.25000	0.00000	1942.09700	0.00000
37	ENVULT MAX	0.50000	0.00000	1974.15800	0.00000
37	ENVULT MAX	0.75000	0.00000	2006.41200	0.00000
37	ENVULT MAX	1.00000	0.00000	2038.85900	0.00000
37	ENVULT MIN	0.00000	-836.81755	0.00000	-1393.77300
37	ENVULT MIN	0.25000	-836.81755	0.00000	-1544.45500
37	ENVULT MIN	0.50000	-836.81755	0.00000	-1697.59800
37	ENVULT MIN	0.75000	-836.81755	0.00000	-1853.21900
37	ENVULT MIN	1.00000	-836.81755	0.00000	-2011.33300
38	ENVULT MAX	0.00000	0.00000	2038.85900	0.00000
38	ENVULT MAX	0.25000	0.00000	2057.03600	0.00000
38	ENVULT MAX	0.50000	0.00000	2075.27400	0.00000
38	ENVULT MAX	0.75000	0.00000	2093.57200	0.00000
38	ENVULT MAX	1.00000	0.00000	2111.92900	0.00000
38	ENVULT MIN	0.00000	-836.91380	0.00000	-2011.33300
38	ENVULT MIN	0.25000	-836.91380	0.00000	-2100.59100
38	ENVULT MIN	0.50000	-836.91380	0.00000	-2192.69400
38	ENVULT MIN	0.75000	-836.91380	0.00000	-2285.97200
38	ENVULT MIN	1.00000	-836.91380	0.00000	-2380.06900
39	ENVULT MAX	0.00000	0.00000	2111.92900	0.00000
39	ENVULT MAX	0.08824	0.00000	2142.74700	0.00000
39	ENVULT MAX	0.17647	0.00000	2173.56500	0.00000
39	ENVULT MAX	0.26471	0.00000	2204.38200	0.00000
39	ENVULT MAX	0.35294	0.00000	2235.20000	0.00000
39	ENVULT MIN	0.00000	-837.14457	0.00000	-2380.06900
39	ENVULT MIN	0.08824	-837.14457	0.00000	-2539.62000
39	ENVULT MIN	0.17647	-837.14457	0.00000	-2701.48200
39	ENVULT MIN	0.26471	-837.14457	0.00000	-2865.65500
39	ENVULT MIN	0.35294	-837.14457	0.00000	-3032.13900
40	ENVULT MAX	0.56250	0.00000	0.00000	0.00000
40	ENVULT MAX	0.67188	0.00000	0.00000	0.00000
40	ENVULT MAX	0.78125	0.00000	0.00000	0.00000
40	ENVULT MAX	0.89063	0.00000	0.00000	0.00000
40	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
40	ENVULT MIN	0.56250	-2490.89600	-755.98650	-3969.36800
40	ENVULT MIN	0.67188	-2496.67100	-739.75383	-3932.22000
40	ENVULT MIN	0.78125	-2502.44600	-723.40479	-3897.21200
40	ENVULT MIN	0.89063	-2508.22100	-706.93937	-3862.95200
40	ENVULT MIN	1.00000	-2513.99600	-690.35758	-3829.44500
41	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
41	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
41	ENVULT MIN	0.00000	-2513.99600	-690.48711	-3829.44500
41	ENVULT MIN	0.25000	-2519.45100	-674.41128	-3797.90000
41	ENVULT MIN	0.50000	-2524.69200	-658.22765	-3767.06300
41	ENVULT MIN	0.75000	-2529.72100	-641.93621	-3736.93800
41	ENVULT MIN	1.00000	-2534.53700	-625.53696	-3707.53000
42	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
42	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
42	ENVULT MIN	0.00000	-2534.53700	-625.58210	-3707.53000
42	ENVULT MIN	0.25000	-2536.78900	-617.61141	-3693.56500
42	ENVULT MIN	0.50000	-2538.99300	-609.61544	-3679.76900
42	ENVULT MIN	0.75000	-2541.14600	-601.59418	-3666.14200
42	ENVULT MIN	1.00000	-2543.24900	-593.54765	-3652.68600
43	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
43	ENVULT MAX	1.00000	0.00000	10.79359	0.00000
43	ENVULT MIN	0.00000	-2543.24900	-593.64060	-3652.68600
43	ENVULT MIN	0.25000	-2555.65500	-545.08293	-3575.93500
43	ENVULT MIN	0.50000	-2568.06000	-495.62564	-3505.38100
43	ENVULT MIN	0.75000	-2580.46600	-445.26870	-3441.13300
43	ENVULT MIN	1.00000	-2592.87200	-394.01213	-3383.30200
44	ENVULT MAX	0.00000	0.00000	9.57483	0.00000
44	ENVULT MAX	0.25000	0.00000	27.90495	0.00000
44	ENVULT MAX	0.50000	0.00000	46.55814	0.00000
44	ENVULT MAX	0.75000	0.00000	65.53442	0.00000
44	ENVULT MAX	1.00000	0.00000	84.92804	0.00000
44	ENVULT MIN	0.00000	-2592.87200	-394.25018	-3383.30200
44	ENVULT MIN	0.25000	-2607.36900	-333.21471	-3323.99900
44	ENVULT MIN	0.50000	-2621.86500	-270.95140	-3273.78000
44	ENVULT MIN	0.75000	-2636.36200	-207.46024	-3232.82200
44	ENVULT MIN	1.00000	-2650.85900	-142.74123	-3202.71200
45	ENVULT MAX	0.00000	0.00000	84.92802	0.00000
45	ENVULT MAX	0.25000	0.00000	124.17288	0.00000
45	ENVULT MAX	0.50000	0.00000	164.06390	0.00000
45	ENVULT MAX	0.75000	0.00000	216.51141	0.00000
45	ENVULT MAX	1.00000	0.00000	288.41580	0.00000
45	ENVULT MIN	0.00000	-2650.85900	-143.16062	-3202.71200
45	ENVULT MIN	0.25000	-2665.35600	-96.84693	-3208.62100
45	ENVULT MIN	0.50000	-2679.85200	-63.25958	-3224.31300
45	ENVULT MIN	0.75000	-2694.34900	-29.05830	-3249.96300
45	ENVULT MIN	1.00000	-2708.84600	0.00000	-3285.74500
46	ENVULT MAX	0.00000	0.00000	288.41580	0.00000
46	ENVULT MAX	0.25000	0.00000	361.48360	0.00000
46	ENVULT MAX	0.50000	0.00000	435.77795	0.00000
46	ENVULT MAX	0.75000	0.00000	511.29883	0.00000
46	ENVULT MAX	1.00000	0.00000	588.04625	0.00000
46	ENVULT MIN	0.00000	-2708.84600	0.00000	-3285.74500
46	ENVULT MIN	0.25000	-2723.33000	0.00000	-3331.78900
46	ENVULT MIN	0.50000	-2737.81400	0.00000	-3388.29500
46	ENVULT MIN	0.75000	-2752.29800	0.00000	-3455.43800
46	ENVULT MIN	1.00000	-2766.78200	0.00000	-3533.39200
47	ENVULT MAX	0.00000	0.00000	588.04625	0.00000
47	ENVULT MAX	0.25000	0.00000	611.04958	0.00000
47	ENVULT MAX	0.50000	0.00000	634.16072	0.00000
47	ENVULT MAX	0.75000	0.00000	657.37967	0.00000
47	ENVULT MAX	1.00000	0.00000	680.70642	0.00000
47	ENVULT MIN	0.00000	-2766.78200	0.00000	-3533.39200
47	ENVULT MIN	0.25000	-2771.07900	0.00000	-3558.62300
47	ENVULT MIN	0.50000	-2775.37500	0.00000	-3584.82400
47	ENVULT MIN	0.75000	-2779.67200	0.00000	-3612.00200
47	ENVULT MIN	1.00000	-2783.96900	0.00000	-3640.16000
48	ENVULT MAX	0.00000	0.00000	680.70642	0.00000
48	ENVULT MAX	0.13281	0.00000	710.27821	0.00000
48	ENVULT MAX	0.26563	0.00000	740.02159	0.00000
48	ENVULT MAX	0.39844	0.00000	769.93656	0.00000
48	ENVULT MAX	0.53125	0.00000	800.02313	0.00000
48	ENVULT MIN	0.00000	-2783.96900	0.00000	-3640.16000
48	ENVULT MIN	0.13281	-2789.38800	0.00000	-3677.07500
48	ENVULT MIN	0.26563	-2794.80600	0.00000	-3715.56700
48	ENVULT MIN	0.39844	-2800.22500	0.00000	-3755.64200
48	ENVULT MIN	0.53125	-2805.64400	0.00000	-3816.51300

2) 사용하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVUSE MAX	0.52941	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.64706	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.76471	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.88235	0.00000	0.00000	0.00000
1	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
1	ENVUSE MIN	0.52941	-603.94145	-1458.48100	-2193.80100
1	ENVUSE MIN	0.64706	-603.94145	-1462.48100	-2049.14400
1	ENVUSE MIN	0.76471	-603.94145	-1466.48100	-1904.08700
1	ENVUSE MIN	0.88235	-603.94145	-1470.48100	-1758.63000
1	ENVUSE MIN	1.00000	-603.94145	-1474.48100	-1612.77200
2	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
2	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
2	ENVUSE MIN	0.00000	-603.94145	-1474.48100	-1612.77200
2	ENVUSE MIN	0.25000	-603.94145	-1476.27100	-1547.37200
2	ENVUSE MIN	0.50000	-603.94145	-1478.06100	-1481.89100
2	ENVUSE MIN	0.75000	-603.94145	-1479.85100	-1416.33000
2	ENVUSE MIN	1.00000	-603.94145	-1481.64100	-1350.68900
3	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
3	ENVUSE MAX	1.00000	0.00000	0.00000	266.90886
3	ENVUSE MIN	0.00000	-603.94145	-1142.24800	-1350.68900
3	ENVUSE MIN	0.25000	-603.94145	-1152.53800	-1058.27100
3	ENVUSE MIN	0.50000	-603.94145	-1162.82800	-763.20638
3	ENVUSE MIN	0.75000	-603.94145	-1173.11800	-465.49432
3	ENVUSE MIN	1.00000	-603.94145	-1183.40800	-212.86394
4	ENVUSE MAX	0.00000	0.00000	0.00000	266.90886
4	ENVUSE MAX	0.25000	0.00000	0.00000	476.46245
4	ENVUSE MAX	0.50000	0.00000	0.00000	688.66313
4	ENVUSE MAX	0.75000	0.00000	0.00000	903.51092
4	ENVUSE MAX	1.00000	0.00000	0.00000	1121.00600
4	ENVUSE MIN	0.00000	-603.94145	-860.25410	-212.86394
4	ENVUSE MIN	0.25000	-603.94145	-870.54410	-63.71373
4	ENVUSE MIN	0.50000	-603.94145	-880.83410	0.00000
4	ENVUSE MIN	0.75000	-603.94145	-891.12410	0.00000
4	ENVUSE MIN	1.00000	-603.94145	-901.41410	0.00000
5	ENVUSE MAX	0.00000	0.00000	0.00000	1121.00600
5	ENVUSE MAX	0.25000	0.00000	0.00000	1265.51300
5	ENVUSE MAX	0.50000	0.00000	0.00000	1412.67300
5	ENVUSE MAX	0.75000	0.00000	0.00000	1562.48400
5	ENVUSE MAX	1.00000	0.00000	0.00000	1717.74300
5	ENVUSE MIN	0.00000	-603.94145	-594.58532	0.00000
5	ENVUSE MIN	0.25000	-603.94145	-604.88532	0.00000
5	ENVUSE MIN	0.50000	-603.94145	-615.18532	0.00000
5	ENVUSE MIN	0.75000	-603.94145	-625.48532	0.00000
5	ENVUSE MIN	1.00000	-603.94145	-635.78532	0.00000
6	ENVUSE MAX	0.00000	0.00000	0.00000	1717.74300
6	ENVUSE MAX	0.25000	0.00000	0.00000	1804.47200
6	ENVUSE MAX	0.50000	0.00000	0.00000	1893.84900
6	ENVUSE MAX	0.75000	0.00000	0.00000	1985.87200
6	ENVUSE MAX	1.00000	0.00000	0.00000	2080.54300
6	ENVUSE MIN	0.00000	-603.94145	-342.57641	0.00000
6	ENVUSE MIN	0.25000	-603.94145	-352.86641	0.00000
6	ENVUSE MIN	0.50000	-603.94145	-363.15641	0.00000
6	ENVUSE MIN	0.75000	-603.94145	-373.44641	0.00000
6	ENVUSE MIN	1.00000	-603.94145	-383.73641	0.00000
7	ENVUSE MAX	0.00000	0.00000	0.00000	2080.54300
7	ENVUSE MAX	0.25000	0.00000	0.00000	2106.50500
7	ENVUSE MAX	0.50000	0.00000	0.00000	2135.11400
7	ENVUSE MAX	0.75000	0.00000	0.00000	2166.36900
7	ENVUSE MAX	1.00000	0.00000	0.00000	2200.27200
7	ENVUSE MIN	0.00000	-603.94145	-101.77228	0.00000
7	ENVUSE MIN	0.25000	-603.94145	-112.06228	0.00000
7	ENVUSE MIN	0.50000	-603.94145	-122.35228	0.00000
7	ENVUSE MIN	0.75000	-603.94145	-132.64228	0.00000
7	ENVUSE MIN	1.00000	-603.94145	-142.93228	0.00000
8	ENVUSE MAX	0.00000	0.00000	142.87201	2200.27200
8	ENVUSE MAX	0.25000	0.00000	132.58201	2166.38500
8	ENVUSE MAX	0.50000	0.00000	122.29201	2135.14400
8	ENVUSE MAX	0.75000	0.00000	112.00201	2106.55100
8	ENVUSE MAX	1.00000	0.00000	101.71201	2080.60400
8	ENVUSE MIN	0.00000	-603.94150	0.00000	0.00000
8	ENVUSE MIN	0.25000	-603.94150	0.00000	0.00000
8	ENVUSE MIN	0.50000	-603.94150	0.00000	0.00000
8	ENVUSE MIN	0.75000	-603.94150	0.00000	0.00000
8	ENVUSE MIN	1.00000	-603.94150	0.00000	0.00000
9	ENVUSE MAX	0.00000	0.00000	383.67816	2080.60400
9	ENVUSE MAX	0.25000	0.00000	373.38816	1985.94800
9	ENVUSE MAX	0.50000	0.00000	363.09816	1893.93900
9	ENVUSE MAX	0.75000	0.00000	352.80816	1804.57700
9	ENVUSE MAX	1.00000	0.00000	342.51816	1717.86200
9	ENVUSE MIN	0.00000	-603.94150	0.00000	0.00000
9	ENVUSE MIN	0.25000	-603.94150	0.00000	0.00000
9	ENVUSE MIN	0.50000	-603.94150	0.00000	0.00000
9	ENVUSE MIN	0.75000	-603.94150	0.00000	0.00000
9	ENVUSE MIN	1.00000	-603.94150	0.00000	0.00000
10	ENVUSE MAX	0.00000	0.00000	635.73305	1717.86200
10	ENVUSE MAX	0.25000	0.00000	625.44305	1562.76000
10	ENVUSE MAX	0.50000	0.00000	615.15305	1413.10200
10	ENVUSE MAX	0.75000	0.00000	604.86305	1266.09100
10	ENVUSE MAX	1.00000	0.00000	594.57305	1121.72800
10	ENVUSE MIN	0.00000	-603.94150	0.00000	0.00000
10	ENVUSE MIN	0.25000	-603.94150	0.00000	0.00000
10	ENVUSE MIN	0.50000	-603.94150	0.00000	0.00000
10	ENVUSE MIN	0.75000	-603.94150	0.00000	0.00000
10	ENVUSE MIN	1.00000	-603.94150	0.00000	0.00000
11	ENVUSE MAX	0.00000	0.00000	901.39662	1121.72800
11	ENVUSE MAX	0.25000	0.00000	891.09662	904.02744
11	ENVUSE MAX	0.50000	0.00000	880.79662	688.97908
11	ENVUSE MAX	0.75000	0.00000	870.49662	476.58296
11	ENVUSE MAX	1.00000	0.00000	860.19662	266.83909
11	ENVUSE MIN	0.00000	-603.94150	0.00000	0.00000
11	ENVUSE MIN	0.25000	-603.94150	0.00000	0.00000
11	ENVUSE MIN	0.50000	-603.94150	0.00000	0.00000
11	ENVUSE MIN	0.75000	-603.94150	0.00000	-63.62998
11	ENVUSE MIN	1.00000	-603.94150	0.00000	-212.91606
12	ENVUSE MAX	0.00000	0.00000	1183.36400	266.83909
12	ENVUSE MAX	0.25000	0.00000	1173.07400	0.00000
12	ENVUSE MAX	0.50000	0.00000	1162.78400	0.00000
12	ENVUSE MAX	0.75000	0.00000	1152.49400	0.00000
12	ENVUSE MAX	1.00000	0.00000	1142.20400	0.00000
12	ENVUSE MIN	0.00000	-603.94150	0.00000	-212.91607
12	ENVUSE MIN	0.25000	-603.94150	0.00000	-465.55362
12	ENVUSE MIN	0.50000	-603.94150	0.00000	-763.25450
12	ENVUSE MIN	0.75000	-603.94150	0.00000	-1058.30800
12	ENVUSE MIN	1.00000	-603.94150	0.00000	-1350.71500
13	ENVUSE MAX	0.00000	0.00000	1481.61400	0.00000
13	ENVUSE MAX	0.25000	0.00000	1479.82400	0.00000
13	ENVUSE MAX	0.50000	0.00000	1478.03400	0.00000
13	ENVUSE MAX	0.75000	0.00000	1476.24400	0.00000
13	ENVUSE MAX	1.00000	0.00000	1474.45400	0.00000
13	ENVUSE MIN	0.00000	-603.94150	0.00000	-1350.71500
13	ENVUSE MIN	0.25000	-603.94150	0.00000	-1416.35500
13	ENVUSE MIN	0.50000	-603.94150	0.00000	-1481.91400
13	ENVUSE MIN	0.75000	-603.94150	0.00000	-1547.39400
13	ENVUSE MIN	1.00000	-603.94150	0.00000	-1612.79300
14	ENVUSE MAX	0.00000	0.00000	1474.45400	0.00000
14	ENVUSE MAX	0.11765	0.00000	1470.45400	0.00000
14	ENVUSE MAX	0.23529	0.00000	1466.45400	0.00000
14	ENVUSE MAX	0.35294	0.00000	1462.45400	0.00000
14	ENVUSE MAX	0.47059	0.00000	1458.45400	0.00000
14	ENVUSE MIN	0.00000	-603.94150	0.00000	-1612.79300
14	ENVUSE MIN	0.11765	-603.94150	0.00000	-1758.64800
14	ENVUSE MIN	0.23529	-603.94150	0.00000	-1904.10300
14	ENVUSE MIN	0.35294	-603.94150	0.00000	-2049.15700
14	ENVUSE MIN	0.47059	-603.94150	0.00000	-2193.81200
15	ENVUSE MAX	0.46875	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.60156	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.73438	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.86719	0.00000	0.00000	0.00000
15	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
15	ENVUSE MIN	0.46875	-1890.47400	-536.71684	-2629.96700
15	ENVUSE MIN	0.60156	-1885.95900	-517.91274	-2588.02300
15	ENVUSE MIN	0.73438	-1881.44300	-499.21588	-2559.07600
15	ENVUSE MIN	0.86719	-1876.92700	-480.62626	-2531.12000
15	ENVUSE MIN	1.00000	-1872.41200	-462.14390	-2504.14800
16	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
16	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
16	ENVUSE MIN	0.00000	-1872.41200	-462.14390	-2504.14800
16	ENVUSE MIN	0.25000	-1868.83100	-447.56468	-2483.45700
16	ENVUSE MIN	0.50000	-1865.25000	-433.05284	-2463.37900
16	ENVUSE MIN	0.75000	-1861.67000	-418.60837	-2443.91000
16	ENVUSE MIN	1.00000	-1858.08900	-404.23129	-2425.04900
17	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
17	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
17	ENVUSE MIN	0.00000	-1858.08900	-404.23129	-2425.04900

FRAME	LOAD	DIST	P	V2	M3
17	ENVUSE MIN	0.25000	-1846.01900	-356.26415	-2365.90400
17	ENVUSE MIN	0.50000	-1833.94900	-309.06360	-2313.51600
17	ENVUSE MIN	0.75000	-1821.87900	-262.62964	-2267.77700
17	ENVUSE MIN	1.00000	-1809.80900	-216.96226	-2228.57600
18	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
18	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
18	ENVUSE MAX	0.50000	0.00000	20.79070	0.00000
18	ENVUSE MAX	0.75000	0.00000	41.78279	0.00000
18	ENVUSE MAX	1.00000	0.00000	70.72885	0.00000
18	ENVUSE MIN	0.00000	-1809.80900	-216.96226	-2228.57600
18	ENVUSE MIN	0.25000	-1797.72900	-172.02201	-2195.78000
18	ENVUSE MIN	0.50000	-1785.64800	-139.24232	-2169.31600
18	ENVUSE MIN	0.75000	-1773.56700	-114.31044	-2149.07500
18	ENVUSE MIN	1.00000	-1761.48700	-89.78240	-2134.95000
19	ENVUSE MAX	0.00000	0.00000	70.50606	0.00000
19	ENVUSE MAX	0.25000	0.00000	110.95544	0.00000
19	ENVUSE MAX	0.50000	0.00000	150.63742	0.00000
19	ENVUSE MAX	0.75000	0.00000	189.55199	0.00000
19	ENVUSE MAX	1.00000	0.00000	227.69916	0.00000
19	ENVUSE MIN	0.00000	-1761.48700	-89.78241	-2134.95000
19	ENVUSE MIN	0.25000	-1749.40600	-77.66142	-2148.83700
19	ENVUSE MIN	0.50000	-1737.32500	-65.80125	-2169.80100
19	ENVUSE MIN	0.75000	-1725.24500	-54.14300	-2196.55100
19	ENVUSE MIN	1.00000	-1713.16400	-42.68668	-2228.98000
20	ENVUSE MAX	0.00000	0.00000	227.58183	0.00000
20	ENVUSE MAX	0.25000	0.00000	259.61718	0.00000
20	ENVUSE MAX	0.50000	0.00000	291.09027	0.00000
20	ENVUSE MAX	0.75000	0.00000	322.00108	0.00000
20	ENVUSE MAX	1.00000	0.00000	352.34962	0.00000
20	ENVUSE MIN	0.00000	-1713.16400	-44.17763	-2228.98000
20	ENVUSE MIN	0.25000	-1702.82600	-34.53415	-2261.15700
20	ENVUSE MIN	0.50000	-1692.48800	-25.03866	-2297.34500
20	ENVUSE MIN	0.75000	-1682.15000	-15.69116	-2337.47400
20	ENVUSE MIN	1.00000	-1671.81200	-6.49164	-2381.47700
21	ENVUSE MAX	0.00000	0.00000	352.30293	0.00000
21	ENVUSE MAX	0.25000	0.00000	357.33202	0.00000
21	ENVUSE MAX	0.50000	0.00000	362.34530	0.00000
21	ENVUSE MAX	0.75000	0.00000	367.34278	0.00000
21	ENVUSE MAX	1.00000	0.00000	372.32447	0.00000
21	ENVUSE MIN	0.00000	-1671.81200	-9.62573	-2381.47700
21	ENVUSE MIN	0.25000	-1670.05900	-8.09908	-2389.22200
21	ENVUSE MIN	0.50000	-1668.26500	-6.57658	-2397.07400
21	ENVUSE MIN	0.75000	-1666.42900	-5.05825	-2405.03200
21	ENVUSE MIN	1.00000	-1664.55100	-3.54408	-2413.09600
22	ENVUSE MAX	0.00000	0.00000	372.30131	0.00000
22	ENVUSE MAX	0.25000	0.00000	382.55084	0.00000
22	ENVUSE MAX	0.50000	0.00000	392.73299	0.00000
22	ENVUSE MAX	0.75000	0.00000	402.84776	0.00000
22	ENVUSE MAX	1.00000	0.00000	412.89515	0.00000
22	ENVUSE MIN	0.00000	-1664.55100	-5.24269	-2413.09600
22	ENVUSE MIN	0.25000	-1660.53800	-2.12533	-2430.10200
22	ENVUSE MIN	0.50000	-1656.34800	0.00000	-2447.55600
22	ENVUSE MIN	0.75000	-1651.98000	0.00000	-2465.45500
22	ENVUSE MIN	1.00000	-1647.43500	0.00000	-2483.79700
23	ENVUSE MAX	0.00000	0.00000	412.82388	0.00000
23	ENVUSE MAX	0.10937	0.00000	423.18750	0.00000
23	ENVUSE MAX	0.21875	0.00000	433.47838	0.00000
23	ENVUSE MAX	0.32812	0.00000	443.69653	0.00000
23	ENVUSE MAX	0.43750	0.00000	453.84195	0.00000
23	ENVUSE MIN	0.00000	-1647.43500	0.00000	-2483.79700
23	ENVUSE MIN	0.10937	-1642.62200	0.00000	-2503.31100
23	ENVUSE MIN	0.21875	-1637.81000	0.00000	-2523.29700
23	ENVUSE MIN	0.32812	-1632.99700	0.00000	-2543.75000
23	ENVUSE MIN	0.43750	-1628.18500	0.00000	-2565.54000
24	ENVUSE MAX	0.64706	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.73529	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.82353	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.91176	0.00000	0.00000	0.00000
24	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
24	ENVUSE MIN	0.64706	-504.56573	-1454.96800	-1938.56600
24	ENVUSE MIN	0.73529	-504.56573	-1434.72300	-1830.20200
24	ENVUSE MIN	0.82353	-504.56573	-1414.47700	-1723.35700
24	ENVUSE MIN	0.91176	-504.56573	-1394.23200	-1620.97000
24	ENVUSE MIN	1.00000	-504.56573	-1373.98600	-1521.18300
25	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
25	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
25	ENVUSE MIN	0.00000	-504.42179	-1373.98600	-1521.18300
25	ENVUSE MIN	0.25000	-504.42179	-1361.93200	-1462.34000
25	ENVUSE MIN	0.50000	-504.42179	-1349.92700	-1404.01500
25	ENVUSE MIN	0.75000	-504.42179	-1337.97300	-1346.20700
25	ENVUSE MIN	1.00000	-504.42179	-1326.06800	-1288.91200
26	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
26	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
26	ENVUSE MIN	0.00000	-504.36175	-1326.06800	-1288.91200
26	ENVUSE MIN	0.25000	-504.36175	-1304.84600	-1187.44500
26	ENVUSE MIN	0.50000	-504.36175	-1283.78400	-1087.61000
26	ENVUSE MIN	0.75000	-504.36175	-1262.88300	-989.39513
26	ENVUSE MIN	1.00000	-504.36175	-1242.14300	-892.78630
27	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
27	ENVUSE MAX	0.25000	0.00000	0.00000	12.90440
27	ENVUSE MAX	0.50000	0.00000	0.00000	141.56026
27	ENVUSE MAX	0.75000	0.00000	0.00000	264.90162
27	ENVUSE MAX	1.00000	0.00000	0.00000	386.06710
27	ENVUSE MIN	0.00000	-504.26279	-1242.14300	-892.78630
27	ENVUSE MIN	0.25000	-504.26279	-1196.57600	-685.34325
27	ENVUSE MIN	0.50000	-504.26279	-1151.01000	-485.65222
27	ENVUSE MIN	0.75000	-504.26279	-1105.44300	-293.74553
27	ENVUSE MIN	1.00000	-504.26279	-1059.87600	-114.59280
28	ENVUSE MAX	0.00000	0.00000	0.00000	386.06711
28	ENVUSE MAX	0.25000	0.00000	0.00000	617.07786
28	ENVUSE MAX	0.50000	0.00000	0.00000	860.22011
28	ENVUSE MAX	0.75000	0.00000	0.00000	1086.29300
28	ENVUSE MAX	1.00000	0.00000	0.00000	1295.29500
28	ENVUSE MIN	0.00000	-504.12917	-1059.87600	-114.59280
28	ENVUSE MIN	0.25000	-504.12917	-993.58565	0.00000
28	ENVUSE MIN	0.50000	-504.12917	-927.29511	0.00000
28	ENVUSE MIN	0.75000	-504.12917	-861.00457	0.00000
28	ENVUSE MIN	1.00000	-504.12917	-794.71402	0.00000
29	ENVUSE MAX	0.00000	0.00000	0.00000	1295.29500
29	ENVUSE MAX	0.25000	0.00000	0.00000	1487.05000
29	ENVUSE MAX	0.50000	0.00000	0.00000	1661.76800
29	ENVUSE MAX	0.75000	0.00000	0.00000	1823.38300
29	ENVUSE MAX	1.00000	0.00000	0.00000	1968.19500
29	ENVUSE MIN	0.00000	-504.01540	-794.71402	0.00000
29	ENVUSE MIN	0.25000	-504.01540	-728.48784	0.00000
29	ENVUSE MIN	0.50000	-504.01540	-662.26166	0.00000
29	ENVUSE MIN	0.75000	-504.01540	-596.03547	0.00000
29	ENVUSE MIN	1.00000	-504.01540	-529.80929	0.00000
30	ENVUSE MAX	0.00000	0.00000	0.00000	1968.19500
30	ENVUSE MAX	0.25000	0.00000	0.00000	2095.97000
30	ENVUSE MAX	0.50000	0.00000	0.00000	2206.70900
30	ENVUSE MAX	0.75000	0.00000	0.00000	2300.41000
30	ENVUSE MAX	1.00000	0.00000	0.00000	2377.07600
30	ENVUSE MIN	0.00000	-503.94160	-529.80929	0.00000
30	ENVUSE MIN	0.25000	-503.94160	-463.91529	0.00000
30	ENVUSE MIN	0.50000	-503.94160	-400.26161	0.00000
30	ENVUSE MIN	0.75000	-503.94160	-336.60793	0.00000
30	ENVUSE MIN	1.00000	-503.94160	-272.95424	0.00000
31	ENVUSE MAX	0.00000	0.00000	0.00000	2377.07600
31	ENVUSE MAX	0.25000	0.00000	0.00000	2436.70400
31	ENVUSE MAX	0.50000	0.00000	0.00000	2479.29600
31	ENVUSE MAX	0.75000	0.00000	0.00000	2504.85100
31	ENVUSE MAX	1.00000	0.00000	22.50286	2513.36900
31	ENVUSE MIN	0.00000	-503.90528	-272.95424	0.00000
31	ENVUSE MIN	0.25000	-503.90528	-209.30056	0.00000
31	ENVUSE MIN	0.50000	-503.90528	-145.64688	0.00000
31	ENVUSE MIN	0.75000	-503.90528	-81.99320	0.00000
31	ENVUSE MIN	1.00000	-503.90528	-18.33957	0.00000
32	ENVUSE MAX	0.00000	0.00000	18.33988	2513.36900
32	ENVUSE MAX	0.25000	0.00000	81.99356	2504.85000
32	ENVUSE MAX	0.50000	0.00000	145.64724	2479.29500
32	ENVUSE MAX	0.75000	0.00000	209.30093	2436.70400
32	ENVUSE MAX	1.00000	0.00000	272.95461	2377.07500
32	ENVUSE MIN	0.00000	-503.90533	-22.50208	0.00000
32	ENVUSE MIN	0.25000	-503.90533	0.00000	0.00000
32	ENVUSE MIN	0.50000	-503.90533	0.00000	0.00000
32	ENVUSE MIN	0.75000	-503.90533	0.00000	0.00000
32	ENVUSE MIN	1.00000	-503.90533	0.00000	0.00000
33	ENVUSE MAX	0.00000	0.00000	272.95461	2377.07500
33	ENVUSE MAX	0.25000	0.00000	336.60829	2300.41000
33	ENVUSE MAX	0.50000	0.00000	400.26198	2206.70800
33	ENVUSE MAX	0.75000	0.00000	463.91566	2095.97000
33	ENVUSE MAX	1.00000	0.00000	529.80968	1968.19500
33	ENVUSE MIN	0.00000	-503.94176	0.00000	0.00000
33	ENVUSE MIN	0.25000	-503.94176	0.00000	0.00000
33	ENVUSE MIN	0.50000	-503.94176	0.00000	0.00000
33	ENVUSE MIN	0.75000	-503.94176	0.00000	0.00000
33	ENVUSE MIN	1.00000	-503.94176	0.00000	0.00000
34	ENVUSE MAX	0.00000	0.00000	529.80968	1968.19500
34	ENVUSE MAX	0.25000	0.00000	596.10022	1823.23400
34	ENVUSE MAX	0.50000	0.00000	662.39076	1661.44400
34	ENVUSE MAX	0.75000	0.00000	728.68130	1486.51500
34	ENVUSE MAX	1.00000	0.00000	794.97185	1294.51500
34	ENVUSE MIN	0.00000	-504.01569	0.00000	0.00000
34	ENVUSE MIN	0.25000	-504.01569	0.00000	0.00000
34	ENVUSE MIN	0.50000	-504.01569	0.00000	0.00000
34	ENVUSE MIN	0.75000	-504.01569	0.00000	0.00000
34	ENVUSE MIN	1.00000	-504.01569	0.00000	0.00000
35	ENVUSE MAX	0.00000	0.00000	794.97185	1294.51500
35	ENVUSE MAX	0.25000	0.00000	861.19803	1085.65800
35	ENVUSE MAX	0.50000	0.00000	927.42421	859.76318
35	ENVUSE MAX	0.75000	0.00000	993.65040	616.83207

FRAME	LOAD	DIST	P	V2	M3
35	ENVUSE MAX	1.00000	0.00000	1059.87700	386.06613
35	ENVUSE MIN	0.00000	-504.12960	0.00000	0.00000
35	ENVUSE MIN	0.25000	-504.12960	0.00000	0.00000
35	ENVUSE MIN	0.50000	-504.12960	0.00000	0.00000
35	ENVUSE MIN	0.75000	-504.12960	0.00000	0.00000
35	ENVUSE MIN	1.00000	-504.12960	0.00000	-114.59658
36	ENVUSE MAX	0.00000	0.00000	1059.87700	386.06613
36	ENVUSE MAX	0.25000	0.00000	1105.44300	264.89912
36	ENVUSE MAX	0.50000	0.00000	1151.01000	141.55762
36	ENVUSE MAX	0.75000	0.00000	1196.57700	12.90163
36	ENVUSE MAX	1.00000	0.00000	1242.14300	0.00000
36	ENVUSE MIN	0.00000	-504.26323	0.00000	-114.59659
36	ENVUSE MIN	0.25000	-504.26323	0.00000	-293.74950
36	ENVUSE MIN	0.50000	-504.26323	0.00000	-485.65403
36	ENVUSE MIN	0.75000	-504.26323	0.00000	-685.34514
36	ENVUSE MIN	1.00000	-504.26323	0.00000	-892.78826
37	ENVUSE MAX	0.00000	0.00000	1242.14300	0.00000
37	ENVUSE MAX	0.25000	0.00000	1262.88300	0.00000
37	ENVUSE MAX	0.50000	0.00000	1283.78400	0.00000
37	ENVUSE MAX	0.75000	0.00000	1304.84600	0.00000
37	ENVUSE MAX	1.00000	0.00000	1326.06900	0.00000
37	ENVUSE MIN	0.00000	-504.36224	0.00000	-892.78826
37	ENVUSE MIN	0.25000	-504.36224	0.00000	-989.39711
37	ENVUSE MIN	0.50000	-504.36224	0.00000	-1087.61200
37	ENVUSE MIN	0.75000	-504.36224	0.00000	-1187.44700
37	ENVUSE MIN	1.00000	-504.36224	0.00000	-1288.91400
38	ENVUSE MAX	0.00000	0.00000	1326.06900	0.00000
38	ENVUSE MAX	0.25000	0.00000	1337.97300	0.00000
38	ENVUSE MAX	0.50000	0.00000	1349.92800	0.00000
38	ENVUSE MAX	0.75000	0.00000	1361.93200	0.00000
38	ENVUSE MAX	1.00000	0.00000	1373.98700	0.00000
38	ENVUSE MIN	0.00000	-504.42230	0.00000	-1288.91400
38	ENVUSE MIN	0.25000	-504.42230	0.00000	-1346.20900
38	ENVUSE MIN	0.50000	-504.42230	0.00000	-1404.01800
38	ENVUSE MIN	0.75000	-504.42230	0.00000	-1462.34200
38	ENVUSE MIN	1.00000	-504.42230	0.00000	-1521.18500
39	ENVUSE MAX	0.00000	0.00000	1373.98700	0.00000
39	ENVUSE MAX	0.08824	0.00000	1394.23200	0.00000
39	ENVUSE MAX	0.17647	0.00000	1414.47800	0.00000
39	ENVUSE MAX	0.26471	0.00000	1434.72300	0.00000
39	ENVUSE MAX	0.35294	0.00000	1454.96900	0.00000
39	ENVUSE MIN	0.00000	-504.56633	0.00000	-1521.18500
39	ENVUSE MIN	0.08824	-504.56633	0.00000	-1620.97200
39	ENVUSE MIN	0.17647	-504.56633	0.00000	-1723.35900
39	ENVUSE MIN	0.26471	-504.56633	0.00000	-1830.20400
39	ENVUSE MIN	0.35294	-504.56633	0.00000	-1938.56800
40	ENVUSE MAX	0.56250	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.67188	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.78125	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.89063	0.00000	0.00000	0.00000
40	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
40	ENVUSE MIN	0.56250	-1628.18500	-453.84265	-2565.54300
40	ENVUSE MIN	0.67188	-1632.99700	-443.69723	-2543.75200
40	ENVUSE MIN	0.78125	-1637.81000	-433.47908	-2523.29900
40	ENVUSE MIN	0.89063	-1642.62200	-423.18820	-2503.31400
40	ENVUSE MIN	1.00000	-1647.43500	-412.82458	-2483.79900
41	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.75000	0.00000	2.12468	0.00000
41	ENVUSE MAX	1.00000	0.00000	5.24204	0.00000
41	ENVUSE MIN	0.00000	-1647.43500	-412.89592	-2483.79900
41	ENVUSE MIN	0.25000	-1651.98000	-402.84853	-2465.45800
41	ENVUSE MIN	0.50000	-1656.34800	-392.73376	-2447.55800
41	ENVUSE MIN	0.75000	-1660.53800	-382.55161	-2430.10400
41	ENVUSE MIN	1.00000	-1664.55200	-372.30208	-2413.09800
42	ENVUSE MAX	0.00000	0.00000	3.54344	0.00000
42	ENVUSE MAX	0.25000	0.00000	5.05761	0.00000
42	ENVUSE MAX	0.50000	0.00000	6.57594	0.00000
42	ENVUSE MAX	0.75000	0.00000	8.09844	0.00000
42	ENVUSE MAX	1.00000	0.00000	9.62509	0.00000
42	ENVUSE MIN	0.00000	-1664.55200	-372.32526	-2413.09800
42	ENVUSE MIN	0.25000	-1666.42900	-367.34357	-2405.03500
42	ENVUSE MIN	0.50000	-1668.26500	-362.34609	-2397.07700
42	ENVUSE MIN	0.75000	-1670.05900	-357.33281	-2389.22500
42	ENVUSE MIN	1.00000	-1671.81200	-352.30372	-2381.47900
43	ENVUSE MAX	0.00000	0.00000	6.49097	0.00000
43	ENVUSE MAX	0.25000	0.00000	15.69049	0.00000
43	ENVUSE MAX	0.50000	0.00000	25.03799	0.00000
43	ENVUSE MAX	0.75000	0.00000	34.53348	0.00000
43	ENVUSE MAX	1.00000	0.00000	44.17696	0.00000
43	ENVUSE MIN	0.00000	-1671.81200	-352.35046	-2381.47900
43	ENVUSE MIN	0.25000	-1682.15000	-322.00192	-2337.47700
43	ENVUSE MIN	0.50000	-1692.48800	-291.09111	-2297.34800
43	ENVUSE MIN	0.75000	-1702.82600	-259.61802	-2261.16000
43	ENVUSE MIN	1.00000	-1713.16500	-227.58267	-2228.98300
44	ENVUSE MAX	0.00000	0.00000	42.68660	0.00000
44	ENVUSE MAX	0.25000	0.00000	54.14293	0.00000
44	ENVUSE MAX	0.50000	0.00000	65.80117	0.00000
44	ENVUSE MAX	0.75000	0.00000	77.66135	0.00000
44	ENVUSE MAX	1.00000	0.00000	89.78236	0.00000
44	ENVUSE MIN	0.00000	-1713.16500	-227.70007	-2228.98300
44	ENVUSE MIN	0.25000	-1725.24500	-189.55290	-2196.55400
44	ENVUSE MIN	0.50000	-1737.32600	-150.63833	-2169.80300
44	ENVUSE MIN	0.75000	-1749.40600	-110.95636	-2148.84000
44	ENVUSE MIN	1.00000	-1761.48700	-70.50698	-2134.95200
45	ENVUSE MAX	0.00000	0.00000	89.78235	0.00000
45	ENVUSE MAX	0.25000	0.00000	114.31039	0.00000
45	ENVUSE MAX	0.50000	0.00000	139.24227	0.00000
45	ENVUSE MAX	0.75000	0.00000	172.02196	0.00000
45	ENVUSE MAX	1.00000	0.00000	216.96221	0.00000
45	ENVUSE MIN	0.00000	-1761.48700	-70.72982	-2134.95200
45	ENVUSE MIN	0.25000	-1773.56800	-41.78376	-2149.07800
45	ENVUSE MIN	0.50000	-1785.64800	-20.79167	-2169.31800
45	ENVUSE MIN	0.75000	-1797.72900	0.00000	-2195.78200
45	ENVUSE MIN	1.00000	-1809.81000	0.00000	-2228.57800
46	ENVUSE MAX	0.00000	0.00000	216.96221	0.00000
46	ENVUSE MAX	0.25000	0.00000	262.62959	0.00000
46	ENVUSE MAX	0.50000	0.00000	309.06355	0.00000
46	ENVUSE MAX	0.75000	0.00000	356.26410	0.00000
46	ENVUSE MAX	1.00000	0.00000	404.23124	0.00000
46	ENVUSE MIN	0.00000	-1809.81000	0.00000	-2228.57800
46	ENVUSE MIN	0.25000	-1821.88000	0.00000	-2267.77900
46	ENVUSE MIN	0.50000	-1833.95000	0.00000	-2313.51900
46	ENVUSE MIN	0.75000	-1846.02000	0.00000	-2365.90700
46	ENVUSE MIN	1.00000	-1858.09000	0.00000	-2425.05200
47	ENVUSE MAX	0.00000	0.00000	404.23124	0.00000
47	ENVUSE MAX	0.25000	0.00000	418.60832	0.00000
47	ENVUSE MAX	0.50000	0.00000	433.05279	0.00000
47	ENVUSE MAX	0.75000	0.00000	447.56463	0.00000
47	ENVUSE MAX	1.00000	0.00000	462.14385	0.00000
47	ENVUSE MIN	0.00000	-1858.09000	0.00000	-2425.05200
47	ENVUSE MIN	0.25000	-1861.67000	0.00000	-2443.91300
47	ENVUSE MIN	0.50000	-1865.25100	0.00000	-2463.38100
47	ENVUSE MIN	0.75000	-1868.83100	0.00000	-2483.45900
47	ENVUSE MIN	1.00000	-1872.41200	0.00000	-2504.15000
48	ENVUSE MAX	0.00000	0.00000	462.14385	0.00000
48	ENVUSE MAX	0.13281	0.00000	480.62621	0.00000
48	ENVUSE MAX	0.26563	0.00000	499.21583	0.00000
48	ENVUSE MAX	0.39844	0.00000	517.91269	0.00000
48	ENVUSE MAX	0.53125	0.00000	536.71679	0.00000
48	ENVUSE MIN	0.00000	-1872.41200	0.00000	-2504.15000
48	ENVUSE MIN	0.13281	-1876.92800	0.00000	-2531.12200
48	ENVUSE MIN	0.26563	-1881.44300	0.00000	-2559.07800
48	ENVUSE MIN	0.39844	-1885.95900	0.00000	-2588.02500
48	ENVUSE MIN	0.53125	-1890.47500	0.00000	-2629.96900

19. OUTPUT DATA (기능수행)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.52941	100.62865	0.00000	936.98325
1	ENVEQ MAX	0.64706	96.58285	0.00000	955.49409
1	ENVEQ MAX	0.76471	92.53705	0.00000	974.36493
1	ENVEQ MAX	0.88235	88.49125	0.00000	993.59577
1	ENVEQ MAX	1.00000	84.44545	0.00000	1013.18700
1	ENVEQ MIN	0.52941	-635.99387	-1143.06000	-2032.38100
1	ENVEQ MIN	0.64706	-631.94807	-1147.86000	-1920.20900
1	ENVEQ MIN	0.76471	-627.90227	-1152.66000	-1827.78000
1	ENVEQ MIN	0.88235	-623.85647	-1157.46000	-1734.87100
1	ENVEQ MIN	1.00000	-619.81067	-1162.26000	-1641.48300
2	ENVEQ MAX	0.00000	84.47814	0.00000	1013.18700
2	ENVEQ MAX	0.25000	82.66764	0.00000	1022.07000
2	ENVEQ MAX	0.50000	80.85714	0.00000	1031.02600
2	ENVEQ MAX	0.75000	79.04665	0.00000	1040.05300
2	ENVEQ MAX	1.00000	77.23615	0.00000	1049.15300
2	ENVEQ MIN	0.00000	-619.81031	-1162.26000	-1641.48300
2	ENVEQ MIN	0.25000	-617.99981	-1164.40800	-1602.39800
2	ENVEQ MIN	0.50000	-616.18932	-1166.55600	-1567.33400
2	ENVEQ MIN	0.75000	-614.37882	-1168.70400	-1532.19900
2	ENVEQ MIN	1.00000	-612.56833	-1170.85200	-1496.99100
3	ENVEQ MAX	0.00000	75.37329	31.70869	1049.15300
3	ENVEQ MAX	0.25000	64.96547	22.44769	1071.76800
3	ENVEQ MAX	0.50000	54.55765	13.18669	1126.13900
3	ENVEQ MAX	0.75000	44.14983	3.92569	1183.68600
3	ENVEQ MAX	1.00000	33.74201	0.00000	1245.92700
3	ENVEQ MIN	0.00000	-593.79953	-789.12610	-1496.99100
3	ENVEQ MIN	0.25000	-583.39170	-801.47410	-1341.94100
3	ENVEQ MIN	0.50000	-572.98388	-813.82210	-1184.50900
3	ENVEQ MIN	0.75000	-562.57606	-826.17010	-1024.69500
3	ENVEQ MIN	1.00000	-552.16824	-838.51810	-862.49835
4	ENVEQ MAX	0.00000	32.04272	132.40269	1245.92700
4	ENVEQ MAX	0.25000	21.63490	123.14169	1243.83400
4	ENVEQ MAX	0.50000	11.22708	113.88069	1244.91800
4	ENVEQ MAX	0.75000	0.81926	104.61969	1249.17900
4	ENVEQ MAX	1.00000	0.00000	95.35869	1256.61600
4	ENVEQ MIN	0.00000	-534.72731	-521.75942	-862.49835
4	ENVEQ MIN	0.25000	-524.31949	-534.10742	-746.88360
4	ENVEQ MIN	0.50000	-513.91167	-546.45542	-628.88646
4	ENVEQ MIN	0.75000	-503.50385	-558.80342	-508.50693
4	ENVEQ MIN	1.00000	-493.09603	-571.15142	-385.74501
5	ENVEQ MAX	0.00000	0.00000	172.79483	1256.61600
5	ENVEQ MAX	0.25000	0.00000	163.52483	1226.40400
5	ENVEQ MAX	0.50000	0.00000	154.25483	1199.37400
5	ENVEQ MAX	0.75000	0.00000	144.98483	1175.52800
5	ENVEQ MAX	1.00000	0.00000	135.71483	1154.86400
5	ENVEQ MIN	0.00000	-476.84632	-331.58699	-385.74501
5	ENVEQ MIN	0.25000	-466.42839	-343.94699	-302.77505
5	ENVEQ MIN	0.50000	-456.01045	-356.30699	-217.41808
5	ENVEQ MIN	0.75000	-445.59252	-368.66699	-129.67407
5	ENVEQ MIN	1.00000	-435.17458	-381.02699	-39.54304
6	ENVEQ MAX	0.00000	0.00000	183.51300	1154.86400
6	ENVEQ MAX	0.25000	0.00000	174.25200	1113.67000
6	ENVEQ MAX	0.50000	0.00000	164.99100	1075.65200
6	ENVEQ MAX	0.75000	0.00000	155.73000	1040.81100
6	ENVEQ MAX	1.00000	0.00000	146.46900	1009.14600
6	ENVEQ MIN	0.00000	-419.98291	-227.81226	-39.54304
6	ENVEQ MIN	0.25000	-409.57509	-237.07326	0.00000
6	ENVEQ MIN	0.50000	-399.16727	-246.57438	0.00000
6	ENVEQ MIN	0.75000	-388.75945	-258.92238	0.00000
6	ENVEQ MIN	1.00000	-378.35162	-271.27038	0.00000
7	ENVEQ MAX	0.00000	0.00000	191.77786	1009.14600
7	ENVEQ MAX	0.25000	0.00000	180.94555	963.89842
7	ENVEQ MAX	0.50000	0.00000	171.68455	921.82717
7	ENVEQ MAX	0.75000	0.00000	162.42355	882.93244
7	ENVEQ MAX	1.00000	0.00000	153.16255	847.21424
7	ENVEQ MIN	0.00000	-364.08519	-175.59360	0.00000
7	ENVEQ MIN	0.25000	-353.67737	-184.85460	0.00000
7	ENVEQ MIN	0.50000	-343.26955	-194.11560	0.00000
7	ENVEQ MIN	0.75000	-332.86173	-203.37660	0.00000
7	ENVEQ MIN	1.00000	-322.45391	-215.12564	0.00000
8	ENVEQ MAX	0.00000	0.00000	215.10882	847.21424
8	ENVEQ MAX	0.25000	0.00000	203.36264	882.92724
8	ENVEQ MAX	0.50000	0.00000	194.10164	921.82571
8	ENVEQ MAX	0.75000	0.00000	184.84064	963.90071
8	ENVEQ MAX	1.00000	0.00000	175.57964	1009.15200
8	ENVEQ MIN	0.00000	-322.45604	-153.17311	0.00000
8	ENVEQ MIN	0.25000	-332.86386	-162.43411	0.00000
8	ENVEQ MIN	0.50000	-343.27168	-171.69511	0.00000
8	ENVEQ MIN	0.75000	-353.67950	-180.95611	0.00000
8	ENVEQ MIN	1.00000	-364.08732	-191.79139	0.00000
9	ENVEQ MAX	0.00000	0.00000	271.25203	1009.15200
9	ENVEQ MAX	0.25000	0.00000	258.90403	1040.81900
9	ENVEQ MAX	0.50000	0.00000	246.55603	1075.66200
9	ENVEQ MAX	0.75000	0.00000	237.05724	1113.68200
9	ENVEQ MAX	1.00000	0.00000	227.79624	1154.87900
9	ENVEQ MIN	0.00000	-378.35379	-146.47508	0.00000
9	ENVEQ MIN	0.25000	-388.76161	-155.73608	0.00000
9	ENVEQ MIN	0.50000	-399.16943	-164.99708	0.00000
9	ENVEQ MIN	0.75000	-409.57725	-174.25808	0.00000
9	ENVEQ MIN	1.00000	-419.98507	-183.51908	-39.50256
10	ENVEQ MAX	0.00000	0.00000	381.01308	1154.87900
10	ENVEQ MAX	0.25000	0.00000	368.66508	1175.52100
10	ENVEQ MAX	0.50000	0.00000	356.31708	1199.34000
10	ENVEQ MAX	0.75000	0.00000	343.96908	1226.33500
10	ENVEQ MAX	1.00000	0.00000	331.62108	1256.50700
10	ENVEQ MIN	0.00000	-435.17679	-135.71528	-39.50256
10	ENVEQ MIN	0.25000	-445.58461	-144.97628	-129.54314
10	ENVEQ MIN	0.50000	-455.99243	-154.23728	-217.20132
10	ENVEQ MIN	0.75000	-466.40025	-163.49828	-302.47711
10	ENVEQ MIN	1.00000	-476.80807	-172.75928	-385.37050
11	ENVEQ MAX	0.00000	0.00000	571.12183	1256.50700
11	ENVEQ MAX	0.25000	0.79150	558.76183	1249.07000
11	ENVEQ MAX	0.50000	11.20944	546.40183	1244.81500
11	ENVEQ MAX	0.75000	21.62737	534.04183	1243.74400
11	ENVEQ MAX	1.00000	32.04531	521.68183	1245.85500
11	ENVEQ MIN	0.00000	-493.05675	-95.35849	-385.37050
11	ENVEQ MIN	0.25000	-503.47468	-104.62849	-508.24852
11	ENVEQ MIN	0.50000	-513.89262	-113.89849	-628.73952
11	ENVEQ MIN	0.75000	-524.31055	-123.16849	-746.84349
11	ENVEQ MIN	1.00000	-534.72849	-132.43849	-862.56043
12	ENVEQ MAX	0.00000	33.74466	838.45691	1245.85500
12	ENVEQ MAX	0.25000	44.15248	826.10891	1183.63000
12	ENVEQ MAX	0.50000	54.56030	813.76091	1126.09600
12	ENVEQ MAX	0.75000	64.96812	801.41291	1071.73900
12	ENVEQ MAX	1.00000	75.37594	789.06491	1049.14900
12	ENVEQ MIN	0.00000	-552.16950	0.00000	-862.56043
12	ENVEQ MIN	0.25000	-562.57732	-3.95230	-1024.74800
12	ENVEQ MIN	0.50000	-572.98514	-13.21330	-1184.55300
12	ENVEQ MIN	0.75000	-583.39297	-22.47430	-1341.97600
12	ENVEQ MIN	1.00000	-593.80079	-31.73530	-1497.01700
13	ENVEQ MAX	0.00000	77.23891	1170.80800	1049.14900
13	ENVEQ MAX	0.25000	79.04941	1168.66000	1040.05000
13	ENVEQ MAX	0.50000	80.85990	1166.51200	1031.02300
13	ENVEQ MAX	0.75000	82.67040	1164.36400	1022.06800
13	ENVEQ MAX	1.00000	84.48089	1162.21600	1013.18600
13	ENVEQ MIN	0.00000	-612.56968	0.00000	-1497.01700
13	ENVEQ MIN	0.25000	-614.38017	0.00000	-1532.22400
13	ENVEQ MIN	0.50000	-616.19067	0.00000	-1567.35800
13	ENVEQ MIN	0.75000	-618.00116	0.00000	-1602.42100
13	ENVEQ MIN	1.00000	-619.81166	0.00000	-1641.50800
14	ENVEQ MAX	0.00000	84.44821	1162.21600	1013.18600
14	ENVEQ MAX	0.11765	88.49401	1157.41600	993.59666
14	ENVEQ MAX	0.23529	92.53981	1152.61600	974.36778
14	ENVEQ MAX	0.35294	96.58561	1147.81600	955.49890
14	ENVEQ MAX	0.47059	100.63141	1143.01600	936.99002
14	ENVEQ MIN	0.00000	-619.81201	0.00000	-1641.50800
14	ENVEQ MIN	0.11765	-623.85781	0.00000	-1734.89300
14	ENVEQ MIN	0.23529	-627.90361	0.00000	-1827.79900
14	ENVEQ MIN	0.35294	-631.94941	0.00000	-1920.22400
14	ENVEQ MIN	0.47059	-635.99521	0.00000	-2032.39200
15	ENVEQ MAX	0.46875	0.00000	132.04902	833.45021
15	ENVEQ MAX	0.60156	0.00000	130.25951	826.76154
15	ENVEQ MAX	0.73438	0.00000	128.08591	820.28341
15	ENVEQ MAX	0.86719	0.00000	125.52821	814.05663
15	ENVEQ MAX	1.00000	0.00000	122.58641	808.12201
15	ENVEQ MIN	0.46875	-1621.09900	-650.81215	-2375.01900
15	ENVEQ MIN	0.60156	-1611.48400	-649.02264	-2328.55600
15	ENVEQ MIN	0.73438	-1601.87000	-646.84904	-2282.36100
15	ENVEQ MIN	0.86719	-1592.25500	-644.29134	-2236.47300
15	ENVEQ MIN	1.00000	-1582.64100	-641.34955	-2190.93400
16	ENVEQ MAX	0.00000	0.00000	122.85178	808.12201
16	ENVEQ MAX	0.25000	0.00000	120.24523	803.65091
16	ENVEQ MAX	0.50000	0.00000	117.39546	799.40965
16	ENVEQ MAX	0.75000	0.00000	114.30248	795.41874
16	ENVEQ MAX	1.00000	0.00000	110.96630	791.69865
16	ENVEQ MIN	0.00000	-1582.64100	-641.35018	-2190.93400
16	ENVEQ MIN	0.25000	-1575.01700	-638.74362	-2155.11500
16	ENVEQ MIN	0.50000	-1567.39300	-635.89385	-2119.56900
16	ENVEQ MIN	0.75000	-1559.76900	-632.80088	-2084.82300
16	ENVEQ MIN	1.00000	-1552.14600	-629.46469	-2051.30200
17	ENVEQ MAX	0.00000	0.00000	457.59592	791.69865
17	ENVEQ MAX	0.25000	0.00000	444.59298	694.66807
17	ENVEQ MAX	0.50000	0.00000	429.02333	601.71287
17	ENVEQ MAX	0.75000	0.00000	411.34234	513.59817

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	0.00000	390.96733	431.08905
17	ENVEQ MIN	0.00000	-1775.94200	-629.30917	-2051.30200
17	ENVEQ MIN	0.25000	-1750.24300	-616.30623	-1940.69600
17	ENVEQ MIN	0.50000	-1724.54300	-600.60926	-1834.36700
17	ENVEQ MIN	0.75000	-1698.84400	-582.21828	-1733.08000
17	ENVEQ MIN	1.00000	-1695.02400	-561.13326	-1637.60100
18	ENVEQ MAX	0.00000	0.00000	1096.16900	431.08905
18	ENVEQ MAX	0.25000	0.00000	1073.32600	183.43970
18	ENVEQ MAX	0.50000	0.00000	1048.28000	0.00000
18	ENVEQ MAX	0.75000	0.00000	1021.03000	0.00000
18	ENVEQ MAX	1.00000	0.00000	991.57660	0.00000
18	ENVEQ MIN	0.00000	-2036.24200	-560.95831	-1637.60100
18	ENVEQ MIN	0.25000	-2032.97000	-537.40478	-1548.59500
18	ENVEQ MIN	0.50000	-2029.69900	-511.64775	-1466.80000
18	ENVEQ MIN	0.75000	-2026.42700	-483.68722	-1392.84100
18	ENVEQ MIN	1.00000	-2023.15500	-453.52318	-1424.73300
19	ENVEQ MAX	0.00000	0.00000	1214.42600	0.00000
19	ENVEQ MAX	0.25000	0.00000	1179.27700	0.00000
19	ENVEQ MAX	0.50000	0.00000	1135.64600	0.00000
19	ENVEQ MAX	0.75000	0.00000	1082.83200	40.77929
19	ENVEQ MAX	1.00000	0.00000	1020.82900	122.46796
19	ENVEQ MIN	0.00000	-2096.39500	-453.52318	-1424.73300
19	ENVEQ MIN	0.25000	-2093.12300	-417.66340	-1765.14200
19	ENVEQ MIN	0.50000	-2089.85200	-372.61568	-2094.25400
19	ENVEQ MIN	0.75000	-2086.58000	-318.38000	-2409.45700
19	ENVEQ MIN	1.00000	-2083.30800	-254.95636	-2708.14000
20	ENVEQ MAX	0.00000	0.00000	1302.07600	122.46796
20	ENVEQ MAX	0.25000	0.00000	1241.80800	177.11891
20	ENVEQ MAX	0.50000	0.00000	1174.98600	216.01678
20	ENVEQ MAX	0.75000	0.00000	1101.61100	237.56729
20	ENVEQ MAX	1.00000	0.00000	1021.68100	240.17617
20	ENVEQ MIN	0.00000	-2158.26200	-254.95636	-2708.14000
20	ENVEQ MIN	0.25000	-2155.46200	-193.47252	-3017.11000
20	ENVEQ MIN	0.50000	-2152.66200	-125.43461	-3310.47400
20	ENVEQ MIN	0.75000	-2149.86200	-50.84264	-3586.63900
20	ENVEQ MIN	1.00000	-2147.06200	0.00000	-3844.01100
21	ENVEQ MAX	0.00000	0.00000	1021.68100	240.17617
21	ENVEQ MAX	0.25000	0.00000	1007.65100	238.64823
21	ENVEQ MAX	0.50000	0.00000	993.44020	236.53659
21	ENVEQ MAX	0.75000	0.00000	979.04766	233.83384
21	ENVEQ MAX	1.00000	0.00000	964.47373	230.53259
21	ENVEQ MIN	0.00000	-2147.06200	0.00000	-3844.01100
21	ENVEQ MIN	0.25000	-2146.56800	0.00000	-3885.17600
21	ENVEQ MIN	0.50000	-2146.02400	0.00000	-3925.76200
21	ENVEQ MIN	0.75000	-2145.43100	0.00000	-3965.76000
21	ENVEQ MIN	1.00000	-2144.78700	0.00000	-4005.16500
22	ENVEQ MAX	0.00000	0.00000	1272.80400	230.53259
22	ENVEQ MAX	0.25000	0.00000	1245.07700	221.85824
22	ENVEQ MAX	0.50000	0.00000	1222.53600	211.03085
22	ENVEQ MAX	0.75000	0.00000	1205.17900	198.48725
22	ENVEQ MAX	1.00000	0.00000	1193.00700	184.66426
22	ENVEQ MIN	0.00000	-2221.49100	0.00000	-4005.16500
22	ENVEQ MIN	0.25000	-2220.00300	0.00000	-4110.77400
22	ENVEQ MIN	0.50000	-2218.30100	0.00000	-4214.24900
22	ENVEQ MIN	0.75000	-2216.38700	0.00000	-4316.02500
22	ENVEQ MIN	1.00000	-2214.25900	0.00000	-4416.54000
23	ENVEQ MAX	0.00000	0.00000	1193.00700	184.66426
23	ENVEQ MAX	0.10937	0.00000	1182.94000	169.33708
23	ENVEQ MAX	0.21875	0.00000	1172.63900	153.08052
23	ENVEQ MAX	0.32812	0.00000	1162.10200	135.87401
23	ENVEQ MAX	0.43750	0.00000	1151.33100	117.69698
23	ENVEQ MIN	0.00000	-2214.25900	0.00000	-4416.54000
23	ENVEQ MIN	0.10937	-2211.94000	0.00000	-4519.98000
23	ENVEQ MIN	0.21875	-2209.62000	0.00000	-4622.51900
23	ENVEQ MIN	0.32812	-2207.30100	0.00000	-4724.12700
23	ENVEQ MIN	0.43750	-2204.98100	0.00000	-4824.78300
24	ENVEQ MAX	0.64706	0.00000	0.00000	322.14441
24	ENVEQ MAX	0.73529	0.00000	0.00000	361.33445
24	ENVEQ MAX	0.82353	0.00000	0.00000	399.65306
24	ENVEQ MAX	0.91176	0.00000	0.00000	437.10023
24	ENVEQ MAX	1.00000	0.00000	0.00000	473.67597
24	ENVEQ MIN	0.64706	-1158.55900	-2015.99200	-4172.33100
24	ENVEQ MIN	0.73529	-1153.25100	-1991.84700	-4022.03800
24	ENVEQ MIN	0.82353	-1147.94400	-1967.70300	-3873.55600
24	ENVEQ MIN	0.91176	-1142.63600	-1943.55800	-3726.88400
24	ENVEQ MIN	1.00000	-1137.32800	-1919.41400	-3582.02300
25	ENVEQ MAX	0.00000	0.00000	0.00000	473.67597
25	ENVEQ MAX	0.25000	0.00000	0.00000	495.08473
25	ENVEQ MAX	0.50000	0.00000	0.00000	516.18527
25	ENVEQ MAX	0.75000	0.00000	0.00000	536.97961
25	ENVEQ MAX	1.00000	0.00000	0.00000	557.46976
25	ENVEQ MIN	0.00000	-1137.32800	-1919.41400	-3582.02300
25	ENVEQ MIN	0.25000	-1134.16100	-1905.03700	-3496.45200
25	ENVEQ MIN	0.50000	-1130.99400	-1890.72100	-3411.52200
25	ENVEQ MIN	0.75000	-1127.82700	-1876.46600	-3327.23200
25	ENVEQ MIN	1.00000	-1124.66000	-1862.27000	-3243.57900
26	ENVEQ MAX	0.00000	0.00000	0.00000	557.46976
26	ENVEQ MAX	0.25000	0.00000	0.00000	593.45919
26	ENVEQ MAX	0.50000	0.00000	0.00000	628.48851
26	ENVEQ MAX	0.75000	0.00000	0.00000	662.56932
26	ENVEQ MAX	1.00000	0.00000	0.00000	695.71327
26	ENVEQ MIN	0.00000	-1142.76100	-1862.27000	-3243.57900
26	ENVEQ MIN	0.25000	-1137.08200	-1836.96300	-3095.14900
26	ENVEQ MIN	0.50000	-1131.40300	-1811.84900	-2948.74200
26	ENVEQ MIN	0.75000	-1125.72300	-1786.92900	-2804.34300
26	ENVEQ MIN	1.00000	-1120.04400	-1762.20100	-2661.93600
27	ENVEQ MAX	0.00000	0.00000	0.00000	695.71327
27	ENVEQ MAX	0.25000	0.00000	0.00000	765.54060
27	ENVEQ MAX	0.50000	0.00000	0.00000	830.86686
27	ENVEQ MAX	0.75000	0.00000	0.00000	891.69202
27	ENVEQ MAX	1.00000	0.00000	0.00000	948.01611
27	ENVEQ MIN	0.00000	-1120.04400	-1762.20100	-2661.93600
27	ENVEQ MIN	0.25000	-1107.51800	-1707.87500	-2358.74300
27	ENVEQ MIN	0.50000	-1094.99100	-1653.54900	-2066.51300
27	ENVEQ MIN	0.75000	-1082.46500	-1599.22300	-1783.58600
27	ENVEQ MIN	1.00000	-1069.93800	-1544.89700	-1509.96100
28	ENVEQ MAX	0.00000	0.00000	0.00000	948.01611
28	ENVEQ MAX	0.25000	0.00000	0.00000	1091.07400
28	ENVEQ MAX	0.50000	0.00000	0.00000	1309.40300
28	ENVEQ MAX	0.75000	0.00000	0.00000	1507.38100
28	ENVEQ MAX	1.00000	0.00000	0.00000	1685.07700
28	ENVEQ MIN	0.00000	-1088.19200	-1544.89700	-1509.96100
28	ENVEQ MIN	0.25000	-1069.96800	-1465.86400	-1185.76000
28	ENVEQ MIN	0.50000	-1051.74500	-1386.83000	-974.09763
28	ENVEQ MIN	0.75000	-1033.52100	-1307.79600	-771.96130
28	ENVEQ MIN	1.00000	-1015.29800	-1228.76300	-579.35129
29	ENVEQ MAX	0.00000	0.00000	0.00000	1685.07700
29	ENVEQ MAX	0.25000	0.00000	0.00000	1842.40000
29	ENVEQ MAX	0.50000	0.00000	0.00000	1979.41100
29	ENVEQ MAX	0.75000	0.00000	0.00000	2099.42100
29	ENVEQ MAX	1.00000	0.00000	0.00000	2199.72300
29	ENVEQ MIN	0.00000	-1033.70100	-1228.76300	-579.35129
29	ENVEQ MIN	0.25000	-1015.49500	-1149.80600	-396.44012
29	ENVEQ MIN	0.50000	-997.28898	-1070.84900	-223.03678
29	ENVEQ MIN	0.75000	-979.08314	-991.89196	-59.14127
29	ENVEQ MIN	1.00000	-960.87730	-912.93504	0.00000
30	ENVEQ MAX	0.00000	0.00000	0.00000	2199.72300
30	ENVEQ MAX	0.25000	0.00000	27.28801	2279.71300
30	ENVEQ MAX	0.50000	0.00000	64.24750	2339.39100
30	ENVEQ MAX	0.75000	0.00000	101.20700	2378.75800
30	ENVEQ MAX	1.00000	0.00000	138.16649	2397.81300
30	ENVEQ MIN	0.00000	-979.42151	-912.93516	0.00000
30	ENVEQ MIN	0.25000	-961.21567	-833.97824	0.00000
30	ENVEQ MIN	0.50000	-943.00983	-755.49138	0.00000
30	ENVEQ MIN	0.75000	-924.80399	-679.10696	0.00000
30	ENVEQ MIN	1.00000	-906.59816	-602.72254	0.00000
31	ENVEQ MAX	0.00000	0.00000	138.16336	2397.81300
31	ENVEQ MAX	0.25000	0.00000	175.12285	2396.55700
31	ENVEQ MAX	0.50000	0.00000	212.08235	2374.98900
31	ENVEQ MAX	0.75000	0.00000	249.04184	2333.10900
31	ENVEQ MAX	1.00000	0.00000	300.24254	2270.91700
31	ENVEQ MIN	0.00000	-925.27596	-602.72504	0.00000
31	ENVEQ MIN	0.25000	-907.07012	-526.34062	0.00000
31	ENVEQ MIN	0.50000	-888.86429	-449.95621	0.00000
31	ENVEQ MIN	0.75000	-870.65845	-373.57179	0.00000
31	ENVEQ MIN	1.00000	-871.25540	-300.23714	0.00000
32	ENVEQ MAX	0.00000	0.00000	300.23917	2270.91700
32	ENVEQ MAX	0.25000	0.00000	373.57461	2333.10800
32	ENVEQ MAX	0.50000	0.00000	449.95903	2374.98700
32	ENVEQ MAX	0.75000	0.00000	526.34345	2396.55400
32	ENVEQ MAX	1.00000	0.00000	602.72787	2397.81000
32	ENVEQ MIN	0.00000	-871.25634	-300.24051	0.00000
32	ENVEQ MIN	0.25000	-870.65755	-249.04036	0.00000
32	ENVEQ MIN	0.50000	-888.86339	-212.08087	0.00000
32	ENVEQ MIN	0.75000	-907.06923	-175.12137	0.00000
32	ENVEQ MIN	1.00000	-925.27507	-138.16188	0.00000
33	ENVEQ MAX	0.00000	0.00000	602.72537	2397.81000
33	ENVEQ MAX	0.25000	0.00000	679.10979	2378.75400
33	ENVEQ MAX	0.50000	0.00000	755.49421	2339.38600
33	ENVEQ MAX	0.75000	0.00000	833.98111	2279.70700
33	ENVEQ MAX	1.00000	0.00000	912.93803	2199.71600
33	ENVEQ MIN	0.00000	-906.59731	-138.16501	0.00000
33	ENVEQ MIN	0.25000	-924.80315	-101.20551	0.00000
33	ENVEQ MIN	0.50000	-943.00899	-64.24602	0.00000
33	ENVEQ MIN	0.75000	-961.21483	-27.28653	0.00000
33	ENVEQ MIN	1.00000	-979.42067	0.00000	0.00000
34	ENVEQ MAX	0.00000	0.00000	912.93791	2199.71600
34	ENVEQ MAX	0.25000	0.00000	991.97156	2099.30600
34	ENVEQ MAX	0.50000	0.00000	1071.00500	1979.15600
34	ENVEQ MAX	0.75000	0.00000	1150.03900	1841.96200
34	ENVEQ MAX	1.00000	0.00000	1229.07300	1684.41600
34	ENVEQ MIN	0.00000	-960.87651	0.00000	0.00000
34	ENVEQ MIN	0.25000	-979.10005	0.00000	-59.29872
34	ENVEQ MIN	0.50000	-997.32358	0.00000	-223.36777
34	ENVEQ MIN	0.75000	-1015.54700	0.00000	-396.96313
34	ENVEQ MIN	1.00000	-1033.77100	0.00000	-580.08481
35	ENVEQ MAX	0.00000	0.00000	1229.07300	1684.41600
35	ENVEQ MAX	0.25000	0.00000	1308.02900	1506.82400

FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	1386.98600	1308.98900
35	ENVEQ MAX	0.75000	0.00000	1465.94300	1090.84100
35	ENVEQ MAX	1.00000	0.00000	1544.90000	948.00936
35	ENVEQ MIN	0.00000	-1015.36800	0.00000	-580.08481
35	ENVEQ MIN	0.25000	-1033.57400	0.00000	-772.54054
35	ENVEQ MIN	0.50000	-1051.78000	0.00000	-974.50411
35	ENVEQ MIN	0.75000	-1069.98500	0.00000	-1185.97500
35	ENVEQ MIN	1.00000	-1088.19100	0.00000	-1509.97200
36	ENVEQ MAX	0.00000	0.00000	1544.90000	948.00936
36	ENVEQ MAX	0.25000	0.00000	1599.22600	891.68502
36	ENVEQ MAX	0.50000	0.00000	1653.55200	830.85959
36	ENVEQ MAX	0.75000	0.00000	1707.87800	765.53307
36	ENVEQ MAX	1.00000	0.00000	1762.20400	695.70547
36	ENVEQ MIN	0.00000	-1069.93800	0.00000	-1509.97200
36	ENVEQ MIN	0.25000	-1082.46400	0.00000	-1783.59700
36	ENVEQ MIN	0.50000	-1094.99100	0.00000	-2066.52500
36	ENVEQ MIN	0.75000	-1107.51700	0.00000	-2358.75600
36	ENVEQ MIN	1.00000	-1120.04300	0.00000	-2661.95000
37	ENVEQ MAX	0.00000	0.00000	1762.20400	695.70547
37	ENVEQ MAX	0.25000	0.00000	1786.93200	662.56141
37	ENVEQ MAX	0.50000	0.00000	1811.85200	628.48047
37	ENVEQ MAX	0.75000	0.00000	1836.96600	593.45104
37	ENVEQ MAX	1.00000	0.00000	1862.27300	557.46149
37	ENVEQ MIN	0.00000	-1120.04300	0.00000	-2661.95000
37	ENVEQ MIN	0.25000	-1125.72300	0.00000	-2804.35700
37	ENVEQ MIN	0.50000	-1131.40200	0.00000	-2948.75600
37	ENVEQ MIN	0.75000	-1137.08100	0.00000	-3095.16300
37	ENVEQ MIN	1.00000	-1142.76100	0.00000	-3243.59300
38	ENVEQ MAX	0.00000	0.00000	1862.27300	557.46149
38	ENVEQ MAX	0.25000	0.00000	1876.46800	536.97127
38	ENVEQ MAX	0.50000	0.00000	1890.72400	516.17686
38	ENVEQ MAX	0.75000	0.00000	1905.04000	495.07626
38	ENVEQ MAX	1.00000	0.00000	1919.41600	473.66743
38	ENVEQ MIN	0.00000	-1124.66000	0.00000	-3243.59300
38	ENVEQ MIN	0.25000	-1127.82700	0.00000	-3327.24700
38	ENVEQ MIN	0.50000	-1130.99400	0.00000	-3411.53700
38	ENVEQ MIN	0.75000	-1134.16100	0.00000	-3496.46700
38	ENVEQ MIN	1.00000	-1137.32800	0.00000	-3582.03800
39	ENVEQ MAX	0.00000	0.00000	1919.41600	473.66743
39	ENVEQ MAX	0.08824	0.00000	1943.56100	437.09158
39	ENVEQ MAX	0.17647	0.00000	1967.70600	399.64430
39	ENVEQ MAX	0.26471	0.00000	1991.85000	361.32558
39	ENVEQ MAX	0.35294	0.00000	2015.99500	322.13543
39	ENVEQ MIN	0.00000	-1137.32700	0.00000	-3582.03800
39	ENVEQ MIN	0.08824	-1142.63500	0.00000	-3726.89900
39	ENVEQ MIN	0.17647	-1147.94300	0.00000	-3873.57100
39	ENVEQ MIN	0.26471	-1153.25100	0.00000	-4022.05400
39	ENVEQ MIN	0.35294	-1158.55900	0.00000	-4172.34700
40	ENVEQ MAX	0.56250	0.00000	0.00000	117.68779
40	ENVEQ MAX	0.67188	0.00000	0.00000	135.86493
40	ENVEQ MAX	0.78125	0.00000	0.00000	153.07156
40	ENVEQ MAX	0.89063	0.00000	0.00000	169.32824
40	ENVEQ MAX	1.00000	0.00000	0.00000	184.65553
40	ENVEQ MIN	0.56250	-2204.98400	-1151.33100	-4824.80100
40	ENVEQ MIN	0.67188	-2207.30300	-1162.10200	-4724.14400
40	ENVEQ MIN	0.78125	-2209.62300	-1172.63900	-4622.53600
40	ENVEQ MIN	0.89063	-2211.94300	-1182.94000	-4519.99700
40	ENVEQ MIN	1.00000	-2214.26200	-1193.00700	-4416.55700
41	ENVEQ MAX	0.00000	0.00000	0.00000	184.65553
41	ENVEQ MAX	0.25000	0.00000	0.00000	198.47864
41	ENVEQ MAX	0.50000	0.00000	0.00000	211.02235
41	ENVEQ MAX	0.75000	0.00000	0.00000	221.84986
41	ENVEQ MAX	1.00000	0.00000	0.00000	230.52432
41	ENVEQ MIN	0.00000	-2214.26200	-1193.00700	-4416.55700
41	ENVEQ MIN	0.25000	-2216.38900	-1205.17900	-4316.04200
41	ENVEQ MIN	0.50000	-2218.30400	-1222.53500	-4214.26600
41	ENVEQ MIN	0.75000	-2220.00500	-1245.07700	-4110.79200
41	ENVEQ MIN	1.00000	-2221.49400	-1272.80400	-4005.18200
42	ENVEQ MAX	0.00000	0.00000	0.00000	230.52432
42	ENVEQ MAX	0.25000	0.00000	0.00000	233.82562
42	ENVEQ MAX	0.50000	0.00000	0.00000	236.52843
42	ENVEQ MAX	0.75000	0.00000	0.00000	238.64013
42	ENVEQ MAX	1.00000	0.00000	0.00000	240.16812
42	ENVEQ MIN	0.00000	-2144.79100	-964.47389	-4005.18200
42	ENVEQ MIN	0.25000	-2145.43500	-979.04781	-3965.77800
42	ENVEQ MIN	0.50000	-2146.02900	-993.44035	-3925.77900
42	ENVEQ MIN	0.75000	-2146.57300	-1007.65100	-3885.19300
42	ENVEQ MIN	1.00000	-2147.06700	-1021.68100	-3844.02800
43	ENVEQ MAX	0.00000	0.00000	0.00000	240.16812
43	ENVEQ MAX	0.25000	0.00000	50.84129	237.55957
43	ENVEQ MAX	0.50000	0.00000	125.43327	216.00939
43	ENVEQ MAX	0.75000	0.00000	193.47117	177.11184
43	ENVEQ MAX	1.00000	0.00000	254.95501	122.46122
43	ENVEQ MIN	0.00000	-2147.06700	-1021.68100	-3844.02800
43	ENVEQ MIN	0.25000	-2149.86600	-1101.61100	-3586.65700
43	ENVEQ MIN	0.50000	-2152.66600	-1174.98700	-3310.49200
43	ENVEQ MIN	0.75000	-2155.46600	-1241.80800	-3017.12700
43	ENVEQ MIN	1.00000	-2158.26600	-1302.07600	-2708.15700
44	ENVEQ MAX	0.00000	0.00000	254.95501	122.46122
44	ENVEQ MAX	0.25000	0.00000	318.37865	40.77294
44	ENVEQ MAX	0.50000	0.00000	372.61433	0.00000
44	ENVEQ MAX	0.75000	0.00000	417.66206	0.00000
44	ENVEQ MAX	1.00000	0.00000	453.52183	0.00000
44	ENVEQ MIN	0.00000	-2083.31400	-1020.82900	-2708.15700
44	ENVEQ MIN	0.25000	-2086.58600	-1082.83200	-2409.47400
44	ENVEQ MIN	0.50000	-2089.85700	-1135.64600	-2094.27100
44	ENVEQ MIN	0.75000	-2093.12900	-1179.27700	-1765.15900
44	ENVEQ MIN	1.00000	-2096.40100	-1214.42600	-1424.75000
45	ENVEQ MAX	0.00000	0.00000	453.52183	0.00000
45	ENVEQ MAX	0.25000	0.00000	483.68587	0.00000
45	ENVEQ MAX	0.50000	0.00000	511.64641	0.00000
45	ENVEQ MAX	0.75000	0.00000	537.40344	183.42919
45	ENVEQ MAX	1.00000	0.00000	560.95696	431.07838
45	ENVEQ MIN	0.00000	-2023.16200	-991.57627	-1424.75000
45	ENVEQ MIN	0.25000	-2026.43400	-1021.03000	-1392.85500
45	ENVEQ MIN	0.50000	-2029.70600	-1048.28000	-1466.81300
45	ENVEQ MIN	0.75000	-2032.97800	-1073.32600	-1548.60800
45	ENVEQ MIN	1.00000	-2036.24900	-1096.16900	-1637.61300
46	ENVEQ MAX	0.00000	0.00000	561.13192	431.07838
46	ENVEQ MAX	0.25000	0.00000	582.21693	513.58700
46	ENVEQ MAX	0.50000	0.00000	600.60792	601.70121
46	ENVEQ MAX	0.75000	0.00000	616.30488	694.65590
46	ENVEQ MAX	1.00000	0.00000	629.30782	791.68599
46	ENVEQ MIN	0.00000	-1695.03900	-390.96506	-1637.61300
46	ENVEQ MIN	0.25000	-1698.86000	-411.34007	-1733.09200
46	ENVEQ MIN	0.50000	-1724.56000	-429.02106	-1834.37900
46	ENVEQ MIN	0.75000	-1750.25900	-444.59074	-1940.70700
46	ENVEQ MIN	1.00000	-1775.95800	-457.59368	-2051.31200
47	ENVEQ MAX	0.00000	0.00000	629.46334	791.68599
47	ENVEQ MAX	0.25000	0.00000	632.79953	795.40586
47	ENVEQ MAX	0.50000	0.00000	635.89250	799.39656
47	ENVEQ MAX	0.75000	0.00000	638.74227	803.63759
47	ENVEQ MAX	1.00000	0.00000	641.34883	808.10848
47	ENVEQ MIN	0.00000	-1552.17000	-110.96290	-2051.31200
47	ENVEQ MIN	0.25000	-1559.79400	-114.29909	-2084.83400
47	ENVEQ MIN	0.50000	-1567.41700	-117.39206	-2119.57900
47	ENVEQ MIN	0.75000	-1575.04100	-120.24183	-2155.12600
47	ENVEQ MIN	1.00000	-1582.66500	-122.84839	-2190.94400
48	ENVEQ MAX	0.00000	0.00000	641.34820	808.10848
48	ENVEQ MAX	0.13281	0.00000	644.28999	814.04282
48	ENVEQ MAX	0.26563	0.00000	646.84769	820.26932
48	ENVEQ MAX	0.39844	0.00000	649.02130	826.74718
48	ENVEQ MAX	0.53125	0.00000	650.81080	833.43557
48	ENVEQ MIN	0.00000	-1582.66500	-122.58301	-2190.94400
48	ENVEQ MIN	0.13281	-1592.28000	-125.52480	-2236.48300
48	ENVEQ MIN	0.26563	-1601.89400	-128.08250	-2282.37000
48	ENVEQ MIN	0.39844	-1611.50900	-130.25610	-2328.56600
48	ENVEQ MIN	0.53125	-1621.12300	-132.04561	-2375.02800

20. OUTPUT DATA (붕괴방지)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.52941	128.27242	0.00000	913.66461
1	ENVEQ MAX	0.64706	125.41022	0.00000	949.91712
1	ENVEQ MAX	0.76471	122.54802	0.00000	986.52963
1	ENVEQ MAX	0.88235	119.68582	0.00000	1023.50200
1	ENVEQ MAX	1.00000	116.82362	0.00000	1060.83500
1	ENVEQ MIN	0.52941	-657.39302	-1301.23800	-2600.94400
1	ENVEQ MIN	0.64706	-654.53082	-1306.03800	-2471.28900
1	ENVEQ MIN	0.76471	-651.66862	-1310.83800	-2341.15300
1	ENVEQ MIN	0.88235	-648.80642	-1315.63800	-2210.53800
1	ENVEQ MIN	1.00000	-645.94422	-1320.43800	-2079.44200
2	ENVEQ MAX	0.00000	116.64790	0.00000	1060.83500
2	ENVEQ MAX	0.25000	115.36707	0.00000	1077.65800
2	ENVEQ MAX	0.50000	114.08623	0.00000	1094.55300
2	ENVEQ MAX	0.75000	112.80540	0.00000	1111.52000
2	ENVEQ MAX	1.00000	111.52457	0.00000	1128.55900
2	ENVEQ MIN	0.00000	-645.94408	-1320.43800	-2079.44200
2	ENVEQ MIN	0.25000	-644.66325	-1322.58600	-2020.62100
2	ENVEQ MIN	0.50000	-643.38241	-1324.73400	-1961.70400
2	ENVEQ MIN	0.75000	-642.10158	-1326.88200	-1902.69100
2	ENVEQ MIN	1.00000	-640.82074	-1329.03000	-1843.58200
3	ENVEQ MAX	0.00000	87.77232	0.00000	1128.55900
3	ENVEQ MAX	0.25000	80.40932	0.00000	1162.79100
3	ENVEQ MAX	0.50000	73.04631	0.00000	1221.37600
3	ENVEQ MAX	0.75000	65.68330	0.00000	1354.63200
3	ENVEQ MAX	1.00000	58.32029	0.00000	1491.06400
3	ENVEQ MIN	0.00000	-607.60822	-1011.61500	-1843.58200
3	ENVEQ MIN	0.25000	-600.24521	-1023.96300	-1610.96100
3	ENVEQ MIN	0.50000	-592.88220	-1036.31100	-1415.89500
3	ENVEQ MIN	0.75000	-585.51919	-1048.65900	-1241.03200
3	ENVEQ MIN	1.00000	-578.15618	-1061.00700	-1063.78700
4	ENVEQ MAX	0.00000	34.49367	23.58344	1491.06400
4	ENVEQ MAX	0.25000	27.13066	14.32244	1548.37700
4	ENVEQ MAX	0.50000	19.76765	5.06144	1611.44800
4	ENVEQ MAX	0.75000	12.40464	0.00000	1677.69500
4	ENVEQ MAX	1.00000	5.04163	0.00000	1747.11900
4	ENVEQ MIN	0.00000	-545.48037	-775.85982	-1063.78700
4	ENVEQ MIN	0.25000	-538.11736	-788.20782	-921.66725
4	ENVEQ MIN	0.50000	-530.75435	-800.55582	-777.16480
4	ENVEQ MIN	0.75000	-523.39134	-812.90382	-630.27997
4	ENVEQ MIN	1.00000	-516.02833	-825.25182	-481.01274
5	ENVEQ MAX	0.00000	0.00000	129.08587	1747.11900
5	ENVEQ MAX	0.25000	0.00000	119.81587	1755.58900
5	ENVEQ MAX	0.50000	0.00000	110.54587	1767.24200
5	ENVEQ MAX	0.75000	0.00000	101.27587	1782.07800
5	ENVEQ MAX	1.00000	0.00000	92.00587	1800.09600
5	ENVEQ MIN	0.00000	-483.83307	-581.17417	-481.01274
5	ENVEQ MIN	0.25000	-476.46291	-593.53417	-364.45033
5	ENVEQ MIN	0.50000	-469.09274	-605.89417	-245.50090
5	ENVEQ MIN	0.75000	-461.72258	-618.25417	-124.16444
5	ENVEQ MIN	1.00000	-454.35241	-630.61417	-0.44096
6	ENVEQ MAX	0.00000	0.00000	205.23253	1800.09600
6	ENVEQ MAX	0.25000	0.00000	195.97153	1770.84800
6	ENVEQ MAX	0.50000	0.00000	186.71053	1744.77700
6	ENVEQ MAX	0.75000	0.00000	177.44953	1721.88200
6	ENVEQ MAX	1.00000	0.00000	168.18853	1702.16400
6	ENVEQ MIN	0.00000	-422.58230	-425.87108	-0.44096
6	ENVEQ MIN	0.25000	-415.21929	-438.21908	0.00000
6	ENVEQ MIN	0.50000	-407.85628	-450.56708	0.00000
6	ENVEQ MIN	0.75000	-400.49327	-462.91508	0.00000
6	ENVEQ MIN	1.00000	-393.13026	-475.26308	0.00000
7	ENVEQ MAX	0.00000	0.00000	267.70512	1702.16400
7	ENVEQ MAX	0.25000	0.00000	258.44412	1642.63900
7	ENVEQ MAX	0.50000	0.00000	249.18312	1586.29000
7	ENVEQ MAX	0.75000	0.00000	239.92212	1533.11800
7	ENVEQ MAX	1.00000	0.00000	230.66112	1483.12300
7	ENVEQ MIN	0.00000	-361.72943	-300.88514	0.00000
7	ENVEQ MIN	0.25000	-354.36642	-313.23314	0.00000
7	ENVEQ MIN	0.50000	-347.00341	-325.58114	0.00000
7	ENVEQ MIN	0.75000	-339.64040	-337.92914	0.00000
7	ENVEQ MIN	1.00000	-332.27739	-350.27714	0.00000
8	ENVEQ MAX	0.00000	0.00000	350.24731	1483.12300
8	ENVEQ MAX	0.25000	0.00000	337.89931	1533.12600
8	ENVEQ MAX	0.50000	0.00000	325.55131	1586.30500
8	ENVEQ MAX	0.75000	0.00000	313.20331	1642.66200
8	ENVEQ MAX	1.00000	0.00000	300.85531	1702.19400
8	ENVEQ MIN	0.00000	-332.27880	-230.67835	0.00000
8	ENVEQ MIN	0.25000	-339.64181	-239.93935	0.00000
8	ENVEQ MIN	0.50000	-347.00482	-249.20035	0.00000
8	ENVEQ MIN	0.75000	-354.36783	-258.46135	0.00000
8	ENVEQ MIN	1.00000	-361.73084	-267.72235	0.00000
9	ENVEQ MAX	0.00000	0.00000	475.23336	1702.19400
9	ENVEQ MAX	0.25000	0.00000	462.88536	1721.91900
9	ENVEQ MAX	0.50000	0.00000	450.53736	1744.82000
9	ENVEQ MAX	0.75000	0.00000	438.18936	1770.89700
9	ENVEQ MAX	1.00000	0.00000	425.84136	1800.15200
9	ENVEQ MIN	0.00000	-393.13194	-168.20315	0.00000
9	ENVEQ MIN	0.25000	-400.49495	-177.46415	0.00000
9	ENVEQ MIN	0.50000	-407.85796	-186.72515	0.00000
9	ENVEQ MIN	0.75000	-415.22097	-195.98615	0.00000
9	ENVEQ MIN	1.00000	-422.58398	-205.24715	-0.40242
10	ENVEQ MAX	0.00000	0.00000	630.58720	1800.15200
10	ENVEQ MAX	0.25000	0.00000	618.23920	1782.15400
10	ENVEQ MAX	0.50000	0.00000	605.89120	1767.33300
10	ENVEQ MAX	0.75000	0.00000	593.54320	1755.68900
10	ENVEQ MAX	1.00000	0.00000	581.19520	1747.22100
10	ENVEQ MIN	0.00000	-454.35437	-92.01667	-0.40242
10	ENVEQ MIN	0.25000	-461.71738	-101.27767	-124.00203
10	ENVEQ MIN	0.50000	-469.08039	-110.53867	-245.21923
10	ENVEQ MIN	0.75000	-476.44340	-119.79967	-364.05405
10	ENVEQ MIN	1.00000	-483.80641	-129.06067	-480.50647
11	ENVEQ MAX	0.00000	5.01273	825.23910	1747.22100
11	ENVEQ MAX	0.25000	12.38289	812.87910	1677.73700
11	ENVEQ MAX	0.50000	19.75306	800.51910	1611.43600
11	ENVEQ MAX	0.75000	27.12322	788.15910	1548.31800
11	ENVEQ MAX	1.00000	34.49339	775.79910	1490.96700
11	ENVEQ MIN	0.00000	-516.00151	0.00000	-480.50647
11	ENVEQ MIN	0.25000	-523.37168	0.00000	-629.91937
11	ENVEQ MIN	0.50000	-530.74184	-5.08490	-776.94525
11	ENVEQ MIN	0.75000	-538.11201	-14.35490	-921.58409
11	ENVEQ MIN	1.00000	-545.48217	-23.62490	-1063.83600
12	ENVEQ MAX	0.00000	58.31975	1060.95700	1490.96700
12	ENVEQ MAX	0.25000	65.68276	1048.60900	1354.54900
12	ENVEQ MAX	0.50000	73.04577	1036.26100	1221.30800
12	ENVEQ MAX	0.75000	80.40878	1023.91300	1162.76200
12	ENVEQ MAX	1.00000	87.77179	1011.56500	1128.53900
12	ENVEQ MIN	0.00000	-578.15830	0.00000	-1063.83600
12	ENVEQ MIN	0.25000	-585.52131	0.00000	-1241.07500
12	ENVEQ MIN	0.50000	-592.88432	0.00000	-1415.93100
12	ENVEQ MIN	0.75000	-600.24733	0.00000	-1611.00200
12	ENVEQ MIN	1.00000	-607.61033	0.00000	-1843.62300
13	ENVEQ MAX	0.00000	111.52360	1328.99100	1128.53900
13	ENVEQ MAX	0.25000	112.80444	1326.84300	1111.50100
13	ENVEQ MAX	0.50000	114.08527	1324.69500	1094.53500
13	ENVEQ MAX	0.75000	115.36611	1322.54700	1077.64100
13	ENVEQ MAX	1.00000	116.64694	1320.39900	1060.81900
13	ENVEQ MIN	0.00000	-640.82316	0.00000	-1843.62300
13	ENVEQ MIN	0.25000	-642.10400	0.00000	-1902.73100
13	ENVEQ MIN	0.50000	-643.38483	0.00000	-1961.74200
13	ENVEQ MIN	0.75000	-644.66567	0.00000	-2020.65700
13	ENVEQ MIN	1.00000	-645.94650	0.00000	-2079.47600
14	ENVEQ MAX	0.00000	116.82266	1320.39900	1060.81900
14	ENVEQ MAX	0.11765	119.68486	1315.59900	1023.48900
14	ENVEQ MAX	0.23529	122.54706	1310.79900	986.51907
14	ENVEQ MAX	0.35294	125.40926	1305.99900	949.90911
14	ENVEQ MAX	0.47059	128.27146	1301.19900	913.65915
14	ENVEQ MIN	0.00000	-645.94664	0.00000	-2079.47600
14	ENVEQ MIN	0.11765	-648.80884	0.00000	-2210.56800
14	ENVEQ MIN	0.23529	-651.67104	0.00000	-2341.18000
14	ENVEQ MIN	0.35294	-654.53324	0.00000	-2471.31100
14	ENVEQ MIN	0.47059	-657.39544	0.00000	-2600.96300
15	ENVEQ MAX	0.46875	0.00000	281.92507	678.41040
15	ENVEQ MAX	0.60156	0.00000	280.09937	657.05435
15	ENVEQ MAX	0.73438	0.00000	277.96815	635.90852
15	ENVEQ MAX	0.86719	0.00000	275.53142	615.00535
15	ENVEQ MAX	1.00000	0.00000	272.78918	594.37732
15	ENVEQ MIN	0.46875	-1681.31900	-666.22969	-2983.75300
15	ENVEQ MIN	0.60156	-1672.56000	-664.40398	-2929.05600
15	ENVEQ MIN	0.73438	-1663.80100	-662.27276	-2874.76800
15	ENVEQ MIN	0.86719	-1655.04200	-659.83603	-2821.90200
15	ENVEQ MIN	1.00000	-1646.28200	-657.09380	-2769.94400
16	ENVEQ MAX	0.00000	0.00000	273.32810	594.37732
16	ENVEQ MAX	0.25000	0.00000	270.93555	578.23759
16	ENVEQ MAX	0.50000	0.00000	268.34905	562.30759
16	ENVEQ MAX	0.75000	0.00000	265.56858	546.60368
16	ENVEQ MAX	1.00000	0.00000	262.59414	531.14220
16	ENVEQ MIN	0.00000	-1646.28200	-657.09401	-2769.94400
16	ENVEQ MIN	0.25000	-1639.33700	-654.70147	-2728.98300
16	ENVEQ MIN	0.50000	-1632.39100	-652.11497	-2688.25000
16	ENVEQ MIN	0.75000	-1625.44600	-649.33449	-2647.76000
16	ENVEQ MIN	1.00000	-1618.50000	-646.36006	-2607.53100
17	ENVEQ MAX	0.00000	0.00000	578.11110	531.14220
17	ENVEQ MAX	0.25000	0.00000	566.67921	397.98548
17	ENVEQ MAX	0.50000	0.00000	553.09056	268.38167
17	ENVEQ MAX	0.75000	0.00000	537.34513	142.94331

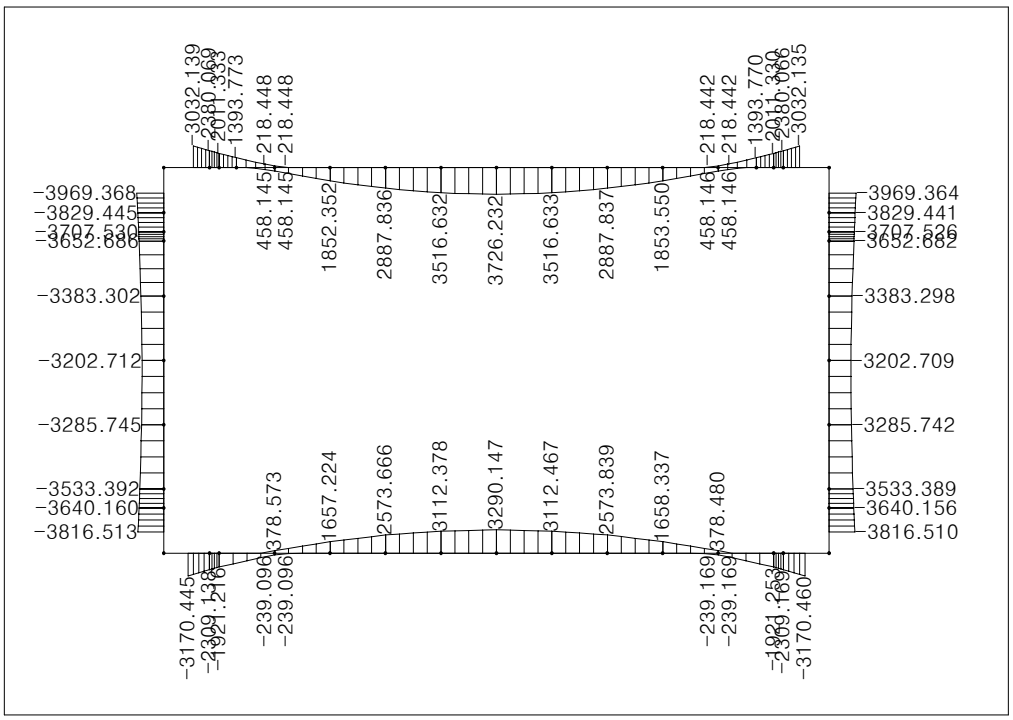
FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	0.00000	519.44295	22.28290
17	ENVEQ MIN	0.00000	-1855.52200	-646.31944	-2607.53100
17	ENVEQ MIN	0.25000	-1849.96700	-634.88756	-2474.05100
17	ENVEQ MIN	0.50000	-1844.41200	-621.29890	-2344.32500
17	ENVEQ MIN	0.75000	-1838.85700	-605.55348	-2218.96600
17	ENVEQ MIN	1.00000	-1833.30200	-587.65129	-2098.58700
18	ENVEQ MAX	0.00000	0.00000	1027.26600	22.28290
18	ENVEQ MAX	0.25000	0.00000	1007.38700	0.00000
18	ENVEQ MAX	0.50000	0.00000	985.74537	0.00000
18	ENVEQ MAX	0.75000	0.00000	962.34080	0.00000
18	ENVEQ MAX	1.00000	0.00000	937.17330	0.00000
18	ENVEQ MIN	0.00000	-2126.90400	-587.61387	-2098.58700
18	ENVEQ MIN	0.25000	-2121.34400	-567.73513	-1983.68300
18	ENVEQ MIN	0.50000	-2115.78400	-546.09348	-1874.88200
18	ENVEQ MIN	0.75000	-2110.22400	-522.68890	-1772.68500
18	ENVEQ MIN	1.00000	-2104.66500	-497.52141	-2037.77800
19	ENVEQ MAX	0.00000	0.00000	1080.21200	0.00000
19	ENVEQ MAX	0.25000	0.00000	1050.50100	0.00000
19	ENVEQ MAX	0.50000	0.00000	1014.40400	0.00000
19	ENVEQ MAX	0.75000	0.00000	971.46138	0.00000
19	ENVEQ MAX	1.00000	0.00000	921.19276	0.00000
19	ENVEQ MIN	0.00000	-2166.93000	-497.52141	-2037.77800
19	ENVEQ MIN	0.25000	-2161.37000	-467.80946	-2340.43500
19	ENVEQ MIN	0.50000	-2155.81000	-430.77155	-2633.80700
19	ENVEQ MIN	0.75000	-2150.25000	-386.40765	-2915.81200
19	ENVEQ MIN	1.00000	-2144.69000	-334.71779	-3184.36800
20	ENVEQ MAX	0.00000	0.00000	1090.33500	0.00000
20	ENVEQ MAX	0.25000	0.00000	1041.56900	74.67595
20	ENVEQ MAX	0.50000	0.00000	987.57835	137.32370
20	ENVEQ MAX	0.75000	0.00000	928.36175	185.90673
20	ENVEQ MAX	1.00000	0.00000	863.91954	219.15389
20	ENVEQ MIN	0.00000	-2207.64600	-334.71779	-3184.36800
20	ENVEQ MIN	0.25000	-2202.88800	-284.73617	-3443.10400
20	ENVEQ MIN	0.50000	-2198.13000	-229.52895	-3689.19500
20	ENVEQ MIN	0.75000	-2193.37200	-169.09610	-3921.36900
20	ENVEQ MIN	1.00000	-2188.61400	-103.43763	-4138.35500
21	ENVEQ MAX	0.00000	0.00000	863.91962	219.15389
21	ENVEQ MAX	0.25000	0.00000	852.61441	223.13403
21	ENVEQ MAX	0.50000	0.00000	841.16531	226.64224
21	ENVEQ MAX	0.75000	0.00000	829.57232	229.67266
21	ENVEQ MAX	1.00000	0.00000	817.83545	232.21944
21	ENVEQ MIN	0.00000	-2188.61400	-103.43763	-4138.35500
21	ENVEQ MIN	0.25000	-2187.79200	-91.92867	-4173.13000
21	ENVEQ MIN	0.50000	-2186.92000	-80.27582	-4207.43700
21	ENVEQ MIN	0.75000	-2185.99900	-68.47908	-4241.27100
21	ENVEQ MIN	1.00000	-2185.02700	-56.53846	-4274.62500
22	ENVEQ MAX	0.00000	0.00000	999.50479	232.21944
22	ENVEQ MAX	0.25000	0.00000	977.15426	235.99191
22	ENVEQ MAX	0.50000	0.00000	958.93176	238.01974
22	ENVEQ MAX	0.75000	0.00000	944.83730	238.65074
22	ENVEQ MAX	1.00000	0.00000	934.87089	238.23268
22	ENVEQ MIN	0.00000	-2248.68100	-56.53846	-4274.62500
22	ENVEQ MIN	0.25000	-2246.51400	-33.76667	-4357.41200
22	ENVEQ MIN	0.50000	-2244.13400	-15.12293	-4438.47100
22	ENVEQ MIN	0.75000	-2241.54100	-0.60722	-4518.15300
22	ENVEQ MIN	1.00000	-2238.73600	0.00000	-4596.80400
23	ENVEQ MAX	0.00000	0.00000	934.87100	238.23268
23	ENVEQ MAX	0.10937	0.00000	926.56983	236.99320
23	ENVEQ MAX	0.21875	0.00000	918.08078	234.98087
23	ENVEQ MAX	0.32812	0.00000	909.40385	232.17925
23	ENVEQ MAX	0.43750	0.00000	900.53905	228.57189
23	ENVEQ MIN	0.00000	-2238.73600	0.00000	-4596.80400
23	ENVEQ MIN	0.10937	-2235.71200	0.00000	-4677.70300
23	ENVEQ MIN	0.21875	-2232.68800	0.00000	-4757.84900
23	ENVEQ MIN	0.32812	-2229.66400	0.00000	-4837.22500
23	ENVEQ MIN	0.43750	-2226.64000	0.00000	-4915.81400
24	ENVEQ MAX	0.64706	0.00000	0.00000	501.20815
24	ENVEQ MAX	0.73529	0.00000	0.00000	539.10351
24	ENVEQ MAX	0.82353	0.00000	0.00000	576.12744
24	ENVEQ MAX	0.91176	0.00000	0.00000	612.27993
24	ENVEQ MAX	1.00000	0.00000	0.00000	647.56099
24	ENVEQ MIN	0.64706	-881.74731	-2034.02800	-4142.89100
24	ENVEQ MIN	0.73529	-877.21498	-2009.88400	-3991.24400
24	ENVEQ MIN	0.82353	-872.68266	-1985.73900	-3841.40800
24	ENVEQ MIN	0.91176	-868.15033	-1961.59500	-3693.38300
24	ENVEQ MIN	1.00000	-863.61801	-1937.45000	-3547.16900
25	ENVEQ MAX	0.00000	0.00000	0.00000	647.56099
25	ENVEQ MAX	0.25000	0.00000	0.00000	668.19726
25	ENVEQ MAX	0.50000	0.00000	0.00000	688.52531
25	ENVEQ MAX	0.75000	0.00000	0.00000	708.54715
25	ENVEQ MAX	1.00000	0.00000	0.00000	728.26481
25	ENVEQ MIN	0.00000	-863.61811	-1937.45000	-3547.16900
25	ENVEQ MIN	0.25000	-860.91383	-1923.07400	-3460.79000
25	ENVEQ MIN	0.50000	-858.20954	-1908.75800	-3375.05300
25	ENVEQ MIN	0.75000	-855.50525	-1894.50200	-3289.95600
25	ENVEQ MIN	1.00000	-852.80096	-1880.30700	-3205.49500
26	ENVEQ MAX	0.00000	0.00000	0.00000	728.26481
26	ENVEQ MAX	0.25000	0.00000	0.00000	762.86894
26	ENVEQ MAX	0.50000	0.00000	0.00000	796.51294
26	ENVEQ MAX	0.75000	0.00000	0.00000	829.20845
26	ENVEQ MAX	1.00000	0.00000	0.00000	860.96709
26	ENVEQ MIN	0.00000	-863.59735	-1880.30700	-3205.49500
26	ENVEQ MIN	0.25000	-858.74776	-1855.00000	-3055.61700
26	ENVEQ MIN	0.50000	-853.89817	-1829.88600	-2907.76200
26	ENVEQ MIN	0.75000	-849.04858	-1804.96600	-2762.55100
26	ENVEQ MIN	1.00000	-844.19900	-1780.23800	-2621.26200
27	ENVEQ MAX	0.00000	0.00000	0.00000	860.96709
27	ENVEQ MAX	0.25000	0.00000	0.00000	927.73898
27	ENVEQ MAX	0.50000	0.00000	0.00000	990.00979
27	ENVEQ MAX	0.75000	0.00000	0.00000	1047.78000
27	ENVEQ MAX	1.00000	0.00000	0.00000	1105.77400
27	ENVEQ MIN	0.00000	-844.19908	-1780.23800	-2621.26200
27	ENVEQ MIN	0.25000	-833.50279	-1725.91200	-2316.39900
27	ENVEQ MIN	0.50000	-822.80651	-1671.58600	-2020.83900
27	ENVEQ MIN	0.75000	-812.11022	-1617.26000	-1734.58100
27	ENVEQ MIN	1.00000	-801.41393	-1562.93400	-1457.62600
28	ENVEQ MAX	0.00000	0.00000	0.00000	1105.77400
28	ENVEQ MAX	0.25000	0.00000	0.00000	1293.40600
28	ENVEQ MAX	0.50000	0.00000	0.00000	1506.89200
28	ENVEQ MAX	0.75000	0.00000	0.00000	1700.02600
28	ENVEQ MAX	1.00000	0.00000	0.00000	1872.80900
28	ENVEQ MIN	0.00000	-812.25517	-1562.93400	-1457.62600
28	ENVEQ MIN	0.25000	-796.69419	-1483.90100	-1170.35600
28	ENVEQ MIN	0.50000	-781.13320	-1404.86700	-954.24705
28	ENVEQ MIN	0.75000	-765.57222	-1325.83300	-747.66442
28	ENVEQ MIN	1.00000	-750.01124	-1246.80000	-550.60810
29	ENVEQ MAX	0.00000	0.00000	0.00000	1872.80900
29	ENVEQ MAX	0.25000	0.00000	0.00000	2025.10300
29	ENVEQ MAX	0.50000	0.00000	0.00000	2157.08500
29	ENVEQ MAX	0.75000	0.00000	0.00000	2272.30900
29	ENVEQ MAX	1.00000	0.00000	7.58387	2367.96800
29	ENVEQ MIN	0.00000	-760.89577	-1246.80000	-550.60810
29	ENVEQ MIN	0.25000	-745.34990	-1167.84300	-363.25547
29	ENVEQ MIN	0.50000	-729.80402	-1088.88600	-185.41067
29	ENVEQ MIN	0.75000	-714.25815	-1009.92900	-17.07370
29	ENVEQ MIN	1.00000	-698.71227	-930.97216	0.00000
30	ENVEQ MAX	0.00000	0.00000	7.58350	2367.96800
30	ENVEQ MAX	0.25000	0.00000	44.54299	2443.31500
30	ENVEQ MAX	0.50000	0.00000	81.50248	2498.35000
30	ENVEQ MAX	0.75000	0.00000	118.46198	2533.07400
30	ENVEQ MAX	1.00000	0.00000	155.42147	2547.48600
30	ENVEQ MIN	0.00000	-709.63720	-930.97243	0.00000
30	ENVEQ MIN	0.25000	-694.09132	-852.01551	0.00000
30	ENVEQ MIN	0.50000	-678.54545	-774.30153	0.00000
30	ENVEQ MIN	0.75000	-662.99957	-697.91711	0.00000
30	ENVEQ MIN	1.00000	-647.45370	-621.53269	0.00000
31	ENVEQ MAX	0.00000	0.00000	155.42107	2547.48600
31	ENVEQ MAX	0.25000	0.00000	192.38056	2541.58600
31	ENVEQ MAX	0.50000	0.00000	229.34005	2515.37500
31	ENVEQ MAX	0.75000	0.00000	266.67749	2468.85200
31	ENVEQ MAX	1.00000	0.00000	318.52931	2402.01700
31	ENVEQ MIN	0.00000	-658.41618	-621.53324	0.00000
31	ENVEQ MIN	0.25000	-642.87030	-545.14882	0.00000
31	ENVEQ MIN	0.50000	-627.32443	-468.76440	0.00000
31	ENVEQ MIN	0.75000	-611.77855	-392.37998	0.00000
31	ENVEQ MIN	1.00000	-607.22696	-318.52630	0.00000
32	ENVEQ MAX	0.00000	0.00000	318.52892	2402.01700
32	ENVEQ MAX	0.25000	0.00000	392.38365	2468.85000
32	ENVEQ MAX	0.50000	0.00000	468.76807	2515.37200
32	ENVEQ MAX	0.75000	0.00000	545.15249	2541.58200
32	ENVEQ MAX	1.00000	0.00000	621.53691	2547.48100
32	ENVEQ MIN	0.00000	-607.22987	-318.52669	0.00000
32	ENVEQ MIN	0.25000	-611.77580	-266.67487	0.00000
32	ENVEQ MIN	0.50000	-627.32168	-229.33815	0.00000
32	ENVEQ MIN	0.75000	-642.86755	-192.37865	0.00000
32	ENVEQ MIN	1.00000	-658.41343	-155.41916	0.00000
33	ENVEQ MAX	0.00000	0.00000	621.53636	2547.48100
33	ENVEQ MAX	0.25000	0.00000	697.92078	2533.06800
33	ENVEQ MAX	0.50000	0.00000	774.30520	2498.34300
33	ENVEQ MAX	0.75000	0.00000	852.01923	2443.30700
33	ENVEQ MAX	1.00000	0.00000	930.97615	2367.95900
33	ENVEQ MIN	0.00000	-647.45111	-155.41956	0.00000
33	ENVEQ MIN	0.25000	-662.99698	-118.46007	0.00000
33	ENVEQ MIN	0.50000	-678.54286	-81.50058	0.00000
33	ENVEQ MIN	0.75000	-694.08873	-44.54108	0.00000
33	ENVEQ MIN	1.00000	-709.63461	-7.58159	0.00000
34	ENVEQ MAX	0.00000	0.00000	930.97588	2367.95900
34	ENVEQ MAX	0.25000	0.00000	1010.01000	2272.19600
34	ENVEQ MAX	0.50000	0.00000	1089.04300	2156.83700
34	ENVEQ MAX	0.75000	0.00000	1168.07700	2024.67700
34	ENVEQ MAX	1.00000	0.00000	1247.11000	1872.16500
34	ENVEQ MIN	0.00000	-698.70984	-7.58196	0.00000
34	ENVEQ MIN	0.25000	-714.27082	0.00000	-17.23631
34	ENVEQ MIN	0.50000	-729.83180	0.00000	-185.75124
34	ENVEQ MIN	0.75000	-745.39279	0.00000	-363.79249
34	ENVEQ MIN	1.00000	-760.95377	0.00000	-551.36005
35	ENVEQ MAX	0.00000	0.00000	1247.11000	1872.16500
35	ENVEQ MAX	0.25000	0.00000	1326.06700	1699.48000

FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	1405.02400	1506.48300
35	ENVEQ MAX	0.75000	0.00000	1483.98100	1293.17400
35	ENVEQ MAX	1.00000	0.00000	1562.93800	1105.76200
35	ENVEQ MIN	0.00000	-750.06943	0.00000	-551.36005
35	ENVEQ MIN	0.25000	-765.61531	0.00000	-748.25788
35	ENVEQ MIN	0.50000	-781.16118	0.00000	-954.66354
35	ENVEQ MIN	0.75000	-796.70706	0.00000	-1170.57700
35	ENVEQ MIN	1.00000	-812.25293	0.00000	-1457.64000
36	ENVEQ MAX	0.00000	0.00000	1562.93800	1105.76200
36	ENVEQ MAX	0.25000	0.00000	1617.26400	1047.77100
36	ENVEQ MAX	0.50000	0.00000	1671.59000	990.00046
36	ENVEQ MAX	0.75000	0.00000	1725.91600	927.72932
36	ENVEQ MAX	1.00000	0.00000	1780.24200	860.95709
36	ENVEQ MIN	0.00000	-801.41185	0.00000	-1457.64000
36	ENVEQ MIN	0.25000	-812.10814	0.00000	-1734.59600
36	ENVEQ MIN	0.50000	-822.80443	0.00000	-2020.85400
36	ENVEQ MIN	0.75000	-833.50072	0.00000	-2316.41500
36	ENVEQ MIN	1.00000	-844.19700	0.00000	-2621.27800
37	ENVEQ MAX	0.00000	0.00000	1780.24200	860.95709
37	ENVEQ MAX	0.25000	0.00000	1804.96900	829.19830
37	ENVEQ MAX	0.50000	0.00000	1829.89000	796.50264
37	ENVEQ MAX	0.75000	0.00000	1855.00400	762.85848
37	ENVEQ MAX	1.00000	0.00000	1880.31000	728.25420
37	ENVEQ MIN	0.00000	-844.19692	0.00000	-2621.27800
37	ENVEQ MIN	0.25000	-849.04651	0.00000	-2762.56800
37	ENVEQ MIN	0.50000	-853.89609	0.00000	-2907.78000
37	ENVEQ MIN	0.75000	-858.74568	0.00000	-3055.63500
37	ENVEQ MIN	1.00000	-863.59527	0.00000	-3205.51300
38	ENVEQ MAX	0.00000	0.00000	1880.31000	728.25420
38	ENVEQ MAX	0.25000	0.00000	1894.50600	708.53645
38	ENVEQ MAX	0.50000	0.00000	1908.76200	688.51452
38	ENVEQ MAX	0.75000	0.00000	1923.07800	668.18639
38	ENVEQ MAX	1.00000	0.00000	1937.45400	647.55003
38	ENVEQ MIN	0.00000	-852.79904	0.00000	-3205.51300
38	ENVEQ MIN	0.25000	-855.50333	0.00000	-3289.97400
38	ENVEQ MIN	0.50000	-858.20762	0.00000	-3375.07200
38	ENVEQ MIN	0.75000	-860.91191	0.00000	-3460.80900
38	ENVEQ MIN	1.00000	-863.61619	0.00000	-3547.18800
39	ENVEQ MAX	0.00000	0.00000	1937.45400	647.55003
39	ENVEQ MAX	0.08824	0.00000	1961.59900	612.26883
39	ENVEQ MAX	0.17647	0.00000	1985.74300	576.11620
39	ENVEQ MAX	0.26471	0.00000	2009.88800	539.09213
39	ENVEQ MAX	0.35294	0.00000	2034.03200	501.19663
39	ENVEQ MIN	0.00000	-863.61609	0.00000	-3547.18800
39	ENVEQ MIN	0.08824	-868.14841	0.00000	-3693.40200
39	ENVEQ MIN	0.17647	-872.68074	0.00000	-3841.42800
39	ENVEQ MIN	0.26471	-877.21306	0.00000	-3991.26400
39	ENVEQ MIN	0.35294	-881.74539	0.00000	-4142.91100
40	ENVEQ MAX	0.56250	0.00000	0.00000	228.56040
40	ENVEQ MAX	0.67188	0.00000	0.00000	232.16797
40	ENVEQ MAX	0.78125	0.00000	0.00000	234.96981
40	ENVEQ MAX	0.89063	0.00000	0.00000	236.98236
40	ENVEQ MAX	1.00000	0.00000	0.00000	238.22205
40	ENVEQ MIN	0.56250	-2226.64400	-900.53806	-4915.83600
40	ENVEQ MIN	0.67188	-2229.66800	-909.40286	-4837.24700
40	ENVEQ MIN	0.78125	-2232.69200	-918.07978	-4757.87100
40	ENVEQ MIN	0.89063	-2235.71600	-926.56883	-4677.72500
40	ENVEQ MIN	1.00000	-2238.74000	-934.87001	-4596.82700
41	ENVEQ MAX	0.00000	0.00000	0.00000	238.22205
41	ENVEQ MAX	0.25000	0.00000	0.60480	238.64031
41	ENVEQ MAX	0.50000	0.00000	15.12050	238.00952
41	ENVEQ MAX	0.75000	0.00000	33.76425	235.98188
41	ENVEQ MAX	1.00000	0.00000	56.53603	232.20962
41	ENVEQ MIN	0.00000	-2238.74000	-934.86989	-4596.82700
41	ENVEQ MIN	0.25000	-2241.54500	-944.83631	-4518.17600
41	ENVEQ MIN	0.50000	-2244.13800	-958.93077	-4438.49400
41	ENVEQ MIN	0.75000	-2246.51800	-977.15326	-4357.43500
41	ENVEQ MIN	1.00000	-2248.68500	-999.50380	-4274.64800
42	ENVEQ MAX	0.00000	0.00000	56.53603	232.20962
42	ENVEQ MAX	0.25000	0.00000	68.47666	229.66294
42	ENVEQ MAX	0.50000	0.00000	80.27340	226.63261
42	ENVEQ MAX	0.75000	0.00000	91.92625	223.12450
42	ENVEQ MAX	1.00000	0.00000	103.43521	219.14447
42	ENVEQ MIN	0.00000	-2185.03200	-817.83637	-4274.64800
42	ENVEQ MIN	0.25000	-2186.00400	-829.57324	-4241.29400
42	ENVEQ MIN	0.50000	-2186.92600	-841.16623	-4207.46000
42	ENVEQ MIN	0.75000	-2187.79800	-852.61533	-4173.15300
42	ENVEQ MIN	1.00000	-2188.62000	-863.92054	-4138.37800
43	ENVEQ MAX	0.00000	0.00000	103.43521	219.14447
43	ENVEQ MAX	0.25000	0.00000	169.09368	185.89789
43	ENVEQ MAX	0.50000	0.00000	229.52652	137.31545
43	ENVEQ MAX	0.75000	0.00000	284.73375	74.66829
43	ENVEQ MAX	1.00000	0.00000	334.71536	0.00000
43	ENVEQ MIN	0.00000	-2188.62000	-863.92046	-4138.37800
43	ENVEQ MIN	0.25000	-2193.37800	-928.36267	-3921.39100
43	ENVEQ MIN	0.50000	-2198.13600	-987.57927	-3689.21700
43	ENVEQ MIN	0.75000	-2202.89400	-1041.57000	-3443.12600
43	ENVEQ MIN	1.00000	-2207.65200	-1090.33600	-3184.39000
44	ENVEQ MAX	0.00000	0.00000	334.71536	0.00000
44	ENVEQ MAX	0.25000	0.00000	386.40523	0.00000
44	ENVEQ MAX	0.50000	0.00000	430.76912	0.00000
44	ENVEQ MAX	0.75000	0.00000	467.80704	0.00000
44	ENVEQ MAX	1.00000	0.00000	497.51898	0.00000
44	ENVEQ MIN	0.00000	-2144.69700	-921.19495	-3184.39000
44	ENVEQ MIN	0.25000	-2150.25700	-971.46357	-2915.83400
44	ENVEQ MIN	0.50000	-2155.81700	-1014.40600	-2633.82800
44	ENVEQ MIN	0.75000	-2161.37700	-1050.50300	-2340.45500
44	ENVEQ MIN	1.00000	-2166.93700	-1080.21500	-2037.79700
45	ENVEQ MAX	0.00000	0.00000	497.51898	0.00000
45	ENVEQ MAX	0.25000	0.00000	522.68648	0.00000
45	ENVEQ MAX	0.50000	0.00000	546.09105	0.00000
45	ENVEQ MAX	0.75000	0.00000	567.73271	0.00000
45	ENVEQ MAX	1.00000	0.00000	587.61145	22.27321
45	ENVEQ MIN	0.00000	-2104.67300	-937.17614	-2037.79700
45	ENVEQ MIN	0.25000	-2110.23300	-962.34364	-1772.69500
45	ENVEQ MIN	0.50000	-2115.79300	-985.74822	-1874.89100
45	ENVEQ MIN	0.75000	-2121.35300	-1007.39000	-1983.69100
45	ENVEQ MIN	1.00000	-2126.91300	-1027.26900	-2098.59400
46	ENVEQ MAX	0.00000	0.00000	587.64887	22.27321
46	ENVEQ MAX	0.25000	0.00000	605.55106	142.93412
46	ENVEQ MAX	0.50000	0.00000	621.29648	268.37300
46	ENVEQ MAX	0.75000	0.00000	634.88513	397.97732
46	ENVEQ MAX	1.00000	0.00000	646.31702	531.13455
46	ENVEQ MIN	0.00000	-1833.31900	-519.44704	-2098.59400
46	ENVEQ MIN	0.25000	-1838.87400	-537.34923	-2218.97200
46	ENVEQ MIN	0.50000	-1844.42900	-553.09465	-2344.33000
46	ENVEQ MIN	0.75000	-1849.98400	-566.68330	-2474.05400
46	ENVEQ MIN	1.00000	-1855.53900	-578.11519	-2607.53400
47	ENVEQ MAX	0.00000	0.00000	646.35764	531.13455
47	ENVEQ MAX	0.25000	0.00000	649.33207	546.59616
47	ENVEQ MAX	0.50000	0.00000	652.11254	562.30019
47	ENVEQ MAX	0.75000	0.00000	654.69905	578.23031
47	ENVEQ MAX	1.00000	0.00000	657.09159	594.37016
47	ENVEQ MIN	0.00000	-1618.52200	-262.59754	-2607.53400
47	ENVEQ MIN	0.25000	-1625.46700	-265.57197	-2647.76300
47	ENVEQ MIN	0.50000	-1632.41300	-268.35244	-2688.25200
47	ENVEQ MIN	0.75000	-1639.35800	-270.93895	-2728.98500
47	ENVEQ MIN	1.00000	-1646.30400	-273.33149	-2769.94600
48	ENVEQ MAX	0.00000	0.00000	657.09137	594.37016
48	ENVEQ MAX	0.13281	0.00000	659.83361	614.99835
48	ENVEQ MAX	0.26563	0.00000	662.27034	635.90167
48	ENVEQ MAX	0.39844	0.00000	664.40156	657.04765
48	ENVEQ MAX	0.53125	0.00000	666.22727	678.40386
48	ENVEQ MIN	0.00000	-1646.30400	-272.79257	-2769.94600
48	ENVEQ MIN	0.13281	-1655.06300	-275.53480	-2821.90300
48	ENVEQ MIN	0.26563	-1663.82300	-277.97153	-2874.76900
48	ENVEQ MIN	0.39844	-1672.58200	-280.10275	-2929.05600
48	ENVEQ MIN	0.53125	-1681.34100	-281.92846	-2983.75300

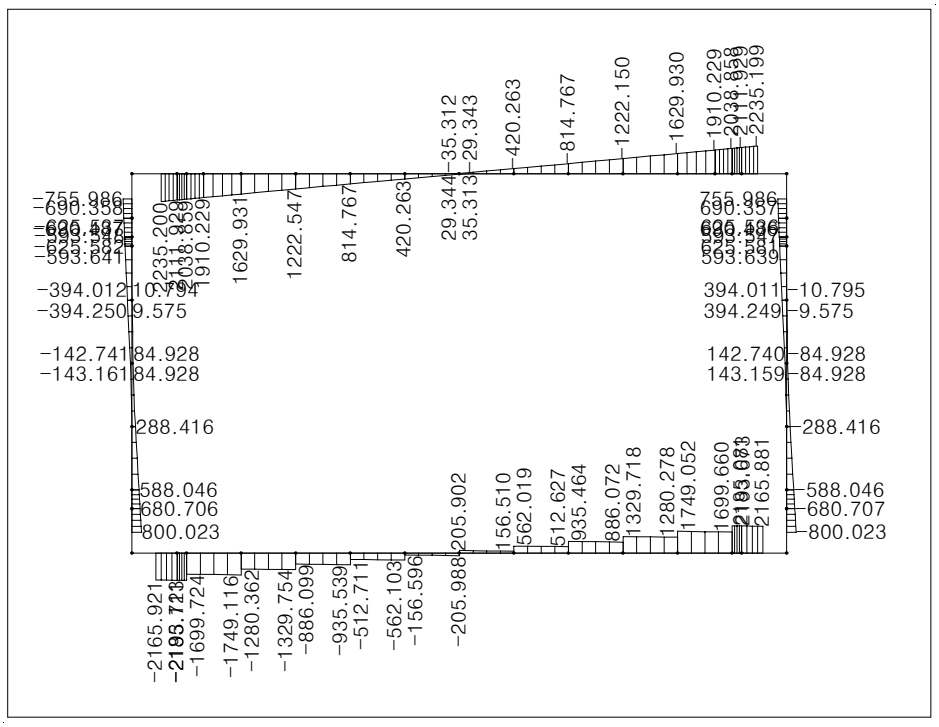
21. 단면력정리

21.1 상시

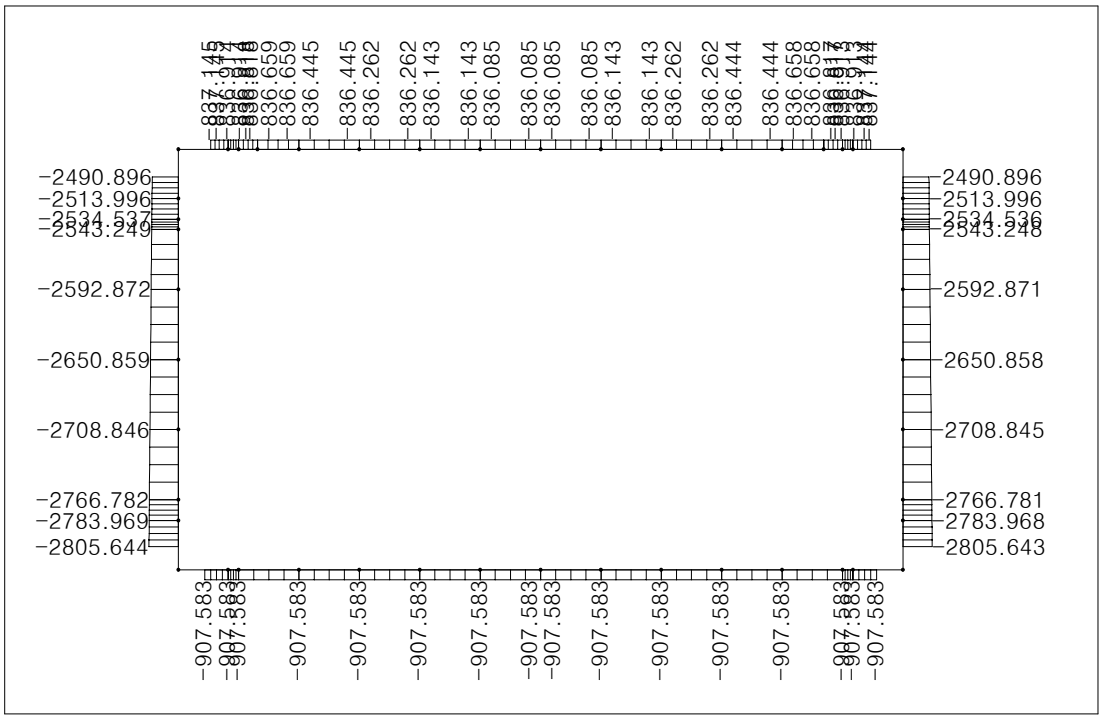
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



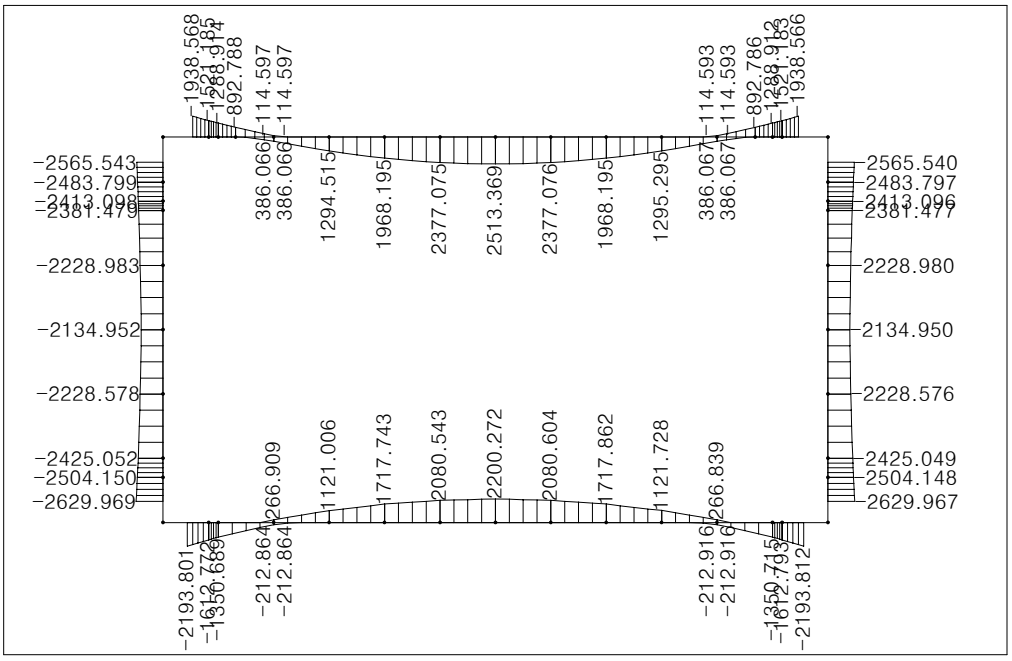
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

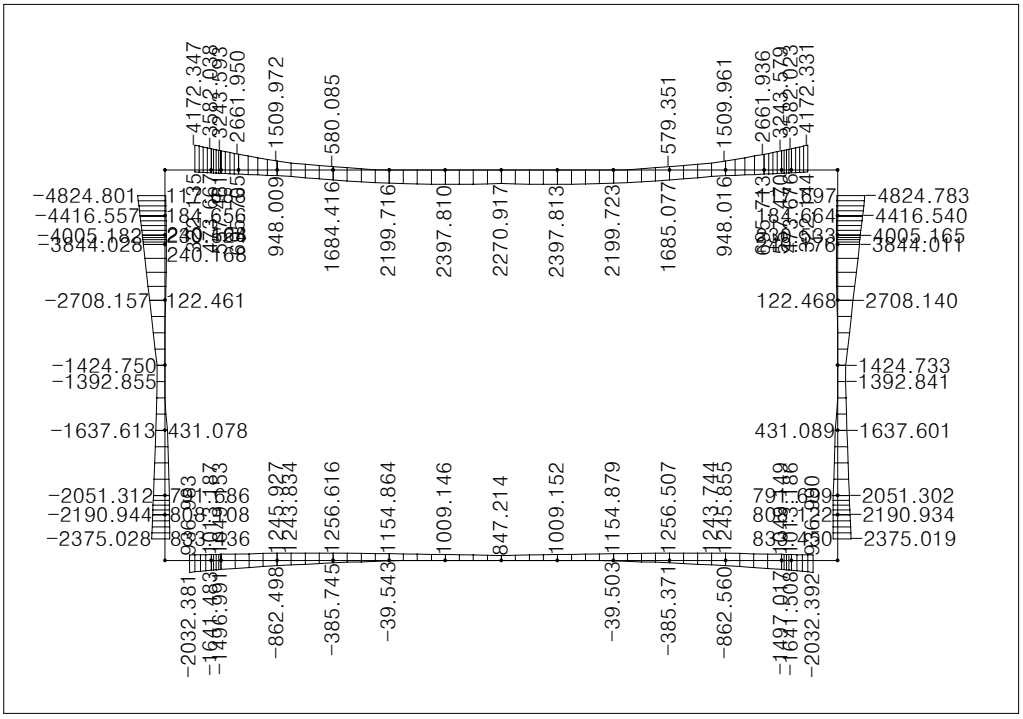


5) 단면력 정리

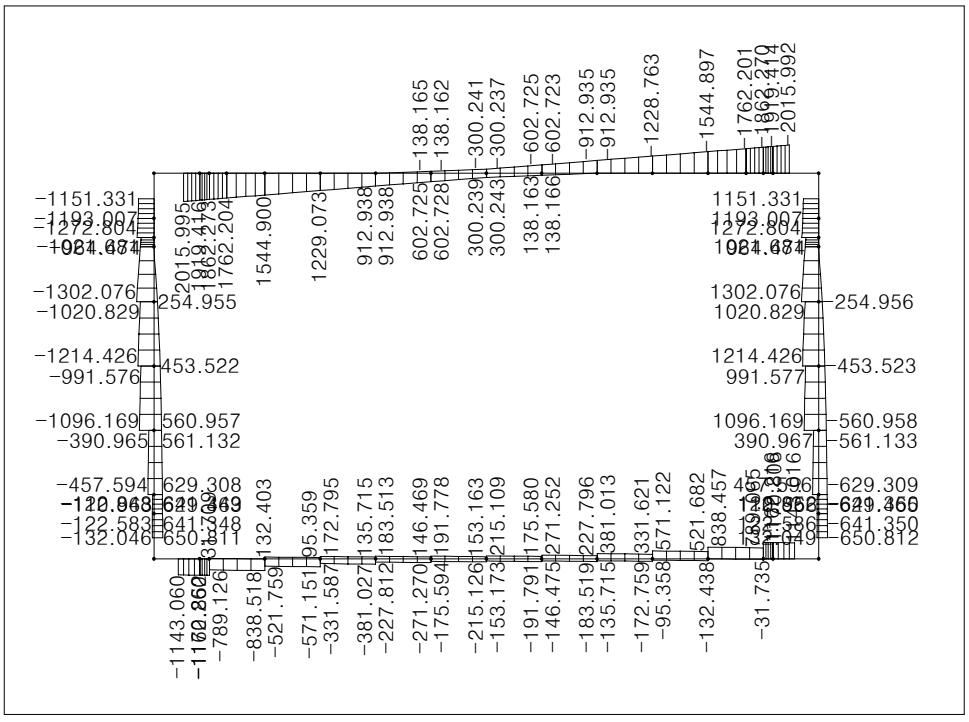
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	2380.07	1514.48	836.91	1521.19	1000.00	1766.67	
		중앙부	2	3726.23	35.31	836.09	2513.37	1000.00	1600.00	
		우측	3	2380.07	1514.36	836.91	1521.18	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	2309.14	1294.36	907.58	1612.77	1000.00	1600.00	
		측구부	5	672.80	2165.92	907.58	476.46	1000.00	1600.00	
		중앙부	6	3290.15	205.99	907.58	2200.27	1000.00	1600.00	
		우측	7	2309.17	1294.29	907.58	1612.79	1000.00	1600.00	
좌측 벽체	1 층	상부	8	3829.45	367.04	2514.00	2483.80	1000.00	1866.67	
		중앙부	9	0.00	511.30	2752.30	0.00	1000.00	1700.00	
		하부	10	3640.16	256.37	2783.97	2504.15	1000.00	1700.00	
우측 벽체	1 층	상부	11	3829.44	367.04	2514.00	2483.80	1000.00	1855.33	
		중앙부	12	0.00	511.30	2752.30	0.00	1000.00	1700.00	
		하부	13	3640.16	256.37	2783.97	2504.15	1000.00	1700.00	

21.2 지진시(기능수행)

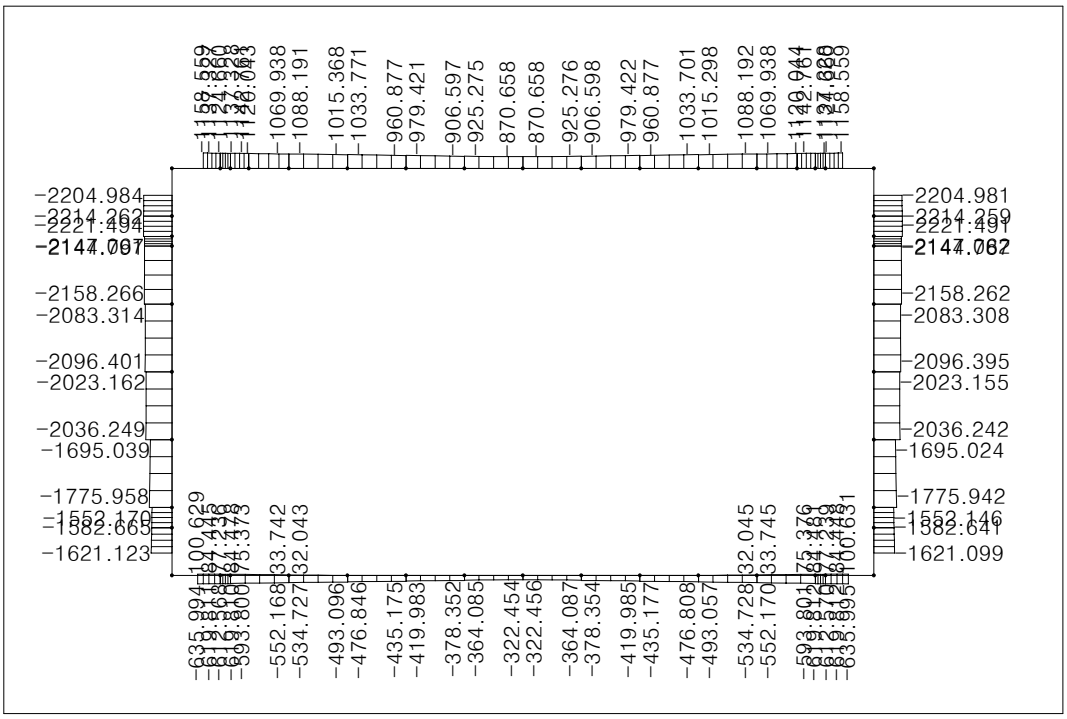
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

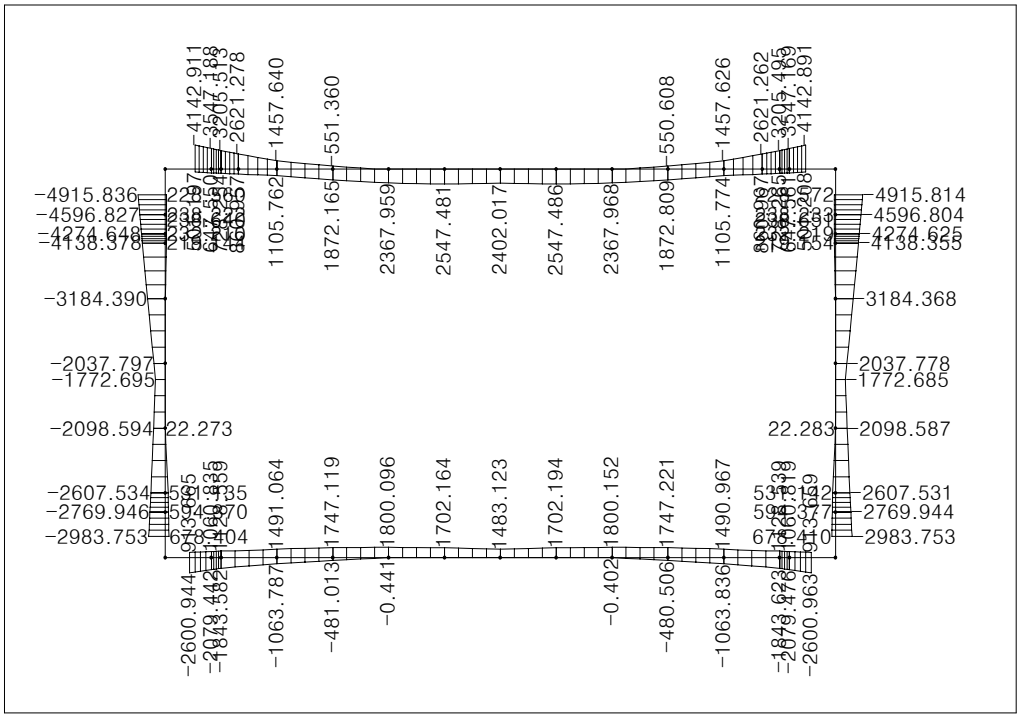


4) 단면력 정리

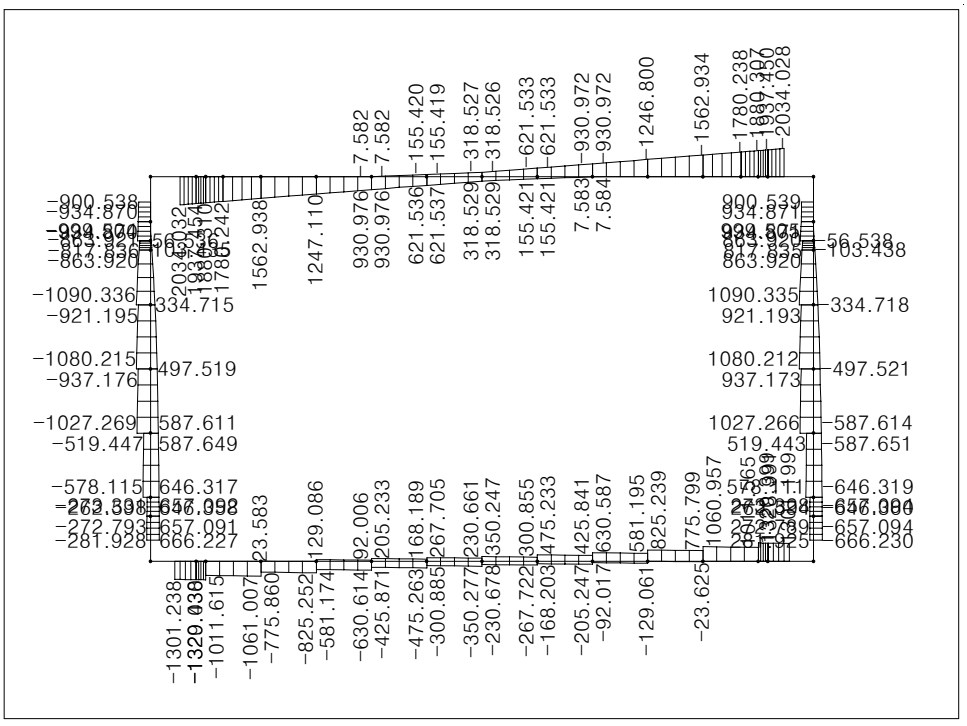
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	3582.04	1455.39	1137.33	1000.00	1766.67	
		중앙부	2	2270.92	300.24	871.26	1000.00	1600.00	
		우측	3	3582.02	1455.30	1137.33	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	1641.48	535.76	619.81	1000.00	1600.00	
		측구부	5	1243.83	1143.06	635.99	1000.00	1600.00	
		중앙부	6	847.21	215.13	322.45	1000.00	1600.00	
		우측	7	1641.51	535.69	619.81	1000.00	1600.00	
좌측 벽체	1 층	상부	8	4416.56	1048.47	2214.26	1000.00	1866.67	
		중앙부	9	694.66	616.31	1750.26	1000.00	1700.00	
		하부	10	2190.94	1085.99	1582.67	1000.00	1700.00	
우측 벽체	1 층	상부	11	4416.54	1048.47	2214.26	1000.00	1855.33	
		중앙부	12	694.67	616.31	1750.24	1000.00	1700.00	
		하부	13	2190.93	1085.99	1582.64	1000.00	1700.00	

21.3 지진시(붕괴방지)

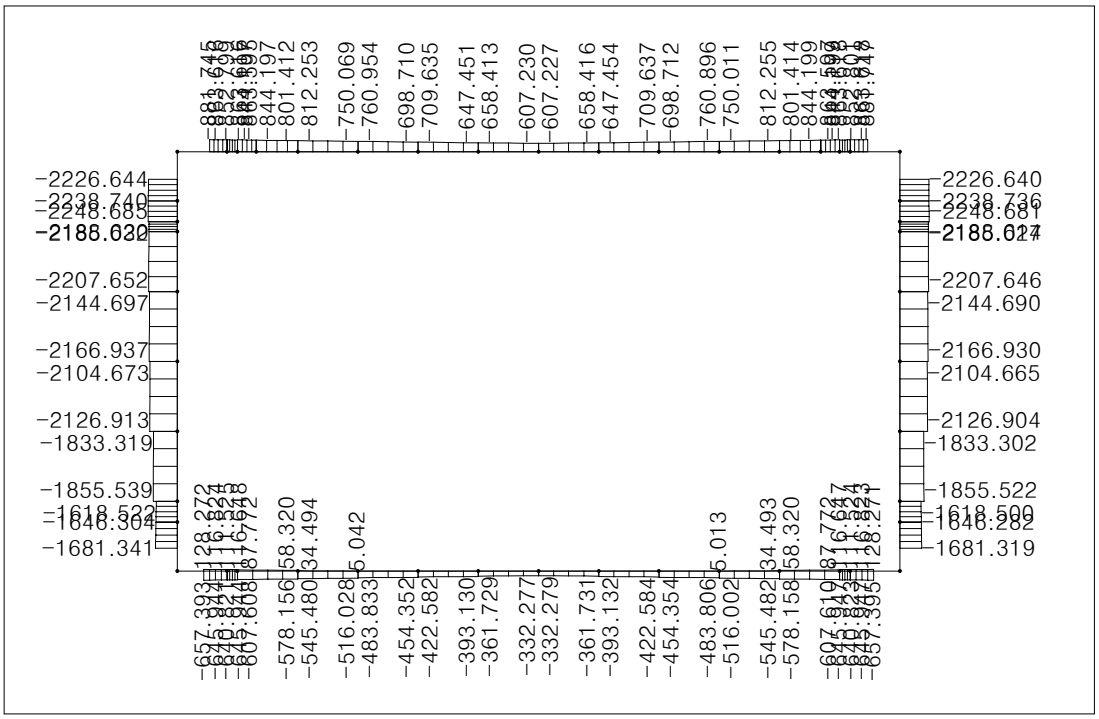
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	3547.19	1473.43	863.62	1000.00	1766.67	
		중앙부	2	2402.02	318.53	607.23	1000.00	1600.00	
		우측	3	3547.17	1473.34	863.62	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	2079.44	789.86	645.94	1000.00	1600.00	
		측구부	5	1548.38	1301.24	657.39	1000.00	1600.00	
		중앙부	6	1483.12	350.28	332.28	1000.00	1600.00	
		우측	7	2079.48	789.81	645.95	1000.00	1600.00	
좌측 벽체	1 층	상부	8	4596.83	943.60	2238.74	1000.00	1866.67	
		중앙부	9	397.98	634.89	1849.98	1000.00	1700.00	
		하부	10	2769.95	1018.41	1646.30	1000.00	1700.00	
우측 벽체	1 층	상부	11	4596.80	943.60	2238.74	1000.00	1855.33	
		중앙부	12	397.99	634.89	1849.97	1000.00	1700.00	
		하부	13	2769.94	1018.41	1646.28	1000.00	1700.00	

21.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-2380.07	-	-3547.19	-3582.04	-3582.04	
		중앙부	2	3726.23	-	2402.02	2270.92	3726.23	
		우측	3	-2380.07	-	-3547.17	-3582.02	-3582.02	
하부 슬래브	1 경간	좌측	4	-2309.14	-	-2079.44	-1641.48	-2309.14	
		측구부	5	672.80	-	1548.38	1243.83	1548.38	
		중앙부	6	3290.15	-	1483.12	847.21	3290.15	
		우측	7	-2309.17	-	-2079.48	-1641.51	-2309.17	
좌측 벽체	1 층	상부	8	-3829.45	-	-4596.83	-4416.56	-4596.83	
		중앙부	9	-	-	397.98	694.66	694.66	
		하부	10	-3640.16	-	-2769.95	-2190.94	-3640.16	
우측 벽체	1 층	상부	11	-3829.44	-	-4596.80	-4416.54	-4596.80	
		중앙부	12	-	-	397.99	694.67	694.67	
		하부	13	-3640.16	-	-2769.94	-2190.93	-3640.16	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	1514.48	-	1473.43	1455.39	1514.48	
		중앙부	2	35.31	-	318.53	300.24	318.53	
		우측	3	-1514.36	-	-1473.34	-1455.30	-1514.36	
하부 슬래브	1 경간	좌측	4	-1294.36	-	-789.86	-535.76	-1294.36	
		측구부	5	-2165.92	-	-1301.24	-1143.06	-2165.92	
		중앙부	6	-205.99	-	-350.28	-215.13	-350.28	
		우측	7	1294.29	-	789.81	535.69	1294.29	
좌측 벽체	1 층	상부	8	-367.04	-	-943.60	-1048.47	-1048.47	
		중앙부	9	511.30	-	634.89	616.31	634.89	
		하부	10	256.37	-	-1018.41	-1085.99	-1085.99	
우측 벽체	1 층	상부	11	367.04	-	943.60	1048.47	1048.47	
		중앙부	12	-511.30	-	-634.89	-616.31	-634.89	
		하부	13	-256.37	-	1018.41	1085.99	1085.99	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-836.91	-	-863.62	-1137.33	-1137.33	
		중앙부	2	-836.09	-	-607.23	-871.26	-871.26	
		우측	3	-836.91	-	-863.62	-1137.33	-1137.33	
하부 슬래브	1 경간	좌측	4	-907.58	-	-645.94	-619.81	-907.58	
		측구부	5	-907.58	-	-657.39	-635.99	-907.58	
		중앙부	6	-907.58	-	-332.28	-322.45	-907.58	
		우측	7	-907.58	-	-645.95	-619.81	-907.58	
좌측 벽체	1 층	상부	8	-2514.00	-	-2238.74	-2214.26	-2514.00	
		중앙부	9	-2752.30	-	-1849.98	-1750.26	-2752.30	
		하부	10	-2783.97	-	-1646.30	-1582.67	-2783.97	
우측 벽체	1 층	상부	11	-2514.00	-	-2238.74	-2214.26	-2514.00	
		중앙부	12	-2752.30	-	-1849.97	-1750.24	-2752.30	
		하부	13	-2783.97	-	-1646.28	-1582.64	-2783.97	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-1521.19	-	-	-	-1521.19	
		중앙부	2	2513.37	-	-	-	2513.37	
		우측	3	-1521.18	-	-	-	-1521.18	
하부 슬래브	1 경간	좌측	4	-1612.77	-	-	-	-1612.77	
		측구부	5	476.46	-	-	-	476.46	
		중앙부	6	2200.27	-	-	-	2200.27	
		우측	7	-1612.79	-	-	-	-1612.79	
좌측 벽체	1 층	상부	8	-2483.80	-	-	-	-2483.80	
		중앙부	9	-	-	-	-	-	
		하부	10	-2504.15	-	-	-	-2504.15	
우측 벽체	1 층	상부	11	-2483.80	-	-	-	-2483.80	
		중앙부	12	-	-	-	-	-	
		하부	13	-2504.15	-	-	-	-2504.15	

22. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1638	3582.04	4733.19	6669.03	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.32
		중앙부	2	1000	1491	3726.23	4288.22	7695.53	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.15
		우측	3	1000	1638	3582.02	4733.19	6669.00	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.32
하부슬래브	1경간	좌측	4	1000	1467	2309.14	3668.05	4765.57	H29 - 8.0EA + H29 - 4.0EA	7708.80	1.59
		측구부	5	1000	1210	1548.38	2036.01	3871.63	H29 - 8.0EA	5139.20	1.31
		중앙부	6	1000	1496	3290.15	4053.99	6733.47	H32 - 8.0EA + H25 - 4.0EA	8380.40	1.23
		우측	7	1000	1467	2309.17	3668.05	4765.63	H29 - 8.0EA + H29 - 4.0EA	7708.80	1.59
좌측벽체	1층	상부	8	1000	1738	4596.83	5036.58	8109.46	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.10
		중앙부	9	1000	1620	694.66	2184.04	1269.85	H25 - 8.0EA	4053.60	3.14
		하부	10	1000	1567	3640.16	3930.14	7115.47	H29 - 8.0EA + H29 - 4.0EA	7708.80	1.08
우측벽체	1층	상부	11	1000	1727	4596.80	5002.20	8167.41	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.09
		중앙부	12	1000	1620	694.67	2184.04	1269.87	H25 - 8.0EA	4053.60	3.14
		하부	13	1000	1567	3640.16	3930.14	7115.46	H29 - 8.0EA + H29 - 4.0EA	7708.80	1.08

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	955.6	1514.5	1701.18	2.00	189.95	H13	150	253.40	O.K
		중앙부	2	968.6	318.5	1346.44	2.00	-	H13	300	253.40	O.K
		우측	3	955.6	1514.4	1701.18	2.00	189.91	H13	150	253.40	O.K
하부슬래브	1경간	좌측	4	952.6	1294.4	1695.93	2.00	116.50	H13	150	253.40	O.K
		중앙부	6	971.6	350.3	1350.60	2.00	-	H13	300	253.40	O.K
		우측	7	952.6	1294.3	1695.93	2.00	116.48	H13	150	253.40	O.K
좌측벽체	1층	상부	8	1020.5	1048.5	1644.61	2.00	17.78	H16	300	397.20	O.K
		중앙부	9	1052.2	634.9	1695.68	2.00	-	H16	300	397.20	O.K
		하부	10	1017.6	1086.0	1639.86	2.00	43.66	H16	300	397.20	O.K
우측벽체	1층	상부	11	1020.5	1048.5	1644.61	2.00	17.78	H16	300	397.20	O.K
		중앙부	12	1052.2	634.9	1695.68	2.00	-	H16	300	397.20	O.K
		하부	13	1017.6	1086.0	1639.86	2.00	43.66	H16	300	397.20	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1637.87	100.00	3582.04	1514.48

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 182.970) / 182.970 = 0.02433

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 6669.025 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.338]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00545

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1637.87 - a/2) = 4733.192 kN.m

≥ Mu (= 3582.038 kN.m) ∴ O.K [안전률 1.321]

* 전단에 대한 검토 (d = 1471.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1471.20 = 955.574 kN

< Vu (= 1514.477 kN) , 전단보강 필요.

Av_req = (1514.477-955.574) x 150.00 / (400x1471.20xΦ) x 1000 = 189.947 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 1471.20 / 150.00 x 1000 = 994.141 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1471.20 / 1000 = 5096.397 kN ≥ 994.141 kN ∴ O.K

ΦVn = 0.75 x (1274.099 + 994.141) = 1701.180 kN ≥ 1514.477 kN ∴ O.K

▣ TITLE : 상부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1491.20	80.00	3726.23	318.53

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 182.970) / 182.970 = 0.02192

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 7695.527 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 108.8 mm), [사용률 = 1.160]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00598

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1491.20 - a/2) = 4288.222 kN.m

≥ Mu (= 3726.232 kN.m) ∴ O.K [안전률 1.151]

* 전단에 대한 검토 (d = 1491.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1491.20 = 968.565 kN

≥ Vu (= 318.529 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1637.87	100.00	3582.02	1514.36

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 182.970) / 182.970 = 0.02433

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 6668.996 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.338]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00545

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1637.87 - a/2) = 4733.192 kN.m

≥ Mu (= 3582.023 kN.m) ∴ O.K [안전률 1.321]

* 전단에 대한 검토 (d = 1471.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1471.20 = 955.574 kN

< Vu (= 1514.364 kN) , 전단보강 필요.

Av_req = (1514.364-955.574) x 150.00 / (400x1471.20xΦ) x 1000 = 189.909 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 1471.20 / 150.00 x 1000 = 994.141 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1471.20 / 1000 = 5096.397 kN ≥ 994.141 kN ∴ O.K

ΦVn = 0.75 x (1274.099 + 994.141) = 1701.180 kN ≥ 1514.364 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1466.67	100.00	2309.14	1294.36

* 강도감소계수(Φ) 산정

T = As x fy = 7708.800 x 400.00 = 3083520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 134.358 mm, c = 134.358 / β1 = 134.358 / 0.85 = 158.068 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1500.00 - 158.068) / 158.068 = 0.02547

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4765.566 \text{ mm}^2$$

* 사용철근량 = 7708.8 mm² (철근도심 : 133.3 mm), [사용률 = 1.618]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00526

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 134.358 mm

ΦMn = 0.85 x 7708.800 x 400 x (1466.67 - a/2) = 3668.046 kN.m

≥ Mu (= 2309.138 kN.m) ∴ O.K [안전률 1.588]

* 전단에 대한 검토 (d = 1466.67 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1466.67 = 952.628 kN

< Vu (= 1294.360 kN) , 전단보강 필요.

Av_req = (1294.360-952.628) x 150.00 / (400x1466.67xΦ) x 1000 = 116.500 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 1466.67 / 150.00 x 1000 = 991.076 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1466.67 / 1000 = 5080.682 kN ≥ 991.076 kN ∴ O.K

ΦVn = 0.75 x (1270.171 + 991.076) = 1695.935 kN ≥ 1294.360 kN ∴ O.K

▣ TITLE : 하부슬래브 측구부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1290.00	1210.00	80.00	1548.38	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1210.00 - 105.379) / 105.379 = 0.03145

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3871.635 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm), [사용률 = 1.327]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00425

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1210.00 - a/2) = 2036.011 kN.m

≥ Mu (= 1548.377 kN.m) ∴ O.K [안전률 1.315]

▣ TITLE : 하부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1495.82	80.00	3290.15	350.28

* 강도감소계수(Φ) 산정

T = As x fy = 8380.400 x 400.00 = 3352160.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 146.064 mm, c = 146.064 / β1 = 146.064 / 0.85 = 171.840 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 171.840) / 171.840 = 0.02354

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 6733.466 \text{ mm}^2$$

* 사용철근량 = 8380.4 mm² (철근도심 : 104.2 mm), [사용률 = 1.245]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H25 - 4.0 EA (= 2026.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00560

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 146.064 mm

ΦMn = 0.85 x 8380.400 x 400 x (1495.81 - a/2) = 4053.987 kN.m

≥ Mu (= 3290.147 kN.m) ∴ O.K [안전률 1.232]

* 전단에 대한 검토 (d = 1495.81 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1495.81 = 971.560 kN

≥ Vu (= 350.277 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1466.67	100.00	2309.17	1294.29

* 강도감소계수(Φ) 산정

T = As x fy = 7708.800 x 400.00 = 3083520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 134.358 mm, c = 134.358 / β1 = 134.358 / 0.85 = 158.068 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1500.00 - 158.068) / 158.068 = 0.02547

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4765.631 \text{ mm}^2$$

* 사용철근량 = 7708.8 mm² (철근도심 : 133.3 mm), [사용률 = 1.618]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00526

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 134.358 mm

ΦMn = 0.85 x 7708.800 x 400 x (1466.67 - a/2) = 3668.046 kN.m

≥ Mu (= 2309.169 kN.m) ∴ O.K [안전률 1.588]

* 전단에 대한 검토 (d = 1466.67 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1466.67 = 952.628 kN

< Vu (= 1294.289 kN) , 전단보강 필요.

Av_req = (1294.289-952.628) x 150.00 / (400x1466.67xΦ) x 1000 = 116.476 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 1466.67 / 150.00 x 1000 = 991.076 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1466.67 / 1000 = 5080.682 kN ≥ 991.076 kN ∴ O.K

ΦVn = 0.75 x (1270.171 + 991.076) = 1695.935 kN ≥ 1294.289 kN ∴ O.K

▣ TITLE : 좌측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1866.67	1737.87	100.00	4596.83	1048.47

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1766.67 - 182.970) / 182.970 = 0.02597

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 8109.457 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.100]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00513

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1737.87 - a/2) = 5036.581 kN.m

≥ Mu (= 4596.827 kN.m) ∴ O.K [안전률 1.096]

* 전단에 대한 검토 (d = 1571.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1571.20 = 1020.526 kN

< Vu (= 1048.467 kN) , 전단보강 필요.

Av_req = (1048.467-1020.526) x 300.00 / (400x1571.20xΦ) x 1000 = 17.783 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1571.20 / 300.00 x 1000 = 832.109 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1571.20 / 1000 = 5442.807 kN ≥ 832.109 kN ∴ O.K

ΦVn = 0.75 x (1360.702 + 832.109) = 1644.608 kN ≥ 1048.467 kN ∴ O.K

▣ TITLE : 좌측벽체 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1700.00	1620.00	80.00	694.66	634.89

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1620.00 - 83.119) / 83.119 = 0.05547

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1269.851 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 3.192]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00250

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1620.00 - a/2) = 2184.036 kN.m

≥ Mu (= 694.656 kN.m) ∴ O.K [안전률 3.144]

* 전단에 대한 검토 (d = 1620.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1620.00 = 1052.221 kN

≥ Vu (= 634.885 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1700.00	1566.67	100.00	3640.16	1085.99

* 강도감소계수(Φ) 산정

T = As x fy = 7708.800 x 400.00 = 3083520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 134.358 mm, c = 134.358 / β1 = 134.358 / 0.85 = 158.068 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1600.00 - 158.068) / 158.068 = 0.02737

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 7115.472 \text{ mm}^2$$

* 사용철근량 = 7708.8 mm² (철근도심 : 133.3 mm), [사용률 = 1.083]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00492

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 134.358 mm

ΦMn = 0.85 x 7708.800 x 400 x (1566.67 - a/2) = 3930.145 kN.m

≥ Mu (= 3640.160 kN.m) ∴ O.K [안전률 1.080]

* 전단에 대한 검토 (d = 1566.67 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1566.67 = 1017.580 kN

< Vu (= 1085.987 kN) , 전단보강 필요.

Av_req = (1085.987-1017.580) x 300.00 / (400x1566.67xΦ) x 1000 = 43.664 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1566.67 / 300.00 x 1000 = 829.707 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1566.67 / 1000 = 5427.093 kN ≥ 829.707 kN ∴ O.K

ΦVn = 0.75 x (1356.773 + 829.707) = 1639.860 kN ≥ 1085.987 kN ∴ O.K

▣ TITLE : 우측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1855.33	1726.54	100.00	4596.80	1048.47

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1755.33 - 182.970) / 182.970 = 0.02578

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 8167.411 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.093]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00517

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1726.54 - a/2) = 5002.197 kN.m

≥ Mu (= 4596.804 kN.m) ∴ O.K [안전률 1.088]

* 전단에 대한 검토 (d = 1571.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1571.20 = 1020.526 kN

< Vu (= 1048.467 kN) , 전단보강 필요.

Av_req = (1048.467-1020.526) x 300.00 / (400x1571.20xΦ) x 1000 = 17.783 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1571.20 / 300.00 x 1000 = 832.109 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1571.20 / 1000 = 5442.807 kN ≥ 832.109 kN ∴ O.K

ΦVn = 0.75 x (1360.702 + 832.109) = 1644.608 kN ≥ 1048.467 kN ∴ O.K

▣ TITLE : 우측벽체 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1700.00	1620.00	80.00	694.67	634.89

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1620.00 - 83.119) / 83.119 = 0.05547

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1269.873 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 3.192]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00250

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1620.00 - a/2) = 2184.036 kN.m

≥ Mu (= 694.668 kN.m) ∴ O.K [안전률 3.144]

* 전단에 대한 검토 (d = 1620.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1620.00 = 1052.221 kN

≥ Vu (= 634.888 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1700.00	1566.67	100.00	3640.16	1085.99

* 강도감소계수(Φ) 산정

T = As x fy = 7708.800 x 400.00 = 3083520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 134.358 mm, c = 134.358 / β1 = 134.358 / 0.85 = 158.068 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1600.00 - 158.068) / 158.068 = 0.02737

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 7115.464 \text{ mm}^2$$

* 사용철근량 = 7708.8 mm² (철근도심 : 133.3 mm) , [사용률 = 1.083]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00492

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 134.358 mm

ΦMn = 0.85 x 7708.800 x 400 x (1566.67 - a/2) = 3930.145 kN.m

≥ Mu (= 3640.156 kN.m) ∴ O.K [안전률 1.080]

* 전단에 대한 검토 (d = 1566.67 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1566.67 = 1017.580 kN

< Vu (= 1085.987 kN) , 전단보강 필요.

Av_req = (1085.987-1017.580) x 300.00 / (400x1566.67xΦ) x 1000 = 43.664 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1566.67 / 300.00 x 1000 = 829.707 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1566.67 / 1000 = 5427.093 kN ≥ 829.707 kN ∴ O.K

ΦVn = 0.75 x (1356.773 + 829.707) = 1639.860 kN ≥ 1085.987 kN ∴ O.K

23. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1784.640 ∴ O.K

2) 상부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1784.640 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1784.640 ∴ O.K

4) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 7708.800 × 0.20 = 1541.76 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1541.760 ∴ O.K

6) 하부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 3.3EA = 3308.676 ㎟ ≥ 1800.000 ∴ O.K
H16 - 13.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 8380.400 × 0.20 = 1676.08 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1676.080 ∴ O.K

7) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 16.7EA = 4635.324 ㎟ ≥ 1800.000 ∴ O.K
H16 - 6.7EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 7708.800 × 0.20 = 1541.76 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1541.760 ∴ O.K

8) 좌측벽체 : 상부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H19 - 6.7EA = 1910.955 ㎟ ≥ 1784.640 ∴ O.K

9) 좌측벽체 : 중앙부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H19 - 3.3EA = 954.045 ㎟ ≥ 810.720 ∴ O.K

10) 좌측벽체 : 하부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 7708.800 × 0.20 = 1541.76 ㎟

∴ Used As = H19 - 6.7EA = 1910.955 ㎟ ≥ 1541.760 ∴ O.K

11) 우측벽체 : 상부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H19 - 6.7EA = 1910.955 ㎟ ≥ 1784.640 ∴ O.K

12) 우측벽체 : 중앙부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H19 - 3.3EA = 954.045 ㎟ ≥ 810.720 ∴ O.K

13) 우측벽체 : 하부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

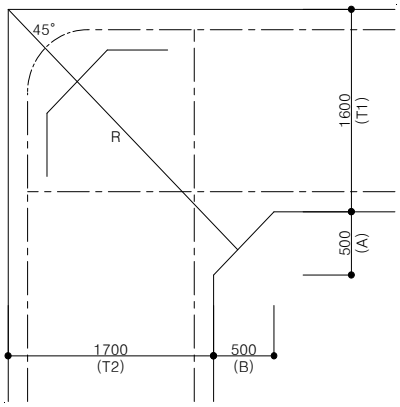
∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 7708.800 × 0.20 = 1541.76 ㎟

∴ Used As = H19 - 6.7EA = 1910.955 ㎟ ≥ 1541.760 ∴ O.K

24. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 2565.543 kN.m
- 절점부 휨모멘트 : Mo = 2565.543 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 2687.006 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

∴ Total Asb = 3176.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 2565.54 \times 10^6}{2687.006^2 \times 1000} = 1.777 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 2565.54 \times 10^6}{2687.006 \times 180} = 10608.847 \text{ mm}$$

Asb = 3176.800 mm²

Req'd As = As - Asb

= 10608.847 mm² - 3176.800 mm²

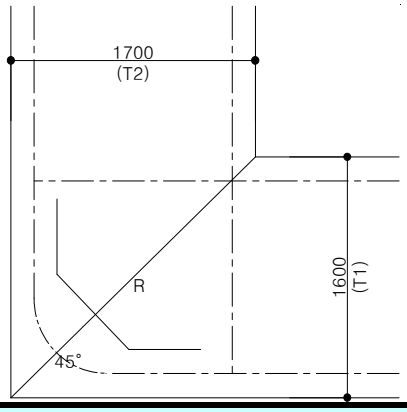
= 7432.047 mm²

- 사용보강철근

Use'd As = H29 - 8EA , H29 - 8EA

∴ Total As = 10278.400 mm² > Req'd As (= 7432.047 mm²) ----------> O.K !!!

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 2629.969 kN.m
- 절점부 휨모멘트 : Mo = 2629.969 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 2334.524$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 2629.97 \times 10^6}{2334.524^2 \times 1000} = 2.413 \text{ MPa} > 0.13\sqrt{fck}\ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 2629.97 \times 10^6}{2334.524 \times 180} = 12517.277 \text{ mm}$$

Asb = 2569.600 mm²

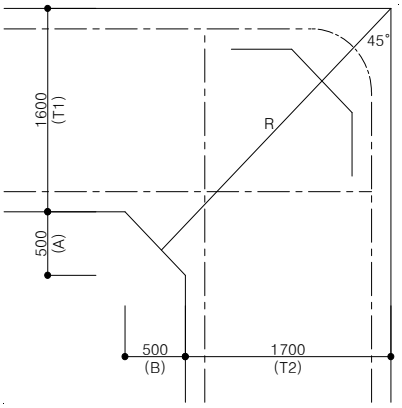
Req'd As = As - Asb
= 12517.277 mm² - 2569.600 mm²
= 9947.677 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H25 - 8EA

∴ Total As = 10407.200 mm² > Req'd As (= 9947.677 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 2565.540 kN.m
- 절점부 휨모멘트 : Mo = 2565.540 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 2687.006 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

∴ Total Asb = 3176.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 2565.54 \times 10^6}{2687.006^2 \times 1000} = 1.777 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 2565.54 \times 10^6}{2687.006 \times 180} = 10608.835 \text{ mm}$$

Asb = 3176.800 mm²

Req'd As = As - Asb

= 10608.835 mm² - 3176.800 mm²

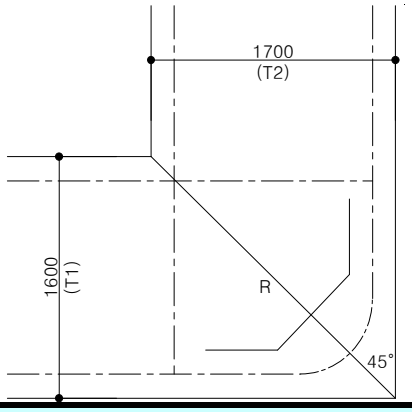
= 7432.035 mm²

- 사용보강철근

Use'd As = H29 - 8EA , H29 - 8EA

∴ Total As = 10278.400 mm² > Req'd As (= 7432.035 mm²) ----------> O.K !!!

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 2629.967 kN.m
- 절점부 휨모멘트 : Mo = 2629.967 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 2334.524$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 2629.97 \times 10^6}{2334.524^2 \times 1000} = 2.413 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 2629.97 \times 10^6}{2334.524 \times 180} = 12517.268 \text{ mm}$$

Asb = 2569.600 mm²

Req'd As = As - Asb
= 12517.268 mm² - 2569.600 mm²
= 9947.668 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H25 - 8EA

∴ Total As = 10407.200 mm² > Req'd As (= 9947.668 mm²) ----------> O.K !!!

25. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 ㎜)

구분	부재 위치			유효높이 (㎜)	인장사용철근량	철근 간격(㎜)	최대 간격 (㎜)	검토 결과	S.F
상부슬래브	1경간	좌측	1	1638	H32 - 8.0EA + H29 - 4.0EA	125	485.909	O.K	3.887
		중앙부	2	1491	H32 - 8.0EA + H29 - 4.0EA	125	222.097	O.K	1.777
		우측	3	1638	H32 - 8.0EA + H29 - 4.0EA	125	485.910	O.K	3.887
하부슬래브	1경간	좌측	4	1467	H29 - 8.0EA + H29 - 4.0EA	125	294.717	O.K	2.358
		측구부	5	1210	H29 - 8.0EA	125	763.050	O.K	6.104
		중앙부	6	1496	H32 - 8.0EA + H25 - 4.0EA	125	252.231	O.K	2.018
		우측	7	1467	H29 - 8.0EA + H29 - 4.0EA	125	294.710	O.K	2.358
좌측벽체	1층	상부	8	1738	H32 - 8.0EA + H29 - 4.0EA	125	243.225	O.K	1.946
		중앙부	9	1620	H25 - 8.0EA	-	-	-	-
		하부	10	1567	H29 - 8.0EA + H29 - 4.0EA	125	136.897	O.K	1.095
우측벽체	1층	상부	11	1727	H32 - 8.0EA + H29 - 4.0EA	125	240.161	O.K	1.921
		중앙부	12	1620	H25 - 8.0EA	-	-	-	-
		하부	13	1567	H29 - 8.0EA + H29 - 4.0EA	125	136.897	O.K	1.095

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1521.185 x 1000000 / [8923.200 x (1637.870 - 394.169/3)]
= 113.161 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1637.9/(7x8923.200)]
= 394.169 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 113.16) - 2.5 x 84.00 = 485.91 mm
300 x (Kcr / fs) = 300 x (210 / 113.16) = 556.73 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 485.91 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 485.91 mm) ∴ O.K

2) 상부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2513.369 x 1000000 / [8923.200 x (1491.203 - 373.645/3)]
= 206.099 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1491.2/(7x8923.200)]
= 373.645 mm

사용철근량 = 8923.2 mm² (철근도심 : 108.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 206.10) - 2.5 x 64.00 = 222.10 mm
300 x (Kcr / fs) = 300 x (210 / 206.10) = 305.68 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 222.10 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 222.10 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1521.183 x 1000000 / [8923.200 x (1637.870 - 394.169/3)]
= 113.161 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1637.9/(7x8923.200)]
= 394.169 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 113.16) - 2.5 x 84.00 = 485.91 mm
300 x (Kcr / fs) = 300 x (210 / 113.16) = 556.73 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 485.91 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 485.91 mm) ∴ O.K

4) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1612.772 x 1000000 / [7708.800 x (1466.667 - 347.535/3)]
= 154.877 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7708.800/1000.0 + 7x7708.800/1000.0 x √[(1 + 2x1000.0x1466.7/(7x7708.800)]
= 347.535 mm

사용철근량 = 7708.8 mm² (철근도심 : 133.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 154.88) - 2.5 x 85.50 = 294.72 mm
300 x (Kcr / fs) = 300 x (210 / 154.88) = 406.77 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 294.72 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 294.72 mm) ∴ O.K

5) 하부슬래브 측구부

① 응력 산정

fs = M / [As x (d - χ/3)] = 476.462 x 1000000 / [5139.200 x (1210.000 - 261.267/3)]
= 82.563 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1210.0/(7x5139.200)]
= 261.267 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 82.56) - 2.5 x 65.50 = 790.06 mm
300 x (Kcr / fs) = 300 x (210 / 82.56) = 763.05 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 763.05 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 763.05 mm) ∴ O.K

6) 하부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2200.272 x 1000000 / [8380.400 x (1495.815 - 364.349/3)]
= 191.033 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8380.400/1000.0 + 7x8380.400/1000.0 x √[(1 + 2x1000.0x1495.8/(7x8380.400)]
= 364.349 mm

사용철근량 = 8380.4 mm² (철근도심 : 104.2 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H25 - 4.0 EA (= 2026.8 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 191.03) - 2.5 x 64.00 = 252.23 mm
300 x (Kcr / fs) = 300 x (210 / 191.03) = 329.79 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 252.23 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 252.23 mm) ∴ O.K

7) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1612.793 x 1000000 / [7708.800 x (1466.667 - 347.535/3)]
= 154.879 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7708.800/1000.0 + 7x7708.800/1000.0 x √[(1 + 2x1000.0x1466.7/(7x7708.800)]
= 347.535 mm

사용철근량 = 7708.8 mm² (철근도심 : 133.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 154.88) - 2.5 x 85.50 = 294.71 mm
300 x (Kcr / fs) = 300 x (210 / 154.88) = 406.77 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 294.71 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 294.71 mm) ∴ O.K

8) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2483.799 x 1000000 / [8923.200 x (1737.870 - 407.649/3)]
= 173.755 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1737.9/(7x8923.200)]
= 407.649 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 173.75) - 2.5 x 84.00 = 243.22 mm
300 x (Kcr / fs) = 300 x (210 / 173.75) = 362.58 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 243.22 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 243.22 mm) ∴ O.K

9) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2504.150 x 1000000 / [7708.800 x (1566.667 - 360.757/3)]
= 224.585 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7708.800/1000.0 + 7x7708.800/1000.0 x √[(1 + 2x1000.0x1566.7/(7x7708.800)]
= 360.757 mm

사용철근량 = 7708.8 mm² (철근도심 : 133.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 224.59) - 2.5 x 85.50 = 136.90 mm
300 x (Kcr / fs) = 300 x (210 / 224.59) = 280.52 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 136.90 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 136.90 mm) ∴ O.K

10) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2483.797 x 1000000 / [8923.200 x (1726.536 - 406.141/3)]
= 174.937 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1726.5/(7x8923.200)]
= 406.141 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 174.94) - 2.5 x 84.00 = 240.16 mm
300 x (Kcr / fs) = 300 x (210 / 174.94) = 360.13 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 240.16 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 240.16 mm) ∴ O.K

11) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2504.148 x 1000000 / [7708.800 x (1566.667 - 360.757/3)]
= 224.585 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7708.800/1000.0 + 7x7708.800/1000.0 x √[(1 + 2x1000.0x1566.7/(7x7708.800)]
= 360.757 mm

사용철근량 = 7708.8 mm² (철근도심 : 133.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 224.58) - 2.5 x 85.50 = 136.90 mm
300 x (Kcr / fs) = 300 x (210 / 224.58) = 280.52 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 136.90 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 136.90 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 12.350 m
- fy = 400 MPa
- 부재두께(T) = 1.60 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28
T = 12.350 / 28
T = 0.441 m < 1.600 m ----------> O.K

26. 기초 지지력 검토

(1) 하중산정

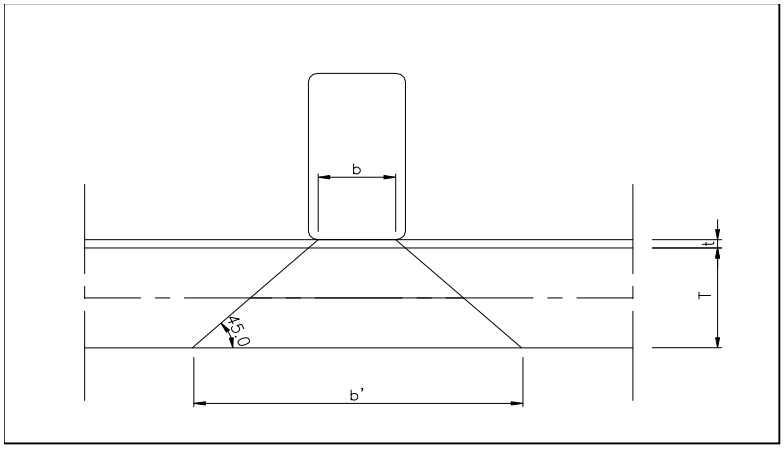
1) 고정하중

- 구체자중 = 1573.950 / 14.050 = 112.025 kN/m²
- 상부연직하중 = 207.439 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.08 × 23.00 = 1.840 kN/m²

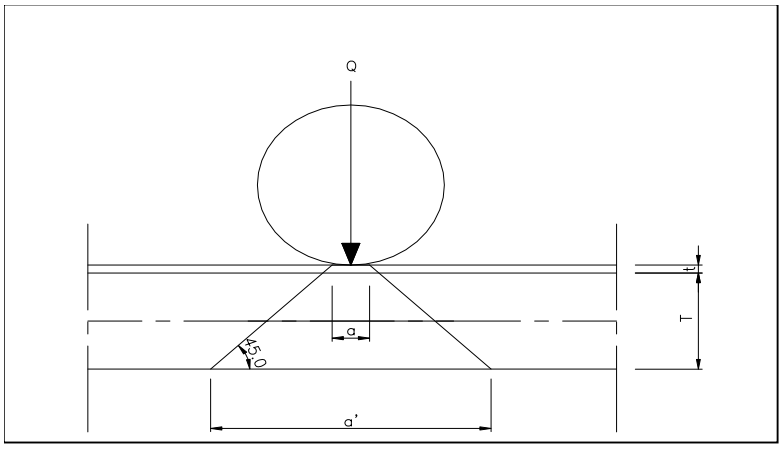
2) 활하중

- 도로 노면 활하중 = 10.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중



t = 80 mm (암거내부 포장두께)
T = 1600 mm (하부 슬래브 두께)
b' = 0.500 + 2 × (1.600 + 0.080) × cot 45°
= 3.860 m



a' = 0.200 + 2 × (1.600 + 0.080) × cot 45°
= 3.560 m

Qz = 96.0 / (3.860 × 3.560)= 6.986 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 112.02 + 207.44 + 10.00 + 1.84 + 6.99

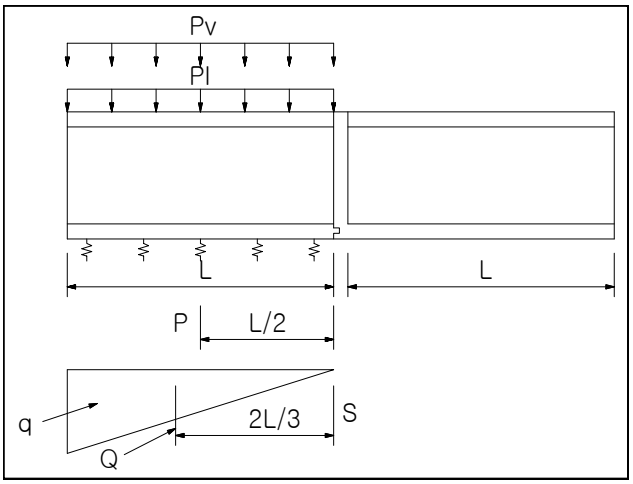
= 338.290 kN/m²

2) 지반의 허용연직지지력 : 지반조사보고서 참고

Qa' = 700.000 kN/m² > Qmax = 338.290 kN/m² ..... O.K !!!

27. 신축이음부 검토

※ 가정 : BOX-TYPE 종방향의 강성 EI는 무한대로 하고, 저면은 스프링 받침으로 한다



$P = \sum Pl + \sum Pv \qquad Q = \sum q$

$P - S - Q = 0$

$P \times L/2 - Q \times 2/3 \times L = 0$

윗식에서

$S = -1/4 \times P$

Pv = B × H × γt

= 14.05 x 10.806 x 19.0

= 2884.66 kN/m

Po = 2 × T1 / 3.0 ÷ 2 × 96 / 3 = 64.0 kN/m

Pl = 2 × Po × (1 + i) = 2 × 64.0 × (1 + 0.2) = 153.6 kN/m

P = (Pv+Pl) × L = (2884.66 + 153.6)x 40.0 = 121469.7 kN

S = P / 4 = 121470 / 4 = 30367.4 kN

(∴ τa = 80 MPa)

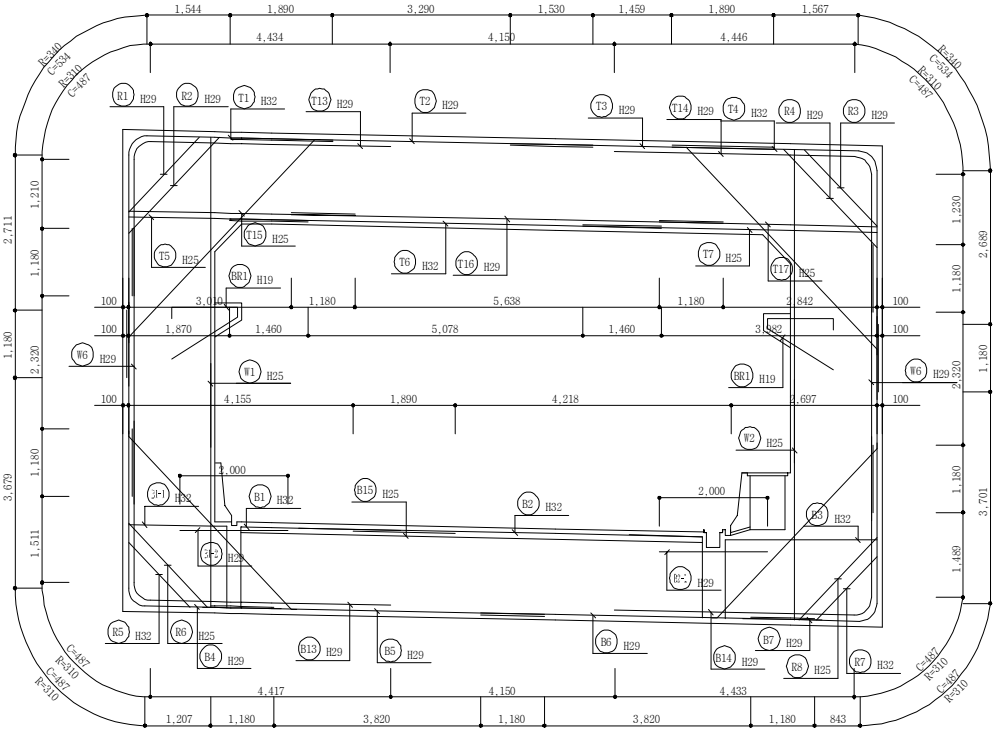
☞ 소요철근량 Areq = S / τa = 30367.4 x 1000 / 80 = 379,593 mm²

☞ 사용철근량 As = D32- 496 EA = 794.2 x 496 = 393,923 mm²

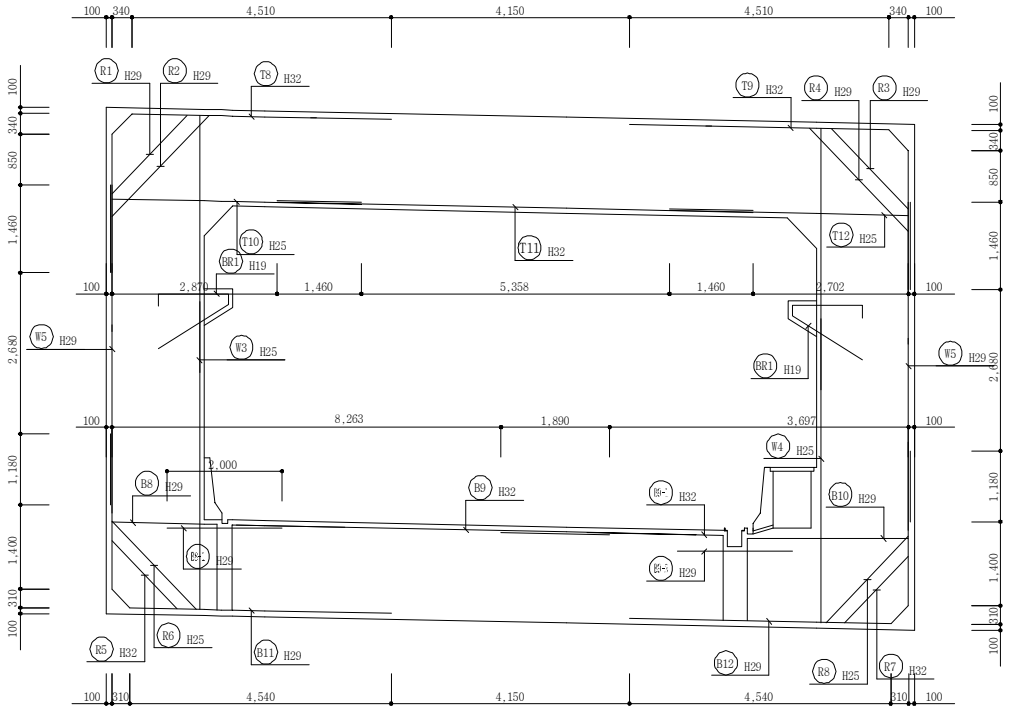
393,923 mm² > 379,593 ……O.K

28. 주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



1.19 B7(STA.0+740.0)
- 본 선 -

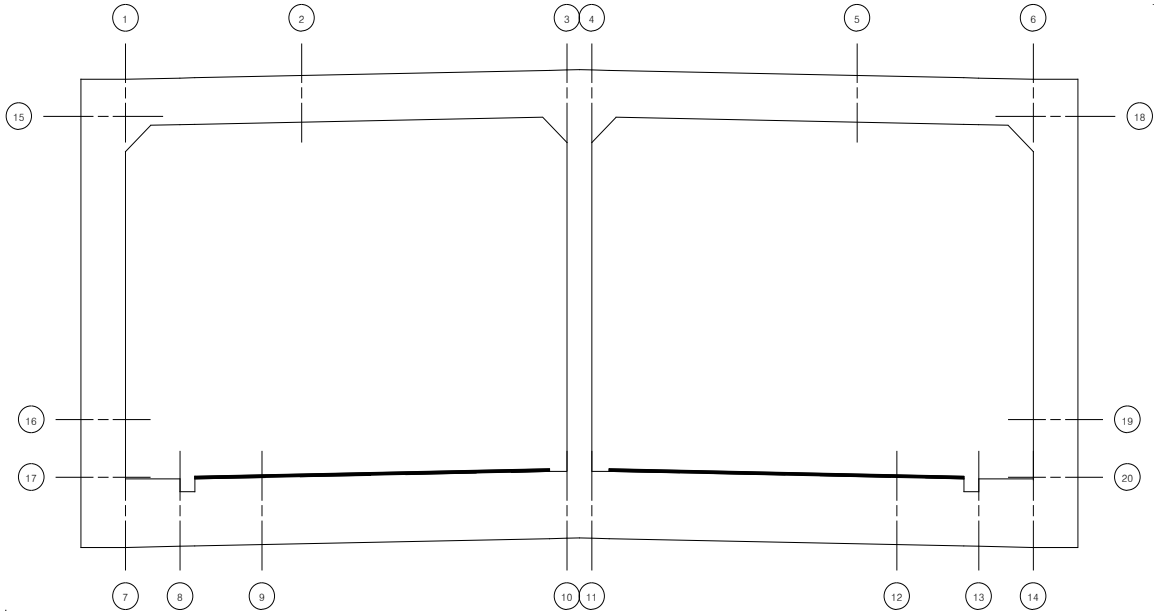
국회대로 지하차도

STA.0+730.000

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. INPUT DATA(상시)
16. INPUT DATA(기능수행)
17. INPUT DATA(붕괴방지)
18. OUTPUT DATA(상시)
19. OUTPUT DATA(기능수행)
20. OUTPUT DATA(붕괴방지)
21. 단면력정리
22. 단면검토 및 철근량 산정
23. 수평철근 검토
24. 거더,기둥,내측벽체 검토
25. 절점부 검토
26. 사용성 검토
27. 기초 지지력 검토
28. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qa(kN)	비 고
직접기초	135.131	200.000	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	1819.05	2350.991	1.292	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	950	1087.26	1581.71	3477.02	H29 - 8.0EA	5139.20	1.45
		중앙부	2	1000	820	849.03	1081.46	3150.81	H25 - 8.0EA	4053.60	1.27
		우측	3	1000	950	1399.53	1581.71	4520.35	H29 - 8.0EA	5139.20	1.13
	2경간	좌측	4	1000	950	1398.56	1581.71	4517.07	H29 - 8.0EA	5139.20	1.13
		중앙부	5	1000	820	843.11	1081.46	3128.05	H25 - 8.0EA	4053.60	1.28
		우측	6	1000	950	1087.26	1581.71	3477.02	H29 - 8.0EA	5139.20	1.45
하부슬래브	1경간	좌측	7	1000	1200	1245.13	2018.54	3122.60	H29 - 8.0EA	5139.20	1.62
		측구부	8	1000	950	567.49	1581.71	1786.21	H29 - 8.0EA	5139.20	2.79
		중앙부	9	1000	1220	1261.19	2053.48	3109.54	H29 - 8.0EA	5139.20	1.63
		우측	10	1000	1200	1422.75	2018.54	3580.21	H29 - 8.0EA	5139.20	1.42
	2경간	좌측	11	1000	1200	1422.73	2018.54	3580.18	H29 - 8.0EA	5139.20	1.42
		중앙부	12	1000	1220	1252.24	2053.48	3086.98	H29 - 8.0EA	5139.20	1.64
		측구부	13	1000	950	558.65	1581.71	1757.90	H29 - 8.0EA	5139.20	2.83
		우측	14	1000	1200	1235.76	2018.54	3098.56	H29 - 8.0EA	5139.20	1.63
좌측벽체	1층	상부	15	1000	950	1178.74	1581.71	3780.44	H29 - 8.0EA	5139.20	1.34
		중앙부	16	1000	820	448.58	623.44	1637.47	H19 - 8.0EA	2292.00	1.39
		하부	17	1000	800	1077.66	1319.61	4149.53	H29 - 8.0EA	5139.20	1.22
우측벽체	1층	상부	18	1000	950	1178.74	1581.71	3780.44	H29 - 8.0EA	5139.20	1.34
		중앙부	19	1000	820	448.58	623.44	1637.47	H19 - 8.0EA	2292.00	1.39
		하부	20	1000	800	1069.64	1319.61	4117.15	H29 - 8.0EA	5139.20	1.23

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부 슬래브	1 경간	좌측	1	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	2	1800.0	1986.0	O.K	810.7	1324.7	O.K
		우측	3	1800.0	1986.0	O.K	1027.8	1324.7	O.K
	2 경간	좌측	4	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	5	1800.0	1986.0	O.K	810.7	1324.7	O.K
		우측	6	1800.0	1986.0	O.K	1027.8	1324.7	O.K
하부 슬래브	1 경간	좌측	7	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		측구부	8	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	9	1800.0	3310.0	O.K	1027.8	2648.7	O.K
		우측	10	1800.0	2648.0	O.K	1027.8	1324.7	O.K
	2 경간	좌측	11	1800.0	2648.0	O.K	1027.8	1324.7	O.K
		중앙부	12	1800.0	3310.0	O.K	1027.8	2648.7	O.K
		측구부	13	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		우측	14	1800.0	1986.0	O.K	1027.8	1324.7	O.K
좌측 벽체	1 층	상부	15	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	16	1800.0	1986.0	O.K	458.4	661.3	O.K
		하부	17	1800.0	1986.0	O.K	1027.8	1324.7	O.K
우측 벽체	1 층	상부	18	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	19	1800.0	1986.0	O.K	458.4	661.3	O.K
		하부	20	1800.0	1986.0	O.K	1027.8	1324.7	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	519.6	480.0	925.06	2.00	131.25	H13	150	253.40	O.K
		중앙부	2	532.6	178.5	740.39	2.00	-	H13	300	253.40	O.K
		우측	3	519.6	694.5	925.06	2.00	109.28	H13	150	253.40	O.K
	2경간	좌측	4	519.6	693.1	925.06	2.00	108.45	H13	150	253.40	O.K
		중앙부	5	532.6	178.5	740.39	2.00	-	H13	300	253.40	O.K
		우측	6	519.6	480.0	925.06	2.00	131.25	H13	150	253.40	O.K
하부슬래브	1경간	좌측	7	779.4	520.6	1387.58	2.00	131.25	H13	150	253.40	O.K
		측구부	8	617.0	520.6	1098.50	2.00	131.25	H13	150	253.40	O.K
		중앙부	9	792.4	366.5	1101.56	2.00	-	H13	300	253.40	O.K
		우측	10	779.4	654.9	1387.58	2.00	131.25	H13	150	253.40	O.K
	2경간	좌측	11	779.4	655.1	1387.58	2.00	131.25	H13	150	253.40	O.K
		중앙부	12	792.4	364.6	1101.56	2.00	-	H13	300	253.40	O.K
		측구부	13	617.0	519.7	1098.50	2.00	131.25	H13	150	253.40	O.K
		우측	14	779.4	519.7	1387.58	2.00	131.25	H13	150	253.40	O.K
좌측벽체	1층	상부	15	519.6	374.2	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	16	532.6	445.3	948.18	2.00	-	H13	150	253.40	O.K
		하부	17	519.6	511.3	925.06	2.00	-	H13	150	253.40	O.K
우측벽체	1층	상부	18	519.6	374.2	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	19	532.6	443.1	948.18	2.00	-	H13	150	253.40	O.K
		하부	20	519.6	509.1	925.06	2.00	-	H13	150	253.40	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	950	H29 - 8.0EA	125	696.502	O.K	5.572
		중앙부	2	820	H25 - 8.0EA	125	245.496	O.K	1.964
		우측	3	950	H29 - 8.0EA	125	153.493	O.K	1.228
	2경간	좌측	4	950	H29 - 8.0EA	125	153.725	O.K	1.230
		중앙부	5	820	H25 - 8.0EA	125	248.142	O.K	1.985
		우측	6	950	H29 - 8.0EA	125	705.447	O.K	5.644
하부슬래브	1경간	좌측	7	1200	H29 - 8.0EA	125	324.776	O.K	2.598
		측구부	8	950	H29 - 8.0EA	125	774.560	O.K	6.196
		중앙부	9	1220	H29 - 8.0EA	125	373.725	O.K	2.990
		우측	10	1200	H29 - 8.0EA	125	292.849	O.K	2.343
	2경간	좌측	11	1200	H29 - 8.0EA	125	291.140	O.K	2.329
		중앙부	12	1220	H29 - 8.0EA	125	377.271	O.K	3.018
		측구부	13	950	H29 - 8.0EA	125	790.068	O.K	6.321
		우측	14	1200	H29 - 8.0EA	125	328.570	O.K	2.629
좌측벽체	1층	상부	15	950	H29 - 8.0EA	125	462.798	O.K	3.702
		중앙부	16	820	H19 - 8.0EA	-	-	-	-
		하부	17	800	H29 - 8.0EA	125	180.595	O.K	1.445
우측벽체	1층	상부	18	950	H29 - 8.0EA	125	470.181	O.K	3.761
		중앙부	19	820	H19 - 8.0EA	-	-	-	-
		하부	20	800	H29 - 8.0EA	125	183.246	O.K	1.466

2. 설 계 조 건

1) 구조형식

- 지중 2 련 지하차도 (내공 : 2@(8.9M × 6.85M), 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (γ_c) = 25.00 kN/m³
- Mortar (γ_{mot}) = 21.50 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sd
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 17.000 kN/m² (∵ 토피 : 1.000 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

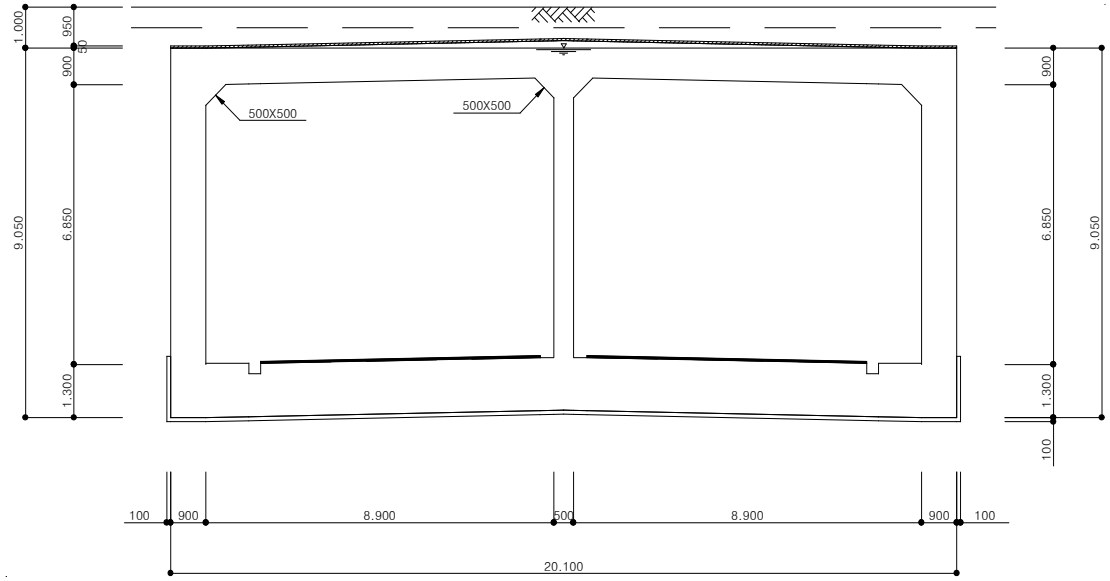
- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

10) 사용프로그램 : SAP2000

11) 참고문헌

- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정


1.000
950
50
900
9.050
6.850
1.300
500X500
500X500
900
6.850
9.050
1.300
100
100
900
8.900
500
8.900
900
100
20.100

4. 부 력 검 토

4.1 시공중 부력검토 (지하수위:G.L -9.6m) -상부슬래브 폐합전

: 부력에 대한 안전률 Fs = 1.10 (R/B)

1) 구체자중

- 하부슬래브	:	20.100 × 1.300 × 25.0	=	653.250	kN/m
- 좌측외벽	:	0.900 × 6.850 × 25.0	=	154.125	kN/m
- 우측외벽	:	0.900 × 6.850 × 25.0	=	154.125	kN/m
- 중간벽체 1	:	0.500 × 6.850 × 25.0	=	85.625	kN/m
		∴ Σ	=	1047.125	kN/m

2) 상재 하중

∴ Σ	=	0.000	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 0.000^2 \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

∴ Σ = 0.000 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 0.450 \times 10.000$

$= 90.450$ kN/m

6) 안정검토

$R = 1047.125 + 0.000 + 0.000 = 1047.125$ kN/m

$Fs = R / U$

$= 1047.125 / 90.450 = 11.577$

$\geq 1.100 \Rightarrow H \leq 10.524$ m

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 10.524m이하로 유지.

4.2 완공후 부력검토 (지하수위:G.L -9.6m)

: 부력에 대한 안전률 Fs = 1.20 (R/B)

부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려

1) 구체자중

- 상부슬래브	:	20.100 × 0.900 × 25.0	=	452.250	kN/m
- 하부슬래브	:	20.100 × 1.300 × 25.0	=	653.250	kN/m
- 좌측외벽	:	0.900 × 6.850 × 25.0	=	154.125	kN/m
- 우측외벽	:	0.900 × 6.850 × 25.0	=	154.125	kN/m
- 중간벽체 1	:	0.500 × 6.850 × 25.0	=	85.625	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 4EA × 25.0	=	12.500	kN/m
		∴ Σ	=	1511.875	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 20.100 × 23.0	=	231.150	kN/m
- 흙의 자중(지하수위 이상	:	1.000 × 20.100 × 19.0	=	381.900	kN/m
- 수목하중	:	20.100 × 10.0	=	201.000	kN/m
- 방수 Mortal	:	0.050 × 20.100 × 21.5	=	21.608	kN/m
		∴ Σ	=	835.658	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 1.000^2 \times \tan(30.0 \times 2/3)$

$= 3.458$ kN/m

∴ Σ = 3.458 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 0.450 \times 10.000$

$= 90.450$ kN/m

6) 안정검토

$R = 1511.875 + 835.658 + 0.000 = 2347.533$ kN/m

$Fs = R / U$

$= 2347.533 / 90.450$

$= 25.954 > 1.200$ ∴O.K

4.3 완공후 부력검토 (극한수위:G.L -1.0m)

: 부력에 대한 안전률 Fs = 1.05 (R/B)

부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려

(최소토피 H = 0.993 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	20.100 × 0.900 × 25.0	=	452.250	kN/m
- 하부슬래브	:	20.100 × 1.300 × 25.0	=	653.250	kN/m
- 좌측외벽	:	0.900 × 6.850 × 25.0	=	154.125	kN/m
- 우측외벽	:	0.900 × 6.850 × 25.0	=	154.125	kN/m
- 중간벽체 1	:	0.500 × 6.850 × 25.0	=	85.625	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 4EA × 25.0	=	12.500	kN/m
		∴ Σ	=	1511.875	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 20.100 × 23.0	=	231.150	kN/m
- 흙의 자중(지하수위 이상	:	1.000 × 20.100 × 19.0	=	381.900	kN/m
- 수목하중	:	20.100 × 10.0	=	201.000	kN/m
- 방수 Mortal	:	0.050 × 20.100 × 21.5	=	21.608	kN/m
		∴ Σ	=	835.658	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 1.000^2 \times \tan(30.0 \times 2/3)$

$= 3.458$ kN/m

∴ Σ = 3.458 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 9.050 \times 10.000$

$= 1819.050$ kN/m

6) 안정검토

$R = 1511.875 + 835.658 + 0.000 = 2350.991$ kN/m

$Fs = R / U$

$= 2350.991 / 1819.050$

$= 1.292 > 1.200$ ∴O.K

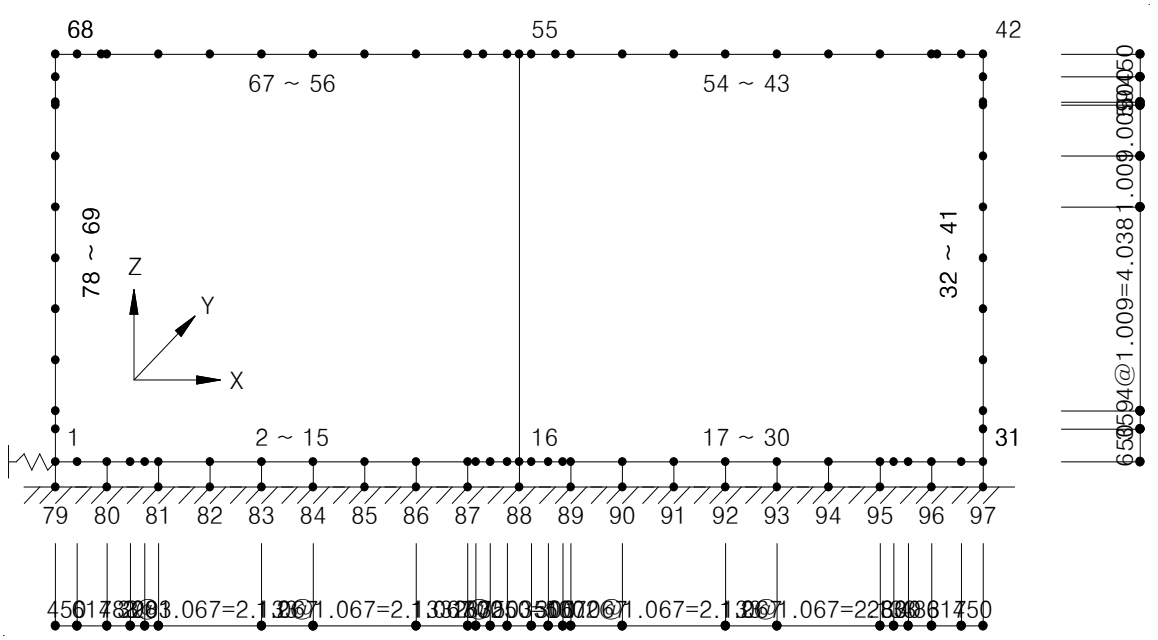
5. 해석모델 및 단면제원 (상시)

1) Modeling

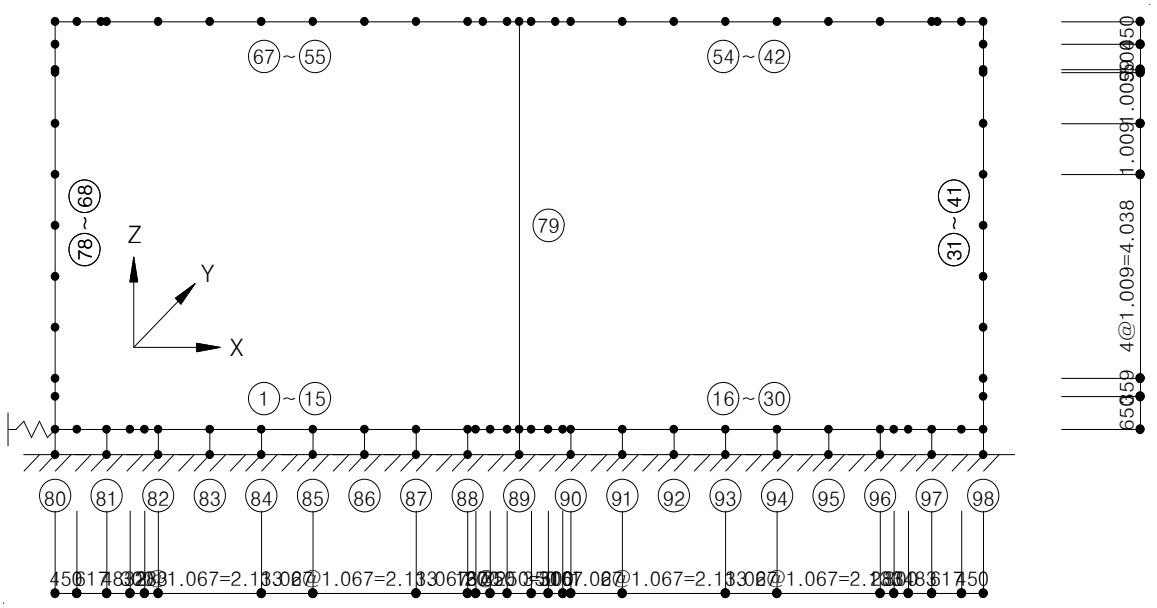
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)	I (m⁴)	부 재
1	1.300 × 1.000 = 1.300	0.18308	1~3,5~26,28~30
2	1.050 × 1.000 = 1.050	0.09647	4,27
3	0.900 × 1.000 = 0.900	0.06075	31~39,44~65,70~78
4	1.400 × 1.000 = 1.400	0.22867	41~42,67~68
5	0.500 × 1.000 = 0.500	0.01042	79

NO	Section(Tapper)	부 재
6	SEC 3 ~ 4	40,66
7	SEC 4 ~ 3	43,69

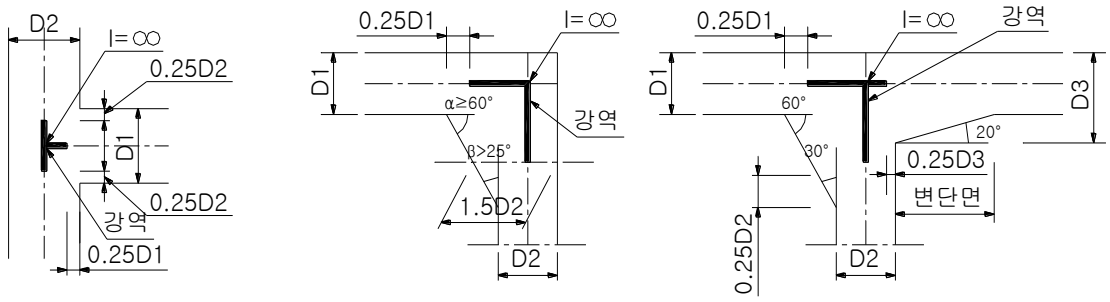
3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	50	12.800	8.575
2	0.450	0.500	51	11.733	8.575
3	1.067	0.500	52	10.667	8.575
4	1.550	0.500	53	10.350	8.575
5	1.850	0.500	54	9.850	8.575
6	2.133	0.500	55	9.600	8.575
7	3.200	0.500	56	9.350	8.575
8	4.267	0.500	57	8.850	8.575
9	5.333	0.500	58	8.533	8.575
10	6.400	0.500	59	7.467	8.575
11	7.467	0.500	60	6.400	8.575
12	8.533	0.500	61	5.333	8.575
13	8.700	0.500	62	4.267	8.575
14	9.000	0.500	63	3.200	8.575
15	9.350	0.500	64	2.133	8.575
16	9.600	0.500	65	1.067	8.575
17	9.850	0.500	66	0.950	8.575
18	10.200	0.500	67	0.450	8.575
19	10.500	0.500	68	0.000	8.575
20	10.667	0.500	69	0.000	8.125
21	11.733	0.500	70	0.000	7.625
22	12.800	0.500	71	0.000	7.566
23	13.867	0.500	72	0.000	6.556
24	14.933	0.500	73	0.000	5.547
25	16.000	0.500	74	0.000	4.537
26	17.067	0.500	75	0.000	3.528
27	17.350	0.500	76	0.000	2.519
28	17.650	0.500	77	0.000	1.509
29	18.133	0.500	78	0.000	1.150
30	18.750	0.500	79	0.000	0.000

31	19.200	0.500	80	1.067	0.000
32	19.200	1.150	81	2.133	0.000
33	19.200	1.509	82	3.200	0.000
34	19.200	2.519	83	4.267	0.000
35	19.200	3.528	84	5.333	0.000
36	19.200	4.537	85	6.400	0.000
37	19.200	5.547	86	7.467	0.000
38	19.200	6.556	87	8.533	0.000
39	19.200	7.566	88	9.600	0.000
40	19.200	7.625	89	10.667	0.000
41	19.200	8.125	90	11.733	0.000
42	19.200	8.575	91	12.800	0.000
43	18.750	8.575	92	13.867	0.000
44	18.250	8.575	93	14.933	0.000
45	18.133	8.575	94	16.000	0.000
46	17.067	8.575	95	17.067	0.000
47	16.000	8.575	96	18.133	0.000
48	14.933	8.575	97	19.200	0.000
49	13.867	8.575			

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

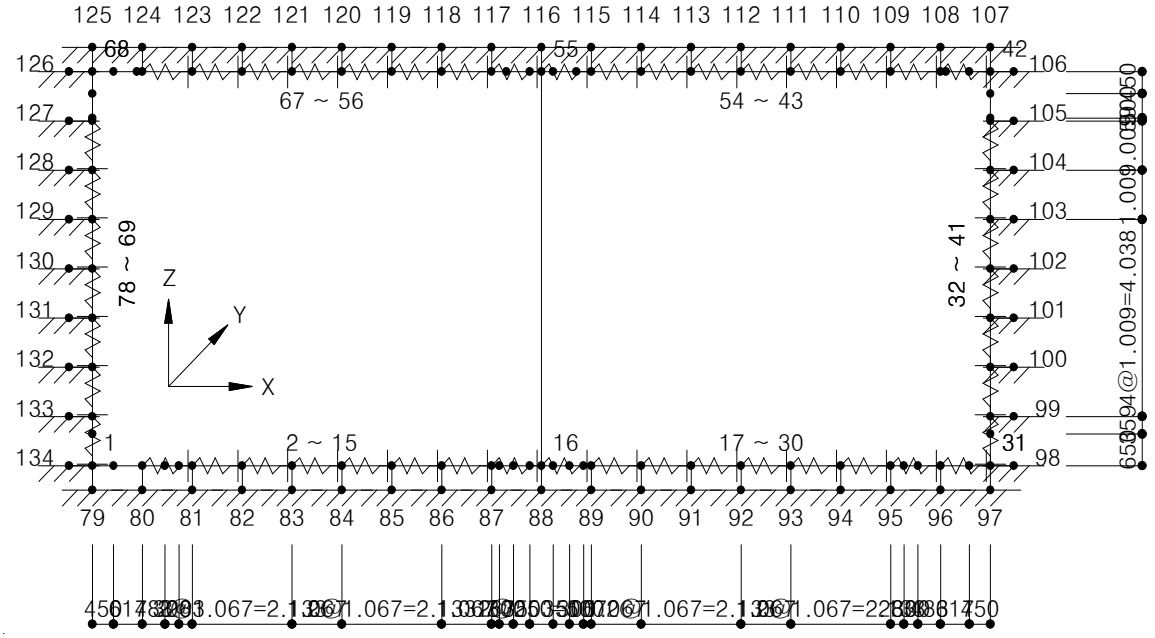
(1) 68 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(2) 68 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(3) 55 지점 - 슬래브 상면 좌측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(4) 55 지점 - 슬래브 상면 우측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(5) 55 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (500 × 500) / (2 × 500) = 700 mm
(6) 42 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(7) 42 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(8) 1 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1300 = 125 mm
(9) 1 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 900 = 425 mm
(10) 16 지점 - 슬래브 하면 좌측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1300 <= 0 mm
(11) 16 지점 - 슬래브 하면 우측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1300 <= 0 mm
(12) 16 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 500 = 525 mm
(13) 31 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1300 = 125 mm
(14) 31 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 900 = 425 mm

6. 해석모델 및 단면제원 (지진시)

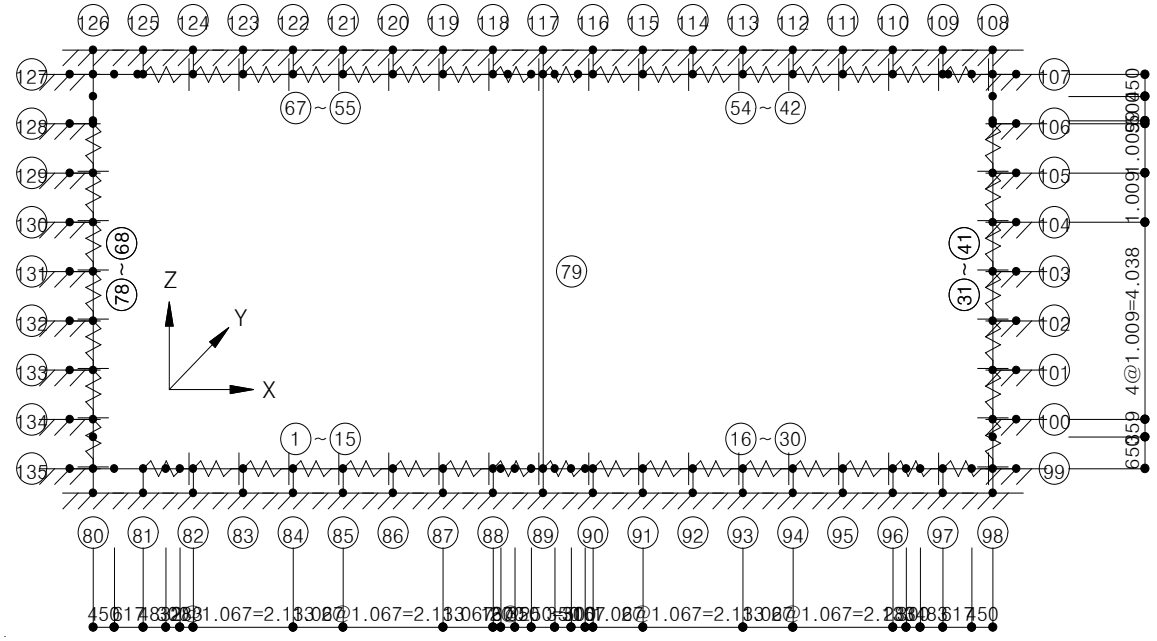
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.300 × 1.000	= 1.300	0.18308	1~3,5~26,28~30
2	1.050 × 1.000	= 1.050	0.09647	4,27
3	0.900 × 1.000	= 0.900	0.06075	31~39,44~65,70~78
4	1.400 × 1.000	= 1.400	0.22867	41~42,67~68
5	0.500 × 1.000	= 0.500	0.01042	79

NO	Section(Tapper)	부 재
6	SEC 3 ~ 4	40,66
7	SEC 4 ~ 3	43,69

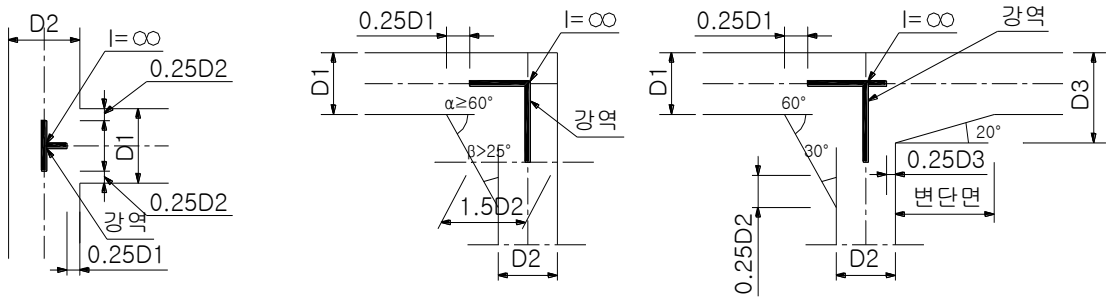
3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.500	0.500	68	0.500	8.575
2	0.950	0.500	69	0.500	8.125
3	1.567	0.500	70	0.500	7.625
4	2.050	0.500	71	0.500	7.566
5	2.350	0.500	72	0.500	6.556
6	2.633	0.500	73	0.500	5.547
7	3.700	0.500	74	0.500	4.537
8	4.767	0.500	75	0.500	3.528
9	5.833	0.500	76	0.500	2.519
10	6.900	0.500	77	0.500	1.509
11	7.967	0.500	78	0.500	1.150
12	9.033	0.500	79	0.500	0.000
13	9.200	0.500	80	1.567	0.000
14	9.500	0.500	81	2.633	0.000
15	9.850	0.500	82	3.700	0.000
16	10.100	0.500	83	4.767	0.000
17	10.350	0.500	84	5.833	0.000
18	10.700	0.500	85	6.900	0.000
19	11.000	0.500	86	7.967	0.000
20	11.167	0.500	87	9.033	0.000
21	12.233	0.500	88	10.100	0.000
22	13.300	0.500	89	11.167	0.000
23	14.367	0.500	90	12.233	0.000
24	15.433	0.500	91	13.300	0.000
25	16.500	0.500	92	14.367	0.000
26	17.567	0.500	93	15.433	0.000
27	17.850	0.500	94	16.500	0.000
28	18.150	0.500	95	17.567	0.000
29	18.633	0.500	96	18.633	0.000
30	19.250	0.500	97	19.700	0.000
31	19.700	0.500	98	20.200	0.500
32	19.700	1.150	99	20.200	1.509
33	19.700	1.509	100	20.200	2.519
34	19.700	2.519	101	20.200	3.528
35	19.700	3.528	102	20.200	4.537
36	19.700	4.537	103	20.200	5.547
37	19.700	5.547	104	20.200	6.556
38	19.700	6.556	105	20.200	7.566
39	19.700	7.566	106	20.200	8.575
40	19.700	7.625	107	19.700	9.075
41	19.700	8.125	108	18.633	9.075

42	19.700	8.575	109	17.567	9.075
43	19.250	8.575	110	16.500	9.075
44	18.750	8.575	111	15.433	9.075
45	18.633	8.575	112	14.367	9.075
46	17.567	8.575	113	13.300	9.075
47	16.500	8.575	114	12.233	9.075
48	15.433	8.575	115	11.167	9.075
49	14.367	8.575	116	10.100	9.075
50	13.300	8.575	117	9.033	9.075
51	12.233	8.575	118	7.967	9.075
52	11.167	8.575	119	6.900	9.075
53	10.850	8.575	120	5.833	9.075
54	10.350	8.575	121	4.767	9.075
55	10.100	8.575	122	3.700	9.075
56	9.850	8.575	123	2.633	9.075
57	9.350	8.575	124	1.567	9.075
58	9.033	8.575	125	0.500	9.075
59	7.967	8.575	126	0.000	8.575
60	6.900	8.575	127	0.000	7.566
61	5.833	8.575	128	0.000	6.556
62	4.767	8.575	129	0.000	5.547
63	3.700	8.575	130	0.000	4.537
64	2.633	8.575	131	0.000	3.528
65	1.567	8.575	132	0.000	2.519
66	1.450	8.575	133	0.000	1.509
67	0.950	8.575	134	0.000	0.500

8) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 68 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(2) 68 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(3) 55 지점 - 슬래브 상면 좌측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(4) 55 지점 - 슬래브 상면 우측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(5) 55 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (500 × 500) / (2 × 500) = 700 mm
(6) 42 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(7) 42 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(8) 1 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1300 = 125 mm
(9) 1 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 900 = 425 mm
(10) 16 지점 - 슬래브 하면 좌측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1300 <= 0 mm
(11) 16 지점 - 슬래브 하면 우측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1300 <= 0 mm
(12) 16 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 500 = 525 mm
(13) 31 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1300 = 125 mm
(14) 31 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 900 = 425 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 300000.00 kN/m²

Bv = √(B × B) = √(20.100 × 20.100) = 20.10 m (L > B)

Kvo = 1 / 0.3 × 1 × 300000 = 1000000.00 kN/m³

Kv = 1000000.000 × (20.100 / 0.3) $^{-3 / 4}$ = 42701.58 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 41990 kN/m	1,31
Kv2	Kv x (1.067/2 + 1.067/2) = 45548 kN/m	3,6~12,16,20~26,29
Kh	1E10 kN/m (무한강성)	16

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 자갈 (EL. : 9.879 ~ 7.156, N=4)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8^2 = 31753.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0^2 = 12404.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m^2

(2) 점토 (EL. : 7.156 ~ 4.556, N=7)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8^2 = 31753.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0^2 = 12404.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m^2

(3) 점토질 자갈 (EL. : 4.556 ~ 2.956, N=9)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8^2 = 31753.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0^2 = 12404.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m^2

(4) 실트 (EL. : 2.956 ~ 0.956, N=16)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8^2 = 31753.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0^2 = 12404.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m^2

(5) 자갈 (EL. : 0.956 ~ -1.044, N=18)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8^2 = 31753.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0^2 = 12404.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m^2

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제1토층 ,자갈

① 연직방향 지반반력계수

Bv	= √(B × B)	= √(20.100 × 20.100)	=	20.100	m
Kvo	= 1 / 0.3 × α × Ed	= 1 / 0.3 × 1 × 92083.7	=	306945.67	kN/m^3
Kv	= 306945.670 × (20.100 / 0.3) $^{-3/4}$		=	13107.06	kN/m^3

② 전단 지반반력계수

Ksb	= λ × Kv	= 1/3.0 × 13107.060	=	4369.02	kN/m^3

(2) 하부슬래브 : 제5토층 , 자갈

① 연직방향 지반반력계수

Bv	= √(B × B)	= √(20.100 × 20.100)	=	20.100	m
Kvo	= 1 / 0.3 × α × Ed	= 1 / 0.3 × 1 × 92083.7	=	306945.67	kN/m^3
Kv	= 306945.670 × (20.100 / 0.3) $^{-3/4}$		=	13107.06	kN/m^3

② 전단 지반반력계수

Ksb	= λ × Kv	= 1/3.0 × 13107.060	=	4369.02	kN/m^3

(3) 측벽 : 제1토층 , 자갈

① 수평방향 지반반력계수

Bv	= √(H × H)	= √(9.050 × 9.050)	=	9.050	m
Kho	= 1 / 0.3 × α × Ed	= 1 / 0.3 × 1 × 92083.7	=	306945.67	kN/m^3
Kh	= 306945.670 × (9.050 / 0.3) $^{-3/4}$		=	23846.03	kN/m^3

② 전단 지반반력계수

Kss	= λ × Kh	= 1/3.0 × 23846.030	=	7948.68	kN/m^3

(4) 측벽 : 제2토층 , 점토

① 수평방향 지반반력계수

Bv = √(H × H) = √(9.050 × 9.050) = 9.050 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m³

Kh = 306945.670 × (9.050 / 0.3)$^{-3 / 4}$ = 23846.03 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 23846.030 = 7948.68 kN/m³

(5) 측벽 : 제3토층 , 점토질 자갈

① 수평방향 지반반력계수

Bv = √(H × H) = √(9.050 × 9.050) = 9.050 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m³

Kh = 306945.670 × (9.050 / 0.3)$^{-3 / 4}$ = 23846.03 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 23846.030 = 7948.68 kN/m³

(6) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 13981 kN/m	45~52,55,58~65
Ksb1	Ksb x (1.067/2 + 1.067/2) = 4660 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.009/2 + 1.009/2) = 24070 kN/m	33~39,71~77
Kss1	Kss x (1.009/2 + 1.009/2) = 8023 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 13981 kN/m	3,6~12,16,20~26,29
Ksb1	Ksb x (1.067/2 + 1.067/2) = 4660 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 12889 kN/m	1,31
Ksb1	Kh x (1.009/2 + 1.300/2) = 27535 kN/m	
Kv2	Kv x (1.067/2 + 0.900/2) = 12889 kN/m	42,68
Ksb2	Kh x (1.009/2 + 0.900/2) = 22766 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제1토층 ,자갈

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kv = 119905.330 × (20.100 / 0.3)$^{-3/4}$ = 5120.15 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 5120.150 = 1706.72 kN/m³

(2) 하부슬래브 : 제5토층 , 자갈

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kv = 119905.330 × (20.100 / 0.3)$^{-3/4}$ = 5120.15 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 5120.150 = 1706.72 kN/m³

(3) 측벽 : 제1토층 , 자갈

① 수평방향 지반반력계수

Bv = √(H × H) = √(9.050 × 9.050) = 9.050 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kh = 119905.330 × (9.050 / 0.3)$^{-3/4}$ = 9315.22 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 9315.220 = 3105.07 kN/m³

(4) 측벽 : 제2토층 , 점토

① 수평방향 지반반력계수

Bv = √(H × H) = √(9.050 × 9.050) = 9.050 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kh = 119905.330 × (9.050 / 0.3)$^{-3/4}$ = 9315.22 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 9315.220 = 3105.07 kN/m³

(5) 측벽 : 제3토층 , 점토질 자갈

① 수평방향 지반반력계수

Bv = √(H × H) = √(9.050 × 9.050) = 9.050 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kh = 119905.330 × (9.050 / 0.3)$^{-3 / 4}$ = 9315.22 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 9315.220 = 3105.07 kN/m³

(6) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 5462 kN/m	45~52,55,58~65
Ksb1	Ksb x (1.067/2 + 1.067/2) = 1821 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.009/2 + 1.009/2) = 9403 kN/m	33~39,71~77
Kss1	Kss x (1.009/2 + 1.009/2) = 3134 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 5462 kN/m	3,6~12,16,20~26,29
Ksb1	Ksb x (1.067/2 + 1.067/2) = 1821 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 5035 kN/m	1,31
Ksb1	Kh x (1.009/2 + 1.300/2) = 10756 kN/m	
Kv2	Kv x (1.067/2 + 0.900/2) = 5035 kN/m	42,68
Ksb2	Kh x (1.009/2 + 0.900/2) = 8893 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

	성능기 / 준 재현주기	기 능 수 행	붕 괴 방 지
설계지진	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.16 = 0.091
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.16 = 0.224

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 토 사	: 2.000 × 19.00	=	38.000	kN/m²
- 수목하중		=	10.000	kN/m²
- 방 수	: 0.050 × 21.50	=	1.075	kN/m²
	∴ Total Wd1	=	60.575	kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 흙(지하수위 이상)	: 1.000 × 19.00	=	19.000	kN/m²
- 흙(지하수위 이하)	: 1.000 × 10.00	=	10.000	kN/m²
- 수목하중		=	10.000	kN/m²
- 방수	: 0.050 × 21.50	=	1.075	kN/m²
	∴ Total Wd2	=	51.575	kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

D / Bo	도로면의 활하중 (kN/m²)	D / Bo	도로면의 활하중 (kN/m²)
0.1	17.0	0.2	27.0
0.3	33.0	0.4	36.0

주) 토피고의 중간값은 Pvl 의 상위값을 적용한다.

① 상부 슬래브에 작용하는 하중 (Wl1) - 토피 1.000m

- Wl1 = 17.000 kN/m²

② 측벽에 작용하는 하중 (Wl2)

- Wl2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 0.950 × 19.000) × 0.500 = 14.775 kN/m²
Wh2 = 14.775 + 0.450 × 19.000 × 0.500 = 19.050 kN/m²
Wh3 = 19.050 + 0.500 × 19.000 × 0.500 = 23.800 kN/m²
Wh4 = 23.800 + 0.059 × 19.000 × 0.500 = 24.364 kN/m²
Wh5 = 24.364 + 1.009 × 19.000 × 0.500 = 33.954 kN/m²
Wh6 = 33.954 + 1.009 × 19.000 × 0.500 = 43.542 kN/m²
Wh7 = 43.542 + 1.009 × 19.000 × 0.500 = 53.131 kN/m²
Wh8 = 53.131 + 1.009 × 19.000 × 0.500 = 62.721 kN/m²
Wh9 = 62.721 + 1.009 × 19.000 × 0.500 = 72.310 kN/m²
Wh10 = 72.310 + 1.009 × 19.000 × 0.500 = 81.898 kN/m²
Wh11 = 81.898 + 0.359 × 19.000 × 0.500 = 85.312 kN/m²
Wh12 = 85.312 + 0.650 × 19.000 × 0.500 = 91.487 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 0.450 × 10.000 = 12.750 kN/m²
Wh2 = 12.750 + 0.450 × 10.000 × 0.500 = 15.000 kN/m²
Wh3 = 15.000 + 0.500 × 10.000 × 0.500 = 17.500 kN/m²
Wh4 = 17.500 + 0.059 × 10.000 × 0.500 = 17.797 kN/m²
Wh5 = 17.797 + 1.009 × 10.000 × 0.500 = 22.844 kN/m²
Wh6 = 22.844 + 1.009 × 10.000 × 0.500 = 27.891 kN/m²
Wh7 = 27.891 + 1.009 × 10.000 × 0.500 = 32.938 kN/m²
Wh8 = 32.938 + 1.009 × 10.000 × 0.500 = 37.984 kN/m²
Wh9 = 37.984 + 1.009 × 10.000 × 0.500 = 43.031 kN/m²
Wh10 = 43.031 + 1.009 × 10.000 × 0.500 = 48.078 kN/m²
Wh11 = 48.078 + 0.359 × 10.000 × 0.500 = 49.875 kN/m²
Wh12 = 49.875 + 0.650 × 10.000 × 0.500 = 53.125 kN/m²

6) 지하수압 (지하수위 : GL = -1.000 m)

① 측벽에 작용하는 하중

- Ww2 = 0.450 × 10.000 = 4.500 kN/m²
Ww2 = 4.500 + 0.450 × 10.000 = 9.000 kN/m²
Ww3 = 9.000 + 0.500 × 10.000 = 14.000 kN/m²
Ww4 = 14.000 + 0.059 × 10.000 = 14.594 kN/m²
Ww5 = 14.594 + 1.009 × 10.000 = 24.688 kN/m²
Ww6 = 24.688 + 1.009 × 10.000 = 34.781 kN/m²
Ww7 = 34.781 + 1.009 × 10.000 = 44.875 kN/m²
Ww8 = 44.875 + 1.009 × 10.000 = 54.969 kN/m²
Ww9 = 54.969 + 1.009 × 10.000 = 65.062 kN/m²
Ww10 = 65.062 + 1.009 × 10.000 = 75.156 kN/m²
Ww11 = 75.156 + 0.359 × 10.000 = 78.750 kN/m²
Ww12 = 78.750 + 0.650 × 10.000 = 85.250 kN/m²

② 하부슬래브에 작용하는 하중

- Ww13 = (1.000 + 9.050 - 1.000) × 10.000 = 90.500 kN/m²

7) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

8) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 1510^{-5}$
- 온도선팽창 계수 $\alpha = 1.010^{-5}$
- $\Delta T = \frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
성토재	0.010	156.000	156.000	19.000	0.000	0.000
자갈	2.713	156.000	156.000	20.000	0.087	0.139
점토	2.600	156.000	156.000	20.000	0.083	0.133
점토질 자갈	1.600	156.000	156.000	20.000	0.051	0.082
실트	2.000	156.000	156.000	20.000	0.064	0.103
자갈	2.000	156.000	156.000	20.000	0.064	0.103
와 자갈 섞인 호	0.600	289.000	289.000	20.000	0.010	0.017
자갈	1.100	289.000	289.000	20.000	0.019	0.030
풍화암	8.700	631.000	631.000	20.000	0.069	0.110
경암	8.677	2059.000	2059.000	20.000	0.021	0.034
계					0.468	0.751

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.468 = 0.585	1.25 Tg' = 1.25 × 0.751 = 0.939

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575
To(sec)	To = 0.2 × Ts = 0.2 × 0.575 = 0.115	To = 0.2 × Ts = 0.2 × 0.575 = 0.115

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $C_d = \frac{1.5}{40h+1} + 0.5$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa) - 붕괴방지수준시(재현주기 1000년적용)

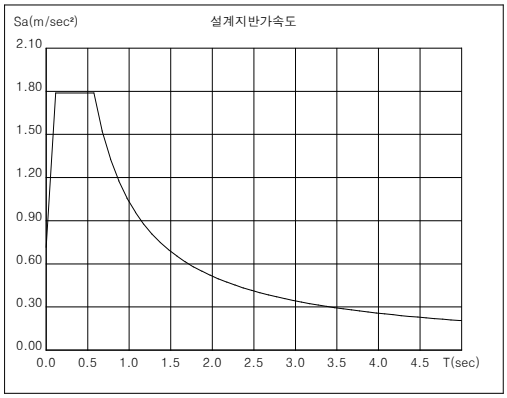
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg = 1.759 m/s²	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg = 2.244 m/s²

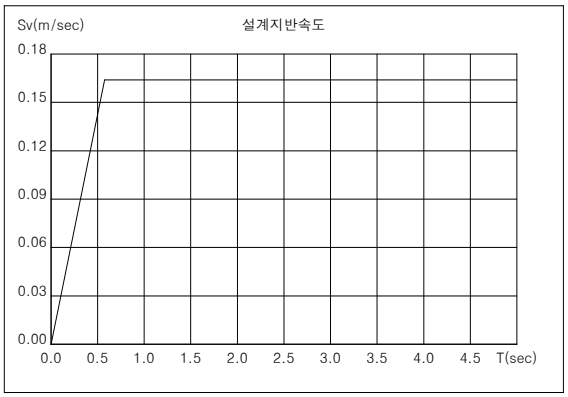
5) 속도 응답스펙트럼(Sv) - 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.585 / 2π × 1.759 = 0.164 m/s	Sv = Tg/2π × Sa = 0.939 / 2π × 2.244 = 0.335 m/s

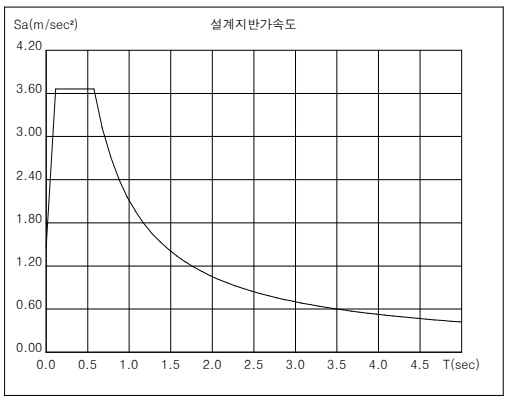
6) 설계응답 응답스펙트럼

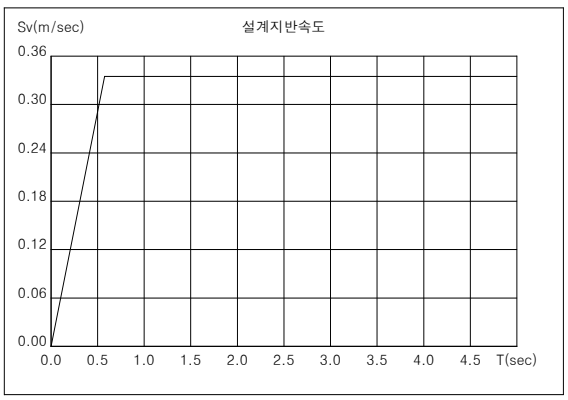
(1) 기능수행수준





(2) 붕괴방지수준





7) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 1.450 m
- 하부슬래브 EL. = 9.525 m
- 기반암 심도(H) = 30.000 m

(1) 기능수행 수준

$U(z) = 2 / \pi^2 \times Sv \times Tg \times \cos(\pi Z / 2H)$

$U(Zu) = 2 / \pi^2 \times 0.164 \times 0.585 \times \cos(\pi \times 1.450 / (2 \times 30.000)) = 0.019386$

$U(Zb) = 2 / \pi^2 \times 0.164 \times 0.585 \times \cos(\pi \times 9.525 / (2 \times 30.000)) = 0.017073$

(2) 붕괴방지 수준

$U(Zu) = 2 / \pi^2 \times 0.335 \times 0.939 \times \cos(\pi \times 1.450 / (2 \times 30.000)) = 0.063561$

$U(Zb) = 2 / \pi^2 \times 0.335 \times 0.939 \times \cos(\pi \times 9.525 / (2 \times 30.000)) = 0.055980$

$Po = Ksb,top \times (U(Zu) - U(Zb))$

기능수행수준	붕괴방지수준
$Po = 4369.020 \times (0.019386 - 0.017073) = 10.106\ kN/m^2$	$Po = 1706.720 \times (0.063561 - 0.055980) = 12.939\ kN/m^2$

8) 측벽 지반변위 하중

$P(z) = Kh \times (Uh(z) - Uh(b))$

(1) 기능수행수준

z(m)	Kh (kN/m^3)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m^2)
1.450	23846.030	0.019386	0.002313	55.156
1.900	23846.030	0.019345	0.002272	54.178
2.400	23846.030	0.019288	0.002215	52.819
2.459	23846.030	0.019281	0.002208	52.652
3.469	23846.030	0.019122	0.002049	48.861
4.478	23846.030	0.018910	0.001837	43.805
5.488	23846.030	0.018644	0.001571	37.462
6.497	23846.030	0.018327	0.001254	29.903
7.506	23846.030	0.017959	0.000886	21.128
8.516	23846.030	0.017541	0.000468	11.160
8.875	23846.030	0.017380	0.000307	7.321
9.525	23846.030	0.017073	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
1.450	9315.220	0.063561	0.007581	70.619
1.900	9315.220	0.063429	0.007449	69.389
2.400	9315.220	0.063242	0.007262	67.647
2.459	9315.220	0.063217	0.007237	67.414
3.469	9315.220	0.062696	0.006716	62.561
4.478	9315.220	0.062000	0.006020	56.078
5.488	9315.220	0.061131	0.005151	47.983
6.497	9315.220	0.060091	0.004111	38.295
7.506	9315.220	0.058884	0.002904	27.051
8.516	9315.220	0.057512	0.001532	14.271
8.875	9315.220	0.056985	0.001005	9.362
9.525	9315.220	0.055980	0.000000	0.000

9) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

Uh1 = 1 /(π×H) × Sv × Tg × sin(π×Zu/(2 × H))

Uh2 = 1 /(π×H) × Sv × Tg × sin(π×Zb/(2 × H))

구분	기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
Vu	31753.000 × 0.000049 = 1.560	12404.000 × 0.000162 = 2.010
Vb	31753.000 × 0.000456 = 14.480	12404.000 × 0.001496 = 18.560
Vs	(1.560 + 14.480) / 2 = 8.020	(2.010 + 18.560) / 2 = 10.290

10) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fu = 0.900×25.000×0.091×(1 - 0.015×1.450) = 2.003	fu = 0.900×25.000×0.224×(1 - 0.015×1.450) = 4.930

② 하부슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fb = 1.300×25.000×0.091×(1 - 0.015×9.525) = 2.535	fb = 1.300×25.000×0.224×(1 - 0.015×9.525) = 6.240

③ 중간벽체

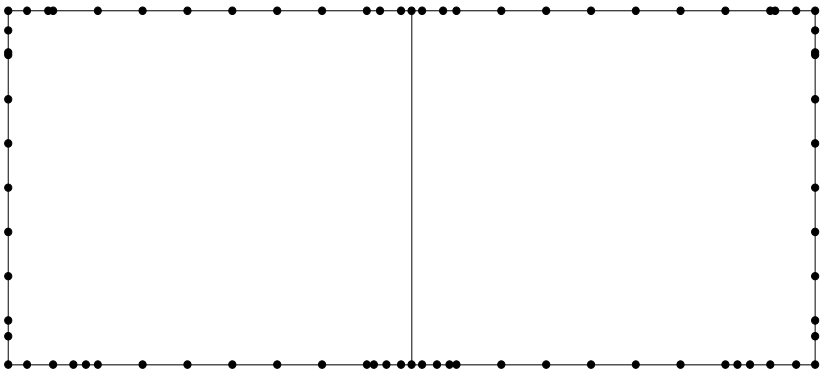
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fu1 = 0.500×25.000×0.091×(1-0.015×0.925) = 1.113	fu1 = 0.500×25.000×0.224×(1-0.015×0.925) = 2.739
fb1 = 0.500×25.000×0.091×(1-0.015×9.525) = 0.975	fb1 = 0.500×25.000×0.224×(1-0.015×9.525) = 2.400

④ 측벽

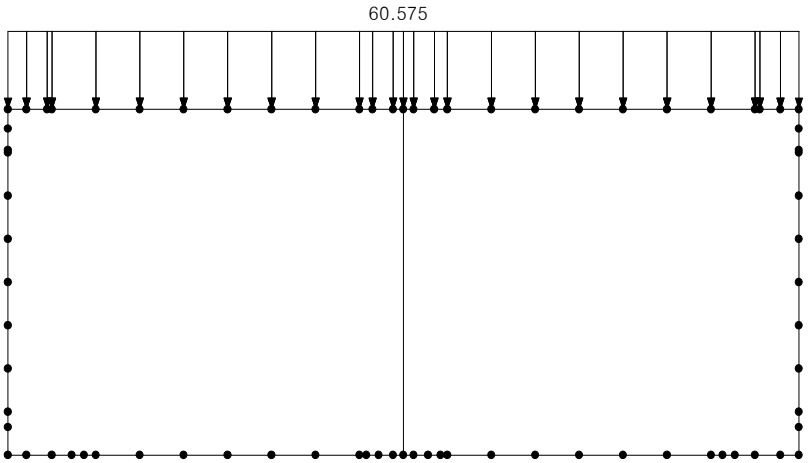
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
f1 = 0.900×25.000×0.091×(1-0.015×1.450) = 2.003	f1 = 0.900×25.000×0.224×(1-0.015×1.450) = 4.930
f2 = 0.900×25.000×0.091×(1-0.015×1.900) = 1.989	f2 = 0.900×25.000×0.224×(1-0.015×1.900) = 4.896
f3 = 0.900×25.000×0.091×(1-0.015×2.400) = 1.974	f3 = 0.900×25.000×0.224×(1-0.015×2.400) = 4.859
f4 = 0.900×25.000×0.091×(1-0.015×2.459) = 1.972	f4 = 0.900×25.000×0.224×(1-0.015×2.459) = 4.854
f5 = 0.900×25.000×0.091×(1-0.015×3.469) = 1.941	f5 = 0.900×25.000×0.224×(1-0.015×3.469) = 4.778
f6 = 0.900×25.000×0.091×(1-0.015×4.478) = 1.910	f6 = 0.900×25.000×0.224×(1-0.015×4.478) = 4.701
f7 = 0.900×25.000×0.091×(1-0.015×5.488) = 1.879	f7 = 0.900×25.000×0.224×(1-0.015×5.488) = 4.625
f8 = 0.900×25.000×0.091×(1-0.015×6.497) = 1.848	f8 = 0.900×25.000×0.224×(1-0.015×6.497) = 4.549
f9 = 0.900×25.000×0.091×(1-0.015×7.506) = 1.817	f9 = 0.900×25.000×0.224×(1-0.015×7.506) = 4.473
f10 = 0.900×25.000×0.091×(1-0.015×8.516) = 1.786	f10 = 0.900×25.000×0.224×(1-0.015×8.516) = 4.396
f11 = 0.900×25.000×0.091×(1-0.015×8.875) = 1.775	f11 = 0.900×25.000×0.224×(1-0.015×8.875) = 4.369
f12 = 0.900×25.000×0.091×(1-0.015×9.525) = 1.755	f12 = 0.900×25.000×0.224×(1-0.015×9.525) = 4.320

11. 하 중 재 하 (상시)

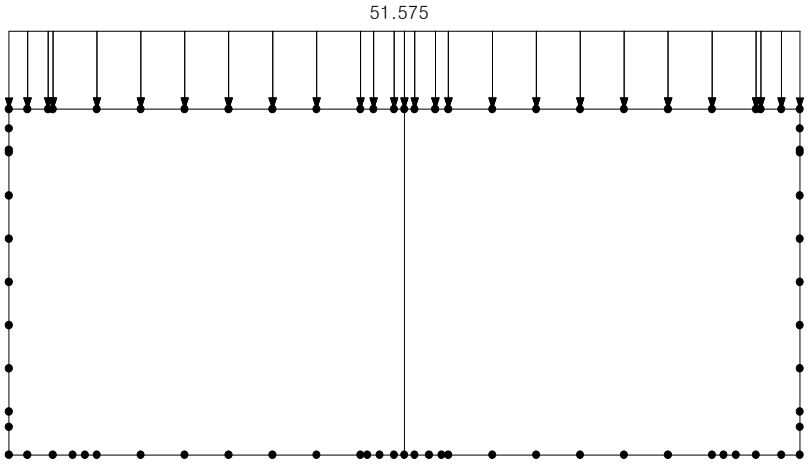
1) CASE1 - 구체자중(SW)



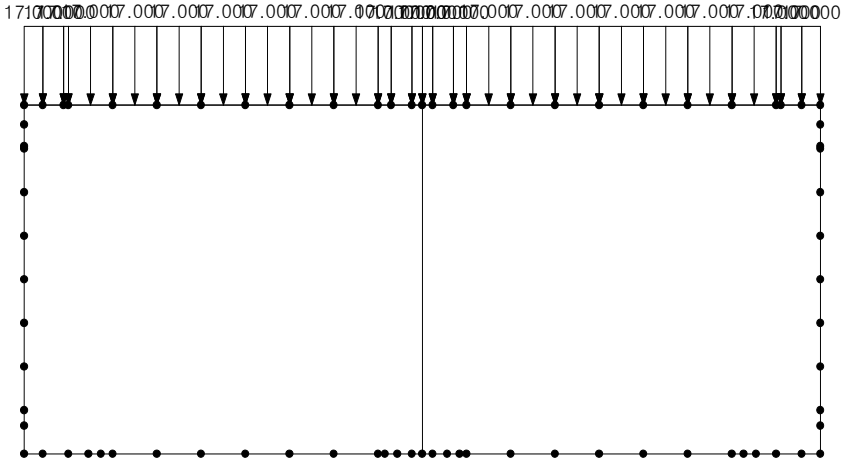
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



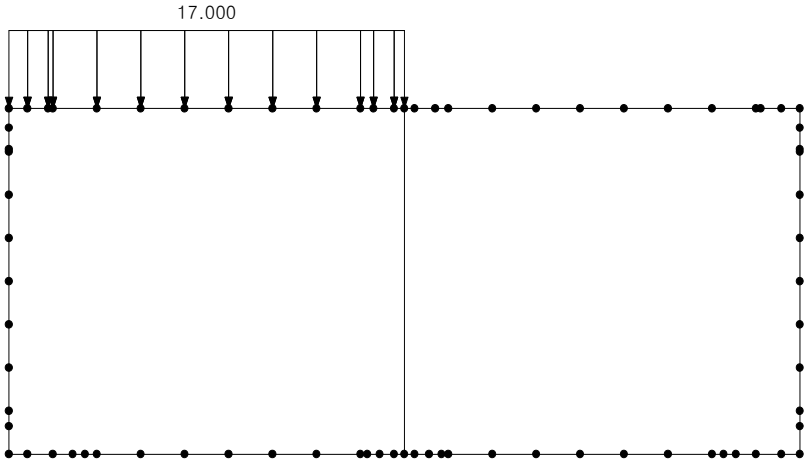
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



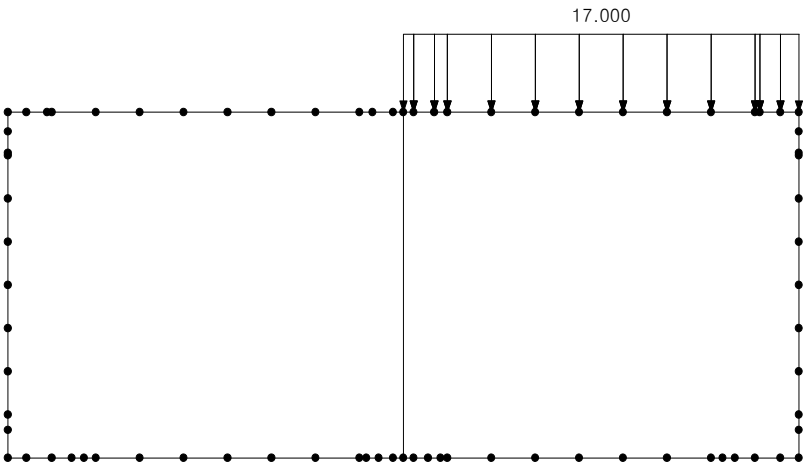
4) CASE4 - 만재활하중(LIVEFU)



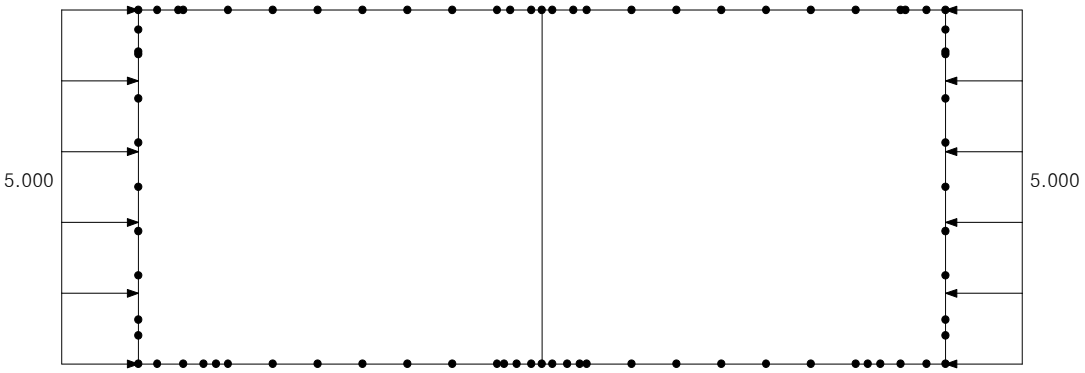
5) CASE5 - 편재활하중(좌측)(LIVELE)



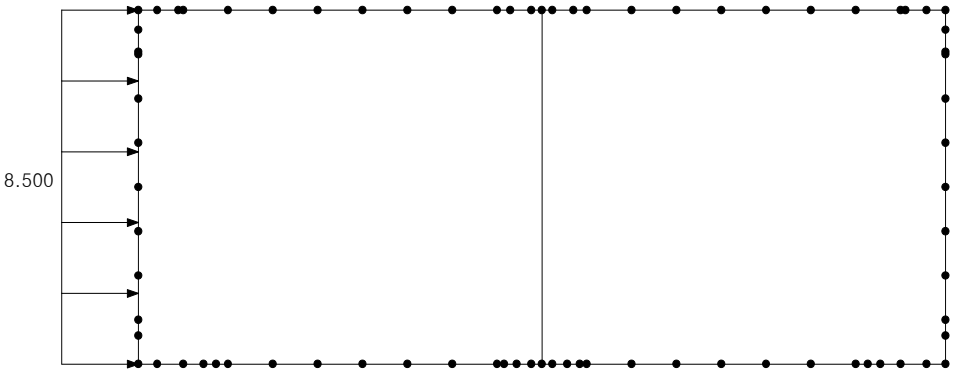
6) CASE6 - 편재활하중(우측)(LIVERI)



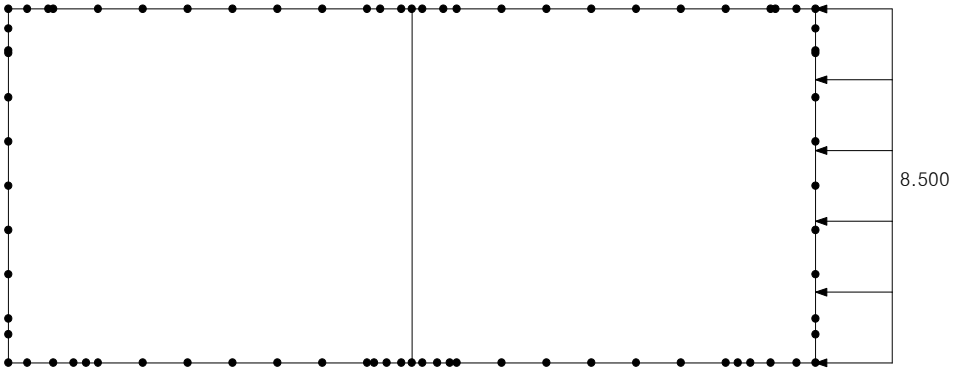
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



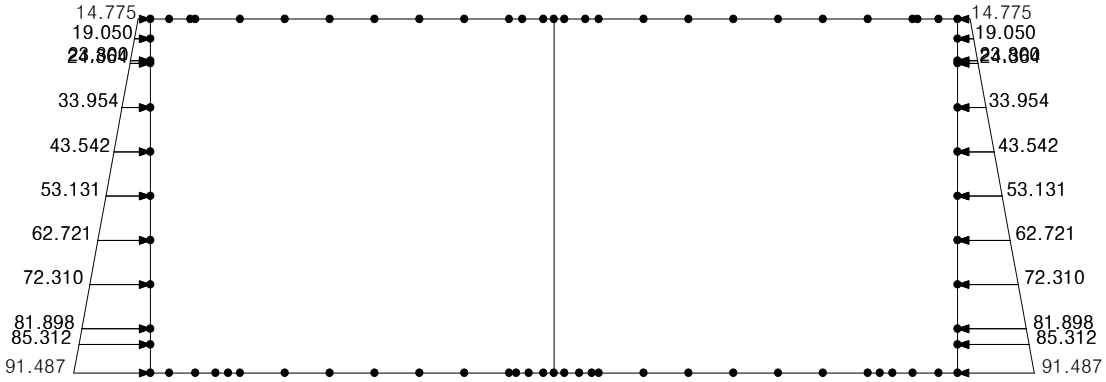
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



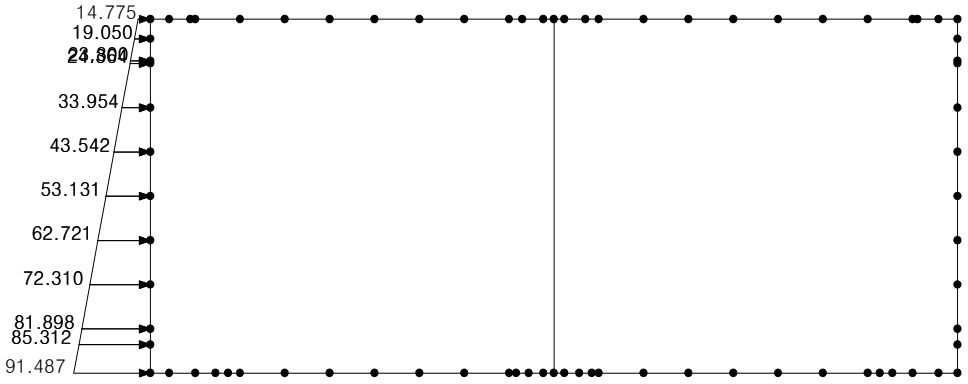
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



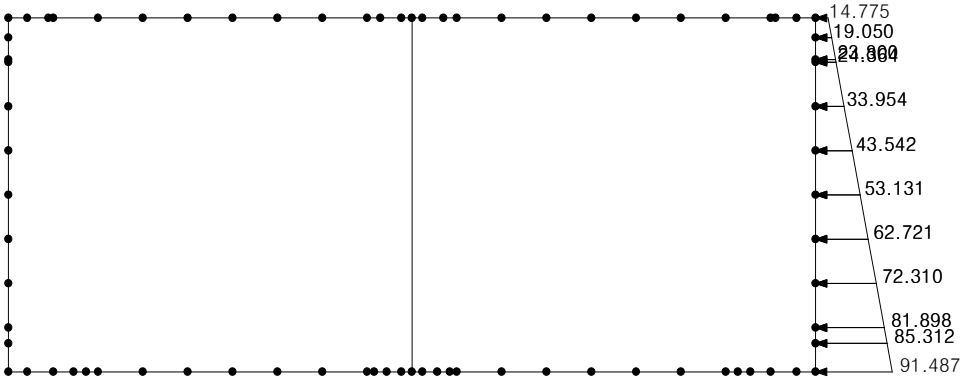
10) CASE10 - 양토압 : 지하수無(SOILB)



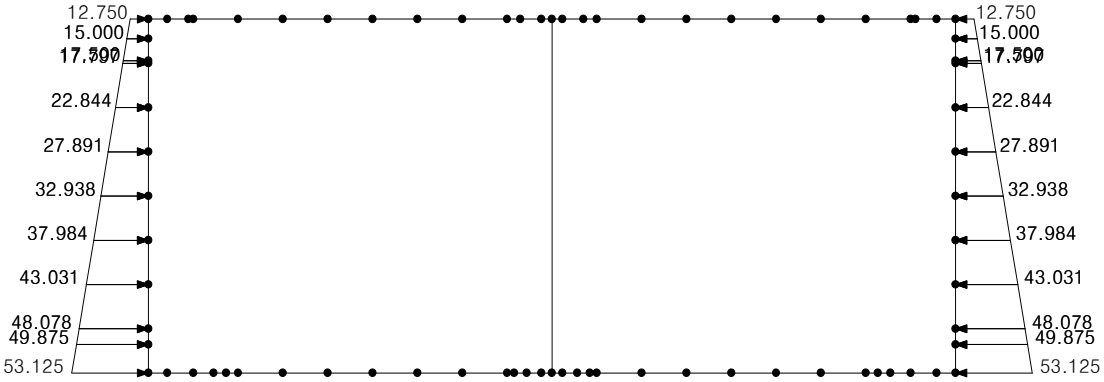
11) CASE11 - 편토압(좌측) : 지하수無(SOILL)



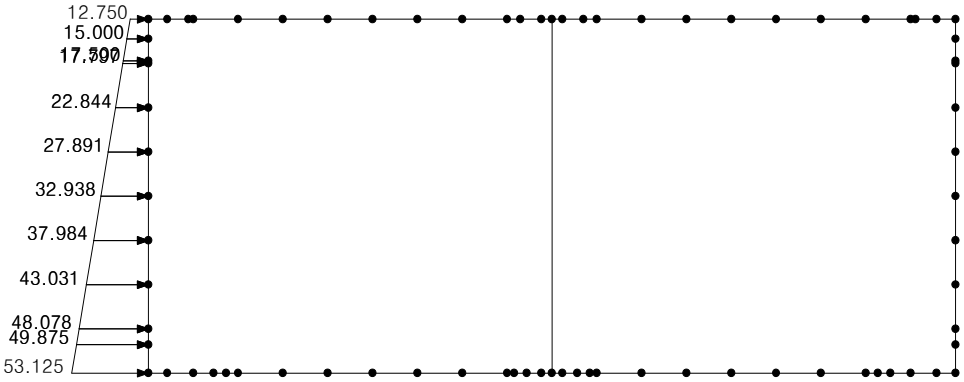
12) CASE12 - 편토압(우측) : 지하수無(SOILR)



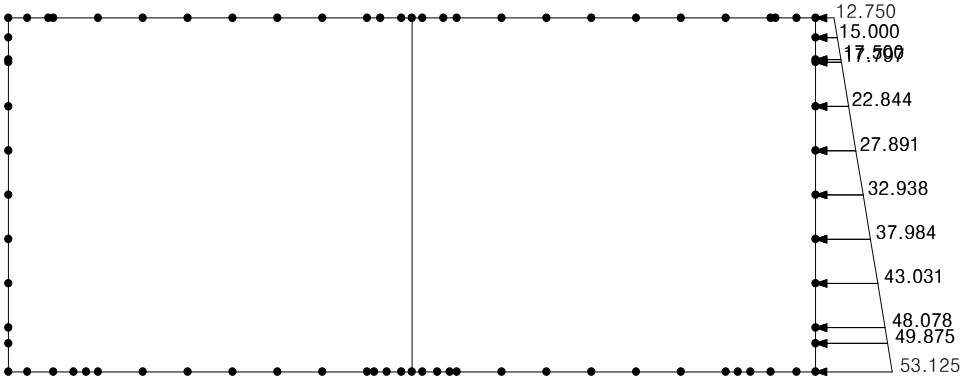
13) CASE13 - 양토압 : 지하수有(SOILBW)



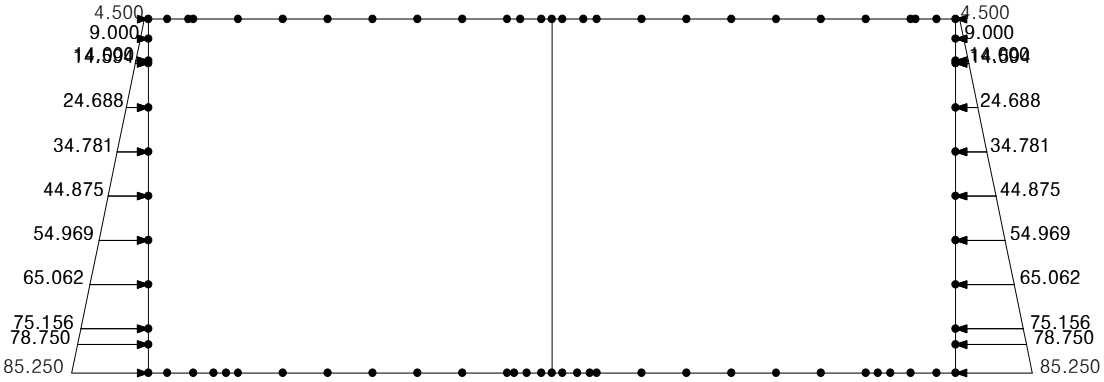
14) CASE14 - 편토압(좌측) : 지하수有(SOILLW)



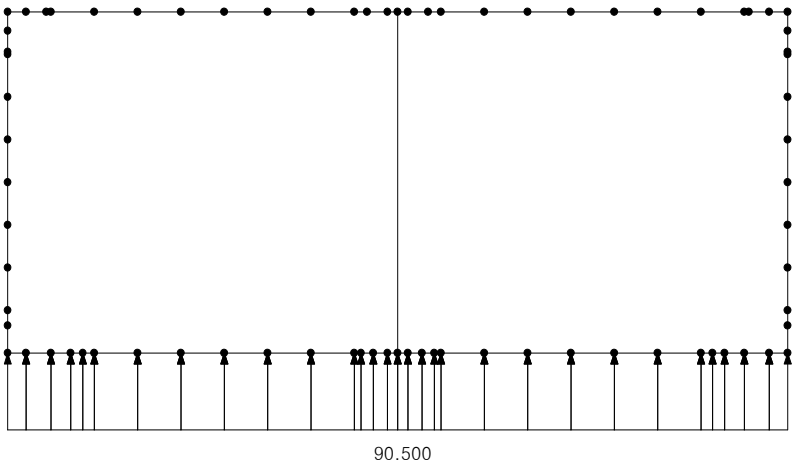
15) CASE15 - 편토압(우측) : 지하수有(SOILRW)



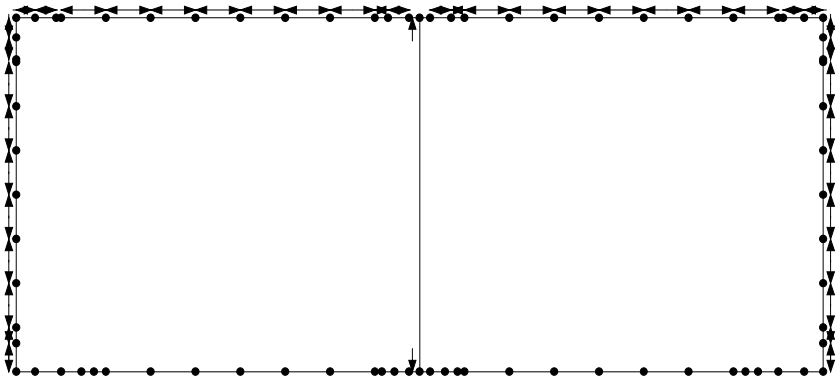
16) CASE16 - 수평수압(WATERH)



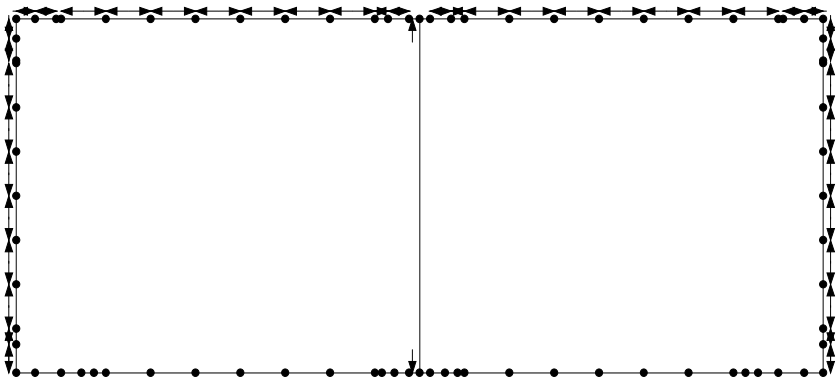
17) CASE17 - 부력(BUOYANCY)



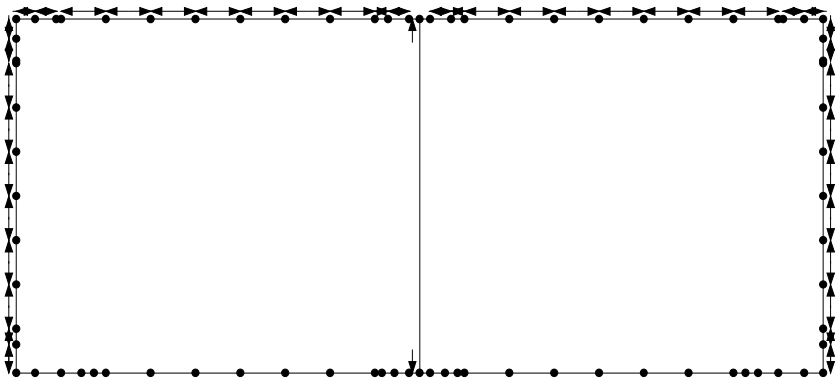
18) CASE18 - 온도변화(+) +10° C(TEMPPLUS)



19) CASE19 - 온도변화(-) -10° C(TEMPMINU)

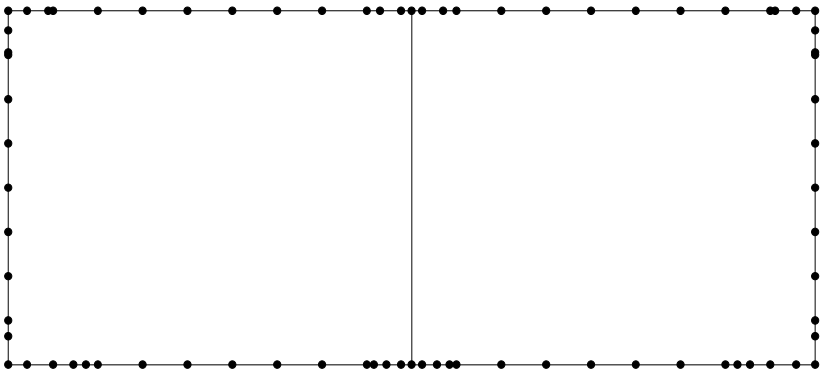


20) CASE20 - 건조수축 -15° C(SHRINK)

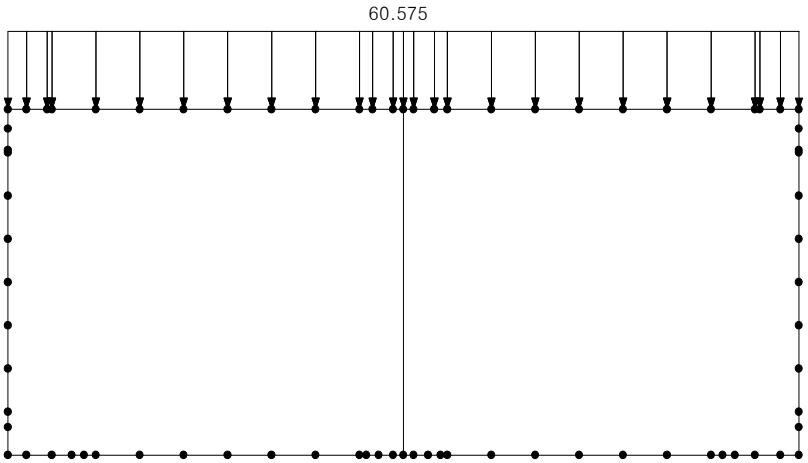


12. 하중 재하 (기능수행)

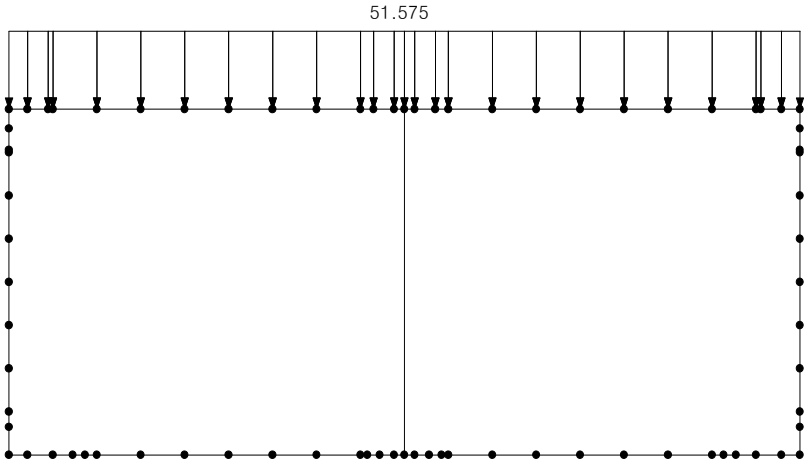
1) CASE1 - 구체자중(SW)



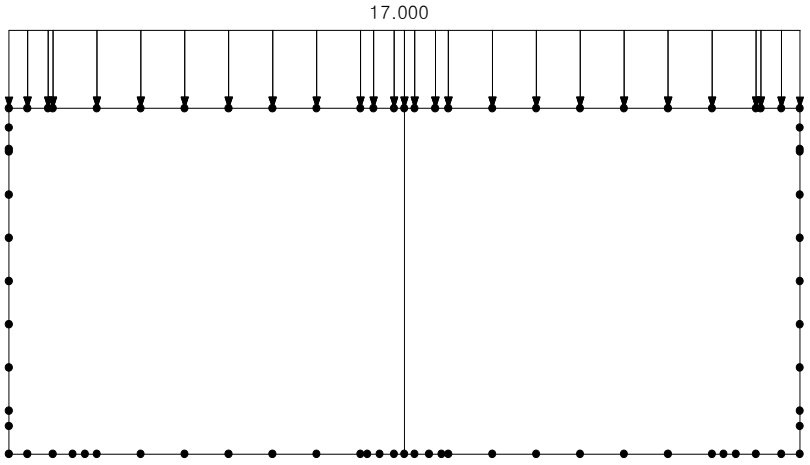
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



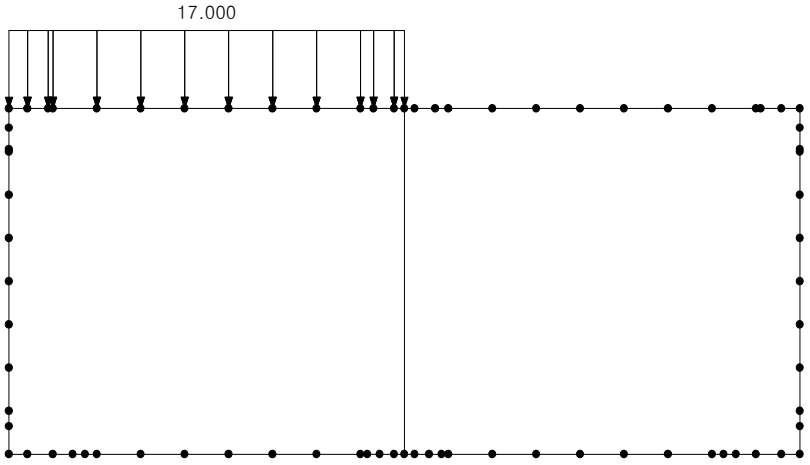
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



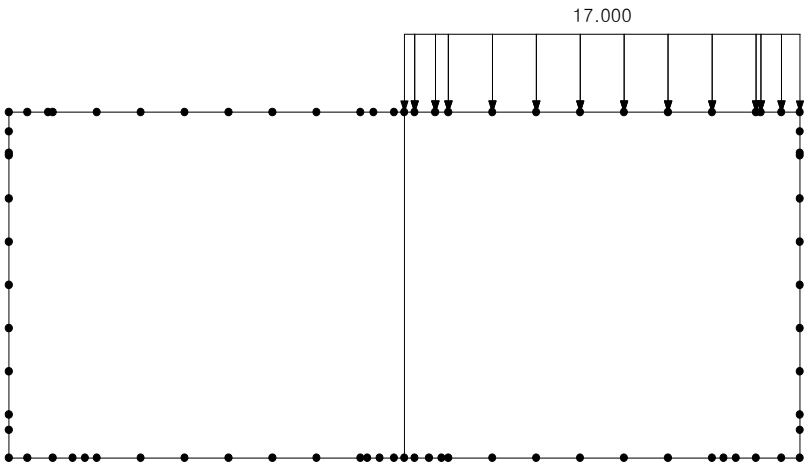
4) CASE4 - 지진시 만재활하중(LIVEFUE)



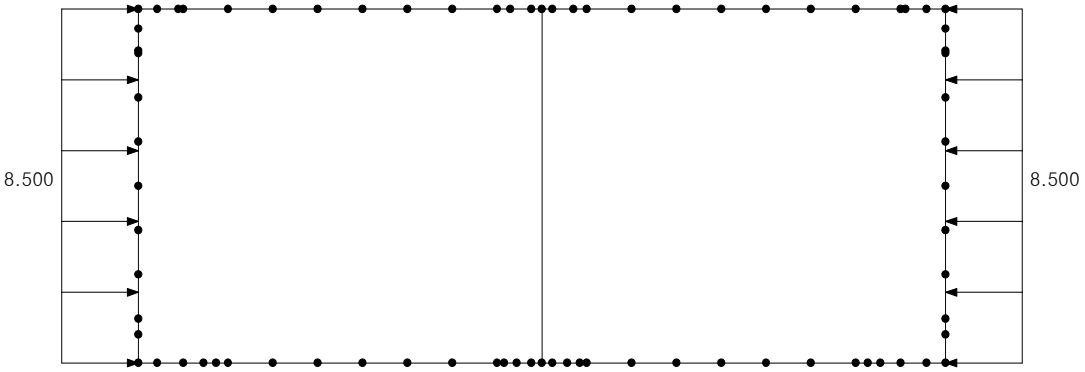
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



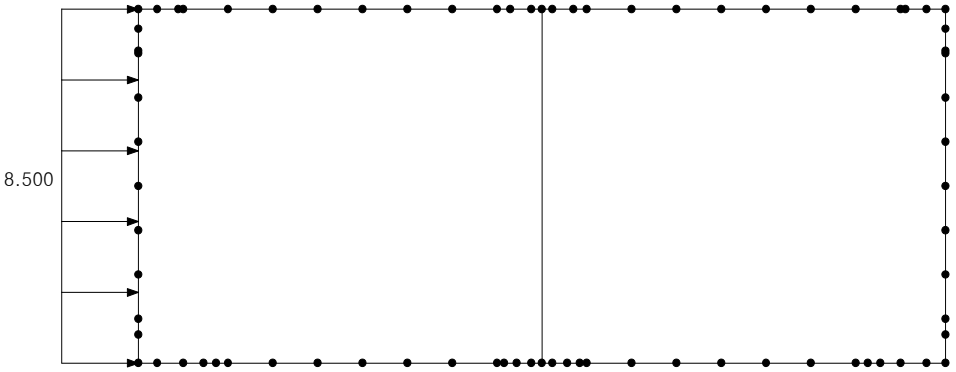
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



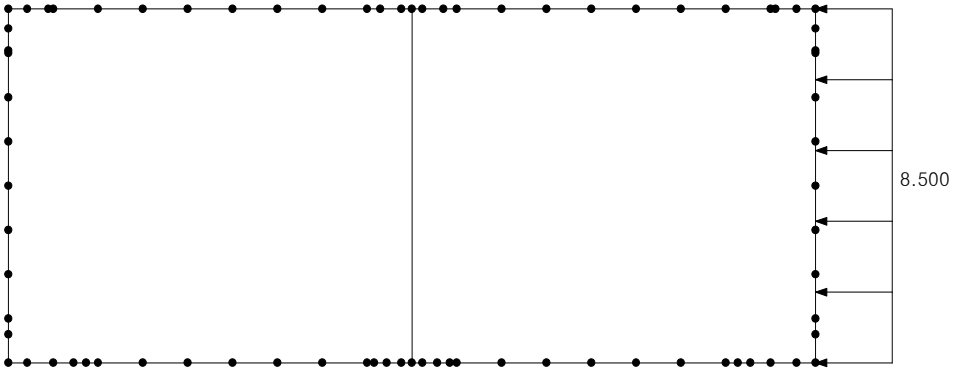
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



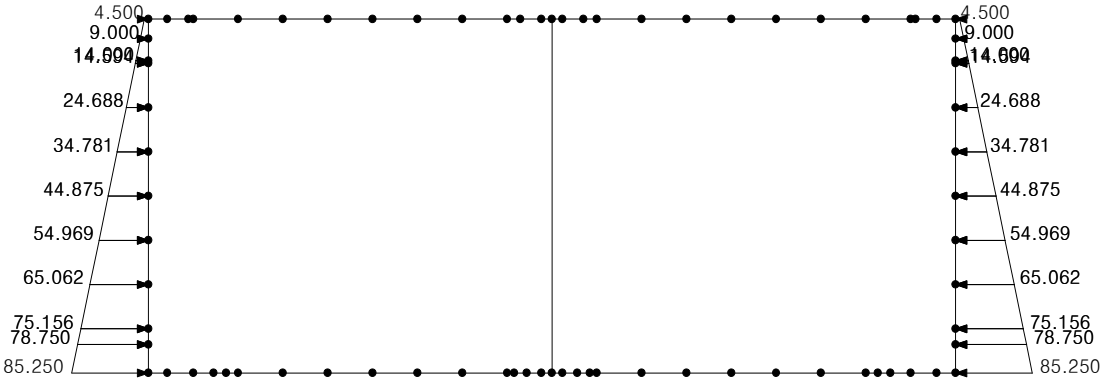
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



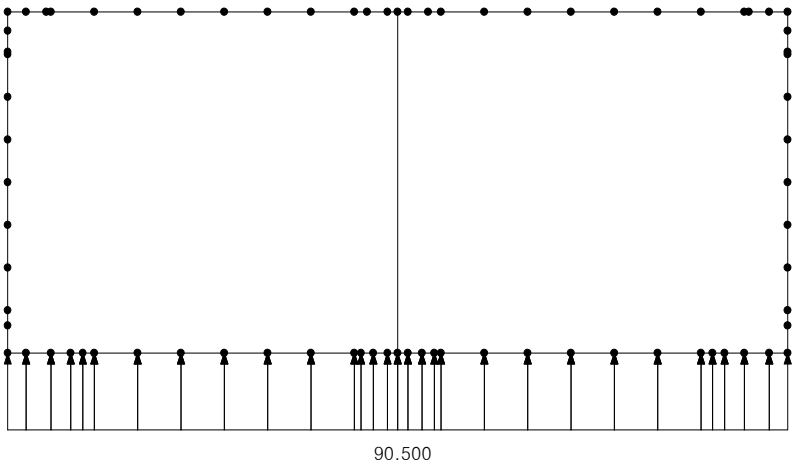
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



10) CASE10 - 수평수압(WATERH)

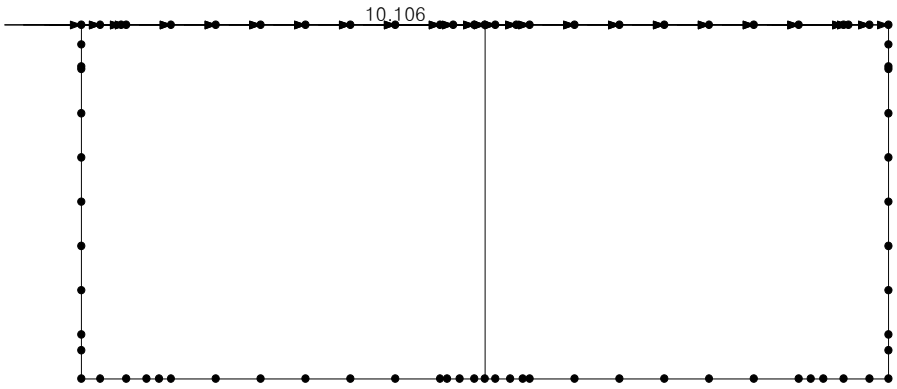


11) CASE11 - 부력(BUOYANCY)

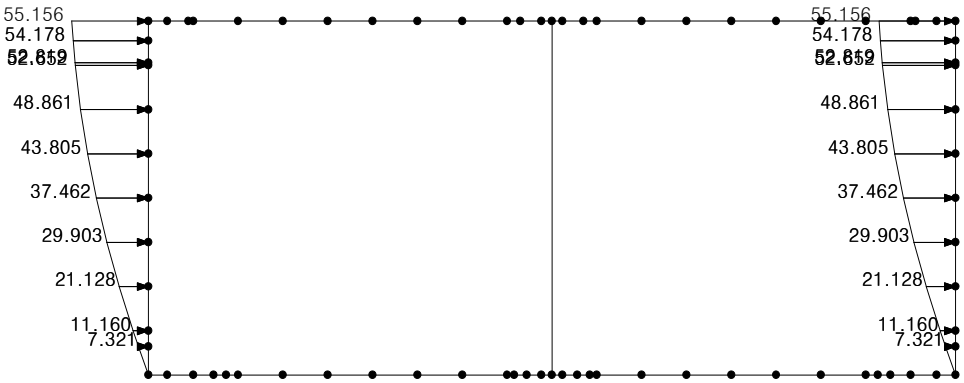


- 지진재하방향(좌측에서 우측으로)

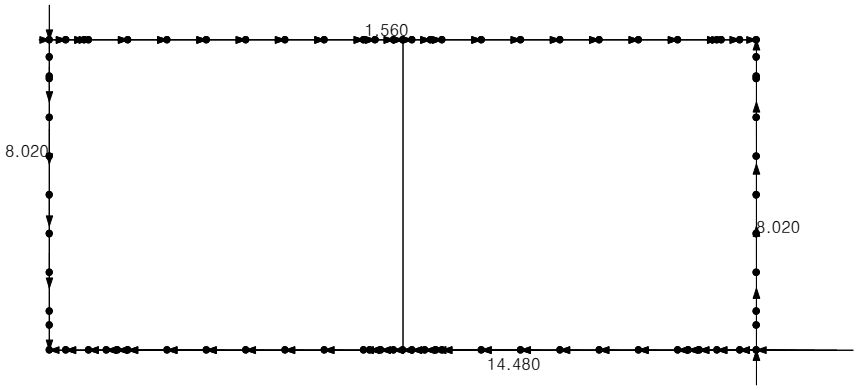
12) CASE12 - 슬래브 지반변위(기능수행)(FUNSLAB)



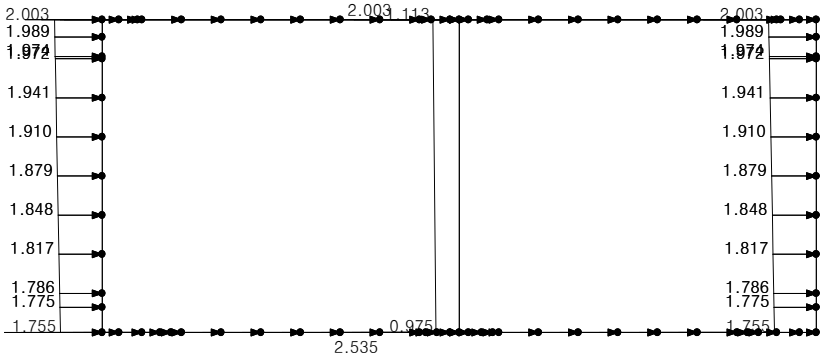
13) CASE13 - 벽체 지반변위(기능수행)(FUNWALL)



14) CASE14 - 주면전단력(기능수행)(FUNMS)

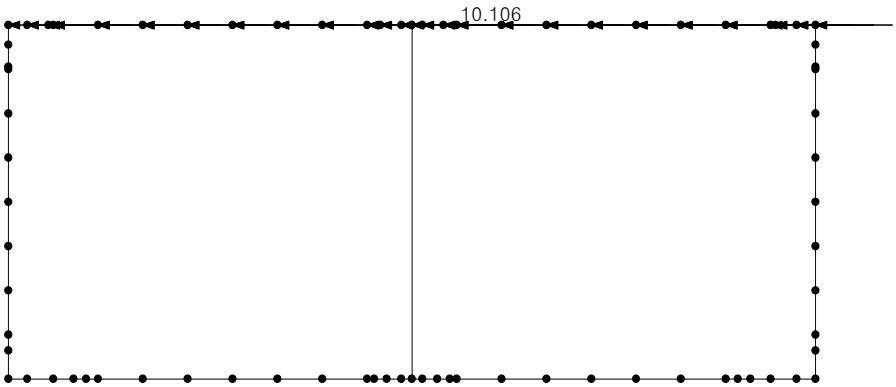


15) CASE15 - 구체 관성력(기능수행)(FUNINER)

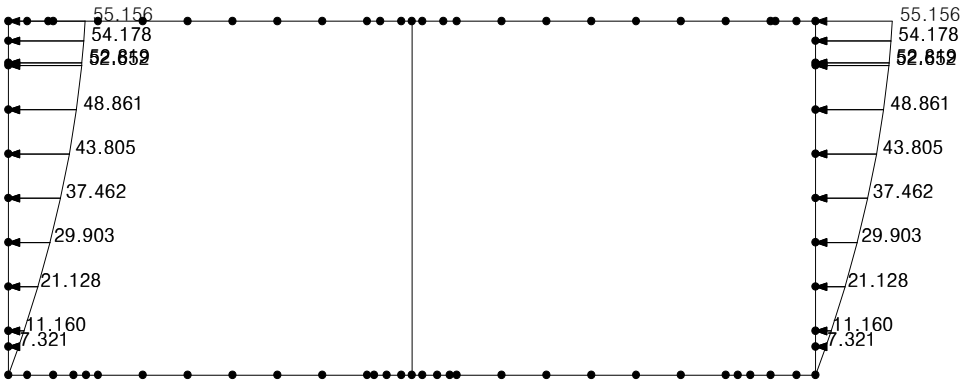


- 지진재하방향(우측에서 좌측으로)

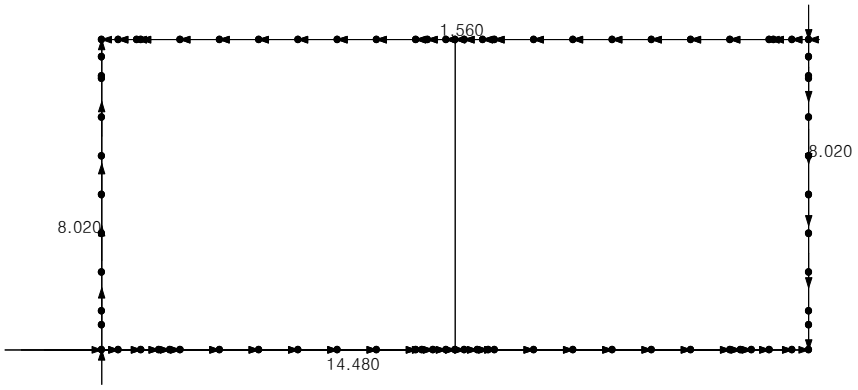
16) CASE16 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



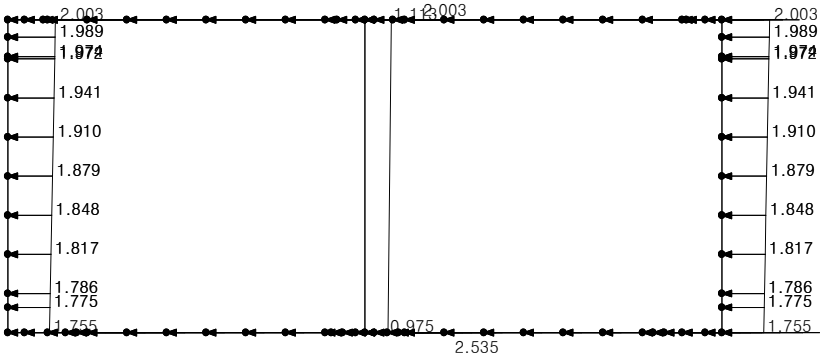
17) CASE17 - 벽체 지반변위(기능수행)2(FUNWALL2)



18) CASE18 - 주면전단력(기능수행)2(FUNMS2)

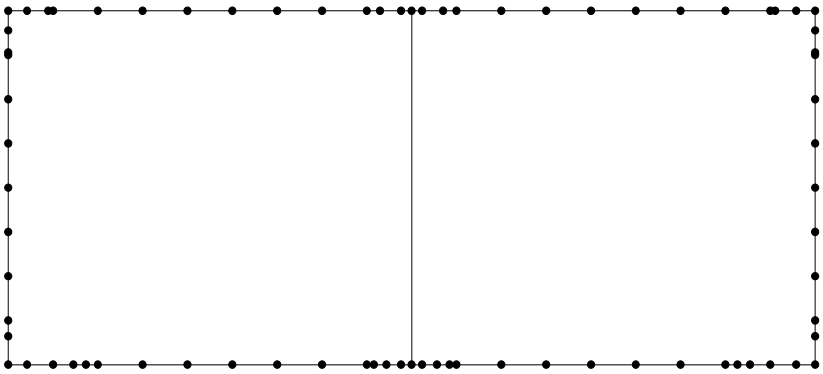


19) CASE19 - 구체 관성력(기능수행)2(FUNINER2)

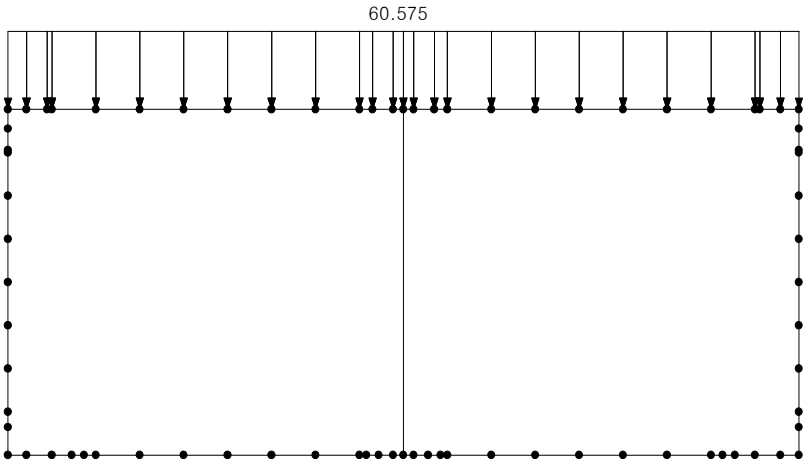


13. 하중 재하 (붕괴방지)

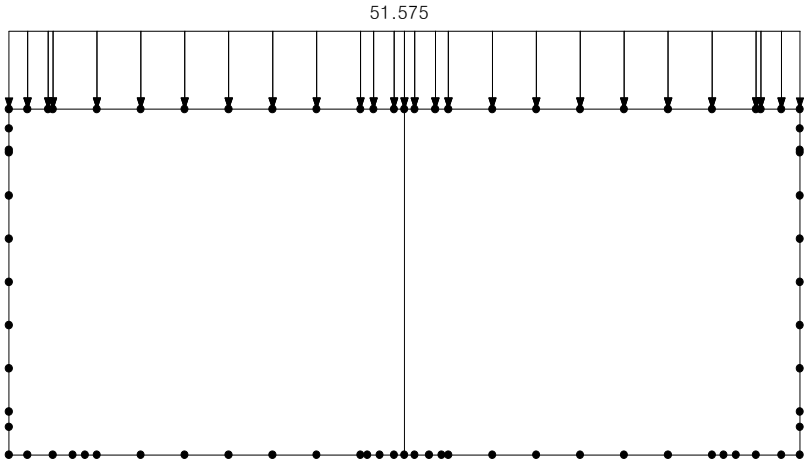
1) CASE1 - 구체자중(SW)



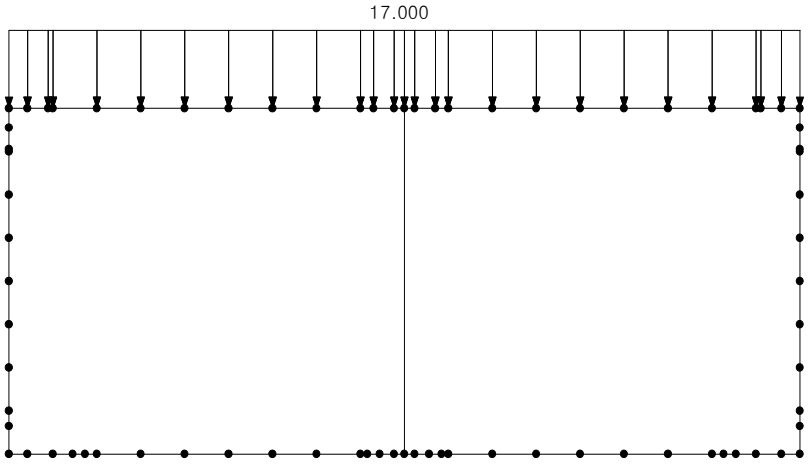
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



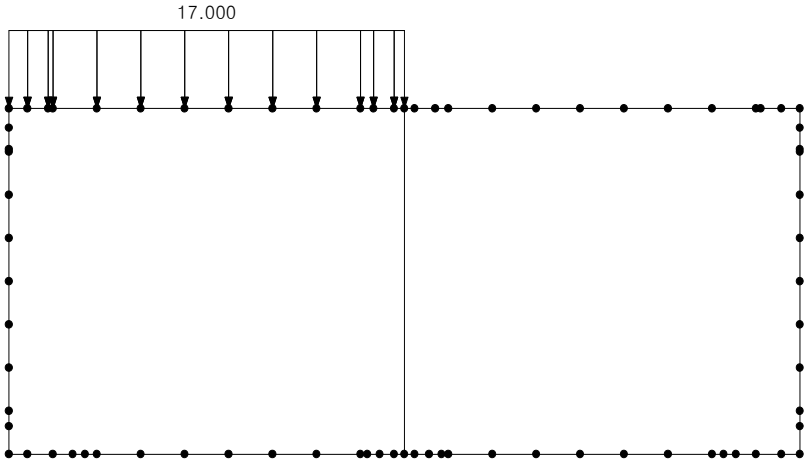
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



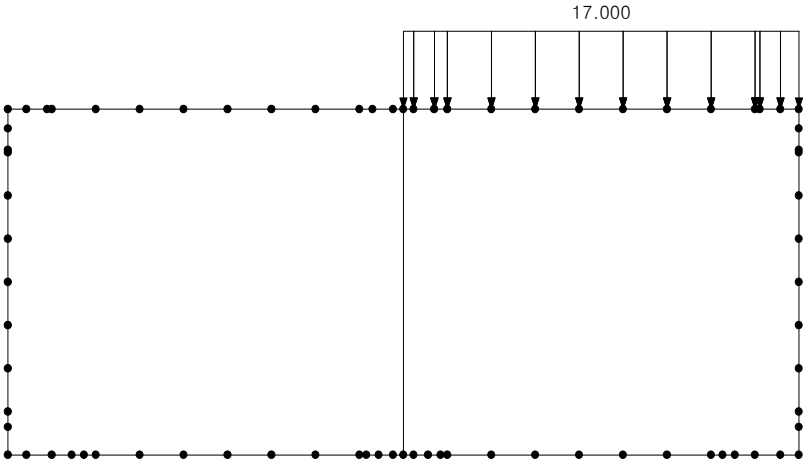
4) CASE4 - 지진시 만재활하중(LIVEFUE)



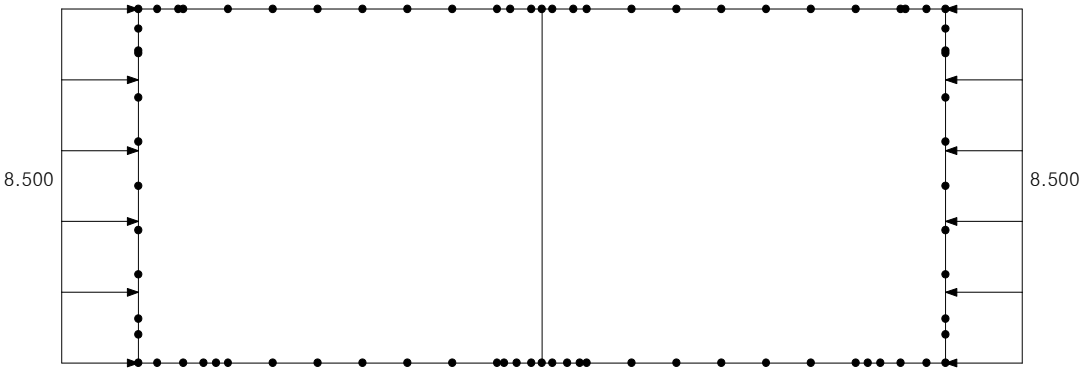
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



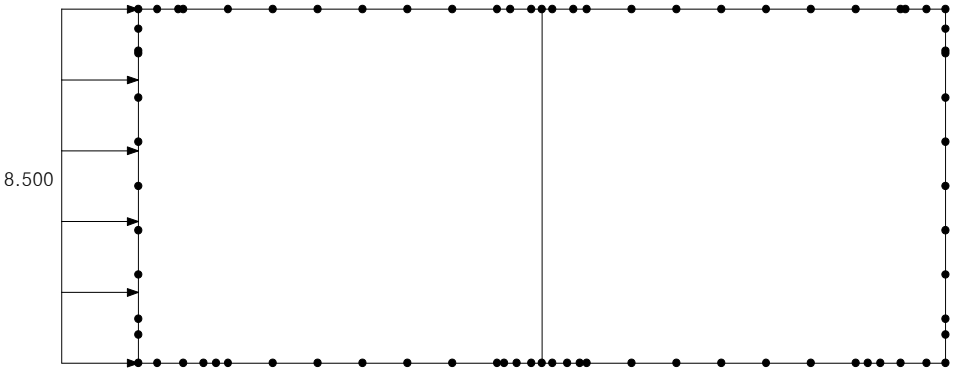
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



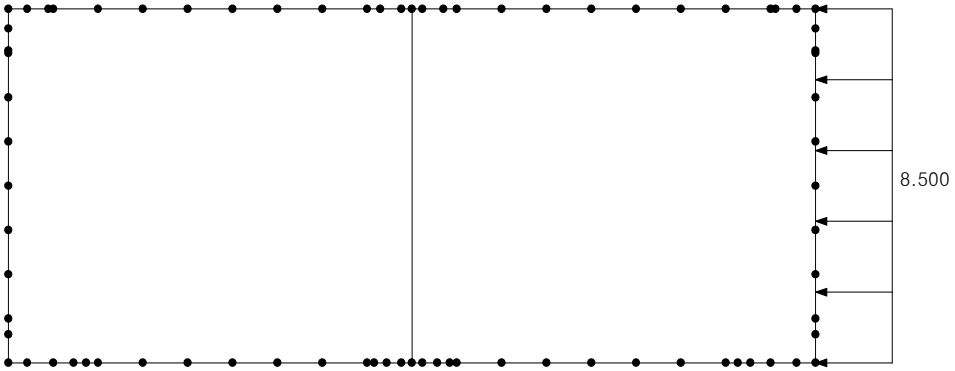
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



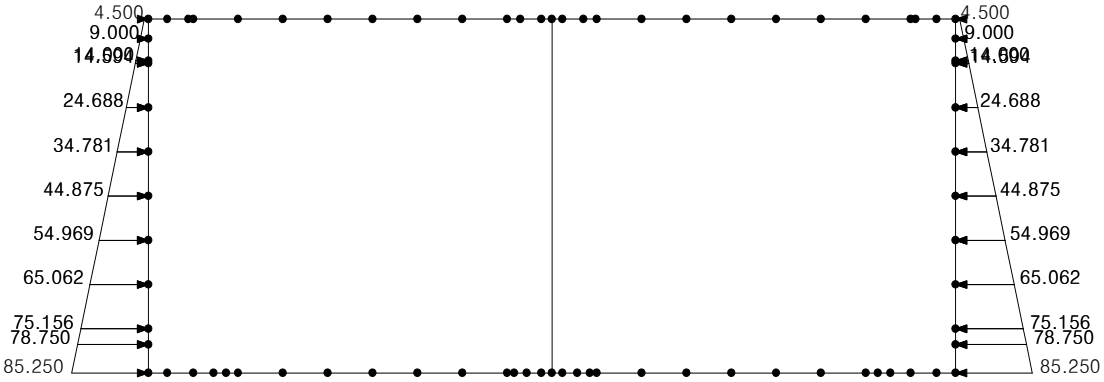
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



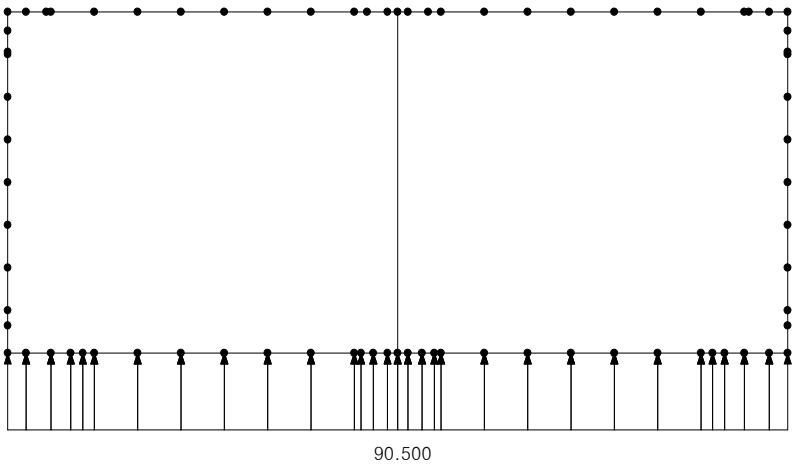
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



10) CASE10 - 수평수압(WATERH)

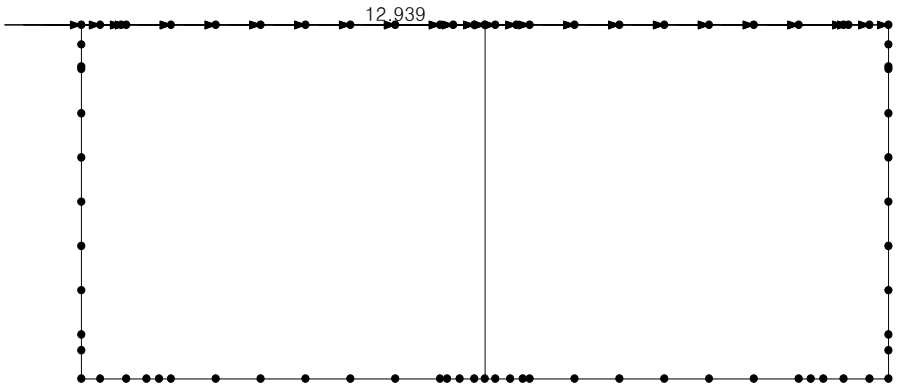


11) CASE11 - 부력(BUOYANCY)

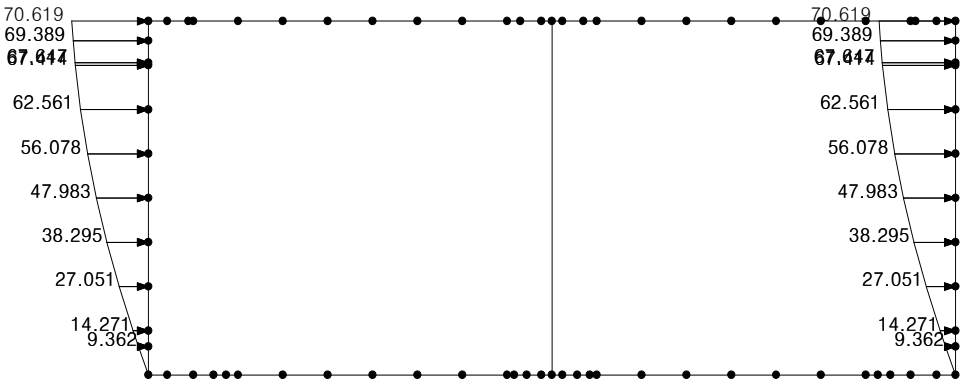


- 지진재하방향(좌측에서 우측으로)

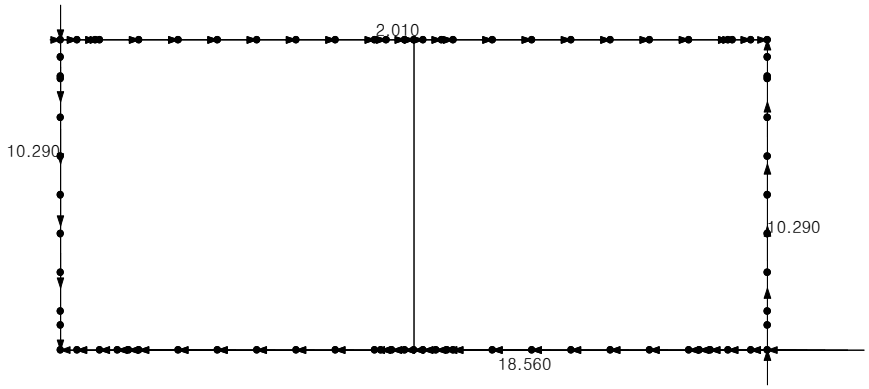
12) CASE12 - 슬래브 지반변위(붕괴방지)(COLSLAB)



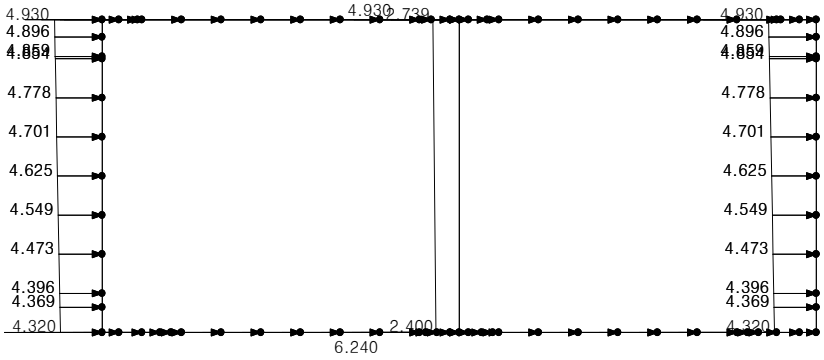
13) CASE13 - 벽체 지반변위(붕괴방지)(COLWALL)



14) CASE14 - 주면전단력(붕괴방지)(COLMS)

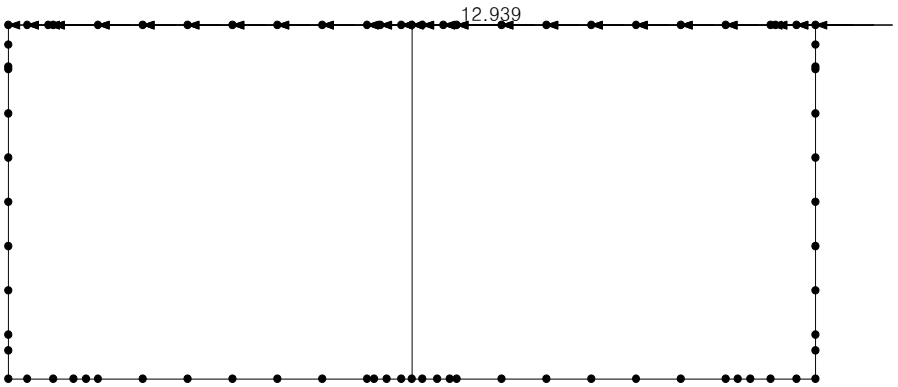


15) CASE15 - 구체 관성력(붕괴방지)(COLINER)

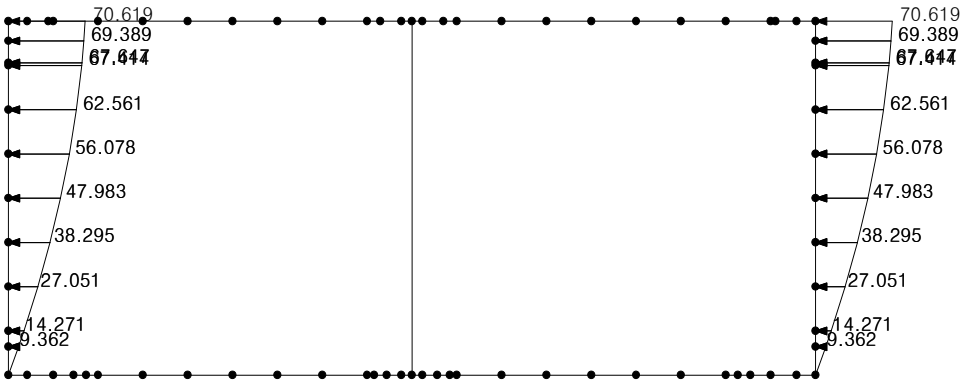


- 지진재하방향(우측에서 좌측으로)

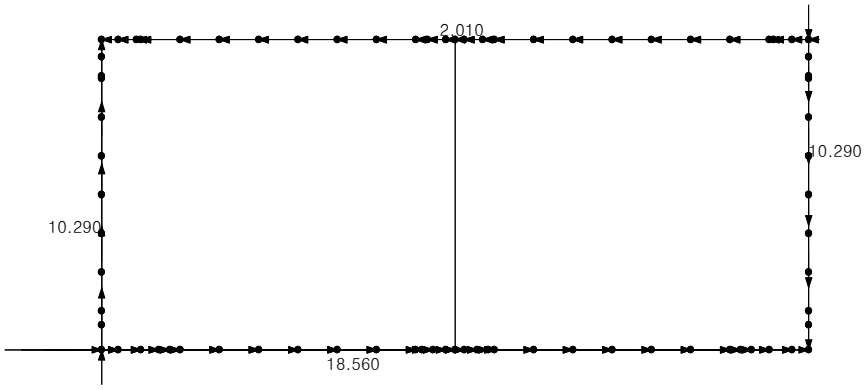
16) CASE16 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



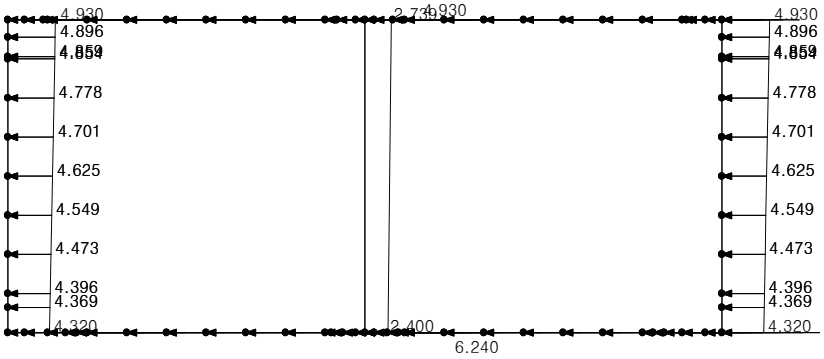
17) CASE17 - 벽체 지반변위(붕괴방지)2(COLWALL2)



18) CASE18 - 주면전단력(붕괴방지)2(COLMS2)



19) CASE19 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 0.975, h = 1.000 m

1) 계수하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.400						
LC2	1.200	1.560	1.600	1.600	1.200		
LC3	1.200		1.000				
LC4	1.200	1.560	1.600	0.800	1.200		
LC5	0.900	0.900		1.600			
LC6	0.900	0.900		0.800			
LC7	1.200	1.560	1.600	1.600	1.200	1.200	●
LC8	1.200	1.560	1.600	0.800	1.200	1.200	●
LC9	0.900	0.900		1.600			●
LC10	0.900	0.900		0.800			●

2) 사용하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.000						
LC2	1.000	1.000	1.000	1.000	1.000		
LC3	1.000		1.000				
LC4	1.000	1.000	1.000	0.500	1.000		
LC5	1.000	1.000		1.000			
LC6	1.000	1.000		0.500			
LC7	1.000	1.000	1.000	1.000	1.000	1.000	●
LC8	1.000	1.000	1.000	0.500	1.000	1.000	●
LC9	1.000	1.000		1.000			●
LC10	1.000	1.000		0.500			●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

15. INPUT DATA (상시)

```
; ACulvert SAP2000 데이터파일 : 평상시
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.000 Y=     0.000 Z=     0.500
  2    X=     0.450 Y=     0.000 Z=     0.500
  3    X=     1.067 Y=     0.000 Z=     0.500
  4    X=     1.550 Y=     0.000 Z=     0.500
  5    X=     1.850 Y=     0.000 Z=     0.500
  6    X=     2.133 Y=     0.000 Z=     0.500
  7    X=     3.200 Y=     0.000 Z=     0.500
  8    X=     4.267 Y=     0.000 Z=     0.500
  9    X=     5.333 Y=     0.000 Z=     0.500
  10   X=     6.400 Y=     0.000 Z=     0.500
  11   X=     7.467 Y=     0.000 Z=     0.500
  12   X=     8.533 Y=     0.000 Z=     0.500
  13   X=     8.700 Y=     0.000 Z=     0.500
  14   X=     9.000 Y=     0.000 Z=     0.500
  15   X=     9.350 Y=     0.000 Z=     0.500
  16   X=     9.600 Y=     0.000 Z=     0.500
  17   X=     9.850 Y=     0.000 Z=     0.500
  18   X=    10.200 Y=     0.000 Z=     0.500
  19   X=    10.500 Y=     0.000 Z=     0.500
  20   X=    10.667 Y=     0.000 Z=     0.500
  21   X=    11.733 Y=     0.000 Z=     0.500
  22   X=    12.800 Y=     0.000 Z=     0.500
  23   X=    13.867 Y=     0.000 Z=     0.500
  24   X=    14.933 Y=     0.000 Z=     0.500
  25   X=    16.000 Y=     0.000 Z=     0.500
  26   X=    17.067 Y=     0.000 Z=     0.500
  27   X=    17.350 Y=     0.000 Z=     0.500
  28   X=    17.650 Y=     0.000 Z=     0.500
  29   X=    18.133 Y=     0.000 Z=     0.500
  30   X=    18.750 Y=     0.000 Z=     0.500
  31   X=    19.200 Y=     0.000 Z=     0.500
  32   X=    19.200 Y=     0.000 Z=     1.150
  33   X=    19.200 Y=     0.000 Z=     1.509
  34   X=    19.200 Y=     0.000 Z=     2.519
  35   X=    19.200 Y=     0.000 Z=     3.528
  36   X=    19.200 Y=     0.000 Z=     4.537
  37   X=    19.200 Y=     0.000 Z=     5.547
  38   X=    19.200 Y=     0.000 Z=     6.556
  39   X=    19.200 Y=     0.000 Z=     7.566
  40   X=    19.200 Y=     0.000 Z=     7.625
  41   X=    19.200 Y=     0.000 Z=     8.125
  42   X=    19.200 Y=     0.000 Z=     8.575
  43   X=    18.750 Y=     0.000 Z=     8.575
  44   X=    18.250 Y=     0.000 Z=     8.575
  45   X=    18.133 Y=     0.000 Z=     8.575
  46   X=    17.067 Y=     0.000 Z=     8.575
  47   X=    16.000 Y=     0.000 Z=     8.575
  48   X=    14.933 Y=     0.000 Z=     8.575
  49   X=    13.867 Y=     0.000 Z=     8.575
  50   X=    12.800 Y=     0.000 Z=     8.575
  51   X=    11.733 Y=     0.000 Z=     8.575
  52   X=    10.667 Y=     0.000 Z=     8.575
  53   X=    10.350 Y=     0.000 Z=     8.575
  54   X=     9.850 Y=     0.000 Z=     8.575
  55   X=     9.600 Y=     0.000 Z=     8.575
  56   X=     9.350 Y=     0.000 Z=     8.575
  57   X=     8.850 Y=     0.000 Z=     8.575
  58   X=     8.533 Y=     0.000 Z=     8.575
  59   X=     7.467 Y=     0.000 Z=     8.575
  60   X=     6.400 Y=     0.000 Z=     8.575
  61   X=     5.333 Y=     0.000 Z=     8.575
  62   X=     4.267 Y=     0.000 Z=     8.575
  63   X=     3.200 Y=     0.000 Z=     8.575
  64   X=     2.133 Y=     0.000 Z=     8.575
  65   X=     1.067 Y=     0.000 Z=     8.575
  66   X=     0.950 Y=     0.000 Z=     8.575
  67   X=     0.450 Y=     0.000 Z=     8.575
  68   X=     0.000 Y=     0.000 Z=     8.575
  69   X=     0.000 Y=     0.000 Z=     8.125
  70   X=     0.000 Y=     0.000 Z=     7.625
  71   X=     0.000 Y=     0.000 Z=     7.566
  72   X=     0.000 Y=     0.000 Z=     6.556
  73   X=     0.000 Y=     0.000 Z=     5.547
  74   X=     0.000 Y=     0.000 Z=     4.537
  75   X=     0.000 Y=     0.000 Z=     3.528
  76   X=     0.000 Y=     0.000 Z=     2.519
  77   X=     0.000 Y=     0.000 Z=     1.509
  78   X=     0.000 Y=     0.000 Z=     1.150
  79   X=     0.000 Y=     0.000 Z=     0.000
  80   X=     1.067 Y=     0.000 Z=     0.000
  81   X=     2.133 Y=     0.000 Z=     0.000
  82   X=     3.200 Y=     0.000 Z=     0.000
  83   X=     4.267 Y=     0.000 Z=     0.000
  84   X=     5.333 Y=     0.000 Z=     0.000
  85   X=     6.400 Y=     0.000 Z=     0.000
  86   X=     7.467 Y=     0.000 Z=     0.000
  87   X=     8.533 Y=     0.000 Z=     0.000
  88   X=     9.600 Y=     0.000 Z=     0.000
  89   X=    10.667 Y=     0.000 Z=     0.000
  90   X=    11.733 Y=     0.000 Z=     0.000
  91   X=    12.800 Y=     0.000 Z=     0.000
  92   X=    13.867 Y=     0.000 Z=     0.000
  93   X=    14.933 Y=     0.000 Z=     0.000
  94   X=    16.000 Y=     0.000 Z=     0.000
  95   X=    17.067 Y=     0.000 Z=     0.000
  96   X=    18.133 Y=     0.000 Z=     0.000
  97   X=    19.200 Y=     0.000 Z=     0.000
RESTRAINT
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=92 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=93 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=94 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=95 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=96 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=97 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=1 UX=1e+010
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=41990. CE=0.99999 K=41990. OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=45548.5 CE=0.99999 K=45548.5 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.3,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.05,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.125 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.125 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.425 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
```

```
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 3 NSEG= 4 ANG=0
    38 J= 38,  39 SEC= 3 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 3 NSEG= 4 ANG=0
    40 J= 40,  41 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    42 J= 42,  43 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    43 J= 43,  44 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 NSEG= 4 ANG=0
    51 J= 51,  52 SEC= 3 NSEG= 4 ANG=0
    52 J= 52,  53 SEC= 3 NSEG= 4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    55 J= 55,  56 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    56 J= 56,  57 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 3 NSEG= 4 ANG=0
    64 J= 64,  65 SEC= 3 NSEG= 4 ANG=0
    65 J= 65,  66 SEC= 3 NSEG= 4 ANG=0
    66 J= 66,  67 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    67 J= 67,  68 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    68 J= 68,  69 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    69 J= 69,  70 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,  73 SEC= 3 NSEG= 4 ANG=180
    73 J= 73,  74 SEC= 3 NSEG= 4 ANG=180
    74 J= 74,  75 SEC= 3 NSEG= 4 ANG=180
    75 J= 75,  76 SEC= 3 NSEG= 4 ANG=180
    76 J= 76,  77 SEC= 3 NSEG= 4 ANG=180
    77 J= 77,  78 SEC= 3 NSEG= 4 ANG=180
    78 J= 78,   1 SEC= 3 IOFF=0 JOFF=0.425 RIGID=1 NSEG=4 ANG=180
    79 J= 55,  16 SEC= 5 IOFF=0.7 JOFF=0.525 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,79 NLP=1 ANG=0
     2 J= 3,80 NLP=2 ANG=0
     3 J= 6,81 NLP=2 ANG=0
     4 J= 7,82 NLP=2 ANG=0
     5 J= 8,83 NLP=2 ANG=0
     6 J= 9,84 NLP=2 ANG=0
     7 J=10,85 NLP=2 ANG=0
     8 J=11,86 NLP=2 ANG=0
     9 J=12,87 NLP=2 ANG=0
    10 J=16,88 NLP=2 ANG=0
    11 J=20,89 NLP=2 ANG=0
    12 J=21,90 NLP=2 ANG=0
    13 J=22,91 NLP=2 ANG=0
    14 J=23,92 NLP=2 ANG=0
    15 J=24,93 NLP=2 ANG=0
    16 J=25,94 NLP=2 ANG=0
    17 J=26,95 NLP=2 ANG=0
    18 J=29,96 NLP=2 ANG=0
    19 J=31,97 NLP=1 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-60.575, -60.575
      ADD=43 RD=0,1 UZ=-60.575, -60.575
      ADD=44 RD=0,1 UZ=-60.575, -60.575
      ADD=45 RD=0,1 UZ=-60.575, -60.575
      ADD=46 RD=0,1 UZ=-60.575, -60.575
      ADD=47 RD=0,1 UZ=-60.575, -60.575
      ADD=48 RD=0,1 UZ=-60.575, -60.575
      ADD=49 RD=0,1 UZ=-60.575, -60.575
      ADD=50 RD=0,1 UZ=-60.575, -60.575
      ADD=51 RD=0,1 UZ=-60.575, -60.575
      ADD=52 RD=0,1 UZ=-60.575, -60.575
      ADD=53 RD=0,1 UZ=-60.575, -60.575
      ADD=54 RD=0,1 UZ=-60.575, -60.575
      ADD=55 RD=0,1 UZ=-60.575, -60.575
      ADD=56 RD=0,1 UZ=-60.575, -60.575
      ADD=57 RD=0,1 UZ=-60.575, -60.575
      ADD=58 RD=0,1 UZ=-60.575, -60.575
      ADD=59 RD=0,1 UZ=-60.575, -60.575
      ADD=60 RD=0,1 UZ=-60.575, -60.575
      ADD=61 RD=0,1 UZ=-60.575, -60.575
      ADD=62 RD=0,1 UZ=-60.575, -60.575
      ADD=63 RD=0,1 UZ=-60.575, -60.575
      ADD=64 RD=0,1 UZ=-60.575, -60.575
      ADD=65 RD=0,1 UZ=-60.575, -60.575
      ADD=66 RD=0,1 UZ=-60.575, -60.575
      ADD=67 RD=0,1 UZ=-60.575, -60.575
   NAME=PAVEW  ; 상부고정하중 : 지하수有
      TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-51.575, -51.575
      ADD=43 RD=0,1 UZ=-51.575, -51.575
      ADD=44 RD=0,1 UZ=-51.575, -51.575
      ADD=45 RD=0,1 UZ=-51.575, -51.575
      ADD=46 RD=0,1 UZ=-51.575, -51.575
      ADD=47 RD=0,1 UZ=-51.575, -51.575
      ADD=48 RD=0,1 UZ=-51.575, -51.575
      ADD=49 RD=0,1 UZ=-51.575, -51.575
      ADD=50 RD=0,1 UZ=-51.575, -51.575
      ADD=51 RD=0,1 UZ=-51.575, -51.575
      ADD=52 RD=0,1 UZ=-51.575, -51.575
      ADD=53 RD=0,1 UZ=-51.575, -51.575
      ADD=54 RD=0,1 UZ=-51.575, -51.575
      ADD=55 RD=0,1 UZ=-51.575, -51.575
      ADD=56 RD=0,1 UZ=-51.575, -51.575
      ADD=57 RD=0,1 UZ=-51.575, -51.575
      ADD=58 RD=0,1 UZ=-51.575, -51.575
      ADD=59 RD=0,1 UZ=-51.575, -51.575
      ADD=60 RD=0,1 UZ=-51.575, -51.575
      ADD=61 RD=0,1 UZ=-51.575, -51.575
      ADD=62 RD=0,1 UZ=-51.575, -51.575
      ADD=63 RD=0,1 UZ=-51.575, -51.575
      ADD=64 RD=0,1 UZ=-51.575, -51.575
      ADD=65 RD=0,1 UZ=-51.575, -51.575
      ADD=66 RD=0,1 UZ=-51.575, -51.575
      ADD=67 RD=0,1 UZ=-51.575, -51.575
   NAME=LIVEFU  ; 만재활하중
      TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-17, -17
      ADD=43 RD=0,1 UZ=-17, -17
      ADD=44 RD=0,1 UZ=-17, -17
      ADD=45 RD=0,1 UZ=-17, -17
      ADD=46 RD=0,1 UZ=-17, -17
      ADD=47 RD=0,1 UZ=-17, -17
      ADD=48 RD=0,1 UZ=-17, -17
      ADD=49 RD=0,1 UZ=-17, -17
      ADD=50 RD=0,1 UZ=-17, -17
      ADD=51 RD=0,1 UZ=-17, -17
      ADD=52 RD=0,1 UZ=-17, -17
      ADD=53 RD=0,1 UZ=-17, -17
      ADD=54 RD=0,1 UZ=-17, -17
      ADD=55 RD=0,1 UZ=-17, -17
      ADD=56 RD=0,1 UZ=-17, -17
      ADD=57 RD=0,1 UZ=-17, -17
      ADD=58 RD=0,1 UZ=-17, -17
      ADD=59 RD=0,1 UZ=-17, -17
      ADD=60 RD=0,1 UZ=-17, -17
      ADD=61 RD=0,1 UZ=-17, -17
      ADD=62 RD=0,1 UZ=-17, -17
      ADD=63 RD=0,1 UZ=-17, -17
      ADD=64 RD=0,1 UZ=-17, -17
      ADD=65 RD=0,1 UZ=-17, -17
      ADD=66 RD=0,1 UZ=-17, -17
      ADD=67 RD=0,1 UZ=-17, -17
   NAME=LIVELE  ; 편재활하중(좌측)
      TYPE=DISTRIBUTED SPAN
      ADD=55 RD=0,1 UZ=-17, -17
      ADD=56 RD=0,1 UZ=-17, -17
      ADD=57 RD=0,1 UZ=-17, -17
      ADD=58 RD=0,1 UZ=-17, -17
      ADD=59 RD=0,1 UZ=-17, -17
      ADD=60 RD=0,1 UZ=-17, -17
      ADD=61 RD=0,1 UZ=-17, -17
      ADD=62 RD=0,1 UZ=-17, -17
      ADD=63 RD=0,1 UZ=-17, -17
      ADD=64 RD=0,1 UZ=-17, -17
      ADD=65 RD=0,1 UZ=-17, -17
      ADD=66 RD=0,1 UZ=-17, -17
      ADD=67 RD=0,1 UZ=-17, -17
   NAME=LIVERI  ; 편재활하중(우측)
      TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-17, -17
      ADD=43 RD=0,1 UZ=-17, -17
      ADD=44 RD=0,1 UZ=-17, -17
      ADD=45 RD=0,1 UZ=-17, -17
      ADD=46 RD=0,1 UZ=-17, -17
      ADD=47 RD=0,1 UZ=-17, -17
      ADD=48 RD=0,1 UZ=-17, -17
      ADD=49 RD=0,1 UZ=-17, -17
      ADD=50 RD=0,1 UZ=-17, -17
      ADD=51 RD=0,1 UZ=-17, -17
      ADD=52 RD=0,1 UZ=-17, -17
      ADD=53 RD=0,1 UZ=-17, -17
      ADD=54 RD=0,1 UZ=-17, -17
```

```
NAME=LIVEFUH  ; 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=5, 5
      ADD=69 RD=0,1 UX=5, 5
      ADD=70 RD=0,1 UX=5, 5
      ADD=71 RD=0,1 UX=5, 5
      ADD=72 RD=0,1 UX=5, 5
      ADD=73 RD=0,1 UX=5, 5
      ADD=74 RD=0,1 UX=5, 5
      ADD=75 RD=0,1 UX=5, 5
      ADD=76 RD=0,1 UX=5, 5
      ADD=77 RD=0,1 UX=5, 5
      ADD=78 RD=0,1 UX=5, 5
      ADD=31 RD=0,1 UX=-5, -5
      ADD=32 RD=0,1 UX=-5, -5
      ADD=33 RD=0,1 UX=-5, -5
      ADD=34 RD=0,1 UX=-5, -5
      ADD=35 RD=0,1 UX=-5, -5
      ADD=36 RD=0,1 UX=-5, -5
      ADD=37 RD=0,1 UX=-5, -5
      ADD=38 RD=0,1 UX=-5, -5
      ADD=39 RD=0,1 UX=-5, -5
      ADD=40 RD=0,1 UX=-5, -5
      ADD=41 RD=0,1 UX=-5, -5
NAME=LIVELEH  ; 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=8.5, 8.5
      ADD=69 RD=0,1 UX=8.5, 8.5
      ADD=70 RD=0,1 UX=8.5, 8.5
      ADD=71 RD=0,1 UX=8.5, 8.5
      ADD=72 RD=0,1 UX=8.5, 8.5
      ADD=73 RD=0,1 UX=8.5, 8.5
      ADD=74 RD=0,1 UX=8.5, 8.5
      ADD=75 RD=0,1 UX=8.5, 8.5
      ADD=76 RD=0,1 UX=8.5, 8.5
      ADD=77 RD=0,1 UX=8.5, 8.5
      ADD=78 RD=0,1 UX=8.5, 8.5
NAME=LIVERIH  ; 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-8.5, -8.5
      ADD=32 RD=0,1 UX=-8.5, -8.5
      ADD=33 RD=0,1 UX=-8.5, -8.5
      ADD=34 RD=0,1 UX=-8.5, -8.5
      ADD=35 RD=0,1 UX=-8.5, -8.5
      ADD=36 RD=0,1 UX=-8.5, -8.5
      ADD=37 RD=0,1 UX=-8.5, -8.5
      ADD=38 RD=0,1 UX=-8.5, -8.5
      ADD=39 RD=0,1 UX=-8.5, -8.5
      ADD=40 RD=0,1 UX=-8.5, -8.5
      ADD=41 RD=0,1 UX=-8.5, -8.5
NAME=SOILB  ; 양토압 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=14.775, 19.05
      ADD=69 RD=0,1 UX=19.05, 23.8
      ADD=70 RD=0,1 UX=23.8, 24.364
      ADD=71 RD=0,1 UX=24.364, 33.954
      ADD=72 RD=0,1 UX=33.954, 43.542
      ADD=73 RD=0,1 UX=43.542, 53.131
      ADD=74 RD=0,1 UX=53.131, 62.721
      ADD=75 RD=0,1 UX=62.721, 72.31
      ADD=76 RD=0,1 UX=72.31, 81.898
      ADD=77 RD=0,1 UX=81.898, 85.312
      ADD=78 RD=0,1 UX=85.312, 91.487
      ADD=31 RD=0,1 UX=-91.487, -85.312
      ADD=32 RD=0,1 UX=-85.312, -81.898
      ADD=33 RD=0,1 UX=-81.898, -72.31
      ADD=34 RD=0,1 UX=-72.31, -62.721
      ADD=35 RD=0,1 UX=-62.721, -53.131
      ADD=36 RD=0,1 UX=-53.131, -43.542
      ADD=37 RD=0,1 UX=-43.542, -33.954
      ADD=38 RD=0,1 UX=-33.954, -24.364
      ADD=39 RD=0,1 UX=-24.364, -23.8
      ADD=40 RD=0,1 UX=-23.8, -19.05
      ADD=41 RD=0,1 UX=-19.05, -14.775
NAME=SOILL  ; 편토압(좌측) : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=14.775, 19.05
      ADD=69 RD=0,1 UX=19.05, 23.8
      ADD=70 RD=0,1 UX=23.8, 24.364
      ADD=71 RD=0,1 UX=24.364, 33.954
      ADD=72 RD=0,1 UX=33.954, 43.542
      ADD=73 RD=0,1 UX=43.542, 53.131
      ADD=74 RD=0,1 UX=53.131, 62.721
      ADD=75 RD=0,1 UX=62.721, 72.31
      ADD=76 RD=0,1 UX=72.31, 81.898
      ADD=77 RD=0,1 UX=81.898, 85.312
      ADD=78 RD=0,1 UX=85.312, 91.487
NAME=SOILR  ; 편토압(우측) : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-91.487, -85.312
      ADD=32 RD=0,1 UX=-85.312, -81.898
      ADD=33 RD=0,1 UX=-81.898, -72.31
      ADD=34 RD=0,1 UX=-72.31, -62.721
      ADD=35 RD=0,1 UX=-62.721, -53.131
      ADD=36 RD=0,1 UX=-53.131, -43.542
      ADD=37 RD=0,1 UX=-43.542, -33.954
      ADD=38 RD=0,1 UX=-33.954, -24.364
      ADD=39 RD=0,1 UX=-24.364, -23.8
      ADD=40 RD=0,1 UX=-23.8, -19.05
      ADD=41 RD=0,1 UX=-19.05, -14.775
NAME=SOILBW  ; 양토압 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=12.75, 15
      ADD=69 RD=0,1 UX=15, 17.5
      ADD=70 RD=0,1 UX=17.5, 17.797
      ADD=71 RD=0,1 UX=17.797, 22.844
      ADD=72 RD=0,1 UX=22.844, 27.891
      ADD=73 RD=0,1 UX=27.891, 32.938
      ADD=74 RD=0,1 UX=32.938, 37.984
      ADD=75 RD=0,1 UX=37.984, 43.031
      ADD=76 RD=0,1 UX=43.031, 48.078
      ADD=77 RD=0,1 UX=48.078, 49.875
      ADD=78 RD=0,1 UX=49.875, 53.125
      ADD=31 RD=0,1 UX=-53.125, -49.875
      ADD=32 RD=0,1 UX=-49.875, -48.078
      ADD=33 RD=0,1 UX=-48.078, -43.031
      ADD=34 RD=0,1 UX=-43.031, -37.984
      ADD=35 RD=0,1 UX=-37.984, -32.938
      ADD=36 RD=0,1 UX=-32.938, -27.891
      ADD=37 RD=0,1 UX=-27.891, -22.844
      ADD=38 RD=0,1 UX=-22.844, -17.797
      ADD=39 RD=0,1 UX=-17.797, -17.5
      ADD=40 RD=0,1 UX=-17.5, -15
      ADD=41 RD=0,1 UX=-15, -12.75
NAME=SOILLW  ; 편토압(좌측) : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=12.75, 15
      ADD=69 RD=0,1 UX=15, 17.5
      ADD=70 RD=0,1 UX=17.5, 17.797
      ADD=71 RD=0,1 UX=17.797, 22.844
      ADD=72 RD=0,1 UX=22.844, 27.891
      ADD=73 RD=0,1 UX=27.891, 32.938
      ADD=74 RD=0,1 UX=32.938, 37.984
      ADD=75 RD=0,1 UX=37.984, 43.031
      ADD=76 RD=0,1 UX=43.031, 48.078
      ADD=77 RD=0,1 UX=48.078, 49.875
      ADD=78 RD=0,1 UX=49.875, 53.125
NAME=SOILRW  ; 편토압(우측) : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-53.125, -49.875
      ADD=32 RD=0,1 UX=-49.875, -48.078
      ADD=33 RD=0,1 UX=-48.078, -43.031
      ADD=34 RD=0,1 UX=-43.031, -37.984
      ADD=35 RD=0,1 UX=-37.984, -32.938
      ADD=36 RD=0,1 UX=-32.938, -27.891
      ADD=37 RD=0,1 UX=-27.891, -22.844
      ADD=38 RD=0,1 UX=-22.844, -17.797
      ADD=39 RD=0,1 UX=-17.797, -17.5
      ADD=40 RD=0,1 UX=-17.5, -15
      ADD=41 RD=0,1 UX=-15, -12.75
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=4.5, 9
      ADD=69 RD=0,1 UX=9, 14
      ADD=70 RD=0,1 UX=14, 14.594
      ADD=71 RD=0,1 UX=14.594, 24.688
      ADD=72 RD=0,1 UX=24.688, 34.781
      ADD=73 RD=0,1 UX=34.781, 44.875
      ADD=74 RD=0,1 UX=44.875, 54.969
      ADD=75 RD=0,1 UX=54.969, 65.062
      ADD=76 RD=0,1 UX=65.062, 75.156
      ADD=77 RD=0,1 UX=75.156, 78.75
      ADD=78 RD=0,1 UX=78.75, 85.25
      ADD=31 RD=0,1 UX=-85.25, -78.75
      ADD=32 RD=0,1 UX=-78.75, -75.156
      ADD=33 RD=0,1 UX=-75.156, -65.062
      ADD=34 RD=0,1 UX=-65.062, -54.969
      ADD=35 RD=0,1 UX=-54.969, -44.875
      ADD=36 RD=0,1 UX=-44.875, -34.781
      ADD=37 RD=0,1 UX=-34.781, -24.688
      ADD=38 RD=0,1 UX=-24.688, -14.594
      ADD=39 RD=0,1 UX=-14.594, -14
      ADD=40 RD=0,1 UX=-14, -9
      ADD=41 RD=0,1 UX=-9, -4.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=90.5, 90.5
      ADD=2 RD=0,1 UZ=90.5, 90.5
      ADD=3 RD=0,1 UZ=90.5, 90.5
      ADD=4 RD=0,1 UZ=90.5, 90.5
```

```
      ADD=5 RD=0,1 UZ=90.5, 90.5
      ADD=6 RD=0,1 UZ=90.5, 90.5
      ADD=7 RD=0,1 UZ=90.5, 90.5
      ADD=8 RD=0,1 UZ=90.5, 90.5
      ADD=9 RD=0,1 UZ=90.5, 90.5
      ADD=10 RD=0,1 UZ=90.5, 90.5
      ADD=11 RD=0,1 UZ=90.5, 90.5
      ADD=12 RD=0,1 UZ=90.5, 90.5
      ADD=13 RD=0,1 UZ=90.5, 90.5
      ADD=14 RD=0,1 UZ=90.5, 90.5
      ADD=15 RD=0,1 UZ=90.5, 90.5
      ADD=16 RD=0,1 UZ=90.5, 90.5
      ADD=17 RD=0,1 UZ=90.5, 90.5
      ADD=18 RD=0,1 UZ=90.5, 90.5
      ADD=19 RD=0,1 UZ=90.5, 90.5
      ADD=20 RD=0,1 UZ=90.5, 90.5
      ADD=21 RD=0,1 UZ=90.5, 90.5
      ADD=22 RD=0,1 UZ=90.5, 90.5
      ADD=23 RD=0,1 UZ=90.5, 90.5
      ADD=24 RD=0,1 UZ=90.5, 90.5
      ADD=25 RD=0,1 UZ=90.5, 90.5
      ADD=26 RD=0,1 UZ=90.5, 90.5
      ADD=27 RD=0,1 UZ=90.5, 90.5
      ADD=28 RD=0,1 UZ=90.5, 90.5
      ADD=29 RD=0,1 UZ=90.5, 90.5
      ADD=30 RD=0,1 UZ=90.5, 90.5
NAME=TEMPPLUS  ; 온도변화(+)
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=10
      ADD=32 T=10
      ADD=33 T=10
      ADD=34 T=10
      ADD=35 T=10
      ADD=36 T=10
      ADD=37 T=10
      ADD=38 T=10
      ADD=39 T=10
      ADD=40 T=10
      ADD=41 T=10
      ADD=42 T=10
      ADD=43 T=10
      ADD=44 T=10
      ADD=45 T=10
      ADD=46 T=10
      ADD=47 T=10
      ADD=48 T=10
      ADD=49 T=10
      ADD=50 T=10
      ADD=51 T=10
      ADD=52 T=10
      ADD=53 T=10
      ADD=54 T=10
      ADD=55 T=10
      ADD=56 T=10
      ADD=57 T=10
      ADD=58 T=10
      ADD=59 T=10
      ADD=60 T=10
      ADD=61 T=10
      ADD=62 T=10
      ADD=63 T=10
      ADD=64 T=10
      ADD=65 T=10
      ADD=66 T=10
      ADD=67 T=10
      ADD=68 T=10
      ADD=69 T=10
      ADD=70 T=10
      ADD=71 T=10
      ADD=72 T=10
      ADD=73 T=10
      ADD=74 T=10
      ADD=75 T=10
      ADD=76 T=10
      ADD=77 T=10
      ADD=78 T=10
      ADD=79 T=10
NAME=TEMPMINU  ; 온도변화(-)
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=-10
      ADD=32 T=-10
      ADD=33 T=-10
      ADD=34 T=-10
      ADD=35 T=-10
      ADD=36 T=-10
      ADD=37 T=-10
      ADD=38 T=-10
      ADD=39 T=-10
      ADD=40 T=-10
      ADD=41 T=-10
      ADD=42 T=-10
      ADD=43 T=-10
      ADD=44 T=-10
      ADD=45 T=-10
      ADD=46 T=-10
      ADD=47 T=-10
      ADD=48 T=-10
      ADD=49 T=-10
      ADD=50 T=-10
      ADD=51 T=-10
      ADD=52 T=-10
      ADD=53 T=-10
      ADD=54 T=-10
      ADD=55 T=-10
      ADD=56 T=-10
      ADD=57 T=-10
      ADD=58 T=-10
      ADD=59 T=-10
      ADD=60 T=-10
      ADD=61 T=-10
      ADD=62 T=-10
      ADD=63 T=-10
      ADD=64 T=-10
      ADD=65 T=-10
      ADD=66 T=-10
      ADD=67 T=-10
      ADD=68 T=-10
      ADD=69 T=-10
      ADD=70 T=-10
      ADD=71 T=-10
      ADD=72 T=-10
      ADD=73 T=-10
      ADD=74 T=-10
      ADD=75 T=-10
      ADD=76 T=-10
      ADD=77 T=-10
      ADD=78 T=-10
      ADD=79 T=-10
NAME=SHRINK  ; 건조수축
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=-15
      ADD=32 T=-15
      ADD=33 T=-15
      ADD=34 T=-15
      ADD=35 T=-15
      ADD=36 T=-15
      ADD=37 T=-15
      ADD=38 T=-15
      ADD=39 T=-15
      ADD=40 T=-15
      ADD=41 T=-15
      ADD=42 T=-15
      ADD=43 T=-15
      ADD=44 T=-15
      ADD=45 T=-15
      ADD=46 T=-15
      ADD=47 T=-15
      ADD=48 T=-15
      ADD=49 T=-15
      ADD=50 T=-15
      ADD=51 T=-15
      ADD=52 T=-15
      ADD=53 T=-15
      ADD=54 T=-15
      ADD=55 T=-15
      ADD=56 T=-15
      ADD=57 T=-15
      ADD=58 T=-15
      ADD=59 T=-15
      ADD=60 T=-15
      ADD=61 T=-15
      ADD=62 T=-15
      ADD=63 T=-15
      ADD=64 T=-15
      ADD=65 T=-15
      ADD=66 T=-15
      ADD=67 T=-15
      ADD=68 T=-15
      ADD=69 T=-15
      ADD=70 T=-15
      ADD=71 T=-15
      ADD=72 T=-15
      ADD=73 T=-15
      ADD=74 T=-15
      ADD=75 T=-15
      ADD=76 T=-15
      ADD=77 T=-15
      ADD=78 T=-15
      ADD=79 T=-15
MODE
```

```
  TYPE=RITZ   N=100   TOL=0.00001
    LOAD=SW
    LOAD=PAVE
    LOAD=PAVEW
    LOAD=LIVEFU
    LOAD=LIVELE
    LOAD=LIVERI
    LOAD=LIVEFUH
    LOAD=LIVELEH
    LOAD=LIVERIH
    LOAD=SOILB
    LOAD=SOILL
    LOAD=SOILR
    LOAD=SOILBW
    LOAD=SOILLW
    LOAD=SOILRW
    LOAD=WATERH
    LOAD=BUOYANCY
    LOAD=TEMPPLUS
    LOAD=TEMPMINU
    LOAD=SHRINK
    NLLINK=*
HISTORY
  NAME=UL01   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.400   AT=1
  NAME=UL02   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVEFU      SF=1.600   AT=1
    LOAD= LIVEFUH     SF=1.600   AT=1
    LOAD= SOILB       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL03   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVEFU      SF=1.600   AT=1
    LOAD= LIVEFUH     SF=1.600   AT=1
    LOAD= SOILB       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL04   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVEFU      SF=1.600   AT=1
    LOAD= LIVEFUH     SF=1.600   AT=1
    LOAD= SOILL       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL05   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVEFU      SF=1.600   AT=1
    LOAD= LIVEFUH     SF=1.600   AT=1
    LOAD= SOILL       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL06   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVEFU      SF=1.600   AT=1
    LOAD= LIVEFUH     SF=1.600   AT=1
    LOAD= SOILR       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL07   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVEFU      SF=1.600   AT=1
    LOAD= LIVEFUH     SF=1.600   AT=1
    LOAD= SOILR       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL08   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVELE      SF=1.600   AT=1
    LOAD= LIVELEH     SF=1.600   AT=1
    LOAD= SOILB       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL09   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVELE      SF=1.600   AT=1
    LOAD= LIVELEH     SF=1.600   AT=1
    LOAD= SOILB       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL10   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVELE      SF=1.600   AT=1
    LOAD= LIVELEH     SF=1.600   AT=1
    LOAD= SOILL       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL11   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVELE      SF=1.600   AT=1
    LOAD= LIVELEH     SF=1.600   AT=1
    LOAD= SOILL       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL12   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVELE      SF=1.600   AT=1
    LOAD= LIVELEH     SF=1.600   AT=1
    LOAD= SOILR       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL13   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVELE      SF=1.600   AT=1
    LOAD= LIVELEH     SF=1.600   AT=1
    LOAD= SOILR       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL14   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVERI      SF=1.600   AT=1
    LOAD= LIVERIH     SF=1.600   AT=1
    LOAD= SOILB       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL15   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVERI      SF=1.600   AT=1
    LOAD= LIVERIH     SF=1.600   AT=1
    LOAD= SOILB       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL16   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVERI      SF=1.600   AT=1
    LOAD= LIVERIH     SF=1.600   AT=1
    LOAD= SOILL       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL17   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVERI      SF=1.600   AT=1
    LOAD= LIVERIH     SF=1.600   AT=1
    LOAD= SOILL       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL18   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVERI      SF=1.600   AT=1
    LOAD= LIVERIH     SF=1.600   AT=1
    LOAD= SOILR       SF=1.600   AT=1
    LOAD= TEMPPLUS    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL19   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= PAVE        SF=1.560   AT=1
    LOAD= LIVERI      SF=1.600   AT=1
    LOAD= LIVERIH     SF=1.600   AT=1
    LOAD= SOILR       SF=1.600   AT=1
    LOAD= TEMPMINU    SF=1.200   AT=1
    LOAD= SHRINK      SF=1.200   AT=1
  NAME=UL20   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= LIVEFU      SF=1.000   AT=1
  NAME=UL21   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= LIVELE      SF=1.000   AT=1
  NAME=UL22   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
    LOAD= LIVERI      SF=1.000   AT=1
  NAME=UL23   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW          SF=1.200   AT=1
```

```
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILR         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILR         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL33    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILR         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL34    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILR         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL35    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL36    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL37    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL38    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL39    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILR         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL40    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILR         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL41    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= SOILB         SF=1.600   AT=1
NAME=UL42    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= SOILL         SF=1.600   AT=1
NAME=UL43    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= SOILR         SF=1.600   AT=1
NAME=UL44    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= SOILB         SF=0.800   AT=1
NAME=UL45    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= SOILL         SF=0.800   AT=1
NAME=UL46    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= SOILR         SF=0.800   AT=1
NAME=UL47    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
   LOAD= WATERH        SF=1.600   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL48    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
```

```
   LOAD= LIVEFUH        SF=1.600   AT=1                              LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1                              LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1                              LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL49    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL58    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1                              LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1                              LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1                              LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1                              LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL50    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL59    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1                              LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1                              LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1                              LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1                              LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL51    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL60    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1                              LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1                              LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1                              LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1                              LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL52    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL61    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1                              LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1                              LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1                              LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1                              LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL53    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL62    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1                              LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1                              LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1                              LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1                              LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL54    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL63    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1                              LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1                              LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1                              LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1                              LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL55    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL64    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1                              LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1                              LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1                              LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1                              LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL56    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL65    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1                              LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1                              LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILLW         SF=1.600   AT=1                              LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERH         SF=1.600   AT=1                              LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1                              LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1                              LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1                              LOAD= SHRINK         SF=1.200   AT=1
NAME=UL57    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1  NAME=UL66    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1                              LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1                              LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1                              LOAD= LIVEFU         SF=1.600   AT=1
```

```
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL67    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL68    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL69    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILRW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL70    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILRW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL71    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL72    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL73    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL74    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL75    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL76    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILRW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL77    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL78    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL79    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL80    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL81    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILRW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL82    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILRW         SF=0.800   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL83    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVEW          SF=0.900   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1
NAME=UL84    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVEW          SF=0.900   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERH         SF=1.600   AT=1
NAME=UL85    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVEW          SF=0.900   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
```

```
   LOAD= WATERH        SF=1.600   AT=1
NAME=UL86    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= WATERH        SF=0.800   AT=1
NAME=UL87    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
   LOAD= SOILLW        SF=0.800   AT=1
   LOAD= WATERH        SF=0.800   AT=1
NAME=UL88    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
   LOAD= SOILRW        SF=0.800   AT=1
   LOAD= WATERH        SF=0.800   AT=1
NAME=SV01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
NAME=SV02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
NAME=SV21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
NAME=SV22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
NAME=SV23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
```

```
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILB         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILL         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILL         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILR         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILR         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILB         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILB         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILL         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILL         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV33    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILR         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV34    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILR         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV35    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILB         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV36    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILB         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV37    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILL         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV38    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILL         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV39    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILR         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV40    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILR         SF=0.500   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV41    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
NAME=SV42    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= SOILL         SF=1.000   AT=1
NAME=SV43    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= SOILR         SF=1.000   AT=1
NAME=SV44    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= SOILB         SF=0.500   AT=1
NAME=SV45    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= SOILL         SF=0.500   AT=1
NAME=SV46    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= SOILR         SF=0.500   AT=1
NAME=SV47    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1
    LOAD= SOILBW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV48    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1
    LOAD= SOILBW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV49    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
```

```
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1                          LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1                          LOAD= LIVELEH       SF=1.000   AT=1
    LOAD= SOILLW        SF=1.000   AT=1                          LOAD= SOILRW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1                          LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV50   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV59   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1                          LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1                          LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILLW        SF=1.000   AT=1                          LOAD= SOILBW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1                          LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV51   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV60   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1                          LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1                          LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILRW        SF=1.000   AT=1                          LOAD= SOILBW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1                          LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV52   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV61   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1                          LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1                          LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILRW        SF=1.000   AT=1                          LOAD= SOILLW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1                          LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV53   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV62   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1                          LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1                          LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILBW        SF=1.000   AT=1                          LOAD= SOILLW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1                          LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV54   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV63   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1                          LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1                          LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILBW        SF=1.000   AT=1                          LOAD= SOILRW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1                          LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV55   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV64   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1                          LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1                          LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILLW        SF=1.000   AT=1                          LOAD= SOILRW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=1.000   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1                          LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV56   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV65   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1                          LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1                          LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILLW        SF=1.000   AT=1                          LOAD= SOILBW        SF=0.500   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1                          LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV57   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV66   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
    LOAD= SW            SF=1.000   AT=1                          LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1                          LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1                          LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1                          LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILRW        SF=1.000   AT=1                          LOAD= SOILBW        SF=0.500   AT=1
    LOAD= WATERH        SF=1.000   AT=1                          LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1                          LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1                          LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1                          LOAD= SHRINK        SF=1.000   AT=1
NAME=SV58   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   NAME=SV67   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
```

```
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILLW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV68    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILLW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV69    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILRW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV70    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILRW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV71    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILBW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV72    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILBW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV73    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILLW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV74    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILLW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV75    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILRW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV76    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=0.500   AT=1
    LOAD= SOILLW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV77    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILBW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV78    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILBW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV79    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILLW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV80    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILLW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV81    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILRW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV82    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=0.500   AT=1
    LOAD= SOILRW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
    LOAD= BUOYANCY      SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV83    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= SOILBW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1
NAME=SV84    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= SOILLW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1
NAME=SV85    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= SOILRW        SF=1.000   AT=1
    LOAD= WATERH        SF=1.000   AT=1
NAME=SV86    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVEW         SF=1.000   AT=1
    LOAD= SOILBW        SF=0.500   AT=1
    LOAD= WATERH        SF=0.500   AT=1
NAME=SV87    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
```

```
      LOAD= SW              SF=1.000    AT=1
      LOAD= PAVEW           SF=1.000    AT=1
      LOAD= SOILLW          SF=0.500    AT=1
      LOAD= WATERH          SF=0.500    AT=1
   NAME=SV88     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
      LOAD= SW              SF=1.000    AT=1
      LOAD= PAVEW           SF=1.000    AT=1
      LOAD= SOILRW          SF=0.500    AT=1
      LOAD= WATERH          SF=0.500    AT=1
COMBO
  NAME=ENVUSE  TYPE=ENVE
     HIST=SV01 SF=1
     HIST=SV02 SF=1
     HIST=SV03 SF=1
     HIST=SV04 SF=1
     HIST=SV05 SF=1
     HIST=SV06 SF=1
     HIST=SV07 SF=1
     HIST=SV08 SF=1
     HIST=SV09 SF=1
     HIST=SV10 SF=1
     HIST=SV11 SF=1
     HIST=SV12 SF=1
     HIST=SV13 SF=1
     HIST=SV14 SF=1
     HIST=SV15 SF=1
     HIST=SV16 SF=1
     HIST=SV17 SF=1
     HIST=SV18 SF=1
     HIST=SV19 SF=1
     HIST=SV20 SF=1
     HIST=SV21 SF=1
     HIST=SV22 SF=1
     HIST=SV23 SF=1
     HIST=SV24 SF=1
     HIST=SV25 SF=1
     HIST=SV26 SF=1
     HIST=SV27 SF=1
     HIST=SV28 SF=1
     HIST=SV29 SF=1
     HIST=SV30 SF=1
     HIST=SV31 SF=1
     HIST=SV32 SF=1
     HIST=SV33 SF=1
     HIST=SV34 SF=1
     HIST=SV35 SF=1
     HIST=SV36 SF=1
     HIST=SV37 SF=1
     HIST=SV38 SF=1
     HIST=SV39 SF=1
     HIST=SV40 SF=1
     HIST=SV41 SF=1
     HIST=SV42 SF=1
     HIST=SV43 SF=1
     HIST=SV44 SF=1
     HIST=SV45 SF=1
     HIST=SV46 SF=1
     HIST=SV47 SF=1
     HIST=SV48 SF=1
     HIST=SV49 SF=1
     HIST=SV50 SF=1
     HIST=SV51 SF=1
     HIST=SV52 SF=1
     HIST=SV53 SF=1
     HIST=SV54 SF=1
     HIST=SV55 SF=1
     HIST=SV56 SF=1
     HIST=SV57 SF=1
     HIST=SV58 SF=1
     HIST=SV59 SF=1
     HIST=SV60 SF=1
     HIST=SV61 SF=1
     HIST=SV62 SF=1
     HIST=SV63 SF=1
     HIST=SV64 SF=1
     HIST=SV65 SF=1
     HIST=SV66 SF=1
     HIST=SV67 SF=1
     HIST=SV68 SF=1
     HIST=SV69 SF=1
     HIST=SV70 SF=1
     HIST=SV71 SF=1
     HIST=SV72 SF=1
     HIST=SV73 SF=1
     HIST=SV74 SF=1
     HIST=SV75 SF=1
     HIST=SV76 SF=1
     HIST=SV77 SF=1
     HIST=SV78 SF=1
     HIST=SV79 SF=1
     HIST=SV80 SF=1
     HIST=SV81 SF=1
     HIST=SV82 SF=1
     HIST=SV83 SF=1
     HIST=SV84 SF=1
     HIST=SV85 SF=1
     HIST=SV86 SF=1
     HIST=SV87 SF=1
     HIST=SV88 SF=1
  NAME=ENVULT  TYPE=ENVE
     HIST=UL01 SF=1
     HIST=UL02 SF=1
     HIST=UL03 SF=1
     HIST=UL04 SF=1
     HIST=UL05 SF=1
     HIST=UL06 SF=1
     HIST=UL07 SF=1
     HIST=UL08 SF=1
     HIST=UL09 SF=1
     HIST=UL10 SF=1
     HIST=UL11 SF=1
     HIST=UL12 SF=1
     HIST=UL13 SF=1
     HIST=UL14 SF=1
     HIST=UL15 SF=1
     HIST=UL16 SF=1
     HIST=UL17 SF=1
     HIST=UL18 SF=1
     HIST=UL19 SF=1
     HIST=UL20 SF=1
     HIST=UL21 SF=1
     HIST=UL22 SF=1
     HIST=UL23 SF=1
     HIST=UL24 SF=1
     HIST=UL25 SF=1
     HIST=UL26 SF=1
     HIST=UL27 SF=1
     HIST=UL28 SF=1
     HIST=UL29 SF=1
     HIST=UL30 SF=1
     HIST=UL31 SF=1
     HIST=UL32 SF=1
     HIST=UL33 SF=1
     HIST=UL34 SF=1
     HIST=UL35 SF=1
     HIST=UL36 SF=1
     HIST=UL37 SF=1
     HIST=UL38 SF=1
     HIST=UL39 SF=1
     HIST=UL40 SF=1
     HIST=UL41 SF=1
     HIST=UL42 SF=1
     HIST=UL43 SF=1
     HIST=UL44 SF=1
     HIST=UL45 SF=1
     HIST=UL46 SF=1
     HIST=UL47 SF=1
     HIST=UL48 SF=1
     HIST=UL49 SF=1
     HIST=UL50 SF=1
     HIST=UL51 SF=1
     HIST=UL52 SF=1
     HIST=UL53 SF=1
     HIST=UL54 SF=1
     HIST=UL55 SF=1
     HIST=UL56 SF=1
     HIST=UL57 SF=1
     HIST=UL58 SF=1
     HIST=UL59 SF=1
     HIST=UL60 SF=1
     HIST=UL61 SF=1
     HIST=UL62 SF=1
     HIST=UL63 SF=1
     HIST=UL64 SF=1
     HIST=UL65 SF=1
     HIST=UL66 SF=1
     HIST=UL67 SF=1
     HIST=UL68 SF=1
     HIST=UL69 SF=1
     HIST=UL70 SF=1
     HIST=UL71 SF=1
     HIST=UL72 SF=1
     HIST=UL73 SF=1
     HIST=UL74 SF=1
     HIST=UL75 SF=1
     HIST=UL76 SF=1
     HIST=UL77 SF=1
     HIST=UL78 SF=1
     HIST=UL79 SF=1
     HIST=UL80 SF=1
```

```
      HIST=UL81 SF=1
      HIST=UL82 SF=1
      HIST=UL83 SF=1
      HIST=UL84 SF=1
      HIST=UL85 SF=1
      HIST=UL86 SF=1
      HIST=UL87 SF=1
      HIST=UL88 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

16. INPUT DATA (기능수행)

```
; ACulvert SAP2000 데이터파일 : 내진(기능)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     0.950 Y=     0.000 Z=     0.500
  3    X=     1.567 Y=     0.000 Z=     0.500
  4    X=     2.050 Y=     0.000 Z=     0.500
  5    X=     2.350 Y=     0.000 Z=     0.500
  6    X=     2.633 Y=     0.000 Z=     0.500
  7    X=     3.700 Y=     0.000 Z=     0.500
  8    X=     4.767 Y=     0.000 Z=     0.500
  9    X=     5.833 Y=     0.000 Z=     0.500
  10   X=     6.900 Y=     0.000 Z=     0.500
  11   X=     7.967 Y=     0.000 Z=     0.500
  12   X=     9.033 Y=     0.000 Z=     0.500
  13   X=     9.200 Y=     0.000 Z=     0.500
  14   X=     9.500 Y=     0.000 Z=     0.500
  15   X=     9.850 Y=     0.000 Z=     0.500
  16   X=    10.100 Y=     0.000 Z=     0.500
  17   X=    10.350 Y=     0.000 Z=     0.500
  18   X=    10.700 Y=     0.000 Z=     0.500
  19   X=    11.000 Y=     0.000 Z=     0.500
  20   X=    11.167 Y=     0.000 Z=     0.500
  21   X=    12.233 Y=     0.000 Z=     0.500
  22   X=    13.300 Y=     0.000 Z=     0.500
  23   X=    14.367 Y=     0.000 Z=     0.500
  24   X=    15.433 Y=     0.000 Z=     0.500
  25   X=    16.500 Y=     0.000 Z=     0.500
  26   X=    17.567 Y=     0.000 Z=     0.500
  27   X=    17.850 Y=     0.000 Z=     0.500
  28   X=    18.150 Y=     0.000 Z=     0.500
  29   X=    18.633 Y=     0.000 Z=     0.500
  30   X=    19.250 Y=     0.000 Z=     0.500
  31   X=    19.700 Y=     0.000 Z=     0.500
  32   X=    19.700 Y=     0.000 Z=     1.150
  33   X=    19.700 Y=     0.000 Z=     1.509
  34   X=    19.700 Y=     0.000 Z=     2.519
  35   X=    19.700 Y=     0.000 Z=     3.528
  36   X=    19.700 Y=     0.000 Z=     4.537
  37   X=    19.700 Y=     0.000 Z=     5.547
  38   X=    19.700 Y=     0.000 Z=     6.556
  39   X=    19.700 Y=     0.000 Z=     7.566
  40   X=    19.700 Y=     0.000 Z=     7.625
  41   X=    19.700 Y=     0.000 Z=     8.125
  42   X=    19.700 Y=     0.000 Z=     8.575
  43   X=    19.250 Y=     0.000 Z=     8.575
  44   X=    18.750 Y=     0.000 Z=     8.575
  45   X=    18.633 Y=     0.000 Z=     8.575
  46   X=    17.567 Y=     0.000 Z=     8.575
  47   X=    16.500 Y=     0.000 Z=     8.575
  48   X=    15.433 Y=     0.000 Z=     8.575
  49   X=    14.367 Y=     0.000 Z=     8.575
  50   X=    13.300 Y=     0.000 Z=     8.575
  51   X=    12.233 Y=     0.000 Z=     8.575
  52   X=    11.167 Y=     0.000 Z=     8.575
  53   X=    10.850 Y=     0.000 Z=     8.575
  54   X=    10.350 Y=     0.000 Z=     8.575
  55   X=    10.100 Y=     0.000 Z=     8.575
  56   X=     9.850 Y=     0.000 Z=     8.575
  57   X=     9.350 Y=     0.000 Z=     8.575
  58   X=     9.033 Y=     0.000 Z=     8.575
  59   X=     7.967 Y=     0.000 Z=     8.575
  60   X=     6.900 Y=     0.000 Z=     8.575
  61   X=     5.833 Y=     0.000 Z=     8.575
  62   X=     4.767 Y=     0.000 Z=     8.575
  63   X=     3.700 Y=     0.000 Z=     8.575
  64   X=     2.633 Y=     0.000 Z=     8.575
  65   X=     1.567 Y=     0.000 Z=     8.575
  66   X=     1.450 Y=     0.000 Z=     8.575
  67   X=     0.950 Y=     0.000 Z=     8.575
  68   X=     0.500 Y=     0.000 Z=     8.575
  69   X=     0.500 Y=     0.000 Z=     8.125
  70   X=     0.500 Y=     0.000 Z=     7.625
  71   X=     0.500 Y=     0.000 Z=     7.566
  72   X=     0.500 Y=     0.000 Z=     6.556
  73   X=     0.500 Y=     0.000 Z=     5.547
  74   X=     0.500 Y=     0.000 Z=     4.537
  75   X=     0.500 Y=     0.000 Z=     3.528
  76   X=     0.500 Y=     0.000 Z=     2.519
  77   X=     0.500 Y=     0.000 Z=     1.509
  78   X=     0.500 Y=     0.000 Z=     1.150
  79   X=     0.500 Y=     0.000 Z=     0.000
  80   X=     1.567 Y=     0.000 Z=     0.000
  81   X=     2.633 Y=     0.000 Z=     0.000
  82   X=     3.700 Y=     0.000 Z=     0.000
  83   X=     4.767 Y=     0.000 Z=     0.000
  84   X=     5.833 Y=     0.000 Z=     0.000
  85   X=     6.900 Y=     0.000 Z=     0.000
  86   X=     7.967 Y=     0.000 Z=     0.000
  87   X=     9.033 Y=     0.000 Z=     0.000
  88   X=    10.100 Y=     0.000 Z=     0.000
  89   X=    11.167 Y=     0.000 Z=     0.000
  90   X=    12.233 Y=     0.000 Z=     0.000
  91   X=    13.300 Y=     0.000 Z=     0.000
  92   X=    14.367 Y=     0.000 Z=     0.000
  93   X=    15.433 Y=     0.000 Z=     0.000
  94   X=    16.500 Y=     0.000 Z=     0.000
  95   X=    17.567 Y=     0.000 Z=     0.000
  96   X=    18.633 Y=     0.000 Z=     0.000
  97   X=    19.700 Y=     0.000 Z=     0.000
  98   X=    20.200 Y=     0.000 Z=     0.500
  99   X=    20.200 Y=     0.000 Z=     1.509
  100  X=    20.200 Y=     0.000 Z=     2.519
  101  X=    20.200 Y=     0.000 Z=     3.528
  102  X=    20.200 Y=     0.000 Z=     4.537
  103  X=    20.200 Y=     0.000 Z=     5.547
  104  X=    20.200 Y=     0.000 Z=     6.556
  105  X=    20.200 Y=     0.000 Z=     7.566
  106  X=    20.200 Y=     0.000 Z=     8.575
  107  X=    19.700 Y=     0.000 Z=     9.075
  108  X=    18.633 Y=     0.000 Z=     9.075
  109  X=    17.567 Y=     0.000 Z=     9.075
  110  X=    16.500 Y=     0.000 Z=     9.075
  111  X=    15.433 Y=     0.000 Z=     9.075
  112  X=    14.367 Y=     0.000 Z=     9.075
  113  X=    13.300 Y=     0.000 Z=     9.075
  114  X=    12.233 Y=     0.000 Z=     9.075
  115  X=    11.167 Y=     0.000 Z=     9.075
  116  X=    10.100 Y=     0.000 Z=     9.075
  117  X=     9.033 Y=     0.000 Z=     9.075
  118  X=     7.967 Y=     0.000 Z=     9.075
  119  X=     6.900 Y=     0.000 Z=     9.075
  120  X=     5.833 Y=     0.000 Z=     9.075
  121  X=     4.767 Y=     0.000 Z=     9.075
  122  X=     3.700 Y=     0.000 Z=     9.075
  123  X=     2.633 Y=     0.000 Z=     9.075
  124  X=     1.567 Y=     0.000 Z=     9.075
  125  X=     0.500 Y=     0.000 Z=     9.075
  126  X=     0.000 Y=     0.000 Z=     8.575
  127  X=     0.000 Y=     0.000 Z=     7.566
  128  X=     0.000 Y=     0.000 Z=     6.556
  129  X=     0.000 Y=     0.000 Z=     5.547
  130  X=     0.000 Y=     0.000 Z=     4.537
  131  X=     0.000 Y=     0.000 Z=     3.528
  132  X=     0.000 Y=     0.000 Z=     2.519
  133  X=     0.000 Y=     0.000 Z=     1.509
  134  X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
   ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=92 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=93 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=94 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=95 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=96 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=97 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=98 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=99 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=100 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=101 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=102 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=103 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=104 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=105 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=106 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=107 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=108 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=109 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=110 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=111 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=112 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=113 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=114 DOF=UX,UY,UZ,RX,RY,RZ
```

```
  ADD=115 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=116 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=117 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=118 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=119 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=120 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=121 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=122 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=123 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=124 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=125 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=126 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=127 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=128 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=129 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=130 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=131 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=132 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=133 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=134 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=4660.3
  ADD=6 UX=4660.3
  ADD=7 UX=4660.3
  ADD=8 UX=4660.3
  ADD=9 UX=4660.3
  ADD=10 UX=4660.3
  ADD=11 UX=4660.3
  ADD=12 UX=4660.3
  ADD=16 UX=4660.3
  ADD=20 UX=4660.3
  ADD=21 UX=4660.3
  ADD=22 UX=4660.3
  ADD=23 UX=4660.3
  ADD=24 UX=4660.3
  ADD=25 UX=4660.3
  ADD=26 UX=4660.3
  ADD=29 UX=4660.3
  ADD=33 UZ=8023.24
  ADD=34 UZ=8023.24
  ADD=35 UZ=8023.24
  ADD=36 UZ=8023.24
  ADD=37 UZ=8023.24
  ADD=38 UZ=8023.24
  ADD=39 UZ=8023.24
  ADD=45 UX=4660.3
  ADD=46 UX=4660.3
  ADD=47 UX=4660.3
  ADD=48 UX=4660.3
  ADD=49 UX=4660.3
  ADD=50 UX=4660.3
  ADD=51 UX=4660.3
  ADD=52 UX=4660.3
  ADD=55 UX=4660.3
  ADD=58 UX=4660.3
  ADD=59 UX=4660.3
  ADD=60 UX=4660.3
  ADD=61 UX=4660.3
  ADD=62 UX=4660.3
  ADD=63 UX=4660.3
  ADD=64 UX=4660.3
  ADD=65 UX=4660.3
  ADD=71 UZ=8023.24
  ADD=72 UZ=8023.24
  ADD=73 UZ=8023.24
  ADD=74 UZ=8023.24
  ADD=75 UZ=8023.24
  ADD=76 UZ=8023.24
  ADD=77 UZ=8023.24
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=12888.6 CE=0.99999 K=12888.6 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=13980.9 CE=0.99999 K=13980.9 OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=27534.8 CE=0.99999 K=27534.8 OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=24069.7 CE=0.99999 K=24069.7 OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=22765.6 CE=0.99999 K=22765.6 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.3,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.05,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.125 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.125 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.425 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 3 NSEG= 4 ANG=0
    38 J= 38,  39 SEC= 3 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 3 NSEG= 4 ANG=0
    40 J= 40,  41 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    42 J= 42,  43 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    43 J= 43,  44 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 NSEG= 4 ANG=0
    51 J= 51,  52 SEC= 3 NSEG= 4 ANG=0
    52 J= 52,  53 SEC= 3 NSEG= 4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    55 J= 55,  56 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    56 J= 56,  57 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 3 NSEG= 4 ANG=0
    64 J= 64,  65 SEC= 3 NSEG= 4 ANG=0
    65 J= 65,  66 SEC= 3 NSEG= 4 ANG=0
    66 J= 66,  67 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    67 J= 67,  68 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    68 J= 68,  69 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    69 J= 69,  70 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,  73 SEC= 3 NSEG= 4 ANG=180
    73 J= 73,  74 SEC= 3 NSEG= 4 ANG=180
    74 J= 74,  75 SEC= 3 NSEG= 4 ANG=180
    75 J= 75,  76 SEC= 3 NSEG= 4 ANG=180
    76 J= 76,  77 SEC= 3 NSEG= 4 ANG=180
    77 J= 77,  78 SEC= 3 NSEG= 4 ANG=180
    78 J= 78,   1 SEC= 3 IOFF=0 JOFF=0.425 RIGID=1 NSEG=4 ANG=180
    79 J= 55,  16 SEC= 5 IOFF=0.7 JOFF=0.525 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,79 NLP=1 ANG=0
     2 J= 3,80 NLP=2 ANG=0
     3 J= 6,81 NLP=2 ANG=0
     4 J= 7,82 NLP=2 ANG=0
     5 J= 8,83 NLP=2 ANG=0
     6 J= 9,84 NLP=2 ANG=0
     7 J=10,85 NLP=2 ANG=0
     8 J=11,86 NLP=2 ANG=0
```

```
     9 J=12,87 NLP=2 ANG=0
    10 J=16,88 NLP=2 ANG=0
    11 J=20,89 NLP=2 ANG=0
    12 J=21,90 NLP=2 ANG=0
    13 J=22,91 NLP=2 ANG=0
    14 J=23,92 NLP=2 ANG=0
    15 J=24,93 NLP=2 ANG=0
    16 J=25,94 NLP=2 ANG=0
    17 J=26,95 NLP=2 ANG=0
    18 J=29,96 NLP=2 ANG=0
    19 J=31,97 NLP=1 ANG=0
    20 J=31,98 NLP=3 ANG=0
    21 J=33,99 NLP=4 ANG=0
    22 J=34,100 NLP=4 ANG=0
    23 J=35,101 NLP=4 ANG=0
    24 J=36,102 NLP=4 ANG=0
    25 J=37,103 NLP=4 ANG=0
    26 J=38,104 NLP=4 ANG=0
    27 J=39,105 NLP=4 ANG=0
    28 J=42,106 NLP=5 ANG=0
    29 J=42,107 NLP=1 ANG=0
    30 J=45,108 NLP=2 ANG=0
    31 J=46,109 NLP=2 ANG=0
    32 J=47,110 NLP=2 ANG=0
    33 J=48,111 NLP=2 ANG=0
    34 J=49,112 NLP=2 ANG=0
    35 J=50,113 NLP=2 ANG=0
    36 J=51,114 NLP=2 ANG=0
    37 J=52,115 NLP=2 ANG=0
    38 J=55,116 NLP=2 ANG=0
    39 J=58,117 NLP=2 ANG=0
    40 J=59,118 NLP=2 ANG=0
    41 J=60,119 NLP=2 ANG=0
    42 J=61,120 NLP=2 ANG=0
    43 J=62,121 NLP=2 ANG=0
    44 J=63,122 NLP=2 ANG=0
    45 J=64,123 NLP=2 ANG=0
    46 J=65,124 NLP=2 ANG=0
    47 J=68,125 NLP=1 ANG=0
    48 J=68,126 NLP=5 ANG=0
    49 J=71,127 NLP=4 ANG=0
    50 J=72,128 NLP=4 ANG=0
    51 J=73,129 NLP=4 ANG=0
    52 J=74,130 NLP=4 ANG=0
    53 J=75,131 NLP=4 ANG=0
    54 J=76,132 NLP=4 ANG=0
    55 J=77,133 NLP=4 ANG=0
    56 J= 1,134 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-60.575, -60.575
      ADD=43 RD=0,1 UZ=-60.575, -60.575
      ADD=44 RD=0,1 UZ=-60.575, -60.575
      ADD=45 RD=0,1 UZ=-60.575, -60.575
      ADD=46 RD=0,1 UZ=-60.575, -60.575
      ADD=47 RD=0,1 UZ=-60.575, -60.575
      ADD=48 RD=0,1 UZ=-60.575, -60.575
      ADD=49 RD=0,1 UZ=-60.575, -60.575
      ADD=50 RD=0,1 UZ=-60.575, -60.575
      ADD=51 RD=0,1 UZ=-60.575, -60.575
      ADD=52 RD=0,1 UZ=-60.575, -60.575
      ADD=53 RD=0,1 UZ=-60.575, -60.575
      ADD=54 RD=0,1 UZ=-60.575, -60.575
      ADD=55 RD=0,1 UZ=-60.575, -60.575
      ADD=56 RD=0,1 UZ=-60.575, -60.575
      ADD=57 RD=0,1 UZ=-60.575, -60.575
      ADD=58 RD=0,1 UZ=-60.575, -60.575
      ADD=59 RD=0,1 UZ=-60.575, -60.575
      ADD=60 RD=0,1 UZ=-60.575, -60.575
      ADD=61 RD=0,1 UZ=-60.575, -60.575
      ADD=62 RD=0,1 UZ=-60.575, -60.575
      ADD=63 RD=0,1 UZ=-60.575, -60.575
      ADD=64 RD=0,1 UZ=-60.575, -60.575
      ADD=65 RD=0,1 UZ=-60.575, -60.575
      ADD=66 RD=0,1 UZ=-60.575, -60.575
      ADD=67 RD=0,1 UZ=-60.575, -60.575
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-51.575, -51.575
      ADD=43 RD=0,1 UZ=-51.575, -51.575
      ADD=44 RD=0,1 UZ=-51.575, -51.575
      ADD=45 RD=0,1 UZ=-51.575, -51.575
      ADD=46 RD=0,1 UZ=-51.575, -51.575
      ADD=47 RD=0,1 UZ=-51.575, -51.575
      ADD=48 RD=0,1 UZ=-51.575, -51.575
      ADD=49 RD=0,1 UZ=-51.575, -51.575
      ADD=50 RD=0,1 UZ=-51.575, -51.575
      ADD=51 RD=0,1 UZ=-51.575, -51.575
      ADD=52 RD=0,1 UZ=-51.575, -51.575
      ADD=53 RD=0,1 UZ=-51.575, -51.575
      ADD=54 RD=0,1 UZ=-51.575, -51.575
      ADD=55 RD=0,1 UZ=-51.575, -51.575
      ADD=56 RD=0,1 UZ=-51.575, -51.575
      ADD=57 RD=0,1 UZ=-51.575, -51.575
      ADD=58 RD=0,1 UZ=-51.575, -51.575
      ADD=59 RD=0,1 UZ=-51.575, -51.575
      ADD=60 RD=0,1 UZ=-51.575, -51.575
      ADD=61 RD=0,1 UZ=-51.575, -51.575
      ADD=62 RD=0,1 UZ=-51.575, -51.575
      ADD=63 RD=0,1 UZ=-51.575, -51.575
      ADD=64 RD=0,1 UZ=-51.575, -51.575
      ADD=65 RD=0,1 UZ=-51.575, -51.575
      ADD=66 RD=0,1 UZ=-51.575, -51.575
      ADD=67 RD=0,1 UZ=-51.575, -51.575
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-17, -17
      ADD=43 RD=0,1 UZ=-17, -17
      ADD=44 RD=0,1 UZ=-17, -17
      ADD=45 RD=0,1 UZ=-17, -17
      ADD=46 RD=0,1 UZ=-17, -17
      ADD=47 RD=0,1 UZ=-17, -17
      ADD=48 RD=0,1 UZ=-17, -17
      ADD=49 RD=0,1 UZ=-17, -17
      ADD=50 RD=0,1 UZ=-17, -17
      ADD=51 RD=0,1 UZ=-17, -17
      ADD=52 RD=0,1 UZ=-17, -17
      ADD=53 RD=0,1 UZ=-17, -17
      ADD=54 RD=0,1 UZ=-17, -17
      ADD=55 RD=0,1 UZ=-17, -17
      ADD=56 RD=0,1 UZ=-17, -17
      ADD=57 RD=0,1 UZ=-17, -17
      ADD=58 RD=0,1 UZ=-17, -17
      ADD=59 RD=0,1 UZ=-17, -17
      ADD=60 RD=0,1 UZ=-17, -17
      ADD=61 RD=0,1 UZ=-17, -17
      ADD=62 RD=0,1 UZ=-17, -17
      ADD=63 RD=0,1 UZ=-17, -17
      ADD=64 RD=0,1 UZ=-17, -17
      ADD=65 RD=0,1 UZ=-17, -17
      ADD=66 RD=0,1 UZ=-17, -17
      ADD=67 RD=0,1 UZ=-17, -17
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=55 RD=0,1 UZ=-17, -17
      ADD=56 RD=0,1 UZ=-17, -17
      ADD=57 RD=0,1 UZ=-17, -17
      ADD=58 RD=0,1 UZ=-17, -17
      ADD=59 RD=0,1 UZ=-17, -17
      ADD=60 RD=0,1 UZ=-17, -17
      ADD=61 RD=0,1 UZ=-17, -17
      ADD=62 RD=0,1 UZ=-17, -17
      ADD=63 RD=0,1 UZ=-17, -17
      ADD=64 RD=0,1 UZ=-17, -17
      ADD=65 RD=0,1 UZ=-17, -17
      ADD=66 RD=0,1 UZ=-17, -17
      ADD=67 RD=0,1 UZ=-17, -17
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-17, -17
      ADD=43 RD=0,1 UZ=-17, -17
      ADD=44 RD=0,1 UZ=-17, -17
      ADD=45 RD=0,1 UZ=-17, -17
      ADD=46 RD=0,1 UZ=-17, -17
      ADD=47 RD=0,1 UZ=-17, -17
      ADD=48 RD=0,1 UZ=-17, -17
      ADD=49 RD=0,1 UZ=-17, -17
      ADD=50 RD=0,1 UZ=-17, -17
      ADD=51 RD=0,1 UZ=-17, -17
      ADD=52 RD=0,1 UZ=-17, -17
      ADD=53 RD=0,1 UZ=-17, -17
      ADD=54 RD=0,1 UZ=-17, -17
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=8.5, 8.5
      ADD=69 RD=0,1 UX=8.5, 8.5
      ADD=70 RD=0,1 UX=8.5, 8.5
      ADD=71 RD=0,1 UX=8.5, 8.5
      ADD=72 RD=0,1 UX=8.5, 8.5
      ADD=73 RD=0,1 UX=8.5, 8.5
      ADD=74 RD=0,1 UX=8.5, 8.5
      ADD=75 RD=0,1 UX=8.5, 8.5
      ADD=76 RD=0,1 UX=8.5, 8.5
      ADD=77 RD=0,1 UX=8.5, 8.5
      ADD=78 RD=0,1 UX=8.5, 8.5
      ADD=31 RD=0,1 UX=-8.5, -8.5
      ADD=32 RD=0,1 UX=-8.5, -8.5
      ADD=33 RD=0,1 UX=-8.5, -8.5
```

```
      ADD=34 RD=0,1 UX=-8.5, -8.5
      ADD=35 RD=0,1 UX=-8.5, -8.5
      ADD=36 RD=0,1 UX=-8.5, -8.5
      ADD=37 RD=0,1 UX=-8.5, -8.5
      ADD=38 RD=0,1 UX=-8.5, -8.5
      ADD=39 RD=0,1 UX=-8.5, -8.5
      ADD=40 RD=0,1 UX=-8.5, -8.5
      ADD=41 RD=0,1 UX=-8.5, -8.5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=8.5, 8.5
      ADD=69 RD=0,1 UX=8.5, 8.5
      ADD=70 RD=0,1 UX=8.5, 8.5
      ADD=71 RD=0,1 UX=8.5, 8.5
      ADD=72 RD=0,1 UX=8.5, 8.5
      ADD=73 RD=0,1 UX=8.5, 8.5
      ADD=74 RD=0,1 UX=8.5, 8.5
      ADD=75 RD=0,1 UX=8.5, 8.5
      ADD=76 RD=0,1 UX=8.5, 8.5
      ADD=77 RD=0,1 UX=8.5, 8.5
      ADD=78 RD=0,1 UX=8.5, 8.5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-8.5, -8.5
      ADD=32 RD=0,1 UX=-8.5, -8.5
      ADD=33 RD=0,1 UX=-8.5, -8.5
      ADD=34 RD=0,1 UX=-8.5, -8.5
      ADD=35 RD=0,1 UX=-8.5, -8.5
      ADD=36 RD=0,1 UX=-8.5, -8.5
      ADD=37 RD=0,1 UX=-8.5, -8.5
      ADD=38 RD=0,1 UX=-8.5, -8.5
      ADD=39 RD=0,1 UX=-8.5, -8.5
      ADD=40 RD=0,1 UX=-8.5, -8.5
      ADD=41 RD=0,1 UX=-8.5, -8.5
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=4.5, 9
      ADD=69 RD=0,1 UX=9, 14
      ADD=70 RD=0,1 UX=14, 14.594
      ADD=71 RD=0,1 UX=14.594, 24.688
      ADD=72 RD=0,1 UX=24.688, 34.781
      ADD=73 RD=0,1 UX=34.781, 44.875
      ADD=74 RD=0,1 UX=44.875, 54.969
      ADD=75 RD=0,1 UX=54.969, 65.062
      ADD=76 RD=0,1 UX=65.062, 75.156
      ADD=77 RD=0,1 UX=75.156, 78.75
      ADD=78 RD=0,1 UX=78.75, 85.25
      ADD=31 RD=0,1 UX=-85.25, -78.75
      ADD=32 RD=0,1 UX=-78.75, -75.156
      ADD=33 RD=0,1 UX=-75.156, -65.062
      ADD=34 RD=0,1 UX=-65.062, -54.969
      ADD=35 RD=0,1 UX=-54.969, -44.875
      ADD=36 RD=0,1 UX=-44.875, -34.781
      ADD=37 RD=0,1 UX=-34.781, -24.688
      ADD=38 RD=0,1 UX=-24.688, -14.594
      ADD=39 RD=0,1 UX=-14.594, -14
      ADD=40 RD=0,1 UX=-14, -9
      ADD=41 RD=0,1 UX=-9, -4.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=90.5, 90.5
      ADD=2 RD=0,1 UZ=90.5, 90.5
      ADD=3 RD=0,1 UZ=90.5, 90.5
      ADD=4 RD=0,1 UZ=90.5, 90.5
      ADD=5 RD=0,1 UZ=90.5, 90.5
      ADD=6 RD=0,1 UZ=90.5, 90.5
      ADD=7 RD=0,1 UZ=90.5, 90.5
      ADD=8 RD=0,1 UZ=90.5, 90.5
      ADD=9 RD=0,1 UZ=90.5, 90.5
      ADD=10 RD=0,1 UZ=90.5, 90.5
      ADD=11 RD=0,1 UZ=90.5, 90.5
      ADD=12 RD=0,1 UZ=90.5, 90.5
      ADD=13 RD=0,1 UZ=90.5, 90.5
      ADD=14 RD=0,1 UZ=90.5, 90.5
      ADD=15 RD=0,1 UZ=90.5, 90.5
      ADD=16 RD=0,1 UZ=90.5, 90.5
      ADD=17 RD=0,1 UZ=90.5, 90.5
      ADD=18 RD=0,1 UZ=90.5, 90.5
      ADD=19 RD=0,1 UZ=90.5, 90.5
      ADD=20 RD=0,1 UZ=90.5, 90.5
      ADD=21 RD=0,1 UZ=90.5, 90.5
      ADD=22 RD=0,1 UZ=90.5, 90.5
      ADD=23 RD=0,1 UZ=90.5, 90.5
      ADD=24 RD=0,1 UZ=90.5, 90.5
      ADD=25 RD=0,1 UZ=90.5, 90.5
      ADD=26 RD=0,1 UZ=90.5, 90.5
      ADD=27 RD=0,1 UZ=90.5, 90.5
      ADD=28 RD=0,1 UZ=90.5, 90.5
      ADD=29 RD=0,1 UZ=90.5, 90.5
      ADD=30 RD=0,1 UZ=90.5, 90.5
NAME=FUNSLAB  ; 슬래브 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=10.106, 10.106
      ADD=43 RD=0,1 UX=10.106, 10.106
      ADD=44 RD=0,1 UX=10.106, 10.106
      ADD=45 RD=0,1 UX=10.106, 10.106
      ADD=46 RD=0,1 UX=10.106, 10.106
      ADD=47 RD=0,1 UX=10.106, 10.106
      ADD=48 RD=0,1 UX=10.106, 10.106
      ADD=49 RD=0,1 UX=10.106, 10.106
      ADD=50 RD=0,1 UX=10.106, 10.106
      ADD=51 RD=0,1 UX=10.106, 10.106
      ADD=52 RD=0,1 UX=10.106, 10.106
      ADD=53 RD=0,1 UX=10.106, 10.106
      ADD=54 RD=0,1 UX=10.106, 10.106
      ADD=55 RD=0,1 UX=10.106, 10.106
      ADD=56 RD=0,1 UX=10.106, 10.106
      ADD=57 RD=0,1 UX=10.106, 10.106
      ADD=58 RD=0,1 UX=10.106, 10.106
      ADD=59 RD=0,1 UX=10.106, 10.106
      ADD=60 RD=0,1 UX=10.106, 10.106
      ADD=61 RD=0,1 UX=10.106, 10.106
      ADD=62 RD=0,1 UX=10.106, 10.106
      ADD=63 RD=0,1 UX=10.106, 10.106
      ADD=64 RD=0,1 UX=10.106, 10.106
      ADD=65 RD=0,1 UX=10.106, 10.106
      ADD=66 RD=0,1 UX=10.106, 10.106
      ADD=67 RD=0,1 UX=10.106, 10.106
NAME=FUNWALL  ; 벽체 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=55.156, 54.178
      ADD=69 RD=0,1 UX=54.178, 52.819
      ADD=70 RD=0,1 UX=52.819, 52.652
      ADD=71 RD=0,1 UX=52.652, 48.861
      ADD=72 RD=0,1 UX=48.861, 43.805
      ADD=73 RD=0,1 UX=43.805, 37.462
      ADD=74 RD=0,1 UX=37.462, 29.903
      ADD=75 RD=0,1 UX=29.903, 21.128
      ADD=76 RD=0,1 UX=21.128, 11.16
      ADD=77 RD=0,1 UX=11.16, 7.321
      ADD=78 RD=0,1 UX=7.321, 0
      ADD=31 RD=0,1 UX=0, 7.321
      ADD=32 RD=0,1 UX=7.321, 11.16
      ADD=33 RD=0,1 UX=11.16, 21.128
      ADD=34 RD=0,1 UX=21.128, 29.903
      ADD=35 RD=0,1 UX=29.903, 37.462
      ADD=36 RD=0,1 UX=37.462, 43.805
      ADD=37 RD=0,1 UX=43.805, 48.861
      ADD=38 RD=0,1 UX=48.861, 52.652
      ADD=39 RD=0,1 UX=52.652, 52.819
      ADD=40 RD=0,1 UX=52.819, 54.178
      ADD=41 RD=0,1 UX=54.178, 55.156
NAME=FUNMS  ; 주면전단력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=1.56, 1.56
      ADD=43 RD=0,1 UX=1.56, 1.56
      ADD=44 RD=0,1 UX=1.56, 1.56
      ADD=45 RD=0,1 UX=1.56, 1.56
      ADD=46 RD=0,1 UX=1.56, 1.56
      ADD=47 RD=0,1 UX=1.56, 1.56
      ADD=48 RD=0,1 UX=1.56, 1.56
      ADD=49 RD=0,1 UX=1.56, 1.56
      ADD=50 RD=0,1 UX=1.56, 1.56
      ADD=51 RD=0,1 UX=1.56, 1.56
      ADD=52 RD=0,1 UX=1.56, 1.56
      ADD=53 RD=0,1 UX=1.56, 1.56
      ADD=54 RD=0,1 UX=1.56, 1.56
      ADD=55 RD=0,1 UX=1.56, 1.56
      ADD=56 RD=0,1 UX=1.56, 1.56
      ADD=57 RD=0,1 UX=1.56, 1.56
      ADD=58 RD=0,1 UX=1.56, 1.56
      ADD=59 RD=0,1 UX=1.56, 1.56
      ADD=60 RD=0,1 UX=1.56, 1.56
      ADD=61 RD=0,1 UX=1.56, 1.56
      ADD=62 RD=0,1 UX=1.56, 1.56
      ADD=63 RD=0,1 UX=1.56, 1.56
      ADD=64 RD=0,1 UX=1.56, 1.56
      ADD=65 RD=0,1 UX=1.56, 1.56
      ADD=66 RD=0,1 UX=1.56, 1.56
      ADD=67 RD=0,1 UX=1.56, 1.56
      ADD=68 RD=0,1 UZ=-8.02, -8.02
      ADD=69 RD=0,1 UZ=-8.02, -8.02
      ADD=70 RD=0,1 UZ=-8.02, -8.02
      ADD=71 RD=0,1 UZ=-8.02, -8.02
      ADD=72 RD=0,1 UZ=-8.02, -8.02
      ADD=73 RD=0,1 UZ=-8.02, -8.02
      ADD=74 RD=0,1 UZ=-8.02, -8.02
      ADD=75 RD=0,1 UZ=-8.02, -8.02
      ADD=76 RD=0,1 UZ=-8.02, -8.02
      ADD=77 RD=0,1 UZ=-8.02, -8.02
```

```
      ADD=78 RD=0,1 UZ=-8.02, -8.02
      ADD=31 RD=0,1 UZ=8.02, 8.02
      ADD=32 RD=0,1 UZ=8.02, 8.02
      ADD=33 RD=0,1 UZ=8.02, 8.02
      ADD=34 RD=0,1 UZ=8.02, 8.02
      ADD=35 RD=0,1 UZ=8.02, 8.02
      ADD=36 RD=0,1 UZ=8.02, 8.02
      ADD=37 RD=0,1 UZ=8.02, 8.02
      ADD=38 RD=0,1 UZ=8.02, 8.02
      ADD=39 RD=0,1 UZ=8.02, 8.02
      ADD=40 RD=0,1 UZ=8.02, 8.02
      ADD=41 RD=0,1 UZ=8.02, 8.02
      ADD=1 RD=0,1 UX=-14.48, -14.48
      ADD=2 RD=0,1 UX=-14.48, -14.48
      ADD=3 RD=0,1 UX=-14.48, -14.48
      ADD=4 RD=0,1 UX=-14.48, -14.48
      ADD=5 RD=0,1 UX=-14.48, -14.48
      ADD=6 RD=0,1 UX=-14.48, -14.48
      ADD=7 RD=0,1 UX=-14.48, -14.48
      ADD=8 RD=0,1 UX=-14.48, -14.48
      ADD=9 RD=0,1 UX=-14.48, -14.48
      ADD=10 RD=0,1 UX=-14.48, -14.48
      ADD=11 RD=0,1 UX=-14.48, -14.48
      ADD=12 RD=0,1 UX=-14.48, -14.48
      ADD=13 RD=0,1 UX=-14.48, -14.48
      ADD=14 RD=0,1 UX=-14.48, -14.48
      ADD=15 RD=0,1 UX=-14.48, -14.48
      ADD=16 RD=0,1 UX=-14.48, -14.48
      ADD=17 RD=0,1 UX=-14.48, -14.48
      ADD=18 RD=0,1 UX=-14.48, -14.48
      ADD=19 RD=0,1 UX=-14.48, -14.48
      ADD=20 RD=0,1 UX=-14.48, -14.48
      ADD=21 RD=0,1 UX=-14.48, -14.48
      ADD=22 RD=0,1 UX=-14.48, -14.48
      ADD=23 RD=0,1 UX=-14.48, -14.48
      ADD=24 RD=0,1 UX=-14.48, -14.48
      ADD=25 RD=0,1 UX=-14.48, -14.48
      ADD=26 RD=0,1 UX=-14.48, -14.48
      ADD=27 RD=0,1 UX=-14.48, -14.48
      ADD=28 RD=0,1 UX=-14.48, -14.48
      ADD=29 RD=0,1 UX=-14.48, -14.48
      ADD=30 RD=0,1 UX=-14.48, -14.48
NAME=FUNINER  ; 구체 관성력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=2.003, 2.003
      ADD=43 RD=0,1 UX=2.003, 2.003
      ADD=44 RD=0,1 UX=2.003, 2.003
      ADD=45 RD=0,1 UX=2.003, 2.003
      ADD=46 RD=0,1 UX=2.003, 2.003
      ADD=47 RD=0,1 UX=2.003, 2.003
      ADD=48 RD=0,1 UX=2.003, 2.003
      ADD=49 RD=0,1 UX=2.003, 2.003
      ADD=50 RD=0,1 UX=2.003, 2.003
      ADD=51 RD=0,1 UX=2.003, 2.003
      ADD=52 RD=0,1 UX=2.003, 2.003
      ADD=53 RD=0,1 UX=2.003, 2.003
      ADD=54 RD=0,1 UX=2.003, 2.003
      ADD=55 RD=0,1 UX=2.003, 2.003
      ADD=56 RD=0,1 UX=2.003, 2.003
      ADD=57 RD=0,1 UX=2.003, 2.003
      ADD=58 RD=0,1 UX=2.003, 2.003
      ADD=59 RD=0,1 UX=2.003, 2.003
      ADD=60 RD=0,1 UX=2.003, 2.003
      ADD=61 RD=0,1 UX=2.003, 2.003
      ADD=62 RD=0,1 UX=2.003, 2.003
      ADD=63 RD=0,1 UX=2.003, 2.003
      ADD=64 RD=0,1 UX=2.003, 2.003
      ADD=65 RD=0,1 UX=2.003, 2.003
      ADD=66 RD=0,1 UX=2.003, 2.003
      ADD=67 RD=0,1 UX=2.003, 2.003
      ADD=68 RD=0,1 UX=2.003, 1.989
      ADD=69 RD=0,1 UX=1.989, 1.974
      ADD=70 RD=0,1 UX=1.974, 1.972
      ADD=71 RD=0,1 UX=1.972, 1.941
      ADD=72 RD=0,1 UX=1.941, 1.91
      ADD=73 RD=0,1 UX=1.91, 1.879
      ADD=74 RD=0,1 UX=1.879, 1.848
      ADD=75 RD=0,1 UX=1.848, 1.817
      ADD=76 RD=0,1 UX=1.817, 1.786
      ADD=77 RD=0,1 UX=1.786, 1.775
      ADD=78 RD=0,1 UX=1.775, 1.755
      ADD=79 RD=0,1 UX=1.113, 0.975
      ADD=31 RD=0,1 UX=1.755, 1.775
      ADD=32 RD=0,1 UX=1.775, 1.786
      ADD=33 RD=0,1 UX=1.786, 1.817
      ADD=34 RD=0,1 UX=1.817, 1.848
      ADD=35 RD=0,1 UX=1.848, 1.879
      ADD=36 RD=0,1 UX=1.879, 1.91
      ADD=37 RD=0,1 UX=1.91, 1.941
      ADD=38 RD=0,1 UX=1.941, 1.972
      ADD=39 RD=0,1 UX=1.972, 1.974
      ADD=40 RD=0,1 UX=1.974, 1.989
      ADD=41 RD=0,1 UX=1.989, 2.003
      ADD=1 RD=0,1 UX=2.535, 2.535
      ADD=2 RD=0,1 UX=2.535, 2.535
      ADD=3 RD=0,1 UX=2.535, 2.535
      ADD=4 RD=0,1 UX=2.535, 2.535
      ADD=5 RD=0,1 UX=2.535, 2.535
      ADD=6 RD=0,1 UX=2.535, 2.535
      ADD=7 RD=0,1 UX=2.535, 2.535
      ADD=8 RD=0,1 UX=2.535, 2.535
      ADD=9 RD=0,1 UX=2.535, 2.535
      ADD=10 RD=0,1 UX=2.535, 2.535
      ADD=11 RD=0,1 UX=2.535, 2.535
      ADD=12 RD=0,1 UX=2.535, 2.535
      ADD=13 RD=0,1 UX=2.535, 2.535
      ADD=14 RD=0,1 UX=2.535, 2.535
      ADD=15 RD=0,1 UX=2.535, 2.535
      ADD=16 RD=0,1 UX=2.535, 2.535
      ADD=17 RD=0,1 UX=2.535, 2.535
      ADD=18 RD=0,1 UX=2.535, 2.535
      ADD=19 RD=0,1 UX=2.535, 2.535
      ADD=20 RD=0,1 UX=2.535, 2.535
      ADD=21 RD=0,1 UX=2.535, 2.535
      ADD=22 RD=0,1 UX=2.535, 2.535
      ADD=23 RD=0,1 UX=2.535, 2.535
      ADD=24 RD=0,1 UX=2.535, 2.535
      ADD=25 RD=0,1 UX=2.535, 2.535
      ADD=26 RD=0,1 UX=2.535, 2.535
      ADD=27 RD=0,1 UX=2.535, 2.535
      ADD=28 RD=0,1 UX=2.535, 2.535
      ADD=29 RD=0,1 UX=2.535, 2.535
      ADD=30 RD=0,1 UX=2.535, 2.535
NAME=FUNSLAB2  ; 슬래브 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=-10.106, -10.106
      ADD=43 RD=0,1 UX=-10.106, -10.106
      ADD=44 RD=0,1 UX=-10.106, -10.106
      ADD=45 RD=0,1 UX=-10.106, -10.106
      ADD=46 RD=0,1 UX=-10.106, -10.106
      ADD=47 RD=0,1 UX=-10.106, -10.106
      ADD=48 RD=0,1 UX=-10.106, -10.106
      ADD=49 RD=0,1 UX=-10.106, -10.106
      ADD=50 RD=0,1 UX=-10.106, -10.106
      ADD=51 RD=0,1 UX=-10.106, -10.106
      ADD=52 RD=0,1 UX=-10.106, -10.106
      ADD=53 RD=0,1 UX=-10.106, -10.106
      ADD=54 RD=0,1 UX=-10.106, -10.106
      ADD=55 RD=0,1 UX=-10.106, -10.106
      ADD=56 RD=0,1 UX=-10.106, -10.106
      ADD=57 RD=0,1 UX=-10.106, -10.106
      ADD=58 RD=0,1 UX=-10.106, -10.106
      ADD=59 RD=0,1 UX=-10.106, -10.106
      ADD=60 RD=0,1 UX=-10.106, -10.106
      ADD=61 RD=0,1 UX=-10.106, -10.106
      ADD=62 RD=0,1 UX=-10.106, -10.106
      ADD=63 RD=0,1 UX=-10.106, -10.106
      ADD=64 RD=0,1 UX=-10.106, -10.106
      ADD=65 RD=0,1 UX=-10.106, -10.106
      ADD=66 RD=0,1 UX=-10.106, -10.106
      ADD=67 RD=0,1 UX=-10.106, -10.106
NAME=FUNWALL2  ; 벽체 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=-55.156, -54.178
      ADD=69 RD=0,1 UX=-54.178, -52.819
      ADD=70 RD=0,1 UX=-52.819, -52.652
      ADD=71 RD=0,1 UX=-52.652, -48.861
      ADD=72 RD=0,1 UX=-48.861, -43.805
      ADD=73 RD=0,1 UX=-43.805, -37.462
      ADD=74 RD=0,1 UX=-37.462, -29.903
      ADD=75 RD=0,1 UX=-29.903, -21.128
      ADD=76 RD=0,1 UX=-21.128, -11.16
      ADD=77 RD=0,1 UX=-11.16, -7.321
      ADD=78 RD=0,1 UX=-7.321, -0
      ADD=31 RD=0,1 UX=-0, -7.321
      ADD=32 RD=0,1 UX=-7.321, -11.16
      ADD=33 RD=0,1 UX=-11.16, -21.128
      ADD=34 RD=0,1 UX=-21.128, -29.903
      ADD=35 RD=0,1 UX=-29.903, -37.462
      ADD=36 RD=0,1 UX=-37.462, -43.805
      ADD=37 RD=0,1 UX=-43.805, -48.861
      ADD=38 RD=0,1 UX=-48.861, -52.652
      ADD=39 RD=0,1 UX=-52.652, -52.819
      ADD=40 RD=0,1 UX=-52.819, -54.178
      ADD=41 RD=0,1 UX=-54.178, -55.156
NAME=FUNMS2  ; 주면전단력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=-1.56, -1.56
      ADD=43 RD=0,1 UX=-1.56, -1.56
      ADD=44 RD=0,1 UX=-1.56, -1.56
```

```
      ADD=45 RD=0,1 UX=-1.56, -1.56
      ADD=46 RD=0,1 UX=-1.56, -1.56
      ADD=47 RD=0,1 UX=-1.56, -1.56
      ADD=48 RD=0,1 UX=-1.56, -1.56
      ADD=49 RD=0,1 UX=-1.56, -1.56
      ADD=50 RD=0,1 UX=-1.56, -1.56
      ADD=51 RD=0,1 UX=-1.56, -1.56
      ADD=52 RD=0,1 UX=-1.56, -1.56
      ADD=53 RD=0,1 UX=-1.56, -1.56
      ADD=54 RD=0,1 UX=-1.56, -1.56
      ADD=55 RD=0,1 UX=-1.56, -1.56
      ADD=56 RD=0,1 UX=-1.56, -1.56
      ADD=57 RD=0,1 UX=-1.56, -1.56
      ADD=58 RD=0,1 UX=-1.56, -1.56
      ADD=59 RD=0,1 UX=-1.56, -1.56
      ADD=60 RD=0,1 UX=-1.56, -1.56
      ADD=61 RD=0,1 UX=-1.56, -1.56
      ADD=62 RD=0,1 UX=-1.56, -1.56
      ADD=63 RD=0,1 UX=-1.56, -1.56
      ADD=64 RD=0,1 UX=-1.56, -1.56
      ADD=65 RD=0,1 UX=-1.56, -1.56
      ADD=66 RD=0,1 UX=-1.56, -1.56
      ADD=67 RD=0,1 UX=-1.56, -1.56
      ADD=68 RD=0,1 UZ=8.02, 8.02
      ADD=69 RD=0,1 UZ=8.02, 8.02
      ADD=70 RD=0,1 UZ=8.02, 8.02
      ADD=71 RD=0,1 UZ=8.02, 8.02
      ADD=72 RD=0,1 UZ=8.02, 8.02
      ADD=73 RD=0,1 UZ=8.02, 8.02
      ADD=74 RD=0,1 UZ=8.02, 8.02
      ADD=75 RD=0,1 UZ=8.02, 8.02
      ADD=76 RD=0,1 UZ=8.02, 8.02
      ADD=77 RD=0,1 UZ=8.02, 8.02
      ADD=78 RD=0,1 UZ=8.02, 8.02
      ADD=31 RD=0,1 UZ=-8.02, -8.02
      ADD=32 RD=0,1 UZ=-8.02, -8.02
      ADD=33 RD=0,1 UZ=-8.02, -8.02
      ADD=34 RD=0,1 UZ=-8.02, -8.02
      ADD=35 RD=0,1 UZ=-8.02, -8.02
      ADD=36 RD=0,1 UZ=-8.02, -8.02
      ADD=37 RD=0,1 UZ=-8.02, -8.02
      ADD=38 RD=0,1 UZ=-8.02, -8.02
      ADD=39 RD=0,1 UZ=-8.02, -8.02
      ADD=40 RD=0,1 UZ=-8.02, -8.02
      ADD=41 RD=0,1 UZ=-8.02, -8.02
      ADD=1 RD=0,1 UX=14.48, 14.48
      ADD=2 RD=0,1 UX=14.48, 14.48
      ADD=3 RD=0,1 UX=14.48, 14.48
      ADD=4 RD=0,1 UX=14.48, 14.48
      ADD=5 RD=0,1 UX=14.48, 14.48
      ADD=6 RD=0,1 UX=14.48, 14.48
      ADD=7 RD=0,1 UX=14.48, 14.48
      ADD=8 RD=0,1 UX=14.48, 14.48
      ADD=9 RD=0,1 UX=14.48, 14.48
      ADD=10 RD=0,1 UX=14.48, 14.48
      ADD=11 RD=0,1 UX=14.48, 14.48
      ADD=12 RD=0,1 UX=14.48, 14.48
      ADD=13 RD=0,1 UX=14.48, 14.48
      ADD=14 RD=0,1 UX=14.48, 14.48
      ADD=15 RD=0,1 UX=14.48, 14.48
      ADD=16 RD=0,1 UX=14.48, 14.48
      ADD=17 RD=0,1 UX=14.48, 14.48
      ADD=18 RD=0,1 UX=14.48, 14.48
      ADD=19 RD=0,1 UX=14.48, 14.48
      ADD=20 RD=0,1 UX=14.48, 14.48
      ADD=21 RD=0,1 UX=14.48, 14.48
      ADD=22 RD=0,1 UX=14.48, 14.48
      ADD=23 RD=0,1 UX=14.48, 14.48
      ADD=24 RD=0,1 UX=14.48, 14.48
      ADD=25 RD=0,1 UX=14.48, 14.48
      ADD=26 RD=0,1 UX=14.48, 14.48
      ADD=27 RD=0,1 UX=14.48, 14.48
      ADD=28 RD=0,1 UX=14.48, 14.48
      ADD=29 RD=0,1 UX=14.48, 14.48
      ADD=30 RD=0,1 UX=14.48, 14.48
NAME=FUNINER2  ; 구체 관성력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=-2.003, -2.003
      ADD=43 RD=0,1 UX=-2.003, -2.003
      ADD=44 RD=0,1 UX=-2.003, -2.003
      ADD=45 RD=0,1 UX=-2.003, -2.003
      ADD=46 RD=0,1 UX=-2.003, -2.003
      ADD=47 RD=0,1 UX=-2.003, -2.003
      ADD=48 RD=0,1 UX=-2.003, -2.003
      ADD=49 RD=0,1 UX=-2.003, -2.003
      ADD=50 RD=0,1 UX=-2.003, -2.003
      ADD=51 RD=0,1 UX=-2.003, -2.003
      ADD=52 RD=0,1 UX=-2.003, -2.003
      ADD=53 RD=0,1 UX=-2.003, -2.003
      ADD=54 RD=0,1 UX=-2.003, -2.003
      ADD=55 RD=0,1 UX=-2.003, -2.003
      ADD=56 RD=0,1 UX=-2.003, -2.003
      ADD=57 RD=0,1 UX=-2.003, -2.003
      ADD=58 RD=0,1 UX=-2.003, -2.003
      ADD=59 RD=0,1 UX=-2.003, -2.003
      ADD=60 RD=0,1 UX=-2.003, -2.003
      ADD=61 RD=0,1 UX=-2.003, -2.003
      ADD=62 RD=0,1 UX=-2.003, -2.003
      ADD=63 RD=0,1 UX=-2.003, -2.003
      ADD=64 RD=0,1 UX=-2.003, -2.003
      ADD=65 RD=0,1 UX=-2.003, -2.003
      ADD=66 RD=0,1 UX=-2.003, -2.003
      ADD=67 RD=0,1 UX=-2.003, -2.003
      ADD=68 RD=0,1 UX=-2.003, -1.989
      ADD=69 RD=0,1 UX=-1.989, -1.974
      ADD=70 RD=0,1 UX=-1.974, -1.972
      ADD=71 RD=0,1 UX=-1.972, -1.941
      ADD=72 RD=0,1 UX=-1.941, -1.91
      ADD=73 RD=0,1 UX=-1.91, -1.879
      ADD=74 RD=0,1 UX=-1.879, -1.848
      ADD=75 RD=0,1 UX=-1.848, -1.817
      ADD=76 RD=0,1 UX=-1.817, -1.786
      ADD=77 RD=0,1 UX=-1.786, -1.775
      ADD=78 RD=0,1 UX=-1.775, -1.755
      ADD=79 RD=0,1 UX=-1.113, -0.975
      ADD=31 RD=0,1 UX=-1.755, -1.775
      ADD=32 RD=0,1 UX=-1.775, -1.786
      ADD=33 RD=0,1 UX=-1.786, -1.817
      ADD=34 RD=0,1 UX=-1.817, -1.848
      ADD=35 RD=0,1 UX=-1.848, -1.879
      ADD=36 RD=0,1 UX=-1.879, -1.91
      ADD=37 RD=0,1 UX=-1.91, -1.941
      ADD=38 RD=0,1 UX=-1.941, -1.972
      ADD=39 RD=0,1 UX=-1.972, -1.974
      ADD=40 RD=0,1 UX=-1.974, -1.989
      ADD=41 RD=0,1 UX=-1.989, -2.003
      ADD=1 RD=0,1 UX=-2.535, -2.535
      ADD=2 RD=0,1 UX=-2.535, -2.535
      ADD=3 RD=0,1 UX=-2.535, -2.535
      ADD=4 RD=0,1 UX=-2.535, -2.535
      ADD=5 RD=0,1 UX=-2.535, -2.535
      ADD=6 RD=0,1 UX=-2.535, -2.535
      ADD=7 RD=0,1 UX=-2.535, -2.535
      ADD=8 RD=0,1 UX=-2.535, -2.535
      ADD=9 RD=0,1 UX=-2.535, -2.535
      ADD=10 RD=0,1 UX=-2.535, -2.535
      ADD=11 RD=0,1 UX=-2.535, -2.535
      ADD=12 RD=0,1 UX=-2.535, -2.535
      ADD=13 RD=0,1 UX=-2.535, -2.535
      ADD=14 RD=0,1 UX=-2.535, -2.535
      ADD=15 RD=0,1 UX=-2.535, -2.535
      ADD=16 RD=0,1 UX=-2.535, -2.535
      ADD=17 RD=0,1 UX=-2.535, -2.535
      ADD=18 RD=0,1 UX=-2.535, -2.535
      ADD=19 RD=0,1 UX=-2.535, -2.535
      ADD=20 RD=0,1 UX=-2.535, -2.535
      ADD=21 RD=0,1 UX=-2.535, -2.535
      ADD=22 RD=0,1 UX=-2.535, -2.535
      ADD=23 RD=0,1 UX=-2.535, -2.535
      ADD=24 RD=0,1 UX=-2.535, -2.535
      ADD=25 RD=0,1 UX=-2.535, -2.535
      ADD=26 RD=0,1 UX=-2.535, -2.535
      ADD=27 RD=0,1 UX=-2.535, -2.535
      ADD=28 RD=0,1 UX=-2.535, -2.535
      ADD=29 RD=0,1 UX=-2.535, -2.535
      ADD=30 RD=0,1 UX=-2.535, -2.535
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=WATERH
      LOAD=BUOYANCY
      LOAD=FUNSLAB
      LOAD=FUNWALL
      LOAD=FUNMS
      LOAD=FUNINER
      LOAD=FUNSLAB2
      LOAD=FUNWALL2
      LOAD=FUNMS2
      LOAD=FUNINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
```

```
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
```

```
      LOAD= FUNMS          SF=1.000   AT=1                                  HIST=UE14 SF=1
      LOAD= FUNINER        SF=1.000   AT=1                                  HIST=UE15 SF=1
   NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE16 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE17 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                  HIST=UE18 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                  HIST=UE19 SF=1
      LOAD= WATERH         SF=0.500   AT=1                                  HIST=UE20 SF=1
      LOAD= FUNSLAB2       SF=1.000   AT=1                                  HIST=UE21 SF=1
      LOAD= FUNWALL2       SF=1.000   AT=1                                  HIST=UE22 SF=1
      LOAD= FUNMS2         SF=1.000   AT=1                                  HIST=UE23 SF=1
      LOAD= FUNINER2       SF=1.000   AT=1                                  HIST=UE24 SF=1
   NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE25 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE26 SF=1
      LOAD= LIVELEE        SF=1.000   AT=1                                  HIST=UE27 SF=1
      LOAD= LIVELEHE       SF=0.500   AT=1                                  HIST=UE28 SF=1
      LOAD= WATERH         SF=0.500   AT=1                                  HIST=UE29 SF=1
      LOAD= FUNSLAB        SF=1.000   AT=1                                  HIST=UE30 SF=1
      LOAD= FUNWALL        SF=1.000   AT=1                                  HIST=UE31 SF=1
      LOAD= FUNMS          SF=1.000   AT=1                                  HIST=UE32 SF=1
      LOAD= FUNINER        SF=1.000   AT=1                              OUTPUT
   NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1      ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
      LOAD= SW             SF=1.200   AT=1                                  ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
      LOAD= LIVELEE        SF=1.000   AT=1
      LOAD= LIVELEHE       SF=0.500   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= WATERH         SF=1.000   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= WATERH         SF=1.000   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
      HIST=UE06 SF=1
      HIST=UE07 SF=1
      HIST=UE08 SF=1
      HIST=UE09 SF=1
      HIST=UE10 SF=1
      HIST=UE11 SF=1
      HIST=UE12 SF=1
      HIST=UE13 SF=1
```

17. INPUT DATA (붕괴방지)

```
; ACulvert SAP2000 데이터파일 : 내진(붕괴)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     0.950 Y=     0.000 Z=     0.500
  3    X=     1.567 Y=     0.000 Z=     0.500
  4    X=     2.050 Y=     0.000 Z=     0.500
  5    X=     2.350 Y=     0.000 Z=     0.500
  6    X=     2.633 Y=     0.000 Z=     0.500
  7    X=     3.700 Y=     0.000 Z=     0.500
  8    X=     4.767 Y=     0.000 Z=     0.500
  9    X=     5.833 Y=     0.000 Z=     0.500
  10   X=     6.900 Y=     0.000 Z=     0.500
  11   X=     7.967 Y=     0.000 Z=     0.500
  12   X=     9.033 Y=     0.000 Z=     0.500
  13   X=     9.200 Y=     0.000 Z=     0.500
  14   X=     9.500 Y=     0.000 Z=     0.500
  15   X=     9.850 Y=     0.000 Z=     0.500
  16   X=    10.100 Y=     0.000 Z=     0.500
  17   X=    10.350 Y=     0.000 Z=     0.500
  18   X=    10.700 Y=     0.000 Z=     0.500
  19   X=    11.000 Y=     0.000 Z=     0.500
  20   X=    11.167 Y=     0.000 Z=     0.500
  21   X=    12.233 Y=     0.000 Z=     0.500
  22   X=    13.300 Y=     0.000 Z=     0.500
  23   X=    14.367 Y=     0.000 Z=     0.500
  24   X=    15.433 Y=     0.000 Z=     0.500
  25   X=    16.500 Y=     0.000 Z=     0.500
  26   X=    17.567 Y=     0.000 Z=     0.500
  27   X=    17.850 Y=     0.000 Z=     0.500
  28   X=    18.150 Y=     0.000 Z=     0.500
  29   X=    18.633 Y=     0.000 Z=     0.500
  30   X=    19.250 Y=     0.000 Z=     0.500
  31   X=    19.700 Y=     0.000 Z=     0.500
  32   X=    19.700 Y=     0.000 Z=     1.150
  33   X=    19.700 Y=     0.000 Z=     1.509
  34   X=    19.700 Y=     0.000 Z=     2.519
  35   X=    19.700 Y=     0.000 Z=     3.528
  36   X=    19.700 Y=     0.000 Z=     4.537
  37   X=    19.700 Y=     0.000 Z=     5.547
  38   X=    19.700 Y=     0.000 Z=     6.556
  39   X=    19.700 Y=     0.000 Z=     7.566
  40   X=    19.700 Y=     0.000 Z=     7.625
  41   X=    19.700 Y=     0.000 Z=     8.125
  42   X=    19.700 Y=     0.000 Z=     8.575
  43   X=    19.250 Y=     0.000 Z=     8.575
  44   X=    18.750 Y=     0.000 Z=     8.575
  45   X=    18.633 Y=     0.000 Z=     8.575
  46   X=    17.567 Y=     0.000 Z=     8.575
  47   X=    16.500 Y=     0.000 Z=     8.575
  48   X=    15.433 Y=     0.000 Z=     8.575
  49   X=    14.367 Y=     0.000 Z=     8.575
  50   X=    13.300 Y=     0.000 Z=     8.575
  51   X=    12.233 Y=     0.000 Z=     8.575
  52   X=    11.167 Y=     0.000 Z=     8.575
  53   X=    10.850 Y=     0.000 Z=     8.575
  54   X=    10.350 Y=     0.000 Z=     8.575
  55   X=    10.100 Y=     0.000 Z=     8.575
  56   X=     9.850 Y=     0.000 Z=     8.575
  57   X=     9.350 Y=     0.000 Z=     8.575
  58   X=     9.033 Y=     0.000 Z=     8.575
  59   X=     7.967 Y=     0.000 Z=     8.575
  60   X=     6.900 Y=     0.000 Z=     8.575
  61   X=     5.833 Y=     0.000 Z=     8.575
  62   X=     4.767 Y=     0.000 Z=     8.575
  63   X=     3.700 Y=     0.000 Z=     8.575
  64   X=     2.633 Y=     0.000 Z=     8.575
  65   X=     1.567 Y=     0.000 Z=     8.575
  66   X=     1.450 Y=     0.000 Z=     8.575
  67   X=     0.950 Y=     0.000 Z=     8.575
  68   X=     0.500 Y=     0.000 Z=     8.575
  69   X=     0.500 Y=     0.000 Z=     8.125
  70   X=     0.500 Y=     0.000 Z=     7.625
  71   X=     0.500 Y=     0.000 Z=     7.566
  72   X=     0.500 Y=     0.000 Z=     6.556
  73   X=     0.500 Y=     0.000 Z=     5.547
  74   X=     0.500 Y=     0.000 Z=     4.537
  75   X=     0.500 Y=     0.000 Z=     3.528
  76   X=     0.500 Y=     0.000 Z=     2.519
  77   X=     0.500 Y=     0.000 Z=     1.509
  78   X=     0.500 Y=     0.000 Z=     1.150
  79   X=     0.500 Y=     0.000 Z=     0.000
  80   X=     1.567 Y=     0.000 Z=     0.000
  81   X=     2.633 Y=     0.000 Z=     0.000
  82   X=     3.700 Y=     0.000 Z=     0.000
  83   X=     4.767 Y=     0.000 Z=     0.000
  84   X=     5.833 Y=     0.000 Z=     0.000
  85   X=     6.900 Y=     0.000 Z=     0.000
  86   X=     7.967 Y=     0.000 Z=     0.000
  87   X=     9.033 Y=     0.000 Z=     0.000
  88   X=    10.100 Y=     0.000 Z=     0.000
  89   X=    11.167 Y=     0.000 Z=     0.000
  90   X=    12.233 Y=     0.000 Z=     0.000
  91   X=    13.300 Y=     0.000 Z=     0.000
  92   X=    14.367 Y=     0.000 Z=     0.000
  93   X=    15.433 Y=     0.000 Z=     0.000
  94   X=    16.500 Y=     0.000 Z=     0.000
  95   X=    17.567 Y=     0.000 Z=     0.000
  96   X=    18.633 Y=     0.000 Z=     0.000
  97   X=    19.700 Y=     0.000 Z=     0.000
  98   X=    20.200 Y=     0.000 Z=     0.500
  99   X=    20.200 Y=     0.000 Z=     1.509
  100  X=    20.200 Y=     0.000 Z=     2.519
  101  X=    20.200 Y=     0.000 Z=     3.528
  102  X=    20.200 Y=     0.000 Z=     4.537
  103  X=    20.200 Y=     0.000 Z=     5.547
  104  X=    20.200 Y=     0.000 Z=     6.556
  105  X=    20.200 Y=     0.000 Z=     7.566
  106  X=    20.200 Y=     0.000 Z=     8.575
  107  X=    19.700 Y=     0.000 Z=     9.075
  108  X=    18.633 Y=     0.000 Z=     9.075
  109  X=    17.567 Y=     0.000 Z=     9.075
  110  X=    16.500 Y=     0.000 Z=     9.075
  111  X=    15.433 Y=     0.000 Z=     9.075
  112  X=    14.367 Y=     0.000 Z=     9.075
  113  X=    13.300 Y=     0.000 Z=     9.075
  114  X=    12.233 Y=     0.000 Z=     9.075
  115  X=    11.167 Y=     0.000 Z=     9.075
  116  X=    10.100 Y=     0.000 Z=     9.075
  117  X=     9.033 Y=     0.000 Z=     9.075
  118  X=     7.967 Y=     0.000 Z=     9.075
  119  X=     6.900 Y=     0.000 Z=     9.075
  120  X=     5.833 Y=     0.000 Z=     9.075
  121  X=     4.767 Y=     0.000 Z=     9.075
  122  X=     3.700 Y=     0.000 Z=     9.075
  123  X=     2.633 Y=     0.000 Z=     9.075
  124  X=     1.567 Y=     0.000 Z=     9.075
  125  X=     0.500 Y=     0.000 Z=     9.075
  126  X=     0.000 Y=     0.000 Z=     8.575
  127  X=     0.000 Y=     0.000 Z=     7.566
  128  X=     0.000 Y=     0.000 Z=     6.556
  129  X=     0.000 Y=     0.000 Z=     5.547
  130  X=     0.000 Y=     0.000 Z=     4.537
  131  X=     0.000 Y=     0.000 Z=     3.528
  132  X=     0.000 Y=     0.000 Z=     2.519
  133  X=     0.000 Y=     0.000 Z=     1.509
  134  X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
   ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=92 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=93 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=94 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=95 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=96 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=97 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=98 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=99 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=100 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=101 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=102 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=103 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=104 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=105 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=106 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=107 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=108 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=109 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=110 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=111 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=112 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=113 DOF=UX,UY,UZ,RX,RY,RZ
   ADD=114 DOF=UX,UY,UZ,RX,RY,RZ
```

```
  ADD=115 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=116 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=117 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=118 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=119 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=120 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=121 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=122 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=123 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=124 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=125 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=126 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=127 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=128 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=129 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=130 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=131 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=132 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=133 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=134 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=1820.51
  ADD=6 UX=1820.51
  ADD=7 UX=1820.51
  ADD=8 UX=1820.51
  ADD=9 UX=1820.51
  ADD=10 UX=1820.51
  ADD=11 UX=1820.51
  ADD=12 UX=1820.51
  ADD=16 UX=1820.51
  ADD=20 UX=1820.51
  ADD=21 UX=1820.51
  ADD=22 UX=1820.51
  ADD=23 UX=1820.51
  ADD=24 UX=1820.51
  ADD=25 UX=1820.51
  ADD=26 UX=1820.51
  ADD=29 UX=1820.51
  ADD=33 UZ=3134.2
  ADD=34 UZ=3134.2
  ADD=35 UZ=3134.2
  ADD=36 UZ=3134.2
  ADD=37 UZ=3134.2
  ADD=38 UZ=3134.2
  ADD=39 UZ=3134.2
  ADD=45 UX=1820.51
  ADD=46 UX=1820.51
  ADD=47 UX=1820.51
  ADD=48 UX=1820.51
  ADD=49 UX=1820.51
  ADD=50 UX=1820.51
  ADD=51 UX=1820.51
  ADD=52 UX=1820.51
  ADD=55 UX=1820.51
  ADD=58 UX=1820.51
  ADD=59 UX=1820.51
  ADD=60 UX=1820.51
  ADD=61 UX=1820.51
  ADD=62 UX=1820.51
  ADD=63 UX=1820.51
  ADD=64 UX=1820.51
  ADD=65 UX=1820.51
  ADD=71 UZ=3134.2
  ADD=72 UZ=3134.2
  ADD=73 UZ=3134.2
  ADD=74 UZ=3134.2
  ADD=75 UZ=3134.2
  ADD=76 UZ=3134.2
  ADD=77 UZ=3134.2
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=5034.82 CE=0.99999 K=5034.82 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=5461.51 CE=0.99999 K=5461.51 OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=10756.2 CE=0.99999 K=10756.2 OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=9402.6 CE=0.99999 K=9402.6 OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=8893.15 CE=0.99999 K=8893.15 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.3,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.05,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.125 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.125 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.425 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 3 NSEG= 4 ANG=0
    38 J= 38,  39 SEC= 3 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 3 NSEG= 4 ANG=0
    40 J= 40,  41 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    42 J= 42,  43 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    43 J= 43,  44 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 NSEG= 4 ANG=0
    51 J= 51,  52 SEC= 3 NSEG= 4 ANG=0
    52 J= 52,  53 SEC= 3 NSEG= 4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    55 J= 55,  56 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    56 J= 56,  57 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 3 NSEG= 4 ANG=0
    64 J= 64,  65 SEC= 3 NSEG= 4 ANG=0
    65 J= 65,  66 SEC= 3 NSEG= 4 ANG=0
    66 J= 66,  67 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    67 J= 67,  68 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    68 J= 68,  69 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    69 J= 69,  70 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,  73 SEC= 3 NSEG= 4 ANG=180
    73 J= 73,  74 SEC= 3 NSEG= 4 ANG=180
    74 J= 74,  75 SEC= 3 NSEG= 4 ANG=180
    75 J= 75,  76 SEC= 3 NSEG= 4 ANG=180
    76 J= 76,  77 SEC= 3 NSEG= 4 ANG=180
    77 J= 77,  78 SEC= 3 NSEG= 4 ANG=180
    78 J= 78,   1 SEC= 3 IOFF=0 JOFF=0.425 RIGID=1 NSEG=4 ANG=180
    79 J= 55,  16 SEC= 5 IOFF=0.7 JOFF=0.525 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,79 NLP=1 ANG=0
     2 J= 3,80 NLP=2 ANG=0
     3 J= 6,81 NLP=2 ANG=0
     4 J= 7,82 NLP=2 ANG=0
     5 J= 8,83 NLP=2 ANG=0
     6 J= 9,84 NLP=2 ANG=0
     7 J=10,85 NLP=2 ANG=0
     8 J=11,86 NLP=2 ANG=0
```

```
     9 J=12,87 NLP=2 ANG=0
    10 J=16,88 NLP=2 ANG=0
    11 J=20,89 NLP=2 ANG=0
    12 J=21,90 NLP=2 ANG=0
    13 J=22,91 NLP=2 ANG=0
    14 J=23,92 NLP=2 ANG=0
    15 J=24,93 NLP=2 ANG=0
    16 J=25,94 NLP=2 ANG=0
    17 J=26,95 NLP=2 ANG=0
    18 J=29,96 NLP=2 ANG=0
    19 J=31,97 NLP=1 ANG=0
    20 J=31,98 NLP=3 ANG=0
    21 J=33,99 NLP=4 ANG=0
    22 J=34,100 NLP=4 ANG=0
    23 J=35,101 NLP=4 ANG=0
    24 J=36,102 NLP=4 ANG=0
    25 J=37,103 NLP=4 ANG=0
    26 J=38,104 NLP=4 ANG=0
    27 J=39,105 NLP=4 ANG=0
    28 J=42,106 NLP=5 ANG=0
    29 J=42,107 NLP=1 ANG=0
    30 J=45,108 NLP=2 ANG=0
    31 J=46,109 NLP=2 ANG=0
    32 J=47,110 NLP=2 ANG=0
    33 J=48,111 NLP=2 ANG=0
    34 J=49,112 NLP=2 ANG=0
    35 J=50,113 NLP=2 ANG=0
    36 J=51,114 NLP=2 ANG=0
    37 J=52,115 NLP=2 ANG=0
    38 J=55,116 NLP=2 ANG=0
    39 J=58,117 NLP=2 ANG=0
    40 J=59,118 NLP=2 ANG=0
    41 J=60,119 NLP=2 ANG=0
    42 J=61,120 NLP=2 ANG=0
    43 J=62,121 NLP=2 ANG=0
    44 J=63,122 NLP=2 ANG=0
    45 J=64,123 NLP=2 ANG=0
    46 J=65,124 NLP=2 ANG=0
    47 J=68,125 NLP=1 ANG=0
    48 J=68,126 NLP=5 ANG=0
    49 J=71,127 NLP=4 ANG=0
    50 J=72,128 NLP=4 ANG=0
    51 J=73,129 NLP=4 ANG=0
    52 J=74,130 NLP=4 ANG=0
    53 J=75,131 NLP=4 ANG=0
    54 J=76,132 NLP=4 ANG=0
    55 J=77,133 NLP=4 ANG=0
    56 J= 1,134 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-60.575, -60.575
      ADD=43 RD=0,1 UZ=-60.575, -60.575
      ADD=44 RD=0,1 UZ=-60.575, -60.575
      ADD=45 RD=0,1 UZ=-60.575, -60.575
      ADD=46 RD=0,1 UZ=-60.575, -60.575
      ADD=47 RD=0,1 UZ=-60.575, -60.575
      ADD=48 RD=0,1 UZ=-60.575, -60.575
      ADD=49 RD=0,1 UZ=-60.575, -60.575
      ADD=50 RD=0,1 UZ=-60.575, -60.575
      ADD=51 RD=0,1 UZ=-60.575, -60.575
      ADD=52 RD=0,1 UZ=-60.575, -60.575
      ADD=53 RD=0,1 UZ=-60.575, -60.575
      ADD=54 RD=0,1 UZ=-60.575, -60.575
      ADD=55 RD=0,1 UZ=-60.575, -60.575
      ADD=56 RD=0,1 UZ=-60.575, -60.575
      ADD=57 RD=0,1 UZ=-60.575, -60.575
      ADD=58 RD=0,1 UZ=-60.575, -60.575
      ADD=59 RD=0,1 UZ=-60.575, -60.575
      ADD=60 RD=0,1 UZ=-60.575, -60.575
      ADD=61 RD=0,1 UZ=-60.575, -60.575
      ADD=62 RD=0,1 UZ=-60.575, -60.575
      ADD=63 RD=0,1 UZ=-60.575, -60.575
      ADD=64 RD=0,1 UZ=-60.575, -60.575
      ADD=65 RD=0,1 UZ=-60.575, -60.575
      ADD=66 RD=0,1 UZ=-60.575, -60.575
      ADD=67 RD=0,1 UZ=-60.575, -60.575
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-51.575, -51.575
      ADD=43 RD=0,1 UZ=-51.575, -51.575
      ADD=44 RD=0,1 UZ=-51.575, -51.575
      ADD=45 RD=0,1 UZ=-51.575, -51.575
      ADD=46 RD=0,1 UZ=-51.575, -51.575
      ADD=47 RD=0,1 UZ=-51.575, -51.575
      ADD=48 RD=0,1 UZ=-51.575, -51.575
      ADD=49 RD=0,1 UZ=-51.575, -51.575
      ADD=50 RD=0,1 UZ=-51.575, -51.575
      ADD=51 RD=0,1 UZ=-51.575, -51.575
      ADD=52 RD=0,1 UZ=-51.575, -51.575
      ADD=53 RD=0,1 UZ=-51.575, -51.575
      ADD=54 RD=0,1 UZ=-51.575, -51.575
      ADD=55 RD=0,1 UZ=-51.575, -51.575
      ADD=56 RD=0,1 UZ=-51.575, -51.575
      ADD=57 RD=0,1 UZ=-51.575, -51.575
      ADD=58 RD=0,1 UZ=-51.575, -51.575
      ADD=59 RD=0,1 UZ=-51.575, -51.575
      ADD=60 RD=0,1 UZ=-51.575, -51.575
      ADD=61 RD=0,1 UZ=-51.575, -51.575
      ADD=62 RD=0,1 UZ=-51.575, -51.575
      ADD=63 RD=0,1 UZ=-51.575, -51.575
      ADD=64 RD=0,1 UZ=-51.575, -51.575
      ADD=65 RD=0,1 UZ=-51.575, -51.575
      ADD=66 RD=0,1 UZ=-51.575, -51.575
      ADD=67 RD=0,1 UZ=-51.575, -51.575
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-17, -17
      ADD=43 RD=0,1 UZ=-17, -17
      ADD=44 RD=0,1 UZ=-17, -17
      ADD=45 RD=0,1 UZ=-17, -17
      ADD=46 RD=0,1 UZ=-17, -17
      ADD=47 RD=0,1 UZ=-17, -17
      ADD=48 RD=0,1 UZ=-17, -17
      ADD=49 RD=0,1 UZ=-17, -17
      ADD=50 RD=0,1 UZ=-17, -17
      ADD=51 RD=0,1 UZ=-17, -17
      ADD=52 RD=0,1 UZ=-17, -17
      ADD=53 RD=0,1 UZ=-17, -17
      ADD=54 RD=0,1 UZ=-17, -17
      ADD=55 RD=0,1 UZ=-17, -17
      ADD=56 RD=0,1 UZ=-17, -17
      ADD=57 RD=0,1 UZ=-17, -17
      ADD=58 RD=0,1 UZ=-17, -17
      ADD=59 RD=0,1 UZ=-17, -17
      ADD=60 RD=0,1 UZ=-17, -17
      ADD=61 RD=0,1 UZ=-17, -17
      ADD=62 RD=0,1 UZ=-17, -17
      ADD=63 RD=0,1 UZ=-17, -17
      ADD=64 RD=0,1 UZ=-17, -17
      ADD=65 RD=0,1 UZ=-17, -17
      ADD=66 RD=0,1 UZ=-17, -17
      ADD=67 RD=0,1 UZ=-17, -17
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=55 RD=0,1 UZ=-17, -17
      ADD=56 RD=0,1 UZ=-17, -17
      ADD=57 RD=0,1 UZ=-17, -17
      ADD=58 RD=0,1 UZ=-17, -17
      ADD=59 RD=0,1 UZ=-17, -17
      ADD=60 RD=0,1 UZ=-17, -17
      ADD=61 RD=0,1 UZ=-17, -17
      ADD=62 RD=0,1 UZ=-17, -17
      ADD=63 RD=0,1 UZ=-17, -17
      ADD=64 RD=0,1 UZ=-17, -17
      ADD=65 RD=0,1 UZ=-17, -17
      ADD=66 RD=0,1 UZ=-17, -17
      ADD=67 RD=0,1 UZ=-17, -17
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UZ=-17, -17
      ADD=43 RD=0,1 UZ=-17, -17
      ADD=44 RD=0,1 UZ=-17, -17
      ADD=45 RD=0,1 UZ=-17, -17
      ADD=46 RD=0,1 UZ=-17, -17
      ADD=47 RD=0,1 UZ=-17, -17
      ADD=48 RD=0,1 UZ=-17, -17
      ADD=49 RD=0,1 UZ=-17, -17
      ADD=50 RD=0,1 UZ=-17, -17
      ADD=51 RD=0,1 UZ=-17, -17
      ADD=52 RD=0,1 UZ=-17, -17
      ADD=53 RD=0,1 UZ=-17, -17
      ADD=54 RD=0,1 UZ=-17, -17
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=8.5, 8.5
      ADD=69 RD=0,1 UX=8.5, 8.5
      ADD=70 RD=0,1 UX=8.5, 8.5
      ADD=71 RD=0,1 UX=8.5, 8.5
      ADD=72 RD=0,1 UX=8.5, 8.5
      ADD=73 RD=0,1 UX=8.5, 8.5
      ADD=74 RD=0,1 UX=8.5, 8.5
      ADD=75 RD=0,1 UX=8.5, 8.5
      ADD=76 RD=0,1 UX=8.5, 8.5
      ADD=77 RD=0,1 UX=8.5, 8.5
      ADD=78 RD=0,1 UX=8.5, 8.5
      ADD=31 RD=0,1 UX=-8.5, -8.5
      ADD=32 RD=0,1 UX=-8.5, -8.5
      ADD=33 RD=0,1 UX=-8.5, -8.5
```

```
      ADD=34 RD=0,1 UX=-8.5, -8.5
      ADD=35 RD=0,1 UX=-8.5, -8.5
      ADD=36 RD=0,1 UX=-8.5, -8.5
      ADD=37 RD=0,1 UX=-8.5, -8.5
      ADD=38 RD=0,1 UX=-8.5, -8.5
      ADD=39 RD=0,1 UX=-8.5, -8.5
      ADD=40 RD=0,1 UX=-8.5, -8.5
      ADD=41 RD=0,1 UX=-8.5, -8.5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=8.5, 8.5
      ADD=69 RD=0,1 UX=8.5, 8.5
      ADD=70 RD=0,1 UX=8.5, 8.5
      ADD=71 RD=0,1 UX=8.5, 8.5
      ADD=72 RD=0,1 UX=8.5, 8.5
      ADD=73 RD=0,1 UX=8.5, 8.5
      ADD=74 RD=0,1 UX=8.5, 8.5
      ADD=75 RD=0,1 UX=8.5, 8.5
      ADD=76 RD=0,1 UX=8.5, 8.5
      ADD=77 RD=0,1 UX=8.5, 8.5
      ADD=78 RD=0,1 UX=8.5, 8.5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-8.5, -8.5
      ADD=32 RD=0,1 UX=-8.5, -8.5
      ADD=33 RD=0,1 UX=-8.5, -8.5
      ADD=34 RD=0,1 UX=-8.5, -8.5
      ADD=35 RD=0,1 UX=-8.5, -8.5
      ADD=36 RD=0,1 UX=-8.5, -8.5
      ADD=37 RD=0,1 UX=-8.5, -8.5
      ADD=38 RD=0,1 UX=-8.5, -8.5
      ADD=39 RD=0,1 UX=-8.5, -8.5
      ADD=40 RD=0,1 UX=-8.5, -8.5
      ADD=41 RD=0,1 UX=-8.5, -8.5
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=4.5, 9
      ADD=69 RD=0,1 UX=9, 14
      ADD=70 RD=0,1 UX=14, 14.594
      ADD=71 RD=0,1 UX=14.594, 24.688
      ADD=72 RD=0,1 UX=24.688, 34.781
      ADD=73 RD=0,1 UX=34.781, 44.875
      ADD=74 RD=0,1 UX=44.875, 54.969
      ADD=75 RD=0,1 UX=54.969, 65.062
      ADD=76 RD=0,1 UX=65.062, 75.156
      ADD=77 RD=0,1 UX=75.156, 78.75
      ADD=78 RD=0,1 UX=78.75, 85.25
      ADD=31 RD=0,1 UX=-85.25, -78.75
      ADD=32 RD=0,1 UX=-78.75, -75.156
      ADD=33 RD=0,1 UX=-75.156, -65.062
      ADD=34 RD=0,1 UX=-65.062, -54.969
      ADD=35 RD=0,1 UX=-54.969, -44.875
      ADD=36 RD=0,1 UX=-44.875, -34.781
      ADD=37 RD=0,1 UX=-34.781, -24.688
      ADD=38 RD=0,1 UX=-24.688, -14.594
      ADD=39 RD=0,1 UX=-14.594, -14
      ADD=40 RD=0,1 UX=-14, -9
      ADD=41 RD=0,1 UX=-9, -4.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=90.5, 90.5
      ADD=2 RD=0,1 UZ=90.5, 90.5
      ADD=3 RD=0,1 UZ=90.5, 90.5
      ADD=4 RD=0,1 UZ=90.5, 90.5
      ADD=5 RD=0,1 UZ=90.5, 90.5
      ADD=6 RD=0,1 UZ=90.5, 90.5
      ADD=7 RD=0,1 UZ=90.5, 90.5
      ADD=8 RD=0,1 UZ=90.5, 90.5
      ADD=9 RD=0,1 UZ=90.5, 90.5
      ADD=10 RD=0,1 UZ=90.5, 90.5
      ADD=11 RD=0,1 UZ=90.5, 90.5
      ADD=12 RD=0,1 UZ=90.5, 90.5
      ADD=13 RD=0,1 UZ=90.5, 90.5
      ADD=14 RD=0,1 UZ=90.5, 90.5
      ADD=15 RD=0,1 UZ=90.5, 90.5
      ADD=16 RD=0,1 UZ=90.5, 90.5
      ADD=17 RD=0,1 UZ=90.5, 90.5
      ADD=18 RD=0,1 UZ=90.5, 90.5
      ADD=19 RD=0,1 UZ=90.5, 90.5
      ADD=20 RD=0,1 UZ=90.5, 90.5
      ADD=21 RD=0,1 UZ=90.5, 90.5
      ADD=22 RD=0,1 UZ=90.5, 90.5
      ADD=23 RD=0,1 UZ=90.5, 90.5
      ADD=24 RD=0,1 UZ=90.5, 90.5
      ADD=25 RD=0,1 UZ=90.5, 90.5
      ADD=26 RD=0,1 UZ=90.5, 90.5
      ADD=27 RD=0,1 UZ=90.5, 90.5
      ADD=28 RD=0,1 UZ=90.5, 90.5
      ADD=29 RD=0,1 UZ=90.5, 90.5
      ADD=30 RD=0,1 UZ=90.5, 90.5
NAME=COLSLAB  ; 슬래브 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=12.939, 12.939
      ADD=43 RD=0,1 UX=12.939, 12.939
      ADD=44 RD=0,1 UX=12.939, 12.939
      ADD=45 RD=0,1 UX=12.939, 12.939
      ADD=46 RD=0,1 UX=12.939, 12.939
      ADD=47 RD=0,1 UX=12.939, 12.939
      ADD=48 RD=0,1 UX=12.939, 12.939
      ADD=49 RD=0,1 UX=12.939, 12.939
      ADD=50 RD=0,1 UX=12.939, 12.939
      ADD=51 RD=0,1 UX=12.939, 12.939
      ADD=52 RD=0,1 UX=12.939, 12.939
      ADD=53 RD=0,1 UX=12.939, 12.939
      ADD=54 RD=0,1 UX=12.939, 12.939
      ADD=55 RD=0,1 UX=12.939, 12.939
      ADD=56 RD=0,1 UX=12.939, 12.939
      ADD=57 RD=0,1 UX=12.939, 12.939
      ADD=58 RD=0,1 UX=12.939, 12.939
      ADD=59 RD=0,1 UX=12.939, 12.939
      ADD=60 RD=0,1 UX=12.939, 12.939
      ADD=61 RD=0,1 UX=12.939, 12.939
      ADD=62 RD=0,1 UX=12.939, 12.939
      ADD=63 RD=0,1 UX=12.939, 12.939
      ADD=64 RD=0,1 UX=12.939, 12.939
      ADD=65 RD=0,1 UX=12.939, 12.939
      ADD=66 RD=0,1 UX=12.939, 12.939
      ADD=67 RD=0,1 UX=12.939, 12.939
NAME=COLWALL  ; 벽체 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=70.619, 69.389
      ADD=69 RD=0,1 UX=69.389, 67.647
      ADD=70 RD=0,1 UX=67.647, 67.414
      ADD=71 RD=0,1 UX=67.414, 62.561
      ADD=72 RD=0,1 UX=62.561, 56.078
      ADD=73 RD=0,1 UX=56.078, 47.983
      ADD=74 RD=0,1 UX=47.983, 38.295
      ADD=75 RD=0,1 UX=38.295, 27.051
      ADD=76 RD=0,1 UX=27.051, 14.271
      ADD=77 RD=0,1 UX=14.271, 9.362
      ADD=78 RD=0,1 UX=9.362, 0
      ADD=31 RD=0,1 UX=0, 9.362
      ADD=32 RD=0,1 UX=9.362, 14.271
      ADD=33 RD=0,1 UX=14.271, 27.051
      ADD=34 RD=0,1 UX=27.051, 38.295
      ADD=35 RD=0,1 UX=38.295, 47.983
      ADD=36 RD=0,1 UX=47.983, 56.078
      ADD=37 RD=0,1 UX=56.078, 62.561
      ADD=38 RD=0,1 UX=62.561, 67.414
      ADD=39 RD=0,1 UX=67.414, 67.647
      ADD=40 RD=0,1 UX=67.647, 69.389
      ADD=41 RD=0,1 UX=69.389, 70.619
NAME=COLMS  ; 주면전단력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=2.01, 2.01
      ADD=43 RD=0,1 UX=2.01, 2.01
      ADD=44 RD=0,1 UX=2.01, 2.01
      ADD=45 RD=0,1 UX=2.01, 2.01
      ADD=46 RD=0,1 UX=2.01, 2.01
      ADD=47 RD=0,1 UX=2.01, 2.01
      ADD=48 RD=0,1 UX=2.01, 2.01
      ADD=49 RD=0,1 UX=2.01, 2.01
      ADD=50 RD=0,1 UX=2.01, 2.01
      ADD=51 RD=0,1 UX=2.01, 2.01
      ADD=52 RD=0,1 UX=2.01, 2.01
      ADD=53 RD=0,1 UX=2.01, 2.01
      ADD=54 RD=0,1 UX=2.01, 2.01
      ADD=55 RD=0,1 UX=2.01, 2.01
      ADD=56 RD=0,1 UX=2.01, 2.01
      ADD=57 RD=0,1 UX=2.01, 2.01
      ADD=58 RD=0,1 UX=2.01, 2.01
      ADD=59 RD=0,1 UX=2.01, 2.01
      ADD=60 RD=0,1 UX=2.01, 2.01
      ADD=61 RD=0,1 UX=2.01, 2.01
      ADD=62 RD=0,1 UX=2.01, 2.01
      ADD=63 RD=0,1 UX=2.01, 2.01
      ADD=64 RD=0,1 UX=2.01, 2.01
      ADD=65 RD=0,1 UX=2.01, 2.01
      ADD=66 RD=0,1 UX=2.01, 2.01
      ADD=67 RD=0,1 UX=2.01, 2.01
      ADD=68 RD=0,1 UZ=-10.29, -10.29
      ADD=69 RD=0,1 UZ=-10.29, -10.29
      ADD=70 RD=0,1 UZ=-10.29, -10.29
      ADD=71 RD=0,1 UZ=-10.29, -10.29
      ADD=72 RD=0,1 UZ=-10.29, -10.29
      ADD=73 RD=0,1 UZ=-10.29, -10.29
      ADD=74 RD=0,1 UZ=-10.29, -10.29
      ADD=75 RD=0,1 UZ=-10.29, -10.29
      ADD=76 RD=0,1 UZ=-10.29, -10.29
      ADD=77 RD=0,1 UZ=-10.29, -10.29
```

```
      ADD=78 RD=0,1 UZ=-10.29, -10.29
      ADD=31 RD=0,1 UZ=10.29, 10.29
      ADD=32 RD=0,1 UZ=10.29, 10.29
      ADD=33 RD=0,1 UZ=10.29, 10.29
      ADD=34 RD=0,1 UZ=10.29, 10.29
      ADD=35 RD=0,1 UZ=10.29, 10.29
      ADD=36 RD=0,1 UZ=10.29, 10.29
      ADD=37 RD=0,1 UZ=10.29, 10.29
      ADD=38 RD=0,1 UZ=10.29, 10.29
      ADD=39 RD=0,1 UZ=10.29, 10.29
      ADD=40 RD=0,1 UZ=10.29, 10.29
      ADD=41 RD=0,1 UZ=10.29, 10.29
      ADD=1 RD=0,1 UX=-18.56, -18.56
      ADD=2 RD=0,1 UX=-18.56, -18.56
      ADD=3 RD=0,1 UX=-18.56, -18.56
      ADD=4 RD=0,1 UX=-18.56, -18.56
      ADD=5 RD=0,1 UX=-18.56, -18.56
      ADD=6 RD=0,1 UX=-18.56, -18.56
      ADD=7 RD=0,1 UX=-18.56, -18.56
      ADD=8 RD=0,1 UX=-18.56, -18.56
      ADD=9 RD=0,1 UX=-18.56, -18.56
      ADD=10 RD=0,1 UX=-18.56, -18.56
      ADD=11 RD=0,1 UX=-18.56, -18.56
      ADD=12 RD=0,1 UX=-18.56, -18.56
      ADD=13 RD=0,1 UX=-18.56, -18.56
      ADD=14 RD=0,1 UX=-18.56, -18.56
      ADD=15 RD=0,1 UX=-18.56, -18.56
      ADD=16 RD=0,1 UX=-18.56, -18.56
      ADD=17 RD=0,1 UX=-18.56, -18.56
      ADD=18 RD=0,1 UX=-18.56, -18.56
      ADD=19 RD=0,1 UX=-18.56, -18.56
      ADD=20 RD=0,1 UX=-18.56, -18.56
      ADD=21 RD=0,1 UX=-18.56, -18.56
      ADD=22 RD=0,1 UX=-18.56, -18.56
      ADD=23 RD=0,1 UX=-18.56, -18.56
      ADD=24 RD=0,1 UX=-18.56, -18.56
      ADD=25 RD=0,1 UX=-18.56, -18.56
      ADD=26 RD=0,1 UX=-18.56, -18.56
      ADD=27 RD=0,1 UX=-18.56, -18.56
      ADD=28 RD=0,1 UX=-18.56, -18.56
      ADD=29 RD=0,1 UX=-18.56, -18.56
      ADD=30 RD=0,1 UX=-18.56, -18.56
   NAME=COLINER  ; 구체 관성력(붕괴방지)
      TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=4.93, 4.93
      ADD=43 RD=0,1 UX=4.93, 4.93
      ADD=44 RD=0,1 UX=4.93, 4.93
      ADD=45 RD=0,1 UX=4.93, 4.93
      ADD=46 RD=0,1 UX=4.93, 4.93
      ADD=47 RD=0,1 UX=4.93, 4.93
      ADD=48 RD=0,1 UX=4.93, 4.93
      ADD=49 RD=0,1 UX=4.93, 4.93
      ADD=50 RD=0,1 UX=4.93, 4.93
      ADD=51 RD=0,1 UX=4.93, 4.93
      ADD=52 RD=0,1 UX=4.93, 4.93
      ADD=53 RD=0,1 UX=4.93, 4.93
      ADD=54 RD=0,1 UX=4.93, 4.93
      ADD=55 RD=0,1 UX=4.93, 4.93
      ADD=56 RD=0,1 UX=4.93, 4.93
      ADD=57 RD=0,1 UX=4.93, 4.93
      ADD=58 RD=0,1 UX=4.93, 4.93
      ADD=59 RD=0,1 UX=4.93, 4.93
      ADD=60 RD=0,1 UX=4.93, 4.93
      ADD=61 RD=0,1 UX=4.93, 4.93
      ADD=62 RD=0,1 UX=4.93, 4.93
      ADD=63 RD=0,1 UX=4.93, 4.93
      ADD=64 RD=0,1 UX=4.93, 4.93
      ADD=65 RD=0,1 UX=4.93, 4.93
      ADD=66 RD=0,1 UX=4.93, 4.93
      ADD=67 RD=0,1 UX=4.93, 4.93
      ADD=68 RD=0,1 UX=4.93, 4.896
      ADD=69 RD=0,1 UX=4.896, 4.859
      ADD=70 RD=0,1 UX=4.859, 4.854
      ADD=71 RD=0,1 UX=4.854, 4.778
      ADD=72 RD=0,1 UX=4.778, 4.701
      ADD=73 RD=0,1 UX=4.701, 4.625
      ADD=74 RD=0,1 UX=4.625, 4.549
      ADD=75 RD=0,1 UX=4.549, 4.473
      ADD=76 RD=0,1 UX=4.473, 4.396
      ADD=77 RD=0,1 UX=4.396, 4.369
      ADD=78 RD=0,1 UX=4.369, 4.32
      ADD=79 RD=0,1 UX=2.739, 2.4
      ADD=31 RD=0,1 UX=4.32, 4.369
      ADD=32 RD=0,1 UX=4.369, 4.396
      ADD=33 RD=0,1 UX=4.396, 4.473
      ADD=34 RD=0,1 UX=4.473, 4.549
      ADD=35 RD=0,1 UX=4.549, 4.625
      ADD=36 RD=0,1 UX=4.625, 4.701
      ADD=37 RD=0,1 UX=4.701, 4.778
      ADD=38 RD=0,1 UX=4.778, 4.854
      ADD=39 RD=0,1 UX=4.854, 4.859
      ADD=40 RD=0,1 UX=4.859, 4.896
      ADD=41 RD=0,1 UX=4.896, 4.93
      ADD=1 RD=0,1 UX=6.24, 6.24
      ADD=2 RD=0,1 UX=6.24, 6.24
      ADD=3 RD=0,1 UX=6.24, 6.24
      ADD=4 RD=0,1 UX=6.24, 6.24
      ADD=5 RD=0,1 UX=6.24, 6.24
      ADD=6 RD=0,1 UX=6.24, 6.24
      ADD=7 RD=0,1 UX=6.24, 6.24
      ADD=8 RD=0,1 UX=6.24, 6.24
      ADD=9 RD=0,1 UX=6.24, 6.24
      ADD=10 RD=0,1 UX=6.24, 6.24
      ADD=11 RD=0,1 UX=6.24, 6.24
      ADD=12 RD=0,1 UX=6.24, 6.24
      ADD=13 RD=0,1 UX=6.24, 6.24
      ADD=14 RD=0,1 UX=6.24, 6.24
      ADD=15 RD=0,1 UX=6.24, 6.24
      ADD=16 RD=0,1 UX=6.24, 6.24
      ADD=17 RD=0,1 UX=6.24, 6.24
      ADD=18 RD=0,1 UX=6.24, 6.24
      ADD=19 RD=0,1 UX=6.24, 6.24
      ADD=20 RD=0,1 UX=6.24, 6.24
      ADD=21 RD=0,1 UX=6.24, 6.24
      ADD=22 RD=0,1 UX=6.24, 6.24
      ADD=23 RD=0,1 UX=6.24, 6.24
      ADD=24 RD=0,1 UX=6.24, 6.24
      ADD=25 RD=0,1 UX=6.24, 6.24
      ADD=26 RD=0,1 UX=6.24, 6.24
      ADD=27 RD=0,1 UX=6.24, 6.24
      ADD=28 RD=0,1 UX=6.24, 6.24
      ADD=29 RD=0,1 UX=6.24, 6.24
      ADD=30 RD=0,1 UX=6.24, 6.24
   NAME=COLSLAB2  ; 슬래브 지반변위(붕괴방지)2
      TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=-12.939, -12.939
      ADD=43 RD=0,1 UX=-12.939, -12.939
      ADD=44 RD=0,1 UX=-12.939, -12.939
      ADD=45 RD=0,1 UX=-12.939, -12.939
      ADD=46 RD=0,1 UX=-12.939, -12.939
      ADD=47 RD=0,1 UX=-12.939, -12.939
      ADD=48 RD=0,1 UX=-12.939, -12.939
      ADD=49 RD=0,1 UX=-12.939, -12.939
      ADD=50 RD=0,1 UX=-12.939, -12.939
      ADD=51 RD=0,1 UX=-12.939, -12.939
      ADD=52 RD=0,1 UX=-12.939, -12.939
      ADD=53 RD=0,1 UX=-12.939, -12.939
      ADD=54 RD=0,1 UX=-12.939, -12.939
      ADD=55 RD=0,1 UX=-12.939, -12.939
      ADD=56 RD=0,1 UX=-12.939, -12.939
      ADD=57 RD=0,1 UX=-12.939, -12.939
      ADD=58 RD=0,1 UX=-12.939, -12.939
      ADD=59 RD=0,1 UX=-12.939, -12.939
      ADD=60 RD=0,1 UX=-12.939, -12.939
      ADD=61 RD=0,1 UX=-12.939, -12.939
      ADD=62 RD=0,1 UX=-12.939, -12.939
      ADD=63 RD=0,1 UX=-12.939, -12.939
      ADD=64 RD=0,1 UX=-12.939, -12.939
      ADD=65 RD=0,1 UX=-12.939, -12.939
      ADD=66 RD=0,1 UX=-12.939, -12.939
      ADD=67 RD=0,1 UX=-12.939, -12.939
   NAME=COLWALL2  ; 벽체 지반변위(붕괴방지)2
      TYPE=DISTRIBUTED SPAN
      ADD=68 RD=0,1 UX=-70.619, -69.389
      ADD=69 RD=0,1 UX=-69.389, -67.647
      ADD=70 RD=0,1 UX=-67.647, -67.414
      ADD=71 RD=0,1 UX=-67.414, -62.561
      ADD=72 RD=0,1 UX=-62.561, -56.078
      ADD=73 RD=0,1 UX=-56.078, -47.983
      ADD=74 RD=0,1 UX=-47.983, -38.295
      ADD=75 RD=0,1 UX=-38.295, -27.051
      ADD=76 RD=0,1 UX=-27.051, -14.271
      ADD=77 RD=0,1 UX=-14.271, -9.362
      ADD=78 RD=0,1 UX=-9.362, -0
      ADD=31 RD=0,1 UX=-0, -9.362
      ADD=32 RD=0,1 UX=-9.362, -14.271
      ADD=33 RD=0,1 UX=-14.271, -27.051
      ADD=34 RD=0,1 UX=-27.051, -38.295
      ADD=35 RD=0,1 UX=-38.295, -47.983
      ADD=36 RD=0,1 UX=-47.983, -56.078
      ADD=37 RD=0,1 UX=-56.078, -62.561
      ADD=38 RD=0,1 UX=-62.561, -67.414
      ADD=39 RD=0,1 UX=-67.414, -67.647
      ADD=40 RD=0,1 UX=-67.647, -69.389
      ADD=41 RD=0,1 UX=-69.389, -70.619
   NAME=COLMS2  ; 주면전단력(붕괴방지)2
      TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=-2.01, -2.01
      ADD=43 RD=0,1 UX=-2.01, -2.01
      ADD=44 RD=0,1 UX=-2.01, -2.01
```

```
      ADD=45 RD=0,1 UX=-2.01, -2.01
      ADD=46 RD=0,1 UX=-2.01, -2.01
      ADD=47 RD=0,1 UX=-2.01, -2.01
      ADD=48 RD=0,1 UX=-2.01, -2.01
      ADD=49 RD=0,1 UX=-2.01, -2.01
      ADD=50 RD=0,1 UX=-2.01, -2.01
      ADD=51 RD=0,1 UX=-2.01, -2.01
      ADD=52 RD=0,1 UX=-2.01, -2.01
      ADD=53 RD=0,1 UX=-2.01, -2.01
      ADD=54 RD=0,1 UX=-2.01, -2.01
      ADD=55 RD=0,1 UX=-2.01, -2.01
      ADD=56 RD=0,1 UX=-2.01, -2.01
      ADD=57 RD=0,1 UX=-2.01, -2.01
      ADD=58 RD=0,1 UX=-2.01, -2.01
      ADD=59 RD=0,1 UX=-2.01, -2.01
      ADD=60 RD=0,1 UX=-2.01, -2.01
      ADD=61 RD=0,1 UX=-2.01, -2.01
      ADD=62 RD=0,1 UX=-2.01, -2.01
      ADD=63 RD=0,1 UX=-2.01, -2.01
      ADD=64 RD=0,1 UX=-2.01, -2.01
      ADD=65 RD=0,1 UX=-2.01, -2.01
      ADD=66 RD=0,1 UX=-2.01, -2.01
      ADD=67 RD=0,1 UX=-2.01, -2.01
      ADD=68 RD=0,1 UZ=10.29, 10.29
      ADD=69 RD=0,1 UZ=10.29, 10.29
      ADD=70 RD=0,1 UZ=10.29, 10.29
      ADD=71 RD=0,1 UZ=10.29, 10.29
      ADD=72 RD=0,1 UZ=10.29, 10.29
      ADD=73 RD=0,1 UZ=10.29, 10.29
      ADD=74 RD=0,1 UZ=10.29, 10.29
      ADD=75 RD=0,1 UZ=10.29, 10.29
      ADD=76 RD=0,1 UZ=10.29, 10.29
      ADD=77 RD=0,1 UZ=10.29, 10.29
      ADD=78 RD=0,1 UZ=10.29, 10.29
      ADD=31 RD=0,1 UZ=-10.29, -10.29
      ADD=32 RD=0,1 UZ=-10.29, -10.29
      ADD=33 RD=0,1 UZ=-10.29, -10.29
      ADD=34 RD=0,1 UZ=-10.29, -10.29
      ADD=35 RD=0,1 UZ=-10.29, -10.29
      ADD=36 RD=0,1 UZ=-10.29, -10.29
      ADD=37 RD=0,1 UZ=-10.29, -10.29
      ADD=38 RD=0,1 UZ=-10.29, -10.29
      ADD=39 RD=0,1 UZ=-10.29, -10.29
      ADD=40 RD=0,1 UZ=-10.29, -10.29
      ADD=41 RD=0,1 UZ=-10.29, -10.29
      ADD=1 RD=0,1 UX=18.56, 18.56
      ADD=2 RD=0,1 UX=18.56, 18.56
      ADD=3 RD=0,1 UX=18.56, 18.56
      ADD=4 RD=0,1 UX=18.56, 18.56
      ADD=5 RD=0,1 UX=18.56, 18.56
      ADD=6 RD=0,1 UX=18.56, 18.56
      ADD=7 RD=0,1 UX=18.56, 18.56
      ADD=8 RD=0,1 UX=18.56, 18.56
      ADD=9 RD=0,1 UX=18.56, 18.56
      ADD=10 RD=0,1 UX=18.56, 18.56
      ADD=11 RD=0,1 UX=18.56, 18.56
      ADD=12 RD=0,1 UX=18.56, 18.56
      ADD=13 RD=0,1 UX=18.56, 18.56
      ADD=14 RD=0,1 UX=18.56, 18.56
      ADD=15 RD=0,1 UX=18.56, 18.56
      ADD=16 RD=0,1 UX=18.56, 18.56
      ADD=17 RD=0,1 UX=18.56, 18.56
      ADD=18 RD=0,1 UX=18.56, 18.56
      ADD=19 RD=0,1 UX=18.56, 18.56
      ADD=20 RD=0,1 UX=18.56, 18.56
      ADD=21 RD=0,1 UX=18.56, 18.56
      ADD=22 RD=0,1 UX=18.56, 18.56
      ADD=23 RD=0,1 UX=18.56, 18.56
      ADD=24 RD=0,1 UX=18.56, 18.56
      ADD=25 RD=0,1 UX=18.56, 18.56
      ADD=26 RD=0,1 UX=18.56, 18.56
      ADD=27 RD=0,1 UX=18.56, 18.56
      ADD=28 RD=0,1 UX=18.56, 18.56
      ADD=29 RD=0,1 UX=18.56, 18.56
      ADD=30 RD=0,1 UX=18.56, 18.56
NAME=COLINER2  ; 구체 관성력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=42 RD=0,1 UX=-4.93, -4.93
      ADD=43 RD=0,1 UX=-4.93, -4.93
      ADD=44 RD=0,1 UX=-4.93, -4.93
      ADD=45 RD=0,1 UX=-4.93, -4.93
      ADD=46 RD=0,1 UX=-4.93, -4.93
      ADD=47 RD=0,1 UX=-4.93, -4.93
      ADD=48 RD=0,1 UX=-4.93, -4.93
      ADD=49 RD=0,1 UX=-4.93, -4.93
      ADD=50 RD=0,1 UX=-4.93, -4.93
      ADD=51 RD=0,1 UX=-4.93, -4.93
      ADD=52 RD=0,1 UX=-4.93, -4.93
      ADD=53 RD=0,1 UX=-4.93, -4.93
      ADD=54 RD=0,1 UX=-4.93, -4.93
      ADD=55 RD=0,1 UX=-4.93, -4.93
      ADD=56 RD=0,1 UX=-4.93, -4.93
      ADD=57 RD=0,1 UX=-4.93, -4.93
      ADD=58 RD=0,1 UX=-4.93, -4.93
      ADD=59 RD=0,1 UX=-4.93, -4.93
      ADD=60 RD=0,1 UX=-4.93, -4.93
      ADD=61 RD=0,1 UX=-4.93, -4.93
      ADD=62 RD=0,1 UX=-4.93, -4.93
      ADD=63 RD=0,1 UX=-4.93, -4.93
      ADD=64 RD=0,1 UX=-4.93, -4.93
      ADD=65 RD=0,1 UX=-4.93, -4.93
      ADD=66 RD=0,1 UX=-4.93, -4.93
      ADD=67 RD=0,1 UX=-4.93, -4.93
      ADD=68 RD=0,1 UX=-4.93, -4.896
      ADD=69 RD=0,1 UX=-4.896, -4.859
      ADD=70 RD=0,1 UX=-4.859, -4.854
      ADD=71 RD=0,1 UX=-4.854, -4.778
      ADD=72 RD=0,1 UX=-4.778, -4.701
      ADD=73 RD=0,1 UX=-4.701, -4.625
      ADD=74 RD=0,1 UX=-4.625, -4.549
      ADD=75 RD=0,1 UX=-4.549, -4.473
      ADD=76 RD=0,1 UX=-4.473, -4.396
      ADD=77 RD=0,1 UX=-4.396, -4.369
      ADD=78 RD=0,1 UX=-4.369, -4.32
      ADD=79 RD=0,1 UX=-2.739, -2.4
      ADD=31 RD=0,1 UX=-4.32, -4.369
      ADD=32 RD=0,1 UX=-4.369, -4.396
      ADD=33 RD=0,1 UX=-4.396, -4.473
      ADD=34 RD=0,1 UX=-4.473, -4.549
      ADD=35 RD=0,1 UX=-4.549, -4.625
      ADD=36 RD=0,1 UX=-4.625, -4.701
      ADD=37 RD=0,1 UX=-4.701, -4.778
      ADD=38 RD=0,1 UX=-4.778, -4.854
      ADD=39 RD=0,1 UX=-4.854, -4.859
      ADD=40 RD=0,1 UX=-4.859, -4.896
      ADD=41 RD=0,1 UX=-4.896, -4.93
      ADD=1 RD=0,1 UX=-6.24, -6.24
      ADD=2 RD=0,1 UX=-6.24, -6.24
      ADD=3 RD=0,1 UX=-6.24, -6.24
      ADD=4 RD=0,1 UX=-6.24, -6.24
      ADD=5 RD=0,1 UX=-6.24, -6.24
      ADD=6 RD=0,1 UX=-6.24, -6.24
      ADD=7 RD=0,1 UX=-6.24, -6.24
      ADD=8 RD=0,1 UX=-6.24, -6.24
      ADD=9 RD=0,1 UX=-6.24, -6.24
      ADD=10 RD=0,1 UX=-6.24, -6.24
      ADD=11 RD=0,1 UX=-6.24, -6.24
      ADD=12 RD=0,1 UX=-6.24, -6.24
      ADD=13 RD=0,1 UX=-6.24, -6.24
      ADD=14 RD=0,1 UX=-6.24, -6.24
      ADD=15 RD=0,1 UX=-6.24, -6.24
      ADD=16 RD=0,1 UX=-6.24, -6.24
      ADD=17 RD=0,1 UX=-6.24, -6.24
      ADD=18 RD=0,1 UX=-6.24, -6.24
      ADD=19 RD=0,1 UX=-6.24, -6.24
      ADD=20 RD=0,1 UX=-6.24, -6.24
      ADD=21 RD=0,1 UX=-6.24, -6.24
      ADD=22 RD=0,1 UX=-6.24, -6.24
      ADD=23 RD=0,1 UX=-6.24, -6.24
      ADD=24 RD=0,1 UX=-6.24, -6.24
      ADD=25 RD=0,1 UX=-6.24, -6.24
      ADD=26 RD=0,1 UX=-6.24, -6.24
      ADD=27 RD=0,1 UX=-6.24, -6.24
      ADD=28 RD=0,1 UX=-6.24, -6.24
      ADD=29 RD=0,1 UX=-6.24, -6.24
      ADD=30 RD=0,1 UX=-6.24, -6.24
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=WATERH
      LOAD=BUOYANCY
      LOAD=COLSLAB
      LOAD=COLWALL
      LOAD=COLMS
      LOAD=COLINER
      LOAD=COLSLAB2
      LOAD=COLWALL2
      LOAD=COLMS2
      LOAD=COLINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
```

```
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
```

```
    LOAD= WATERH         SF=1.000   AT=1
    LOAD= COLSLAB        SF=1.000   AT=1
    LOAD= COLWALL        SF=1.000   AT=1
    LOAD= COLMS          SF=1.000   AT=1
    LOAD= COLINER        SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW             SF=1.200   AT=1
    LOAD= PAVEW          SF=1.200   AT=1
    LOAD= LIVERIE        SF=1.000   AT=1
    LOAD= LIVERIHE       SF=1.000   AT=1
    LOAD= WATERH         SF=1.000   AT=1
    LOAD= COLSLAB2       SF=1.000   AT=1
    LOAD= COLWALL2       SF=1.000   AT=1
    LOAD= COLMS2         SF=1.000   AT=1
    LOAD= COLINER2       SF=1.000   AT=1
NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW             SF=1.200   AT=1
    LOAD= PAVEW          SF=1.200   AT=1
    LOAD= LIVEFUE        SF=1.000   AT=1
    LOAD= LIVEFUHE       SF=0.500   AT=1
    LOAD= WATERH         SF=0.500   AT=1
    LOAD= COLSLAB        SF=1.000   AT=1
    LOAD= COLWALL        SF=1.000   AT=1
    LOAD= COLMS          SF=1.000   AT=1
    LOAD= COLINER        SF=1.000   AT=1
NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW             SF=1.200   AT=1
    LOAD= PAVEW          SF=1.200   AT=1
    LOAD= LIVEFUE        SF=1.000   AT=1
    LOAD= LIVEFUHE       SF=0.500   AT=1
    LOAD= WATERH         SF=0.500   AT=1
    LOAD= COLSLAB2       SF=1.000   AT=1
    LOAD= COLWALL2       SF=1.000   AT=1
    LOAD= COLMS2         SF=1.000   AT=1
    LOAD= COLINER2       SF=1.000   AT=1
NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW             SF=1.200   AT=1
    LOAD= PAVEW          SF=1.200   AT=1
    LOAD= LIVELEE        SF=1.000   AT=1
    LOAD= LIVELEHE       SF=0.500   AT=1
    LOAD= WATERH         SF=0.500   AT=1
    LOAD= COLSLAB        SF=1.000   AT=1
    LOAD= COLWALL        SF=1.000   AT=1
    LOAD= COLMS          SF=1.000   AT=1
    LOAD= COLINER        SF=1.000   AT=1
NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW             SF=1.200   AT=1
    LOAD= PAVEW          SF=1.200   AT=1
    LOAD= LIVELEE        SF=1.000   AT=1
    LOAD= LIVELEHE       SF=0.500   AT=1
    LOAD= WATERH         SF=0.500   AT=1
    LOAD= COLSLAB2       SF=1.000   AT=1
    LOAD= COLWALL2       SF=1.000   AT=1
    LOAD= COLMS2         SF=1.000   AT=1
    LOAD= COLINER2       SF=1.000   AT=1
NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
    LOAD= SW             SF=1.200   AT=1
    LOAD= PAVEW          SF=1.200   AT=1
    LOAD= LIVERIE        SF=1.000   AT=1
    LOAD= LIVERIHE       SF=0.500   AT=1
    LOAD= WATERH         SF=0.500   AT=1
    LOAD= COLSLAB        SF=1.000   AT=1
    LOAD= COLWALL        SF=1.000   AT=1
    LOAD= COLMS          SF=1.000   AT=1
    LOAD= COLINER        SF=1.000   AT=1
NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
    LOAD= SW             SF=1.200   AT=1
    LOAD= PAVEW          SF=1.200   AT=1
    LOAD= LIVERIE        SF=1.000   AT=1
    LOAD= LIVERIHE       SF=0.500   AT=1
    LOAD= WATERH         SF=0.500   AT=1
    LOAD= COLSLAB2       SF=1.000   AT=1
    LOAD= COLWALL2       SF=1.000   AT=1
    LOAD= COLMS2         SF=1.000   AT=1
    LOAD= COLINER2       SF=1.000   AT=1
NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
    LOAD= SW             SF=0.900   AT=1
    LOAD= PAVEW          SF=0.900   AT=1
    LOAD= WATERH         SF=1.000   AT=1
    LOAD= COLSLAB        SF=1.000   AT=1
    LOAD= COLWALL        SF=1.000   AT=1
    LOAD= COLMS          SF=1.000   AT=1
    LOAD= COLINER        SF=1.000   AT=1
NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
    LOAD= SW             SF=0.900   AT=1
    LOAD= PAVEW          SF=0.900   AT=1
    LOAD= WATERH         SF=1.000   AT=1
    LOAD= COLSLAB2       SF=1.000   AT=1
    LOAD= COLWALL2       SF=1.000   AT=1
    LOAD= COLMS2         SF=1.000   AT=1
    LOAD= COLINER2       SF=1.000   AT=1
NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW             SF=0.900   AT=1
    LOAD= PAVEW          SF=0.900   AT=1
    LOAD= WATERH         SF=0.500   AT=1
    LOAD= COLSLAB        SF=1.000   AT=1
    LOAD= COLWALL        SF=1.000   AT=1
    LOAD= COLMS          SF=1.000   AT=1
    LOAD= COLINER        SF=1.000   AT=1
NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
    LOAD= SW             SF=0.900   AT=1
    LOAD= PAVEW          SF=0.900   AT=1
    LOAD= WATERH         SF=0.500   AT=1
    LOAD= COLSLAB2       SF=1.000   AT=1
    LOAD= COLWALL2       SF=1.000   AT=1
    LOAD= COLMS2         SF=1.000   AT=1
    LOAD= COLINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
      HIST=UE06 SF=1
      HIST=UE07 SF=1
      HIST=UE08 SF=1
      HIST=UE09 SF=1
      HIST=UE10 SF=1
      HIST=UE11 SF=1
      HIST=UE12 SF=1
      HIST=UE13 SF=1
      HIST=UE14 SF=1
      HIST=UE15 SF=1
      HIST=UE16 SF=1
      HIST=UE17 SF=1
      HIST=UE18 SF=1
      HIST=UE19 SF=1
      HIST=UE20 SF=1
      HIST=UE21 SF=1
      HIST=UE22 SF=1
      HIST=UE23 SF=1
      HIST=UE24 SF=1
      HIST=UE25 SF=1
      HIST=UE26 SF=1
      HIST=UE27 SF=1
      HIST=UE28 SF=1
      HIST=UE29 SF=1
      HIST=UE30 SF=1
      HIST=UE31 SF=1
      HIST=UE32 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

18. OUTPUT DATA (상시)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVULT MAX	0.27778	205.64036	0.00000	315.48919
1	ENVULT MAX	0.45833	205.64036	0.00000	355.71904
1	ENVULT MAX	0.63889	205.64036	0.00000	396.20634
1	ENVULT MAX	0.81944	205.64036	0.00000	436.95111
1	ENVULT MAX	1.00000	205.64036	0.00000	477.95334
1	ENVULT MIN	0.27778	-877.43629	-721.49647	-1474.04400
1	ENVULT MIN	0.45833	-877.43629	-715.84147	-1416.12700
1	ENVULT MIN	0.63889	-877.43629	-710.18647	-1358.66800
1	ENVULT MIN	0.81944	-877.43629	-704.53147	-1301.66900
1	ENVULT MIN	1.00000	-877.43629	-698.87647	-1245.13000
2	ENVULT MAX	0.00000	205.64036	0.00000	477.95334
2	ENVULT MAX	0.25000	205.64036	0.00000	556.50285
2	ENVULT MAX	0.50000	205.64036	0.00000	635.98029
2	ENVULT MAX	0.75000	205.64036	0.00000	716.38566
2	ENVULT MAX	1.00000	205.64036	0.00000	797.71895
2	ENVULT MIN	0.00000	-877.43630	-698.87648	-1245.13000
2	ENVULT MIN	0.25000	-877.43630	-688.14068	-1139.05600
2	ENVULT MIN	0.50000	-877.43630	-681.35473	-1034.63800
2	ENVULT MIN	0.75000	-877.43630	-687.37048	-931.87586
2	ENVULT MIN	1.00000	-877.43630	-693.38623	-830.76991
3	ENVULT MAX	0.00000	205.64036	0.00000	797.71895
3	ENVULT MAX	0.25000	205.64036	0.00000	829.94517
3	ENVULT MAX	0.50000	205.64036	0.00000	862.74004
3	ENVULT MAX	0.75000	205.64036	0.00000	896.10354
3	ENVULT MAX	1.00000	205.64036	0.00000	930.03569
3	ENVULT MIN	0.00000	-877.43630	-561.89482	-830.76993
3	ENVULT MIN	0.25000	-877.43630	-553.49062	-763.42853
3	ENVULT MIN	0.50000	-877.43630	-545.08642	-697.10194
3	ENVULT MIN	0.75000	-877.43630	-536.68222	-631.79016
3	ENVULT MIN	1.00000	-877.43630	-528.27802	-567.49318
4	ENVULT MAX	0.00000	205.64036	0.00000	930.03569
4	ENVULT MAX	0.25000	205.64036	0.00000	951.37675
4	ENVULT MAX	0.50000	205.64036	0.00000	972.89499
4	ENVULT MAX	0.75000	205.64036	0.00000	994.59043
4	ENVULT MAX	1.00000	205.64036	0.00000	1016.46300
4	ENVULT MIN	0.00000	-877.43631	-528.27802	-567.49317
4	ENVULT MIN	0.25000	-877.43631	-522.49552	-528.08916
4	ENVULT MIN	0.50000	-877.43631	-516.71302	-489.11884
4	ENVULT MIN	0.75000	-877.43631	-510.93052	-450.58221
4	ENVULT MIN	1.00000	-877.43631	-512.39296	-412.84512
5	ENVULT MAX	0.00000	205.64036	0.00000	1016.46300
5	ENVULT MAX	0.25000	205.64036	0.00000	1037.27700
5	ENVULT MAX	0.50000	205.64036	0.00000	1058.28700
5	ENVULT MAX	0.75000	205.64036	0.00000	1082.37800
5	ENVULT MAX	1.00000	205.64036	0.00000	1108.40300
5	ENVULT MIN	0.00000	-877.43631	-512.39296	-412.84512
5	ENVULT MIN	0.25000	-877.43631	-515.15221	-389.78626
5	ENVULT MIN	0.50000	-877.43631	-517.91146	-366.58099
5	ENVULT MIN	0.75000	-877.43631	-520.67071	-343.22930
5	ENVULT MIN	1.00000	-877.43631	-523.42996	-319.73121
6	ENVULT MAX	0.00000	205.64036	0.00000	1108.40300
6	ENVULT MAX	0.25000	205.64036	0.00000	1142.43600
6	ENVULT MAX	0.50000	205.64036	0.00000	1179.24400
6	ENVULT MAX	0.75000	205.64036	0.00000	1218.82800
6	ENVULT MAX	1.00000	205.64036	0.00000	1261.18600
6	ENVULT MIN	0.00000	-877.43632	-400.56650	-319.73121
6	ENVULT MIN	0.25000	-877.43632	-382.00070	-260.53139
6	ENVULT MIN	0.50000	-877.43632	-363.43490	-199.25028
6	ENVULT MIN	0.75000	-877.43632	-356.10975	-135.88787
6	ENVULT MIN	1.00000	-877.43632	-366.51300	-70.44415
7	ENVULT MAX	0.00000	205.64036	71.55720	1261.18600
7	ENVULT MAX	0.25000	205.64036	61.15395	1249.05300
7	ENVULT MAX	0.50000	205.64036	50.75070	1239.69400
7	ENVULT MAX	0.75000	205.64036	40.34745	1233.11100
7	ENVULT MAX	1.00000	205.64036	29.94420	1229.30200
7	ENVULT MIN	0.00000	-877.43633	-247.86226	-70.44415
7	ENVULT MIN	0.25000	-877.43633	-229.29646	-33.34587
7	ENVULT MIN	0.50000	-877.43633	-210.73066	0.00000
7	ENVULT MIN	0.75000	-877.43633	-203.01955	0.00000
7	ENVULT MIN	1.00000	-877.43633	-213.42280	0.00000
8	ENVULT MAX	0.00000	205.64036	207.90068	1229.30200
8	ENVULT MAX	0.25000	205.64036	197.50718	1175.97600
8	ENVULT MAX	0.50000	205.64036	187.11368	1125.41900
8	ENVULT MAX	0.75000	205.64036	176.72018	1077.63200
8	ENVULT MAX	1.00000	205.64036	166.32668	1032.61500
8	ENVULT MIN	0.00000	-877.43634	-99.99601	0.00000
8	ENVULT MIN	0.25000	-877.43634	-81.44761	0.00000
8	ENVULT MIN	0.50000	-877.43634	-69.58733	0.00000
8	ENVULT MIN	0.75000	-877.43634	-77.38246	0.00000
8	ENVULT MIN	1.00000	-877.43634	-85.17758	0.00000
9	ENVULT MAX	0.00000	205.64036	354.79357	1032.61500
9	ENVULT MAX	0.25000	205.64036	344.39032	939.36184
9	ENVULT MAX	0.50000	205.64036	333.98707	848.88326
9	ENVULT MAX	0.75000	205.64036	323.58382	761.17974
9	ENVULT MAX	1.00000	205.64036	313.18057	676.25129
9	ENVULT MIN	0.00000	-877.43633	0.00000	0.00000
9	ENVULT MIN	0.25000	-877.43633	0.00000	0.00000
9	ENVULT MIN	0.50000	-877.43633	0.00000	0.00000
9	ENVULT MIN	0.75000	-877.43633	0.00000	0.00000
9	ENVULT MIN	1.00000	-877.43633	-4.58383	0.00000
10	ENVULT MAX	0.00000	205.64036	510.31036	676.25129
10	ENVULT MAX	0.25000	205.64036	499.90711	541.51353
10	ENVULT MAX	0.50000	205.64036	489.50386	420.33399
10	ENVULT MAX	0.75000	205.64036	479.10061	302.16367
10	ENVULT MAX	1.00000	205.64036	468.69736	198.97058
10	ENVULT MIN	0.00000	-877.43632	0.00000	0.00000
10	ENVULT MIN	0.25000	-877.43632	0.00000	0.00000
10	ENVULT MIN	0.50000	-877.43632	0.00000	0.00000
10	ENVULT MIN	0.75000	-877.43632	0.00000	0.00000
10	ENVULT MIN	1.00000	-877.43632	0.00000	-58.04642
11	ENVULT MAX	0.00000	205.64036	681.54899	198.97056
11	ENVULT MAX	0.25000	205.64036	671.15549	74.15434
11	ENVULT MAX	0.50000	205.64036	660.76199	13.52206
11	ENVULT MAX	0.75000	205.64036	650.36849	0.00000
11	ENVULT MAX	1.00000	205.64036	639.97499	0.00000
11	ENVULT MIN	0.00000	-877.43629	0.00000	-58.04474
11	ENVULT MIN	0.25000	-877.43629	0.00000	-182.58909
11	ENVULT MIN	0.50000	-877.43629	0.00000	-309.96271
11	ENVULT MIN	0.75000	-877.43629	0.00000	-449.21653
11	ENVULT MIN	1.00000	-877.43629	0.00000	-611.75172
12	ENVULT MAX	0.00000	205.64036	875.12245	0.00000
12	ENVULT MAX	0.25000	205.64036	873.49420	0.00000
12	ENVULT MAX	0.50000	205.64036	871.86595	0.00000
12	ENVULT MAX	0.75000	205.64036	870.23770	0.00000
12	ENVULT MAX	1.00000	205.64036	868.60945	0.00000
12	ENVULT MIN	0.00000	-877.43628	0.00000	-611.75172
12	ENVULT MIN	0.25000	-877.43628	0.00000	-647.23664
12	ENVULT MIN	0.50000	-877.43628	0.00000	-682.65359
12	ENVULT MIN	0.75000	-877.43628	0.00000	-718.00255
12	ENVULT MIN	1.00000	-877.43628	0.00000	-753.28354
13	ENVULT MAX	0.00000	205.64036	868.60945	0.00000
13	ENVULT MAX	0.25000	205.64036	865.68445	0.00000
13	ENVULT MAX	0.50000	205.64036	862.75945	0.00000
13	ENVULT MAX	0.75000	205.64036	859.83445	0.00000
13	ENVULT MAX	1.00000	205.64036	856.90945	0.00000
13	ENVULT MIN	0.00000	-877.43628	0.00000	-753.28354
13	ENVULT MIN	0.25000	-877.43628	0.00000	-816.49181
13	ENVULT MIN	0.50000	-877.43628	0.00000	-879.48070
13	ENVULT MIN	0.75000	-877.43628	0.00000	-942.25022
13	ENVULT MIN	1.00000	-877.43628	0.00000	-1004.80000
14	ENVULT MAX	0.00000	205.64036	856.90945	0.00000
14	ENVULT MAX	0.25000	205.64036	853.49695	0.00000
14	ENVULT MAX	0.50000	205.64036	850.08445	0.00000
14	ENVULT MAX	0.75000	205.64036	846.67195	0.00000
14	ENVULT MAX	1.00000	205.64036	843.25945	0.00000
14	ENVULT MIN	0.00000	-877.43627	0.00000	-1004.80000
14	ENVULT MIN	0.25000	-877.43627	0.00000	-1077.49800
14	ENVULT MIN	0.50000	-877.43627	0.00000	-1150.62200
14	ENVULT MIN	0.75000	-877.43627	0.00000	-1224.85600
14	ENVULT MIN	1.00000	-877.43627	0.00000	-1298.79000
15	ENVULT MAX	0.00000	205.64036	843.25945	0.00000
15	ENVULT MAX	0.25000	205.64036	840.82195	0.00000
15	ENVULT MAX	0.50000	205.64036	838.38445	0.00000
15	ENVULT MAX	0.75000	205.64036	835.94695	0.00000
15	ENVULT MAX	1.00000	205.64036	833.50945	0.00000
15	ENVULT MIN	0.00000	-877.43627	0.00000	-1298.79000
15	ENVULT MIN	0.25000	-877.43627	0.00000	-1351.41800
15	ENVULT MIN	0.50000	-877.43627	0.00000	-1403.89300
15	ENVULT MIN	0.75000	-877.43627	0.00000	-1456.21600
15	ENVULT MIN	1.00000	-877.43627	0.00000	-1508.38600
16	ENVULT MAX	0.00000	130.98826	0.00000	0.00000
16	ENVULT MAX	0.25000	130.98826	0.00000	0.00000
16	ENVULT MAX	0.50000	130.98826	0.00000	0.00000
16	ENVULT MAX	0.75000	130.98826	0.00000	0.00000
16	ENVULT MAX	1.00000	130.98826	0.00000	0.00000
16	ENVULT MIN	0.00000	-820.80511	-834.44739	-1513.43900
16	ENVULT MIN	0.25000	-820.80511	-836.88489	-1461.21000
16	ENVULT MIN	0.50000	-820.80511	-839.32239	-1408.82900
16	ENVULT MIN	0.75000	-820.80511	-841.75989	-1356.29500
16	ENVULT MIN	1.00000	-820.80511	-844.19739	-1303.60900
17	ENVULT MAX	0.00000	130.98826	0.00000	0.00000
17	ENVULT MAX	0.25000	130.98826	0.00000	0.00000
17	ENVULT MAX	0.50000	130.98826	0.00000	0.00000
17	ENVULT MAX	0.75000	130.98826	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVULT MAX	1.00000	130.98826	0.00000	0.00000
17	ENVULT MIN	0.00000	-820.80511	-844.19739	-1303.60900
17	ENVULT MIN	0.25000	-820.80511	-847.60989	-1229.59200
17	ENVULT MIN	0.50000	-820.80511	-851.02239	-1155.27700
17	ENVULT MIN	0.75000	-820.80511	-854.43489	-1080.66300
17	ENVULT MIN	1.00000	-820.80511	-857.84739	-1007.04600
18	ENVULT MAX	0.00000	130.98826	0.00000	0.00000
18	ENVULT MAX	0.25000	130.98826	0.00000	0.00000
18	ENVULT MAX	0.50000	130.98826	0.00000	0.00000
18	ENVULT MAX	0.75000	130.98826	0.00000	0.00000
18	ENVULT MAX	1.00000	130.98826	0.00000	0.00000
18	ENVULT MIN	0.00000	-820.80511	-857.84739	-1007.04600
18	ENVULT MIN	0.25000	-820.80511	-860.77239	-944.46021
18	ENVULT MIN	0.50000	-820.80511	-863.69739	-881.65552
18	ENVULT MIN	0.75000	-820.80511	-866.62239	-818.63145
18	ENVULT MIN	1.00000	-820.80511	-869.54739	-755.38801
19	ENVULT MAX	0.00000	130.98826	0.00000	0.00000
19	ENVULT MAX	0.25000	130.98826	0.00000	0.00000
19	ENVULT MAX	0.50000	130.98826	0.00000	0.00000
19	ENVULT MAX	0.75000	130.98826	0.00000	0.00000
19	ENVULT MAX	1.00000	130.98826	0.00000	0.00000
19	ENVULT MIN	0.00000	-820.80511	-869.54739	-755.38801
19	ENVULT MIN	0.25000	-820.80511	-871.17564	-720.08745
19	ENVULT MIN	0.50000	-820.80511	-872.80389	-684.71890
19	ENVULT MIN	0.75000	-820.80511	-874.43214	-649.28238
19	ENVULT MIN	1.00000	-820.80511	-876.06039	-613.77788
20	ENVULT MAX	0.00000	130.98826	0.00000	0.00000
20	ENVULT MAX	0.25000	130.98826	0.00000	0.00000
20	ENVULT MAX	0.50000	130.98826	0.00000	13.52206
20	ENVULT MAX	0.75000	130.98826	0.00000	72.35813
20	ENVULT MAX	1.00000	130.98826	0.00000	197.19689
20	ENVULT MIN	0.00000	-820.80512	-640.15887	-613.77788
20	ENVULT MIN	0.25000	-820.80512	-650.55237	-448.56697
20	ENVULT MIN	0.50000	-820.80512	-660.94587	-308.30187
20	ENVULT MIN	0.75000	-820.80512	-671.33937	-179.30857
20	ENVULT MIN	1.00000	-820.80512	-681.73287	-54.93692
21	ENVULT MAX	0.00000	130.98826	0.00000	197.19689
21	ENVULT MAX	0.25000	130.98826	0.00000	298.81225
21	ENVULT MAX	0.50000	130.98826	0.00000	416.87051
21	ENVULT MAX	0.75000	130.98826	0.00000	537.70384
21	ENVULT MAX	1.00000	130.98826	0.00000	671.86137
21	ENVULT MIN	0.00000	-820.80514	-468.19725	-54.93747
21	ENVULT MIN	0.25000	-820.80514	-478.60050	0.00000
21	ENVULT MIN	0.50000	-820.80514	-489.00375	0.00000
21	ENVULT MIN	0.75000	-820.80514	-499.40700	0.00000
21	ENVULT MIN	1.00000	-820.80514	-509.81025	0.00000
22	ENVULT MAX	0.00000	130.98826	3.91773	671.86137
22	ENVULT MAX	0.25000	130.98826	0.00000	756.50321
22	ENVULT MAX	0.50000	130.98826	0.00000	843.92012
22	ENVULT MAX	0.75000	130.98826	0.00000	934.11209
22	ENVULT MAX	1.00000	130.98826	0.00000	1027.07900
22	ENVULT MIN	0.00000	-820.80518	-312.10611	0.00000
22	ENVULT MIN	0.25000	-820.80518	-322.50936	0.00000
22	ENVULT MIN	0.50000	-820.80518	-332.91261	0.00000
22	ENVULT MIN	0.75000	-820.80518	-343.31586	0.00000
22	ENVULT MIN	1.00000	-820.80518	-353.71911	0.00000
23	ENVULT MAX	0.00000	130.98826	84.25154	1027.07900
23	ENVULT MAX	0.25000	130.98826	76.45641	1071.69800
23	ENVULT MAX	0.50000	130.98826	68.66129	1119.08700
23	ENVULT MAX	0.75000	130.98826	80.28258	1169.24500
23	ENVULT MAX	1.00000	130.98826	98.83098	1222.17400
23	ENVULT MIN	0.00000	-820.80519	-164.59390	0.00000
23	ENVULT MIN	0.25000	-820.80519	-174.98740	0.00000
23	ENVULT MIN	0.50000	-820.80519	-185.38090	0.00000
23	ENVULT MIN	0.75000	-820.80519	-195.77440	0.00000
23	ENVULT MIN	1.00000	-820.80519	-206.16790	0.00000
24	ENVULT MAX	0.00000	130.98826	211.45030	1222.17400
24	ENVULT MAX	0.25000	130.98826	201.04705	1225.52800
24	ENVULT MAX	0.50000	130.98826	209.40446	1231.65800
24	ENVULT MAX	0.75000	130.98826	227.97026	1240.56300
24	ENVULT MAX	1.00000	130.98826	246.53606	1252.24300
24	ENVULT MIN	0.00000	-820.80518	-27.97170	0.00000
24	ENVULT MIN	0.25000	-820.80518	-38.37495	0.00000
24	ENVULT MIN	0.50000	-820.80518	-48.77820	0.00000
24	ENVULT MIN	0.75000	-820.80518	-59.18145	-28.08296
24	ENVULT MIN	1.00000	-820.80518	-69.58470	-64.90005
25	ENVULT MAX	0.00000	130.98826	364.63490	1252.24300
25	ENVULT MAX	0.25000	130.98826	354.23165	1209.45300
25	ENVULT MAX	0.50000	130.98826	362.17216	1169.43700
25	ENVULT MAX	0.75000	130.98826	380.73796	1132.19700
25	ENVULT MAX	1.00000	130.98826	399.30376	1097.73200
25	ENVULT MIN	0.00000	-820.80513	0.00000	-64.90005
25	ENVULT MIN	0.25000	-820.80513	0.00000	-130.07602
25	ENVULT MIN	0.50000	-820.80513	0.00000	-193.17070
25	ENVULT MIN	0.75000	-820.80513	0.00000	-254.18407
25	ENVULT MIN	1.00000	-820.80513	0.00000	-313.11615
26	ENVULT MAX	0.00000	130.98826	522.09061	1097.73200
26	ENVULT MAX	0.25000	130.98826	519.33136	1071.62500
26	ENVULT MAX	0.75000	130.98826	513.81286	1024.61500
26	ENVULT MAX	1.00000	130.98826	511.05361	1003.70600
26	ENVULT MIN	0.00000	-820.80511	0.00000	-313.11616
26	ENVULT MIN	0.25000	-820.80511	0.00000	-336.56362
26	ENVULT MIN	0.50000	-820.80511	0.00000	-359.86466
26	ENVULT MIN	0.75000	-820.80511	0.00000	-383.01929
26	ENVULT MIN	1.00000	-820.80511	0.00000	-406.02751
27	ENVULT MAX	0.00000	130.98826	511.05361	1003.70600
27	ENVULT MAX	0.25000	130.98826	510.03003	981.73313
27	ENVULT MAX	0.50000	130.98826	515.81253	959.93724
27	ENVULT MAX	0.75000	130.98826	521.59503	938.31855
27	ENVULT MAX	1.00000	130.98826	527.37753	916.87704
27	ENVULT MIN	0.00000	-820.80510	0.00000	-406.02751
27	ENVULT MIN	0.25000	-820.80510	0.00000	-441.93766
27	ENVULT MIN	0.50000	-820.80510	0.00000	-480.40675
27	ENVULT MIN	0.75000	-820.80510	0.00000	-519.30954
27	ENVULT MIN	1.00000	-820.80510	0.00000	-558.64601
28	ENVULT MAX	0.00000	130.98826	527.37754	916.87704
28	ENVULT MAX	0.25000	130.98826	535.78174	882.78317
28	ENVULT MAX	0.50000	130.98826	544.18594	849.25794
28	ENVULT MAX	0.75000	130.98826	552.59014	816.30135
28	ENVULT MAX	1.00000	130.98826	560.99434	783.91340
28	ENVULT MIN	0.00000	-820.80508	0.00000	-558.64600
28	ENVULT MIN	0.25000	-820.80508	0.00000	-622.83424
28	ENVULT MIN	0.50000	-820.80508	0.00000	-688.03729
28	ENVULT MIN	0.75000	-820.80508	0.00000	-754.25515
28	ENVULT MIN	1.00000	-820.80508	0.00000	-821.48781
29	ENVULT MAX	0.00000	130.98826	693.35806	783.91340
29	ENVULT MAX	0.25000	130.98826	687.34231	702.54860
29	ENVULT MAX	0.50000	130.98826	681.32656	622.11173
29	ENVULT MAX	0.75000	130.98826	688.11252	542.60278
29	ENVULT MAX	1.00000	130.98826	698.84832	464.02177
29	ENVULT MIN	0.00000	-820.80507	0.00000	-821.48778
29	ENVULT MIN	0.25000	-820.80507	0.00000	-922.57255
29	ENVULT MIN	0.50000	-820.80507	0.00000	-1025.31300
29	ENVULT MIN	0.75000	-820.80507	0.00000	-1129.71000
29	ENVULT MIN	1.00000	-820.80507	0.00000	-1235.76300
30	ENVULT MAX	0.00000	130.98826	698.84833	464.02177
30	ENVULT MAX	0.18056	130.98826	704.50333	423.00295
30	ENVULT MAX	0.36111	130.98826	710.15833	382.24158
30	ENVULT MAX	0.54167	130.98826	715.81333	341.73768
30	ENVULT MAX	0.72222	130.98826	721.46833	301.49124
30	ENVULT MIN	0.00000	-820.80507	0.00000	-1235.76300
30	ENVULT MIN	0.18056	-820.80507	0.00000	-1292.29100
30	ENVULT MIN	0.36111	-820.80507	0.00000	-1349.27900
30	ENVULT MIN	0.54167	-820.80507	0.00000	-1406.72600
30	ENVULT MIN	0.72222	-820.80507	0.00000	-1464.63300
31	ENVULT MAX	0.65385	0.00000	130.98826	185.95734
31	ENVULT MAX	0.74038	0.00000	130.98826	180.11707
31	ENVULT MAX	0.82692	0.00000	130.98826	174.27680
31	ENVULT MAX	0.91346	0.00000	130.98826	168.43653
31	ENVULT MAX	1.00000	0.00000	130.98826	162.59626
31	ENVULT MIN	0.65385	-892.60399	-723.09766	-1226.69200
31	ENVULT MIN	0.74038	-891.08524	-710.49063	-1186.37200
31	ENVULT MIN	0.82692	-889.56649	-697.95954	-1146.76000
31	ENVULT MIN	0.91346	-888.04774	-685.50438	-1107.85100
31	ENVULT MIN	1.00000	-886.52899	-673.12516	-1069.64000
32	ENVULT MAX	0.00000	0.00000	130.98826	162.59626
32	ENVULT MAX	0.25000	0.00000	130.98826	153.27778
32	ENVULT MAX	0.50000	0.00000	130.98826	143.95930
32	ENVULT MAX	0.75000	0.00000	130.98826	134.64083
32	ENVULT MAX	1.00000	0.00000	130.98826	125.32235
32	ENVULT MIN	0.00000	-886.52899	-673.12512	-1069.64000
32	ENVULT MIN	0.25000	-884.10574	-653.53073	-1015.93000
32	ENVULT MIN	0.50000	-881.68249	-634.12989	-971.04503
32	ENVULT MIN	0.75000	-879.25924	-614.92258	-927.34735
32	ENVULT MIN	1.00000	-876.83599	-595.90881	-884.82574
33	ENVULT MAX	0.00000	0.00000	130.98826	125.32235
33	ENVULT MAX	0.25000	0.00000	130.98826	99.10603
33	ENVULT MAX	0.50000	0.00000	130.98826	72.88971
33	ENVULT MAX	0.75000	0.00000	130.98826	85.50817
33	ENVULT MAX	1.00000	0.00000	130.98826	109.63252
33	ENVULT MIN	0.00000	-876.83599	-595.90877	-884.82574
33	ENVULT MIN	0.25000	-870.01849	-543.45285	-771.41071
33	ENVULT MIN	0.50000	-863.20099	-492.52618	-666.97266
33	ENVULT MIN	0.75000	-856.38349	-443.12875	-571.26708
33	ENVULT MIN	1.00000	-849.56599	-395.26055	-484.04944
34	ENVULT MAX	0.00000	0.00000	130.98826	109.63249
34	ENVULT MAX	0.25000	0.00000	130.98826	136.64019
34	ENVULT MAX	0.50000	0.00000	130.98826	184.22724
34	ENVULT MAX	0.75000	0.00000	130.98826	221.58024
34	ENVULT MAX	1.00000	0.00000	130.98826	249.08452
34	ENVULT MIN	0.00000	-849.56599	-395.26067	-484.04944
34	ENVULT MIN	0.25000	-842.75524	-348.96755	-412.24518
34	ENVULT MIN	0.50000	-835.94449	-304.20205	-375.94515
34	ENVULT MIN	0.75000	-829.13374	-260.96418	-348.48287
34	ENVULT MIN	1.00000	-822.32299	-219.25394	-353.90955
35	ENVULT MAX	0.00000	0.00000	130.98826	249.08429

26	ENVULT MAX	0.50000	130.98826	516.57211	1045.72000
FRAME	LOAD	DIST	P	V2	M3
35	ENVULT MAX	0.50000	0.00000	130.98826	276.72863
35	ENVULT MAX	0.75000	0.00000	130.98826	277.31911
35	ENVULT MAX	1.00000	0.00000	130.98826	269.79094
35	ENVULT MIN	0.00000	-822.32299	-219.25389	-353.90955
35	ENVULT MIN	0.25000	-815.51224	-179.07127	-359.76893
35	ENVULT MIN	0.50000	-808.70149	-150.65762	-366.06098
35	ENVULT MIN	0.75000	-801.89074	-124.33190	-372.78572
35	ENVULT MIN	1.00000	-795.07999	-98.97381	-379.94315
36	ENVULT MAX	0.00000	0.00000	130.98826	269.79098
36	ENVULT MAX	0.25000	0.00000	130.98826	264.09856
36	ENVULT MAX	0.50000	0.00000	143.79278	256.72195
36	ENVULT MAX	0.75000	0.00000	159.37355	242.17990
36	ENVULT MAX	1.00000	0.00000	173.93482	220.85854
36	ENVULT MIN	0.00000	-795.07999	-98.97381	-379.94315
36	ENVULT MIN	0.25000	-788.26249	-74.55913	-387.54100
36	ENVULT MIN	0.50000	-781.44499	-51.11294	-405.22272
36	ENVULT MIN	0.75000	-774.62749	-28.63524	-437.11442
36	ENVULT MIN	1.00000	-767.80999	-26.02931	-469.51616
37	ENVULT MAX	0.00000	0.00000	173.93472	220.85856
37	ENVULT MAX	0.25000	0.00000	198.08293	193.17456
37	ENVULT MAX	0.50000	0.00000	223.10391	159.49539
37	ENVULT MAX	0.75000	0.00000	246.59726	120.20640
37	ENVULT MAX	1.00000	0.00000	268.56299	75.69291
37	ENVULT MIN	0.00000	-767.80999	-26.02931	-469.51616
37	ENVULT MIN	0.25000	-760.99924	-26.02931	-502.39512
37	ENVULT MIN	0.50000	-754.18849	-26.02931	-535.78312
37	ENVULT MIN	0.75000	-747.37774	-26.02931	-569.68016
37	ENVULT MIN	1.00000	-740.56699	-26.02931	-604.08623
38	ENVULT MAX	0.00000	0.00000	268.56300	75.69288
38	ENVULT MAX	0.25000	0.00000	289.02130	47.85161
38	ENVULT MAX	0.50000	0.00000	307.95037	22.64462
38	ENVULT MAX	0.75000	0.00000	325.35020	0.00000
38	ENVULT MAX	1.00000	0.00000	341.22078	0.00000
38	ENVULT MIN	0.00000	-740.56699	-26.02931	-604.08623
38	ENVULT MIN	0.25000	-733.74949	-26.02931	-639.03621
38	ENVULT MIN	0.50000	-726.93199	-26.02931	-674.49623
38	ENVULT MIN	0.75000	-720.11449	-26.02931	-710.46631
38	ENVULT MIN	1.00000	-713.29699	-26.02931	-746.94643
39	ENVULT MAX	0.00000	0.00000	341.22078	0.00000
39	ENVULT MAX	0.25000	0.00000	342.10058	0.00000
39	ENVULT MAX	0.50000	0.00000	342.97512	0.00000
39	ENVULT MAX	0.75000	0.00000	343.84441	0.00000
39	ENVULT MAX	1.00000	0.00000	344.70843	0.00000
39	ENVULT MIN	0.00000	-713.29699	-26.02931	-746.94643
39	ENVULT MIN	0.25000	-712.89874	-26.02931	-749.09322
39	ENVULT MIN	0.50000	-712.50049	-26.02931	-751.24174
39	ENVULT MIN	0.75000	-712.10224	-26.02931	-753.39201
39	ENVULT MIN	1.00000	-711.70399	-26.02931	-755.54402
40	ENVULT MAX	0.00000	0.00000	344.70845	0.00000
40	ENVULT MAX	0.22500	0.00000	351.12657	0.00000
40	ENVULT MAX	0.45000	0.00000	357.24095	0.00000
40	ENVULT MAX	0.67500	0.00000	363.05157	0.00000
40	ENVULT MAX	0.90000	0.00000	368.55845	0.00000
40	ENVULT MIN	0.00000	-711.70399	-26.02931	-755.54402
40	ENVULT MIN	0.22500	-708.45556	-26.02931	-772.01489
40	ENVULT MIN	0.45000	-704.78524	-26.02931	-788.58701
40	ENVULT MIN	0.67500	-700.69306	-26.02931	-805.26038
40	ENVULT MIN	0.90000	-696.17899	-26.02931	-822.03500
41	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
41	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
41	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
41	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
41	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
42	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
42	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
42	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
42	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.10000	26.02931	0.00000	48.97013
43	ENVULT MAX	0.32500	26.02931	0.00000	59.09626
43	ENVULT MAX	0.55000	26.02931	0.00000	86.78889
43	ENVULT MAX	0.77500	26.02931	0.00000	139.27442
43	ENVULT MAX	1.00000	26.02931	0.00000	189.83055
43	ENVULT MIN	0.10000	-389.40735	-593.33049	-644.54547
43	ENVULT MIN	0.32500	-389.40735	-575.12552	-583.20957
43	ENVULT MIN	0.55000	-389.40735	-557.34242	-523.72030
43	ENVULT MIN	0.77500	-389.40735	-539.98119	-476.53998

35	ENVULT MAX	0.25000	0.00000	130.98826	267.44548
FRAME	LOAD	DIST	P	V2	M3
44	ENVULT MAX	0.25000	26.02931	0.00000	202.66483
44	ENVULT MAX	0.50000	26.02931	0.00000	215.37188
44	ENVULT MAX	0.75000	26.02931	0.00000	227.95171
44	ENVULT MAX	1.00000	26.02931	0.00000	240.40433
44	ENVULT MIN	0.00000	-389.40735	-523.04184	-431.32763
44	ENVULT MIN	0.25000	-389.40735	-518.69246	-419.79724
44	ENVULT MIN	0.50000	-389.40735	-514.34307	-408.35879
44	ENVULT MIN	0.75000	-389.40735	-509.99368	-397.01228
44	ENVULT MIN	1.00000	-389.40735	-505.64429	-385.75770
45	ENVULT MAX	0.00000	26.02931	0.00000	240.40433
45	ENVULT MAX	0.25000	26.02931	0.00000	348.00153
45	ENVULT MAX	0.50000	26.02931	0.00000	445.03794
45	ENVULT MAX	0.75000	26.02931	0.00000	531.51355
45	ENVULT MAX	1.00000	26.02931	0.00000	607.42837
45	ENVULT MIN	0.00000	-389.40735	-505.64429	-385.75771
45	ENVULT MIN	0.25000	-389.40735	-466.01654	-306.59409
45	ENVULT MIN	0.50000	-389.40735	-426.38879	-241.00752
45	ENVULT MIN	0.75000	-389.40735	-386.76104	-180.15582
45	ENVULT MIN	1.00000	-389.40735	-347.13329	-124.03900
46	ENVULT MAX	0.00000	26.02931	0.00000	607.42837
46	ENVULT MAX	0.25000	26.02931	0.00000	672.83874
46	ENVULT MAX	0.50000	26.02931	0.00000	727.66850
46	ENVULT MAX	0.75000	26.02931	0.00000	771.91763
46	ENVULT MAX	1.00000	26.02931	5.01432	805.58615
46	ENVULT MIN	0.00000	-389.40735	-347.13329	-124.03900
46	ENVULT MIN	0.25000	-389.40735	-307.46837	-72.61108
46	ENVULT MIN	0.50000	-389.40735	-267.80344	-25.92692
46	ENVULT MIN	0.75000	-389.40735	-228.13852	0.00000
46	ENVULT MIN	1.00000	-389.40735	-190.64420	0.00000
47	ENVULT MAX	0.00000	26.02931	4.82251	805.58615
47	ENVULT MAX	0.25000	26.02931	12.02476	828.67405
47	ENVULT MAX	0.50000	26.02931	19.22701	841.18132
47	ENVULT MAX	0.75000	26.02931	30.20025	843.10798
47	ENVULT MAX	1.00000	26.02931	62.60958	834.45402
47	ENVULT MIN	0.00000	-389.40735	-190.64420	0.00000
47	ENVULT MIN	0.25000	-389.40735	-154.72445	0.00000
47	ENVULT MIN	0.50000	-389.40735	-118.80469	0.00000
47	ENVULT MIN	0.75000	-389.40735	-82.88494	0.00000
47	ENVULT MIN	1.00000	-389.40735	-59.41780	0.00000
48	ENVULT MAX	0.00000	26.02931	62.60958	834.45402
48	ENVULT MAX	0.25000	26.02931	95.93959	815.24243
48	ENVULT MAX	0.50000	26.02931	135.56734	785.47003
48	ENVULT MAX	0.75000	26.02931	175.19509	745.13685
48	ENVULT MAX	1.00000	26.02931	214.82284	694.24286
48	ENVULT MIN	0.00000	-389.40735	-59.41780	0.00000
48	ENVULT MIN	0.25000	-389.40735	-41.65091	0.00000
48	ENVULT MIN	0.50000	-389.40735	-23.88402	0.00000
48	ENVULT MIN	0.75000	-389.40735	-6.11713	0.00000
48	ENVULT MIN	1.00000	-389.40735	0.00000	0.00000
49	ENVULT MAX	0.00000	26.02931	214.82284	694.24286
49	ENVULT MAX	0.25000	26.02931	254.48776	632.72548
49	ENVULT MAX	0.50000	26.02931	294.15269	560.62747
49	ENVULT MAX	0.75000	26.02931	333.81761	477.94884
49	ENVULT MAX	1.00000	26.02931	373.48254	391.47102
49	ENVULT MIN	0.00000	-389.40735	0.00000	0.00000
49	ENVULT MIN	0.25000	-389.40735	0.00000	0.00000
49	ENVULT MIN	0.50000	-389.40735	0.00000	0.00000
49	ENVULT MIN	0.75000	-389.40735	0.00000	0.00000
49	ENVULT MIN	1.00000	-389.40735	0.00000	-22.46426
50	ENVULT MAX	0.00000	26.02931	373.48254	391.47102
50	ENVULT MAX	0.25000	26.02931	413.14746	303.41485
50	ENVULT MAX	0.50000	26.02931	452.81239	204.77806
50	ENVULT MAX	0.75000	26.02931	492.47731	107.52932
50	ENVULT MAX	1.00000	26.02931	532.14223	5.95372
50	ENVULT MIN	0.00000	-389.40735	0.00000	-22.46426
50	ENVULT MIN	0.25000	-389.40735	0.00000	-47.75846
50	ENVULT MIN	0.50000	-389.40735	0.00000	-74.97387
50	ENVULT MIN	0.75000	-389.40735	0.00000	-126.88878
50	ENVULT MIN	1.00000	-389.40735	0.00000	-238.70962
51	ENVULT MAX	0.00000	26.02931	532.14223	5.95372
51	ENVULT MAX	0.25000	26.02931	571.76999	0.00000
51	ENVULT MAX	0.50000	26.02931	611.39774	0.00000
51	ENVULT MAX	0.75000	26.02931	651.02549	0.00000
51	ENVULT MAX	1.00000	26.02931	690.65324	0.00000
51	ENVULT MIN	0.00000	-389.40735	0.00000	-238.70962
51	ENVULT MIN	0.25000	-389.40735	0.00000	-359.05870
51	ENVULT MIN	0.50000	-389.40735	0.00000	-490.56885
51	ENVULT MIN	0.75000	-389.40735	0.00000	-647.23839
51	ENVULT MIN	1.00000	-389.40735	0.00000	-825.77772
52	ENVULT MAX	0.00000	26.02931	690.65324	0.00000
52	ENVULT MAX	0.25000	26.02931	702.43747	0.00000
52	ENVULT MAX	0.50000	26.02931	714.22171	0.00000
52	ENVULT MAX	0.75000	26.02931	726.00595	0.00000
52	ENVULT MAX	1.00000	26.02931	737.79019	0.00000
52	ENVULT MIN	0.00000	-389.40735	0.00000	-825.77772
52	ENVULT MIN	0.25000	-389.40735	0.00000	-880.90776
52	ENVULT MIN	0.50000	-389.40735	0.00000	-936.97171

43	ENVULT MIN	1.00000	-389.40735	-523.04184	-431.32763
44	ENVULT MAX	0.00000	26.02931	0.00000	189.83055
FRAME	LOAD	DIST	P	V2	M3
53	ENVULT MAX	0.00000	26.02931	737.79019	0.00000
53	ENVULT MAX	0.22500	26.02931	754.51860	0.00000
53	ENVULT MAX	0.45000	26.02931	771.24701	0.00000
53	ENVULT MAX	0.67500	26.02931	787.97542	0.00000
53	ENVULT MAX	0.90000	26.02931	804.70384	0.00000
53	ENVULT MIN	0.00000	-389.40735	0.00000	-1051.90100
53	ENVULT MIN	0.22500	-389.40735	0.00000	-1135.74300
53	ENVULT MIN	0.45000	-389.40735	0.00000	-1221.46600
53	ENVULT MIN	0.67500	-389.40735	0.00000	-1309.07100
53	ENVULT MIN	0.90000	-389.40735	0.00000	-1398.55800
54	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
54	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
54	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
54	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
54	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
54	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
54	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
54	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
54	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
54	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
55	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
55	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
55	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
55	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
55	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
55	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
55	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
55	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
55	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
55	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
56	ENVULT MAX	0.10000	26.02931	0.00000	0.00000
56	ENVULT MAX	0.32500	26.02931	0.00000	0.00000
56	ENVULT MAX	0.55000	26.02931	0.00000	0.00000
56	ENVULT MAX	0.77500	26.02931	0.00000	0.00000
56	ENVULT MAX	1.00000	26.02931	0.00000	0.00000
56	ENVULT MIN	0.10000	-389.35846	-806.03317	-1399.52800
56	ENVULT MIN	0.32500	-389.35846	-789.30476	-1309.96600
56	ENVULT MIN	0.55000	-389.35846	-772.57634	-1222.28600
56	ENVULT MIN	0.77500	-389.35846	-755.84793	-1136.48800
56	ENVULT MIN	1.00000	-389.35846	-739.11952	-1052.57100
57	ENVULT MAX	0.00000	26.02931	0.00000	0.00000
57	ENVULT MAX	0.25000	26.02931	0.00000	0.00000
57	ENVULT MAX	0.50000	26.02931	0.00000	0.00000
57	ENVULT MAX	0.75000	26.02931	0.00000	0.00000
57	ENVULT MAX	1.00000	26.02931	0.00000	0.00000
57	ENVULT MIN	0.00000	-389.35846	-739.11952	-1052.57100
57	ENVULT MIN	0.25000	-389.35846	-727.33528	-994.58704
57	ENVULT MIN	0.50000	-389.35846	-715.55104	-937.53652
57	ENVULT MIN	0.75000	-389.35846	-703.76681	-881.41990
57	ENVULT MIN	1.00000	-389.35846	-691.98257	-826.23719
58	ENVULT MAX	0.00000	26.02931	0.00000	0.00000
58	ENVULT MAX	0.25000	26.02931	0.00000	0.00000
58	ENVULT MAX	0.50000	26.02931	0.00000	0.00000
58	ENVULT MAX	0.75000	26.02931	0.00000	0.00000
58	ENVULT MAX	1.00000	26.02931	0.00000	5.85680
58	ENVULT MIN	0.00000	-389.35845	-691.98257	-826.23719
58	ENVULT MIN	0.25000	-389.35845	-652.35482	-647.52072
58	ENVULT MIN	0.50000	-389.35845	-612.72707	-490.65721
58	ENVULT MIN	0.75000	-389.35845	-573.09932	-358.99827
58	ENVULT MIN	1.00000	-389.35845	-533.47157	-238.50040
59	ENVULT MAX	0.00000	26.02931	0.00000	5.85680
59	ENVULT MAX	0.25000	26.02931	0.00000	107.66574
59	ENVULT MAX	0.50000	26.02931	0.00000	204.97122
59	ENVULT MAX	0.75000	26.02931	0.00000	303.66473
59	ENVULT MAX	1.00000	26.02931	0.00000	391.77763
59	ENVULT MIN	0.00000	-389.35845	-533.47157	-238.50040
59	ENVULT MIN	0.25000	-389.35845	-493.80664	-126.53062
59	ENVULT MIN	0.50000	-389.35845	-454.14172	-74.97387
59	ENVULT MIN	0.75000	-389.35845	-414.47679	-47.75846
59	ENVULT MIN	1.00000	-389.35845	-374.81187	-22.46426
60	ENVULT MAX	0.00000	26.02931	0.00000	391.77763
60	ENVULT MAX	0.25000	26.02931	0.00000	480.58332
60	ENVULT MAX	0.50000	26.02931	0.00000	563.67327
60	ENVULT MAX	0.75000	26.02931	0.00000	636.18261
60	ENVULT MAX	1.00000	26.02931	0.00000	698.11133
60	ENVULT MIN	0.00000	-389.35845	-374.81187	-22.46426
60	ENVULT MIN	0.25000	-389.35845	-335.14694	0.00000
60	ENVULT MIN	0.50000	-389.35845	-295.48202	0.00000
60	ENVULT MIN	0.75000	-389.35845	-255.81709	0.00000
60	ENVULT MIN	1.00000	-389.35845	-216.15217	0.00000
61	ENVULT MAX	0.00000	26.02931	0.00000	698.11133
61	ENVULT MAX	0.25000	26.02931	6.94123	749.41625
61	ENVULT MAX	0.50000	26.02931	24.70812	790.16039
61	ENVULT MAX	0.75000	26.02931	42.47500	820.34372
61	ENVULT MAX	1.00000	26.02931	60.24189	839.96626
61	ENVULT MIN	0.00000	-389.35845	-216.15217	0.00000
52	ENVULT MIN	0.75000	-389.40735	0.00000	-993.96955
52	ENVULT MIN	1.00000	-389.40735	0.00000	-1051.90100
FRAME	LOAD	DIST	P	V2	M3
61	ENVULT MIN	1.00000	-389.35845	-63.16791	0.00000
62	ENVULT MAX	0.00000	26.02931	60.24188	839.96626
62	ENVULT MAX	0.25000	26.02931	83.49635	849.03155
62	ENVULT MAX	0.50000	26.02931	119.41611	847.51622
62	ENVULT MAX	0.75000	26.02931	155.33586	835.42027
62	ENVULT MAX	1.00000	26.02931	191.25562	812.74370
62	ENVULT MIN	0.00000	-389.35845	-63.16791	0.00000
62	ENVULT MIN	0.25000	-389.35845	-30.75858	0.00000
62	ENVULT MIN	0.50000	-389.35845	-19.22701	0.00000
62	ENVULT MIN	0.75000	-389.35845	-12.02476	0.00000
62	ENVULT MIN	1.00000	-389.35845	-4.82251	0.00000
63	ENVULT MAX	0.00000	26.02931	191.25563	812.74370
63	ENVULT MAX	0.25000	26.02931	229.25518	779.48652
63	ENVULT MAX	0.50000	26.02931	268.92011	735.64871
63	ENVULT MAX	0.75000	26.02931	308.58503	681.23029
63	ENVULT MAX	1.00000	26.02931	348.24995	616.23125
63	ENVULT MIN	0.00000	-389.35846	-5.01896	0.00000
63	ENVULT MIN	0.25000	-389.35846	0.00000	0.00000
63	ENVULT MIN	0.50000	-389.35846	0.00000	-30.19177
63	ENVULT MIN	0.75000	-389.35846	0.00000	-77.09576
63	ENVULT MIN	1.00000	-389.35846	0.00000	-128.74351
64	ENVULT MAX	0.00000	26.02931	348.24995	616.23125
64	ENVULT MAX	0.25000	26.02931	387.87771	540.72737
64	ENVULT MAX	0.50000	26.02931	427.50546	454.66270
64	ENVULT MAX	0.75000	26.02931	467.13321	358.03724
64	ENVULT MAX	1.00000	26.02931	506.76096	250.85098
64	ENVULT MIN	0.00000	-389.35846	0.00000	-128.74351
64	ENVULT MIN	0.25000	-389.35846	0.00000	-185.07995
64	ENVULT MIN	0.50000	-389.35846	0.00000	-246.15127
64	ENVULT MIN	0.75000	-389.35846	0.00000	-311.95746
64	ENVULT MIN	1.00000	-389.35846	0.00000	-392.78147
65	ENVULT MAX	0.00000	26.02931	506.76096	250.85098
65	ENVULT MAX	0.25000	26.02931	511.11034	238.44347
65	ENVULT MAX	0.50000	26.02931	515.45973	225.90873
65	ENVULT MAX	0.75000	26.02931	519.80912	213.24678
65	ENVULT MAX	1.00000	26.02931	524.15851	200.45761
65	ENVULT MIN	0.00000	-389.35846	0.00000	-392.78147
65	ENVULT MIN	0.25000	-389.35846	0.00000	-404.06637
65	ENVULT MIN	0.50000	-389.35846	0.00000	-415.44321
65	ENVULT MIN	0.75000	-389.35846	0.00000	-426.91199
65	ENVULT MIN	1.00000	-389.35846	0.00000	-438.47270
66	ENVULT MAX	0.00000	26.02931	524.15851	200.45761
66	ENVULT MAX	0.22500	26.02931	541.09786	150.07496
66	ENVULT MAX	0.45000	26.02931	558.45908	97.76290
66	ENVULT MAX	0.67500	26.02931	576.24218	59.09626
66	ENVULT MAX	0.90000	26.02931	594.44716	48.97013
66	ENVULT MIN	0.00000	-389.35846	0.00000	-438.47270
66	ENVULT MIN	0.22500	-389.35846	0.00000	-483.80168
66	ENVULT MIN	0.45000	-389.35846	0.00000	-530.53813
66	ENVULT MIN	0.67500	-389.35846	0.00000	-589.16710
66	ENVULT MIN	0.90000	-389.35846	0.00000	-650.59572
67	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
67	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
67	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
67	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
67	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
67	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
67	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
67	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
67	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
67	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
68	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
68	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
68	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
68	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
68	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
68	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
68	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
68	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
68	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
68	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
69	ENVULT MAX	0.10000	0.00000	26.02931	0.00000
69	ENVULT MAX	0.32500	0.00000	26.02931	0.00000
69	ENVULT MAX	0.55000	0.00000	26.02931	0.00000
69	ENVULT MAX	0.77500	0.00000	26.02931	0.00000
69	ENVULT MAX	1.00000	0.00000	26.02931	0.00000
69	ENVULT MIN	0.10000	-697.29566	-368.55845	-831.06523
69	ENVULT MIN	0.32500	-701.80972	-363.05158	-813.97695
69	ENVULT MIN	0.55000	-705.90191	-357.24095	-796.98992
69	ENVULT MIN	0.77500	-709.57222	-351.12658	-780.10414
69	ENVULT MIN	1.00000	-712.82066	-344.70845	-763.31961
70	ENVULT MAX	0.00000	0.00000	26.02931	0.00000
70	ENVULT MAX	0.25000	0.00000	26.02931	0.00000
70	ENVULT MAX	0.50000	0.00000	26.02931	0.00000
70	ENVULT MAX	0.75000	0.00000	26.02931	0.00000
70	ENVULT MAX	1.00000	0.00000	26.02931	0.00000

61	ENVULT MIN	0.25000	-389.35845	-176.52442	0.00000
61	ENVULT MIN	0.50000	-389.35845	-136.89667	0.00000
61	ENVULT MIN	0.75000	-389.35845	-97.26892	0.00000
FRAME	LOAD	DIST	P	V2	M3
70	ENVULT MIN	0.75000	-714.01541	-342.10058	-756.74544
70	ENVULT MIN	1.00000	-714.41366	-341.22078	-754.55754
71	ENVULT MAX	0.00000	0.00000	26.02931	0.00000
71	ENVULT MAX	0.25000	0.00000	26.02931	1.37023
71	ENVULT MAX	0.50000	0.00000	26.02931	28.84775
71	ENVULT MAX	0.75000	0.00000	26.02931	53.35076
71	ENVULT MAX	1.00000	0.00000	26.02931	78.66553
71	ENVULT MIN	0.00000	-714.41366	-341.22078	-754.55754
71	ENVULT MIN	0.25000	-721.23116	-325.35020	-717.37342
71	ENVULT MIN	0.50000	-728.04866	-307.95037	-680.69936
71	ENVULT MIN	0.75000	-734.86616	-289.02131	-644.53535
71	ENVULT MIN	1.00000	-741.68366	-268.56300	-608.88139
72	ENVULT MAX	0.00000	0.00000	26.02931	78.66556
72	ENVULT MAX	0.25000	0.00000	26.02931	122.74305
72	ENVULT MAX	0.50000	0.00000	26.02931	161.59607
72	ENVULT MAX	0.75000	0.00000	26.02931	194.83925
72	ENVULT MAX	1.00000	0.00000	26.02931	222.08726
72	ENVULT MIN	0.00000	-741.68366	-268.56299	-608.88139
72	ENVULT MIN	0.25000	-748.49441	-246.59727	-573.77202
72	ENVULT MIN	0.50000	-755.30516	-223.10391	-539.17169
72	ENVULT MIN	0.75000	-762.11591	-198.16549	-505.08040
72	ENVULT MIN	1.00000	-768.92666	-176.10916	-471.49816
73	ENVULT MAX	0.00000	0.00000	26.02931	222.08723
73	ENVULT MAX	0.25000	0.00000	31.86935	242.97216
73	ENVULT MAX	0.50000	0.00000	54.34705	257.07779
73	ENVULT MAX	0.75000	0.00000	77.79324	264.01799
73	ENVULT MAX	1.00000	0.00000	102.20792	269.85810
73	ENVULT MIN	0.00000	-768.92666	-176.10926	-471.49816
73	ENVULT MIN	0.25000	-775.74416	-161.54799	-438.39242
73	ENVULT MIN	0.50000	-782.56166	-145.96722	-405.79674
73	ENVULT MIN	0.75000	-789.37916	-134.22237	-387.48641
73	ENVULT MIN	1.00000	-796.19666	-134.22237	-379.59288
74	ENVULT MAX	0.00000	0.00000	102.20792	269.85839
74	ENVULT MAX	0.25000	0.00000	127.56601	277.45697
74	ENVULT MAX	0.50000	0.00000	153.89173	276.74821
74	ENVULT MAX	0.75000	0.00000	181.24572	267.34677
74	ENVULT MAX	1.00000	0.00000	221.42834	248.86730
74	ENVULT MIN	0.00000	-796.19666	-134.22237	-379.59288
74	ENVULT MIN	0.25000	-803.00741	-134.22237	-372.14007
74	ENVULT MIN	0.50000	-809.81816	-134.22237	-365.11994
74	ENVULT MIN	0.75000	-816.62891	-134.22237	-358.53249
74	ENVULT MIN	1.00000	-823.43966	-134.22237	-352.37773
75	ENVULT MAX	0.00000	0.00000	221.42837	248.86766
75	ENVULT MAX	0.25000	0.00000	263.13861	221.21178
75	ENVULT MAX	0.50000	0.00000	306.37648	183.70718
75	ENVULT MAX	0.75000	0.00000	351.14198	135.96853
75	ENVULT MAX	1.00000	0.00000	397.43510	113.63739
75	ENVULT MIN	0.00000	-823.43966	-134.22237	-352.37773
75	ENVULT MIN	0.25000	-830.25041	-134.22237	-346.65566
75	ENVULT MIN	0.50000	-837.06116	-134.22237	-378.87625
75	ENVULT MIN	0.75000	-843.87191	-134.22237	-415.58419
75	ENVULT MIN	1.00000	-850.68266	-134.22237	-491.54325
76	ENVULT MAX	0.00000	0.00000	397.43502	113.63743
76	ENVULT MAX	0.25000	0.00000	445.30321	89.94950
76	ENVULT MAX	0.50000	0.00000	494.70064	80.75796
76	ENVULT MAX	0.75000	0.00000	545.62732	107.67827
76	ENVULT MAX	1.00000	0.00000	598.08323	134.59858
76	ENVULT MIN	0.00000	-850.68266	-134.22237	-491.54325
76	ENVULT MIN	0.25000	-857.50016	-134.22237	-579.57750
76	ENVULT MIN	0.50000	-864.31766	-134.22237	-676.09970
76	ENVULT MIN	0.75000	-871.13516	-134.22237	-781.35436
76	ENVULT MIN	1.00000	-877.95266	-134.22237	-895.58600
77	ENVULT MAX	0.00000	0.00000	598.08330	134.59858
77	ENVULT MAX	0.25000	0.00000	617.09707	144.16728
77	ENVULT MAX	0.50000	0.00000	636.30438	153.73599
77	ENVULT MAX	0.75000	0.00000	655.70522	163.30469
77	ENVULT MAX	1.00000	0.00000	675.29960	172.87340
77	ENVULT MIN	0.00000	-877.95266	-134.22237	-895.58600
77	ENVULT MIN	0.25000	-880.37591	-134.22237	-938.39788
77	ENVULT MIN	0.50000	-882.79916	-134.22237	-982.38581
77	ENVULT MIN	0.75000	-885.22241	-134.22237	-1027.56100
77	ENVULT MIN	1.00000	-887.64566	-134.22237	-1077.65500
78	ENVULT MAX	0.00000	0.00000	675.29962	172.87340
78	ENVULT MAX	0.08654	0.00000	687.67884	178.87050
78	ENVULT MAX	0.17308	0.00000	700.13400	184.86760
78	ENVULT MAX	0.25962	0.00000	712.66509	190.86470
78	ENVULT MAX	0.34615	0.00000	725.27212	197.05535
78	ENVULT MIN	0.00000	-887.64566	-134.22237	-1077.65500
78	ENVULT MIN	0.08654	-889.16441	-134.22237	-1115.98800
78	ENVULT MIN	0.17308	-890.68316	-134.22237	-1155.02000
78	ENVULT MIN	0.25962	-892.20191	-134.22237	-1194.75500
78	ENVULT MIN	0.34615	-893.72066	-134.22237	-1235.19600
79	ENVULT MAX	0.08669	0.00000	74.65211	258.92041
79	ENVULT MAX	0.29876	0.00000	74.65211	131.07868
79	ENVULT MAX	0.51084	0.00000	74.65211	14.54541
70	ENVULT MIN	0.00000	-712.82066	-344.70843	-763.31961
70	ENVULT MIN	0.25000	-713.21891	-343.84440	-761.12648
70	ENVULT MIN	0.50000	-713.61716	-342.97512	-758.93509
FRAME	LOAD	DIST	P	V2	M3
79	ENVULT MIN	0.51084	-1726.32400	-74.65211	-14.54541
79	ENVULT MIN	0.72291	-1752.01200	-74.65211	-124.60479
79	ENVULT MIN	0.93498	-1777.69900	-74.65211	-252.44652

79	ENVULT MAX	0.72291	0.00000	74.65211	124.60479
79	ENVULT MAX	0.93498	0.00000	74.65211	252.44652
79	ENVULT MIN	0.08669	-1674.94900	-74.65211	-258.92041
79	ENVULT MIN	0.29876	-1700.63700	-74.65211	-131.07868

2) 사용하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVUSE MAX	0.27778	122.86277	0.00000	156.83514
1	ENVUSE MAX	0.45833	122.86277	0.00000	185.92979
1	ENVUSE MAX	0.63889	122.86277	0.00000	215.23898
1	ENVUSE MAX	0.81944	122.86277	0.00000	244.76273
1	ENVUSE MAX	1.00000	122.86277	0.00000	274.50103
1	ENVUSE MIN	0.27778	-563.23570	-514.57441	-999.66575
1	ENVUSE MIN	0.45833	-563.23570	-509.86191	-958.34424
1	ENVUSE MIN	0.63889	-563.23570	-505.14941	-917.40561
1	ENVUSE MIN	0.81944	-563.23570	-500.43691	-876.84988
1	ENVUSE MIN	1.00000	-563.23570	-495.72441	-836.67705
2	ENVUSE MAX	0.00000	122.86277	0.00000	274.50103
2	ENVUSE MAX	0.25000	122.86277	0.00000	331.54834
2	ENVUSE MAX	0.50000	122.86277	0.00000	389.36893
2	ENVUSE MAX	0.75000	122.86277	0.00000	447.96279
2	ENVUSE MAX	1.00000	122.86277	0.00000	507.32993
2	ENVUSE MIN	0.00000	-563.23570	-495.72442	-836.67706
2	ENVUSE MIN	0.25000	-563.23570	-486.77792	-761.46392
2	ENVUSE MIN	0.50000	-563.23570	-479.73288	-687.63077
2	ENVUSE MIN	0.75000	-563.23570	-484.74600	-615.17763
2	ENVUSE MIN	1.00000	-563.23570	-489.75913	-544.10447
3	ENVUSE MAX	0.00000	122.86277	0.00000	507.32993
3	ENVUSE MAX	0.25000	122.86277	0.00000	531.10882
3	ENVUSE MAX	0.50000	122.86277	0.00000	555.36159
3	ENVUSE MAX	0.75000	122.86277	0.00000	580.08822
3	ENVUSE MAX	1.00000	122.86277	0.00000	605.28872
3	ENVUSE MIN	0.00000	-563.23571	-399.49900	-544.10449
3	ENVUSE MIN	0.25000	-563.23571	-392.49550	-496.28782
3	ENVUSE MIN	0.50000	-563.23571	-385.49200	-449.31682
3	ENVUSE MIN	0.75000	-563.23571	-378.48850	-403.19150
3	ENVUSE MIN	1.00000	-563.23571	-371.48500	-357.91185
4	ENVUSE MAX	0.00000	122.86277	0.00000	605.28872
4	ENVUSE MAX	0.25000	122.86277	0.00000	621.16220
4	ENVUSE MAX	0.50000	122.86277	0.00000	637.18333
4	ENVUSE MAX	0.75000	122.86277	0.00000	653.35212
4	ENVUSE MAX	1.00000	122.86277	0.00000	669.66857
4	ENVUSE MIN	0.00000	-563.23571	-371.48500	-357.91184
4	ENVUSE MIN	0.25000	-563.23571	-366.66625	-330.23117
4	ENVUSE MIN	0.50000	-563.23571	-361.84750	-302.91190
4	ENVUSE MIN	0.75000	-563.23571	-357.02875	-275.95404
4	ENVUSE MIN	1.00000	-563.23571	-358.66738	-249.35759
5	ENVUSE MAX	0.00000	122.86277	0.00000	669.66857
5	ENVUSE MAX	0.25000	122.86277	0.00000	685.21140
5	ENVUSE MAX	0.50000	122.86277	0.00000	700.91691
5	ENVUSE MAX	0.75000	122.86277	0.00000	718.58880
5	ENVUSE MAX	1.00000	122.86277	0.00000	737.51025
5	ENVUSE MIN	0.00000	-563.23571	-358.66738	-249.35759
5	ENVUSE MIN	0.25000	-563.23571	-360.96675	-224.58389
5	ENVUSE MIN	0.50000	-563.23571	-363.26613	-200.10052
5	ENVUSE MIN	0.75000	-563.23571	-365.56550	-175.90747
5	ENVUSE MIN	1.00000	-563.23571	-367.86488	-152.00474
6	ENVUSE MAX	0.00000	122.86277	0.00000	737.51025
6	ENVUSE MAX	0.25000	122.86277	0.00000	762.85513
6	ENVUSE MAX	0.50000	122.86277	0.00000	790.51257
6	ENVUSE MAX	0.75000	122.86277	0.00000	820.48256
6	ENVUSE MAX	1.00000	122.86277	0.00000	852.76511
6	ENVUSE MIN	0.00000	-563.23572	-282.90996	-152.00474
6	ENVUSE MIN	0.25000	-563.23572	-267.43846	-78.60202
6	ENVUSE MIN	0.50000	-563.23572	-251.96696	-9.32632
6	ENVUSE MIN	0.75000	-563.23572	-247.31931	0.00000
6	ENVUSE MIN	1.00000	-563.23572	-255.98869	0.00000
7	ENVUSE MAX	0.00000	122.86277	43.37237	852.76511
7	ENVUSE MAX	0.25000	122.86277	34.70299	845.83104
7	ENVUSE MAX	0.50000	122.86277	26.03362	841.20952
7	ENVUSE MAX	0.75000	122.86277	17.36424	838.90055
7	ENVUSE MAX	1.00000	122.86277	8.69487	838.90415
7	ENVUSE MIN	0.00000	-563.23572	-173.74436	0.00000
7	ENVUSE MIN	0.25000	-563.23572	-158.27286	0.00000
7	ENVUSE MIN	0.50000	-563.23572	-142.80136	0.00000
7	ENVUSE MIN	0.75000	-563.23572	-139.00357	0.00000
7	ENVUSE MIN	1.00000	-563.23572	-147.67294	0.00000
8	ENVUSE MAX	0.00000	122.86277	139.99868	838.90415
8	ENVUSE MAX	0.25000	122.86277	131.33743	803.18242
8	ENVUSE MAX	0.50000	122.86277	122.67618	769.76892
8	ENVUSE MAX	0.75000	122.86277	114.01493	738.66364
8	ENVUSE MAX	1.00000	122.86277	105.35368	709.86659
8	ENVUSE MIN	0.00000	-563.23573	-68.66527	0.00000
8	ENVUSE MIN	0.25000	-563.23573	-53.20827	0.00000
8	ENVUSE MIN	0.50000	-563.23573	-37.75127	0.00000
8	ENVUSE MIN	0.75000	-563.23573	-32.48065	0.00000
8	ENVUSE MIN	1.00000	-563.23573	-41.14190	0.00000
9	ENVUSE MAX	0.75000	122.86277	216.55575	526.16135
9	ENVUSE MAX	1.00000	122.86277	207.88637	469.55138
9	ENVUSE MIN	0.00000	-563.23573	0.00000	0.00000
9	ENVUSE MIN	0.25000	-563.23573	0.00000	0.00000
9	ENVUSE MIN	0.50000	-563.23573	0.00000	0.00000
9	ENVUSE MIN	0.75000	-563.23573	0.00000	0.00000
9	ENVUSE MIN	1.00000	-563.23573	0.00000	0.00000
10	ENVUSE MAX	0.00000	122.86277	350.54497	469.55138
10	ENVUSE MAX	0.25000	122.86277	341.87560	377.19979
10	ENVUSE MAX	0.50000	122.86277	333.20622	293.90022
10	ENVUSE MAX	0.75000	122.86277	324.53685	218.02217
10	ENVUSE MAX	1.00000	122.86277	315.86747	146.16569
10	ENVUSE MIN	0.00000	-563.23572	0.00000	0.00000
10	ENVUSE MIN	0.25000	-563.23572	0.00000	0.00000
10	ENVUSE MIN	0.50000	-563.23572	0.00000	0.00000
10	ENVUSE MIN	0.75000	-563.23572	0.00000	0.00000
10	ENVUSE MIN	1.00000	-563.23572	0.00000	-28.92634
11	ENVUSE MAX	0.00000	122.86277	469.35856	146.16568
11	ENVUSE MAX	0.25000	122.86277	460.69731	59.34324
11	ENVUSE MAX	0.50000	122.86277	452.03606	12.13273
11	ENVUSE MAX	0.75000	122.86277	443.37481	0.00000
11	ENVUSE MAX	1.00000	122.86277	434.71356	0.00000
11	ENVUSE MIN	0.00000	-563.23570	0.00000	-28.92491
11	ENVUSE MIN	0.25000	-563.23570	0.00000	-117.26067
11	ENVUSE MIN	0.50000	-563.23570	0.00000	-207.56715
11	ENVUSE MIN	0.75000	-563.23570	0.00000	-304.72170
11	ENVUSE MIN	1.00000	-563.23570	0.00000	-415.85005
12	ENVUSE MAX	0.00000	122.86277	604.31749	0.00000
12	ENVUSE MAX	0.25000	122.86277	602.96061	0.00000
12	ENVUSE MAX	0.50000	122.86277	601.60374	0.00000
12	ENVUSE MAX	0.75000	122.86277	600.24686	0.00000
12	ENVUSE MAX	1.00000	122.86277	598.88999	0.00000
12	ENVUSE MIN	0.00000	-563.23569	0.00000	-415.85005
12	ENVUSE MIN	0.25000	-563.23569	0.00000	-440.41608
12	ENVUSE MIN	0.50000	-563.23569	0.00000	-464.92545
12	ENVUSE MIN	0.75000	-563.23569	0.00000	-489.37818
12	ENVUSE MIN	1.00000	-563.23569	0.00000	-513.77425
13	ENVUSE MAX	0.00000	122.86277	598.88999	0.00000
13	ENVUSE MAX	0.25000	122.86277	596.45249	0.00000
13	ENVUSE MAX	0.50000	122.86277	594.01499	0.00000
13	ENVUSE MAX	0.75000	122.86277	591.57749	0.00000
13	ENVUSE MAX	1.00000	122.86277	589.13999	0.00000
13	ENVUSE MIN	0.00000	-563.23569	0.00000	-513.77425
13	ENVUSE MIN	0.25000	-563.23569	0.00000	-557.45725
13	ENVUSE MIN	0.50000	-563.23569	0.00000	-600.95744
13	ENVUSE MIN	0.75000	-563.23569	0.00000	-644.27481
13	ENVUSE MIN	1.00000	-563.23569	0.00000	-687.40937
14	ENVUSE MAX	0.00000	122.86277	589.13999	0.00000
14	ENVUSE MAX	0.25000	122.86277	586.29624	0.00000
14	ENVUSE MAX	0.50000	122.86277	583.45249	0.00000
14	ENVUSE MAX	0.75000	122.86277	580.60874	0.00000
14	ENVUSE MAX	1.00000	122.86277	577.76499	0.00000
14	ENVUSE MIN	0.00000	-563.23569	0.00000	-687.40937
14	ENVUSE MIN	0.25000	-563.23569	0.00000	-737.50197
14	ENVUSE MIN	0.50000	-563.23569	0.00000	-787.79882
14	ENVUSE MIN	0.75000	-563.23569	0.00000	-838.72649
14	ENVUSE MIN	1.00000	-563.23569	0.00000	-889.40534
15	ENVUSE MAX	0.00000	122.86277	577.76499	0.00000
15	ENVUSE MAX	0.25000	122.86277	575.73374	0.00000
15	ENVUSE MAX	0.50000	122.86277	573.70249	0.00000
15	ENVUSE MAX	0.75000	122.86277	571.67124	0.00000
15	ENVUSE MAX	1.00000	122.86277	569.63999	0.00000
15	ENVUSE MIN	0.00000	-563.23569	0.00000	-889.40534
15	ENVUSE MIN	0.25000	-563.23569	0.00000	-925.45218
15	ENVUSE MIN	0.50000	-563.23569	0.00000	-961.37206
15	ENVUSE MIN	0.75000	-563.23569	0.00000	-997.16499
15	ENVUSE MIN	1.00000	-563.23569	0.00000	-1032.83100
16	ENVUSE MAX	0.00000	76.20520	0.00000	0.00000
16	ENVUSE MAX	0.25000	76.20520	0.00000	0.00000
16	ENVUSE MAX	0.50000	76.20520	0.00000	0.00000
16	ENVUSE MAX	0.75000	76.20520	0.00000	0.00000
16	ENVUSE MAX	1.00000	76.20520	0.00000	0.00000
16	ENVUSE MIN	0.00000	-527.84121	-570.22620	-1035.98900
16	ENVUSE MIN	0.25000	-527.84121	-572.25745	-1000.28700
16	ENVUSE MIN	0.50000	-527.84121	-574.28870	-964.45697
16	ENVUSE MIN	0.75000	-527.84121	-576.31995	-928.50045
16	ENVUSE MIN	1.00000	-527.84121	-578.35120	-892.41698
17	ENVUSE MAX	0.00000	76.20520	0.00000	0.00000
17	ENVUSE MAX	0.25000	76.20520	0.00000	0.00000
17	ENVUSE MAX	0.50000	76.20520	0.00000	0.00000

9	ENVUSE MAX	0.00000	122.86277	242.56387	709.86659
9	ENVUSE MAX	0.25000	122.86277	233.89450	646.31895
9	ENVUSE MAX	0.50000	122.86277	225.22512	585.08387
FRAME	LOAD	DIST	P	V2	M3
17	ENVUSE MIN	0.25000	-527.84121	-581.19495	-841.68683
17	ENVUSE MIN	0.50000	-527.84121	-584.03870	-790.70786
17	ENVUSE MIN	0.75000	-527.84121	-586.88245	-739.48006
17	ENVUSE MIN	1.00000	-527.84121	-589.72620	-688.81260
18	ENVUSE MAX	0.00000	76.20520	0.00000	0.00000
18	ENVUSE MAX	0.25000	76.20520	0.00000	0.00000
18	ENVUSE MAX	0.50000	76.20520	0.00000	0.00000
18	ENVUSE MAX	0.75000	76.20520	0.00000	0.00000
18	ENVUSE MAX	1.00000	76.20520	0.00000	0.00000
18	ENVUSE MIN	0.00000	-527.84121	-589.72620	-688.81260
18	ENVUSE MIN	0.25000	-527.84121	-592.16370	-645.65606
18	ENVUSE MIN	0.50000	-527.84121	-594.60120	-602.31670
18	ENVUSE MIN	0.75000	-527.84121	-597.03870	-558.79453
18	ENVUSE MIN	1.00000	-527.84121	-599.47620	-515.08955
19	ENVUSE MAX	0.00000	76.20520	0.00000	0.00000
19	ENVUSE MAX	0.25000	76.20520	0.00000	0.00000
19	ENVUSE MAX	0.50000	76.20520	0.00000	0.00000
19	ENVUSE MAX	0.75000	76.20520	0.00000	0.00000
19	ENVUSE MAX	1.00000	76.20520	0.00000	0.00000
19	ENVUSE MIN	0.00000	-527.84121	-599.47620	-515.08955
19	ENVUSE MIN	0.25000	-527.84121	-600.83308	-490.68124
19	ENVUSE MIN	0.50000	-527.84121	-602.18995	-466.21627
19	ENVUSE MIN	0.75000	-527.84121	-603.54683	-441.69466
19	ENVUSE MIN	1.00000	-527.84121	-604.90370	-417.11640
20	ENVUSE MAX	0.00000	76.20520	0.00000	0.00000
20	ENVUSE MAX	0.25000	76.20520	0.00000	0.00000
20	ENVUSE MAX	0.50000	76.20520	0.00000	12.13273
20	ENVUSE MAX	0.75000	76.20520	0.00000	58.84970
20	ENVUSE MAX	1.00000	76.20520	0.00000	145.05713
20	ENVUSE MIN	0.00000	-527.84121	-434.82849	-417.11640
20	ENVUSE MIN	0.25000	-527.84121	-443.48974	-304.31573
20	ENVUSE MIN	0.50000	-527.84121	-452.15099	-206.52913
20	ENVUSE MIN	0.75000	-527.84121	-460.81224	-115.21034
20	ENVUSE MIN	1.00000	-527.84121	-469.47349	-26.97864
21	ENVUSE MAX	0.00000	76.20520	0.00000	145.05713
21	ENVUSE MAX	0.25000	76.20520	0.00000	216.87526
21	ENVUSE MAX	0.50000	76.20520	0.00000	291.73555
21	ENVUSE MAX	0.75000	76.20520	0.00000	374.81873
21	ENVUSE MAX	1.00000	76.20520	0.00000	466.80769
21	ENVUSE MIN	0.00000	-527.84123	-315.55490	-26.97906
21	ENVUSE MIN	0.25000	-527.84123	-324.22428	0.00000
21	ENVUSE MIN	0.50000	-527.84123	-332.89365	0.00000
21	ENVUSE MIN	0.75000	-527.84123	-341.56303	0.00000
21	ENVUSE MIN	1.00000	-527.84123	-350.23240	0.00000
22	ENVUSE MAX	0.00000	76.20520	0.00000	466.80769
22	ENVUSE MAX	0.25000	76.20520	0.00000	523.23852
22	ENVUSE MAX	0.50000	76.20520	0.00000	581.98191
22	ENVUSE MAX	0.75000	76.20520	0.00000	643.03786
22	ENVUSE MAX	1.00000	76.20520	0.00000	706.40636
22	ENVUSE MIN	0.00000	-527.84125	-207.21483	0.00000
22	ENVUSE MIN	0.25000	-527.84125	-215.88421	0.00000
22	ENVUSE MIN	0.50000	-527.84125	-224.55358	0.00000
22	ENVUSE MIN	0.75000	-527.84125	-233.22296	0.00000
22	ENVUSE MIN	1.00000	-527.84125	-241.89233	0.00000
23	ENVUSE MAX	0.00000	76.20520	40.05891	706.40636
23	ENVUSE MAX	0.25000	76.20520	31.39766	734.95460
23	ENVUSE MAX	0.50000	76.20520	37.02313	765.81107
23	ENVUSE MAX	0.75000	76.20520	52.48013	798.97576
23	ENVUSE MAX	1.00000	76.20520	67.93713	834.44867
23	ENVUSE MIN	0.00000	-527.84126	-104.27070	0.00000
23	ENVUSE MIN	0.25000	-527.84126	-112.93195	0.00000
23	ENVUSE MIN	0.50000	-527.84126	-121.59320	0.00000
23	ENVUSE MIN	0.75000	-527.84126	-130.25445	0.00000
23	ENVUSE MIN	1.00000	-527.84126	-138.91570	0.00000
24	ENVUSE MAX	0.00000	76.20520	146.44013	834.44867
24	ENVUSE MAX	0.25000	76.20520	137.77076	834.16158
24	ENVUSE MAX	0.50000	76.20520	141.97249	836.18705
24	ENVUSE MAX	0.75000	76.20520	157.44399	840.52507
24	ENVUSE MAX	1.00000	76.20520	172.91549	847.17565
24	ENVUSE MIN	0.00000	-527.84125	-7.46206	0.00000
24	ENVUSE MIN	0.25000	-527.84125	-16.13143	0.00000
24	ENVUSE MIN	0.50000	-527.84125	-24.80081	0.00000
24	ENVUSE MIN	0.75000	-527.84125	-33.47018	0.00000
24	ENVUSE MIN	1.00000	-527.84125	-42.13956	0.00000
25	ENVUSE MAX	0.00000	76.20520	254.81488	847.17565
25	ENVUSE MAX	0.25000	76.20520	246.14551	814.62317
25	ENVUSE MAX	0.50000	76.20520	251.17775	784.38325
25	ENVUSE MAX	0.75000	76.20520	266.64925	756.45588
25	ENVUSE MAX	1.00000	76.20520	282.12075	730.84107
25	ENVUSE MIN	0.00000	-527.84123	0.00000	0.00000
25	ENVUSE MIN	0.25000	-527.84123	0.00000	0.00000
25	ENVUSE MIN	0.50000	-527.84123	0.00000	-4.54600
25	ENVUSE MIN	0.75000	-527.84123	0.00000	-73.61118
25	ENVUSE MIN	1.00000	-527.84123	0.00000	-146.80338
26	ENVUSE MAX	0.00000	76.20520	367.02779	730.84107
17	ENVUSE MAX	0.75000	76.20520	0.00000	0.00000
17	ENVUSE MAX	1.00000	76.20520	0.00000	0.00000
17	ENVUSE MIN	0.00000	-527.84121	-578.35120	-892.41698
FRAME	LOAD	DIST	P	V2	M3
26	ENVUSE MIN	0.00000	-527.84121	0.00000	-146.80339
26	ENVUSE MIN	0.25000	-527.84121	0.00000	-170.66629
26	ENVUSE MIN	0.50000	-527.84121	0.00000	-194.81953
26	ENVUSE MIN	0.75000	-527.84121	0.00000	-219.26308
26	ENVUSE MIN	1.00000	-527.84121	0.00000	-243.99696
27	ENVUSE MAX	0.00000	76.20520	357.83029	661.69554
27	ENVUSE MAX	0.25000	76.20520	356.46594	645.31631
27	ENVUSE MAX	0.50000	76.20520	361.28469	629.08474
27	ENVUSE MAX	0.75000	76.20520	366.10344	613.00082
27	ENVUSE MAX	1.00000	76.20520	370.92219	597.06457
27	ENVUSE MIN	0.00000	-527.84120	0.00000	-243.99696
27	ENVUSE MIN	0.25000	-527.84120	0.00000	-270.55120
27	ENVUSE MIN	0.50000	-527.84120	0.00000	-297.46685
27	ENVUSE MIN	0.75000	-527.84120	0.00000	-324.74390
27	ENVUSE MIN	1.00000	-527.84120	0.00000	-352.38236
28	ENVUSE MAX	0.00000	76.20520	370.92220	597.06457
28	ENVUSE MAX	0.25000	76.20520	377.92570	571.76299
28	ENVUSE MAX	0.50000	76.20520	384.92920	546.93527
28	ENVUSE MAX	0.75000	76.20520	391.93270	522.58143
28	ENVUSE MAX	1.00000	76.20520	398.93620	498.70146
28	ENVUSE MIN	0.00000	-527.84119	0.00000	-352.38236
28	ENVUSE MIN	0.25000	-527.84119	0.00000	-397.59405
28	ENVUSE MIN	0.50000	-527.84119	0.00000	-443.65142
28	ENVUSE MIN	0.75000	-527.84119	0.00000	-490.55445
28	ENVUSE MIN	1.00000	-527.84119	0.00000	-538.30316
29	ENVUSE MAX	0.00000	76.20520	489.74152	498.70146
29	ENVUSE MAX	0.25000	76.20520	484.72840	439.31463
29	ENVUSE MAX	0.50000	76.20520	479.71527	380.70108
29	ENVUSE MAX	0.75000	76.20520	486.76032	322.86080
29	ENVUSE MAX	1.00000	76.20520	495.70682	265.79380
29	ENVUSE MIN	0.00000	-527.84118	0.00000	-538.30315
29	ENVUSE MIN	0.25000	-527.84118	0.00000	-609.36306
29	ENVUSE MIN	0.50000	-527.84118	0.00000	-681.80297
29	ENVUSE MIN	0.75000	-527.84118	0.00000	-755.62288
29	ENVUSE MIN	1.00000	-527.84118	0.00000	-830.82278
30	ENVUSE MAX	0.00000	76.20520	495.70682	265.79380
30	ENVUSE MAX	0.18056	76.20520	500.41932	236.04513
30	ENVUSE MAX	0.36111	76.20520	505.13182	206.51101
30	ENVUSE MAX	0.54167	76.20520	509.84432	177.19144
30	ENVUSE MAX	0.72222	76.20520	514.55682	148.08642
30	ENVUSE MIN	0.00000	-527.84119	0.00000	-830.82279
30	ENVUSE MIN	0.18056	-527.84119	0.00000	-870.98866
30	ENVUSE MIN	0.36111	-527.84119	0.00000	-911.53742
30	ENVUSE MIN	0.54167	-527.84119	0.00000	-952.46907
30	ENVUSE MIN	0.72222	-527.84119	0.00000	-993.78361
31	ENVUSE MAX	0.65385	0.00000	76.20520	71.34121
31	ENVUSE MAX	0.74038	0.00000	76.20520	67.05466
31	ENVUSE MAX	0.82692	0.00000	76.20520	62.76812
31	ENVUSE MAX	0.91346	0.00000	76.20520	58.48158
31	ENVUSE MAX	1.00000	0.00000	76.20520	54.19504
31	ENVUSE MIN	0.65385	-629.61826	-466.77406	-846.83232
31	ENVUSE MIN	0.74038	-628.35263	-458.89466	-820.79811
31	ENVUSE MIN	0.82692	-627.08701	-451.06273	-795.20578
31	ENVUSE MIN	0.91346	-625.82138	-443.27825	-770.05266
31	ENVUSE MIN	1.00000	-624.55576	-435.54124	-745.33609
32	ENVUSE MAX	0.00000	0.00000	76.20520	54.19504
32	ENVUSE MAX	0.25000	0.00000	76.20520	47.35562
32	ENVUSE MAX	0.50000	0.00000	76.20520	40.51620
32	ENVUSE MAX	0.75000	0.00000	76.20520	33.67679
32	ENVUSE MAX	1.00000	0.00000	76.20520	26.83737
32	ENVUSE MIN	0.00000	-624.55576	-435.54121	-745.33609
32	ENVUSE MIN	0.25000	-622.53638	-423.29473	-706.79673
32	ENVUSE MIN	0.50000	-620.51701	-411.16920	-673.03790
32	ENVUSE MIN	0.75000	-618.49763	-399.16463	-644.59126
32	ENVUSE MIN	1.00000	-616.47826	-387.28102	-616.87966
33	ENVUSE MAX	0.00000	0.00000	76.20520	26.83737
33	ENVUSE MAX	0.25000	0.00000	76.20520	7.59556
33	ENVUSE MAX	0.50000	0.00000	76.20520	0.00000
33	ENVUSE MAX	0.75000	0.00000	76.20520	0.00000
33	ENVUSE MAX	1.00000	0.00000	76.20520	0.00000
33	ENVUSE MIN	0.00000	-616.47826	-387.28100	-616.87966
33	ENVUSE MIN	0.25000	-610.79701	-354.49605	-542.80044
33	ENVUSE MIN	0.50000	-605.11576	-322.66688	-474.33182
33	ENVUSE MIN	0.75000	-599.43451	-291.79348	-411.32100
33	ENVUSE MIN	1.00000	-593.75326	-261.87586	-353.61515
34	ENVUSE MAX	0.00000	0.00000	76.20520	0.00000
34	ENVUSE MAX	0.25000	0.00000	76.20520	6.49537
34	ENVUSE MAX	0.50000	0.00000	76.20520	35.50371
34	ENVUSE MAX	0.75000	0.00000	76.20520	58.11576
34	ENVUSE MAX	1.00000	0.00000	76.20520	74.57236
34	ENVUSE MIN	0.00000	-593.75326	-261.87594	-353.61515
34	ENVUSE MIN	0.25000	-588.07763	-232.94274	-305.54582
34	ENVUSE MIN	0.50000	-582.40201	-204.96430	-279.66662
34	ENVUSE MIN	0.75000	-576.72638	-177.94063	-259.31103
34	ENVUSE MIN	1.00000	-571.05076	-151.87173	-259.51104

26	ENVUSE MAX	0.25000	76.20520	364.72841	711.86856
26	ENVUSE MAX	0.50000	76.20520	362.42904	693.06233
26	ENVUSE MAX	0.75000	76.20520	360.12966	677.29760
26	ENVUSE MAX	1.00000	76.20520	357.83029	661.69554
FRAME	LOAD	DIST	P	V2	M3
35	ENVUSE MAX	1.00000	0.00000	76.20520	86.73789
35	ENVUSE MIN	0.00000	-571.05076	-151.87170	-259.51104
35	ENVUSE MIN	0.25000	-565.37513	-126.75756	-259.98148
35	ENVUSE MIN	0.50000	-559.69951	-106.81381	-260.72234
35	ENVUSE MIN	0.75000	-554.02388	-90.36024	-261.73364
35	ENVUSE MIN	1.00000	-548.34826	-74.51143	-263.01536
36	ENVUSE MAX	0.00000	0.00000	76.20520	86.73647
36	ENVUSE MAX	0.25000	0.00000	76.20520	82.36467
36	ENVUSE MAX	0.50000	0.00000	83.71174	82.99730
36	ENVUSE MAX	0.75000	0.00000	93.44971	80.69056
36	ENVUSE MAX	1.00000	0.00000	102.55051	74.14676
36	ENVUSE MIN	0.00000	-548.34826	-74.51143	-263.01536
36	ENVUSE MIN	0.25000	-542.66701	-59.25226	-264.56918
36	ENVUSE MIN	0.50000	-536.98576	-44.59839	-273.86463
36	ENVUSE MIN	0.75000	-531.30451	-30.54983	-292.36717
36	ENVUSE MIN	1.00000	-525.62326	-18.59236	-311.18849
37	ENVUSE MAX	0.00000	0.00000	102.55045	74.14677
37	ENVUSE MAX	0.25000	0.00000	117.41590	63.61961
37	ENVUSE MAX	0.50000	0.00000	131.79276	49.34546
37	ENVUSE MAX	0.75000	0.00000	146.27561	31.56517
37	ENVUSE MAX	1.00000	0.00000	160.00419	10.51957
37	ENVUSE MIN	0.00000	-525.62326	-18.59236	-311.18849
37	ENVUSE MIN	0.25000	-519.94763	-18.59236	-330.30948
37	ENVUSE MIN	0.50000	-514.27201	-18.59236	-349.74862
37	ENVUSE MIN	0.75000	-508.59638	-18.59236	-369.50591
37	ENVUSE MIN	1.00000	-502.92076	-18.59236	-389.58136
38	ENVUSE MAX	0.00000	0.00000	160.00420	10.51955
38	ENVUSE MAX	0.25000	0.00000	172.79064	0.00000
38	ENVUSE MAX	0.50000	0.00000	184.62131	0.00000
38	ENVUSE MAX	0.75000	0.00000	195.49620	0.00000
38	ENVUSE MAX	1.00000	0.00000	205.41531	0.00000
38	ENVUSE MIN	0.00000	-502.92076	-18.59236	-389.58136
38	ENVUSE MIN	0.25000	-497.23951	-18.59236	-409.99532
38	ENVUSE MIN	0.50000	-491.55826	-18.59236	-430.72806
38	ENVUSE MIN	0.75000	-485.87701	-18.59236	-451.77959
38	ENVUSE MIN	1.00000	-480.19576	-18.59236	-473.14990
39	ENVUSE MAX	0.00000	0.00000	205.41531	0.00000
39	ENVUSE MAX	0.25000	0.00000	205.96519	0.00000
39	ENVUSE MAX	0.50000	0.00000	206.51177	0.00000
39	ENVUSE MAX	0.75000	0.00000	207.05508	0.00000
39	ENVUSE MAX	1.00000	0.00000	207.59510	0.00000
39	ENVUSE MIN	0.00000	-480.19576	-18.59236	-473.14990
39	ENVUSE MIN	0.25000	-479.86388	-18.59236	-474.40812
39	ENVUSE MIN	0.50000	-479.53201	-18.59236	-475.66742
39	ENVUSE MIN	0.75000	-479.20013	-18.59236	-476.92782
39	ENVUSE MIN	1.00000	-478.86826	-18.59236	-478.18930
40	ENVUSE MAX	0.00000	0.00000	207.59511	0.00000
40	ENVUSE MAX	0.22500	0.00000	211.60643	0.00000
40	ENVUSE MAX	0.45000	0.00000	215.42792	0.00000
40	ENVUSE MAX	0.67500	0.00000	219.05956	0.00000
40	ENVUSE MAX	0.90000	0.00000	222.50136	0.00000
40	ENVUSE MIN	0.00000	-478.86826	-18.59236	-478.18930
40	ENVUSE MIN	0.22500	-476.16123	-18.59236	-487.84657
40	ENVUSE MIN	0.45000	-473.10263	-18.59236	-497.56712
40	ENVUSE MIN	0.67500	-469.69248	-18.59236	-507.35095
40	ENVUSE MIN	0.90000	-465.93076	-18.59236	-517.19806
41	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
43	ENVUSE MAX	0.10000	18.59236	0.00000	38.31159
43	ENVUSE MAX	0.32500	18.59236	0.00000	57.97690
43	ENVUSE MAX	0.55000	18.59236	0.00000	93.85519
43	ENVUSE MAX	0.77500	18.59236	0.00000	128.38779
43	ENVUSE MAX	1.00000	18.59236	0.00000	161.61428
43	ENVUSE MIN	0.10000	-235.53192	-392.14326	-384.82266
43	ENVUSE MIN	0.32500	-235.53192	-379.65435	-344.40343
43	ENVUSE MIN	0.55000	-235.53192	-367.51701	-309.12083
35	ENVUSE MAX	0.00000	0.00000	76.20520	74.57221
35	ENVUSE MAX	0.25000	0.00000	76.20520	85.63746
35	ENVUSE MAX	0.50000	0.00000	76.20520	91.35692
35	ENVUSE MAX	0.75000	0.00000	76.20520	91.64344
FRAME	LOAD	DIST	P	V2	M3
44	ENVUSE MAX	0.75000	18.59236	0.00000	186.64654
44	ENVUSE MAX	1.00000	18.59236	0.00000	194.81938
44	ENVUSE MIN	0.00000	-235.53192	-344.29701	-246.02708
44	ENVUSE MIN	0.25000	-235.53192	-341.36981	-238.10719
44	ENVUSE MIN	0.50000	-235.53192	-338.44262	-230.25067
44	ENVUSE MIN	0.75000	-235.53192	-335.51543	-222.45753
44	ENVUSE MIN	1.00000	-235.53192	-332.58823	-214.72777
45	ENVUSE MAX	0.00000	18.59236	0.00000	194.81938
45	ENVUSE MAX	0.25000	18.59236	0.00000	265.33926
45	ENVUSE MAX	0.50000	18.59236	0.00000	328.75159
45	ENVUSE MAX	0.75000	18.59236	0.00000	385.05637
45	ENVUSE MAX	1.00000	18.59236	0.00000	434.25359
45	ENVUSE MIN	0.00000	-235.53192	-332.58823	-214.72777
45	ENVUSE MIN	0.25000	-235.53192	-305.91824	-148.62009
45	ENVUSE MIN	0.50000	-235.53192	-279.24826	-88.83290
45	ENVUSE MIN	0.75000	-235.53192	-252.57827	-34.30668
45	ENVUSE MIN	1.00000	-235.53192	-225.90828	0.00000
46	ENVUSE MAX	0.00000	18.59236	0.00000	434.25359
46	ENVUSE MAX	0.25000	18.59236	0.00000	476.37941
46	ENVUSE MAX	0.50000	18.59236	0.00000	511.38434
46	ENVUSE MAX	0.75000	18.59236	0.00000	539.26838
46	ENVUSE MAX	1.00000	18.59236	5.46857	560.03152
46	ENVUSE MIN	0.00000	-235.53192	-225.90828	0.00000
46	ENVUSE MIN	0.25000	-235.53192	-199.21328	0.00000
46	ENVUSE MIN	0.50000	-235.53192	-172.51827	0.00000
46	ENVUSE MIN	0.75000	-235.53192	-145.82326	0.00000
46	ENVUSE MIN	1.00000	-235.53192	-119.12826	0.00000
47	ENVUSE MAX	0.00000	18.59236	5.35062	560.03152
47	ENVUSE MAX	0.25000	18.59236	11.35249	573.67377
47	ENVUSE MAX	0.50000	18.59236	17.35437	580.19512
47	ENVUSE MAX	0.75000	18.59236	26.58913	579.59559
47	ENVUSE MAX	1.00000	18.59236	48.74939	571.87516
47	ENVUSE MIN	0.00000	-235.53192	-119.12826	0.00000
47	ENVUSE MIN	0.25000	-235.53192	-94.56350	0.00000
47	ENVUSE MIN	0.50000	-235.53192	-70.26925	0.00000
47	ENVUSE MIN	0.75000	-235.53192	-45.97499	0.00000
47	ENVUSE MIN	1.00000	-235.53192	-26.14208	0.00000
48	ENVUSE MAX	0.00000	18.59236	48.74939	571.87516
48	ENVUSE MAX	0.25000	18.59236	71.48329	557.05108
48	ENVUSE MAX	0.50000	18.59236	98.15327	535.11945
48	ENVUSE MAX	0.75000	18.59236	124.82326	506.08026
48	ENVUSE MAX	1.00000	18.59236	151.49325	469.93353
48	ENVUSE MIN	0.00000	-235.53192	-26.30766	0.00000
48	ENVUSE MIN	0.25000	-235.53192	-6.56667	0.00000
48	ENVUSE MIN	0.50000	-235.53192	0.00000	0.00000
48	ENVUSE MIN	0.75000	-235.53192	0.00000	0.00000
48	ENVUSE MIN	1.00000	-235.53192	0.00000	0.00000
49	ENVUSE MAX	0.00000	18.59236	151.49325	469.93353
49	ENVUSE MAX	0.25000	18.59236	178.18826	426.63533
49	ENVUSE MAX	0.50000	18.59236	204.88326	376.21624
49	ENVUSE MAX	0.75000	18.59236	231.57827	318.67625
49	ENVUSE MAX	1.00000	18.59236	258.27327	258.25376
49	ENVUSE MIN	0.00000	-235.53192	0.00000	0.00000
49	ENVUSE MIN	0.25000	-235.53192	0.00000	0.00000
49	ENVUSE MIN	0.50000	-235.53192	0.00000	0.00000
49	ENVUSE MIN	0.75000	-235.53192	0.00000	-6.18990
49	ENVUSE MIN	1.00000	-235.53192	0.00000	-26.02268
50	ENVUSE MAX	0.00000	19.36563	258.27327	258.25376
50	ENVUSE MAX	0.25000	19.36563	284.96828	196.33680
50	ENVUSE MAX	0.50000	19.36563	311.66329	127.29894
50	ENVUSE MAX	0.75000	19.36563	338.35829	55.37284
50	ENVUSE MAX	1.00000	19.36563	365.05330	0.00000
50	ENVUSE MIN	0.00000	-235.53192	0.00000	-26.02268
50	ENVUSE MIN	0.25000	-235.53192	0.00000	-47.45645
50	ENVUSE MIN	0.50000	-235.53192	0.00000	-70.49123
50	ENVUSE MIN	0.75000	-235.53192	0.00000	-95.12701
50	ENVUSE MIN	1.00000	-235.53192	0.00000	-167.43355
51	ENVUSE MAX	0.00000	19.85005	365.05330	0.00000
51	ENVUSE MAX	0.25000	19.85005	391.72329	0.00000
51	ENVUSE MAX	0.50000	19.85005	418.39327	0.00000
51	ENVUSE MAX	0.75000	19.85005	445.06326	0.00000
51	ENVUSE MAX	1.00000	19.85005	471.73325	0.00000
51	ENVUSE MIN	0.00000	-235.53192	0.00000	-167.43355
51	ENVUSE MIN	0.25000	-235.53192	0.00000	-250.66879
51	ENVUSE MIN	0.50000	-235.53192	0.00000	-341.91426
51	ENVUSE MIN	0.75000	-235.53192	0.00000	-449.75212
51	ENVUSE MIN	1.00000	-235.53192	0.00000	-571.76566
52	ENVUSE MAX	0.00000	19.92666	471.73325	0.00000
52	ENVUSE MAX	0.25000	19.92666	479.66419	0.00000
52	ENVUSE MAX	0.50000	19.92666	487.59514	0.00000
52	ENVUSE MAX	0.75000	19.92666	495.52608	0.00000
52	ENVUSE MAX	1.00000	19.92666	503.45702	0.00000
52	ENVUSE MIN	0.00000	-235.53192	0.00000	-571.76566
52	ENVUSE MIN	0.25000	-235.53192	0.00000	-609.42030

43	ENVUSE MIN	0.77500	-235.53192	-355.73123	-277.08542
43	ENVUSE MIN	1.00000	-235.53192	-344.29701	-246.02708
44	ENVUSE MAX	0.00000	18.59236	0.00000	161.61428
44	ENVUSE MAX	0.25000	18.59236	0.00000	170.04398
44	ENVUSE MAX	0.50000	18.59236	0.00000	178.38807
FRAME	LOAD	DIST	P	V2	M3
53	ENVUSE MAX	0.45000	19.93040	525.97390	0.00000
53	ENVUSE MAX	0.67500	19.93040	537.23234	0.00000
53	ENVUSE MAX	0.90000	19.93040	548.49077	0.00000
53	ENVUSE MIN	0.00000	-235.53192	0.00000	-726.15537
53	ENVUSE MIN	0.22500	-235.53192	0.00000	-783.36443
53	ENVUSE MIN	0.45000	-235.53192	0.00000	-841.84005
53	ENVUSE MIN	0.67500	-235.53192	0.00000	-901.58225
53	ENVUSE MIN	0.90000	-235.53192	0.00000	-962.59103
54	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
54	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
55	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
56	ENVUSE MAX	0.10000	18.96036	0.00000	0.00000
56	ENVUSE MAX	0.32500	18.96036	0.00000	0.00000
56	ENVUSE MAX	0.55000	18.96036	0.00000	0.00000
56	ENVUSE MAX	0.77500	18.96036	0.00000	0.00000
56	ENVUSE MAX	1.00000	18.96036	0.00000	0.00000
56	ENVUSE MIN	0.10000	-235.50136	-549.32161	-963.19682
56	ENVUSE MIN	0.32500	-235.50136	-538.06317	-902.14131
56	ENVUSE MIN	0.55000	-235.50136	-526.80473	-842.35237
56	ENVUSE MIN	0.77500	-235.50136	-515.54629	-783.83001
56	ENVUSE MIN	1.00000	-235.50136	-504.28786	-726.57423
57	ENVUSE MAX	0.00000	18.95877	0.00000	0.00000
57	ENVUSE MAX	0.25000	18.95877	0.00000	0.00000
57	ENVUSE MAX	0.50000	18.95877	0.00000	0.00000
57	ENVUSE MAX	0.75000	18.95877	0.00000	0.00000
57	ENVUSE MAX	1.00000	18.95877	0.00000	0.00000
57	ENVUSE MIN	0.00000	-235.50136	-504.28786	-726.57423
57	ENVUSE MIN	0.25000	-235.50136	-496.35691	-687.00109
57	ENVUSE MIN	0.50000	-235.50136	-488.42597	-648.05647
57	ENVUSE MIN	0.75000	-235.50136	-480.49503	-609.74039
57	ENVUSE MIN	1.00000	-235.50136	-472.56408	-572.05283
58	ENVUSE MAX	0.00000	18.88654	0.00000	0.00000
58	ENVUSE MAX	0.25000	18.88654	0.00000	0.00000
58	ENVUSE MAX	0.50000	18.88654	0.00000	0.00000
58	ENVUSE MAX	0.75000	18.88654	0.00000	0.00000
58	ENVUSE MAX	1.00000	18.88654	0.00000	0.00000
58	ENVUSE MIN	0.00000	-235.50136	-472.56408	-572.05283
58	ENVUSE MIN	0.25000	-235.50136	-445.89409	-449.92858
58	ENVUSE MIN	0.50000	-235.50136	-419.22411	-341.96949
58	ENVUSE MIN	0.75000	-235.50136	-392.55412	-250.63102
58	ENVUSE MIN	1.00000	-235.50136	-365.88413	-167.30279
59	ENVUSE MAX	0.00000	18.59236	0.00000	0.00000
59	ENVUSE MAX	0.25000	18.59236	0.00000	55.45810
59	ENVUSE MAX	0.50000	18.59236	0.00000	127.41966
59	ENVUSE MAX	0.75000	18.59236	0.00000	196.49297
59	ENVUSE MAX	1.00000	18.59236	0.00000	258.44539
59	ENVUSE MIN	0.00000	-235.50136	-365.88413	-167.30279
59	ENVUSE MIN	0.25000	-235.50136	-339.18913	-95.12701
59	ENVUSE MIN	0.50000	-235.50136	-312.49412	-70.49123
59	ENVUSE MIN	0.75000	-235.50136	-285.79911	-47.45645
59	ENVUSE MIN	1.00000	-235.50136	-259.10411	-26.02268
60	ENVUSE MAX	0.00000	18.59236	0.00000	258.44539
60	ENVUSE MAX	0.25000	18.59236	0.00000	320.32280
60	ENVUSE MAX	0.50000	18.59236	0.00000	378.11986
60	ENVUSE MAX	0.75000	18.59236	0.00000	428.79604
60	ENVUSE MAX	1.00000	18.59236	0.00000	472.35132
60	ENVUSE MIN	0.00000	-235.50136	-259.10411	-26.02268
60	ENVUSE MIN	0.25000	-235.50136	-232.40910	-6.18990
60	ENVUSE MIN	0.50000	-235.50136	-205.71409	0.00000
60	ENVUSE MIN	0.75000	-235.50136	-179.01909	0.00000
60	ENVUSE MIN	1.00000	-235.50136	-152.32408	0.00000
61	ENVUSE MAX	0.00000	18.59236	0.00000	472.35132
61	ENVUSE MAX	0.25000	18.59236	0.00000	508.75489
61	ENVUSE MAX	0.50000	18.59236	0.00000	538.05092
61	ENVUSE MAX	0.75000	18.59236	6.95932	560.23939
61	ENVUSE MAX	1.00000	18.59236	26.70031	575.32031
52	ENVUSE MIN	0.50000	-235.53192	0.00000	-647.70346
52	ENVUSE MIN	0.75000	-235.53192	0.00000	-686.61516
52	ENVUSE MIN	1.00000	-235.53192	0.00000	-726.15537
53	ENVUSE MAX	0.00000	19.93040	503.45702	0.00000
53	ENVUSE MAX	0.22500	19.93040	514.71546	0.00000
FRAME	LOAD	DIST	P	V2	M3
62	ENVUSE MAX	0.25000	18.59236	46.41664	583.29782
62	ENVUSE MAX	0.50000	18.59236	70.65138	584.15443
62	ENVUSE MAX	0.75000	18.59236	94.94564	577.89016
62	ENVUSE MAX	1.00000	18.59236	119.82617	564.50499
62	ENVUSE MIN	0.00000	-235.50136	-49.09835	0.00000
62	ENVUSE MIN	0.25000	-235.50136	-26.93809	0.00000
62	ENVUSE MIN	0.50000	-235.50136	-17.35437	0.00000
62	ENVUSE MIN	0.75000	-235.50136	-11.35249	0.00000
62	ENVUSE MIN	1.00000	-235.50136	-5.35062	0.00000
63	ENVUSE MAX	0.00000	18.59236	119.82617	564.50499
63	ENVUSE MAX	0.25000	18.59236	146.52118	543.99893
63	ENVUSE MAX	0.50000	18.59236	173.21618	516.37198
63	ENVUSE MAX	0.75000	18.59236	199.91119	481.62413
63	ENVUSE MAX	1.00000	18.59236	226.60620	439.75539
63	ENVUSE MIN	0.00000	-235.50136	-5.47219	0.00000
63	ENVUSE MIN	0.25000	-235.50136	0.00000	0.00000
63	ENVUSE MIN	0.50000	-235.50136	0.00000	0.00000
63	ENVUSE MIN	0.75000	-235.50136	0.00000	0.00000
63	ENVUSE MIN	1.00000	-235.50136	0.00000	0.00000
64	ENVUSE MAX	0.00000	18.59236	226.60620	439.75539
64	ENVUSE MAX	0.25000	18.59236	253.27618	390.81500
64	ENVUSE MAX	0.50000	18.59236	279.94617	334.76707
64	ENVUSE MAX	0.75000	18.59236	306.61616	271.61158
64	ENVUSE MAX	1.00000	18.59236	333.28615	201.34854
64	ENVUSE MIN	0.00000	-235.50136	0.00000	0.00000
64	ENVUSE MIN	0.25000	-235.50136	0.00000	-38.17848
64	ENVUSE MIN	0.50000	-235.50136	0.00000	-92.87739
64	ENVUSE MIN	0.75000	-235.50136	0.00000	-152.83726
64	ENVUSE MIN	1.00000	-235.50136	0.00000	-218.21713
65	ENVUSE MAX	0.00000	18.59236	333.28615	201.34854
65	ENVUSE MAX	0.25000	18.59236	336.21334	193.20388
65	ENVUSE MAX	0.50000	18.59236	339.14053	184.97361
65	ENVUSE MAX	0.75000	18.59236	342.06773	176.65771
65	ENVUSE MAX	1.00000	18.59236	344.99492	168.25619
65	ENVUSE MIN	0.00000	-235.50136	0.00000	-218.21713
65	ENVUSE MIN	0.25000	-235.50136	0.00000	-225.96196
65	ENVUSE MIN	0.50000	-235.50136	0.00000	-233.77017
65	ENVUSE MIN	0.75000	-235.50136	0.00000	-241.64175
65	ENVUSE MIN	1.00000	-235.50136	0.00000	-249.57671
66	ENVUSE MAX	0.00000	18.59236	344.99492	168.25619
66	ENVUSE MAX	0.22500	18.59236	356.42914	135.13813
66	ENVUSE MAX	0.45000	18.59236	368.21492	100.71394
66	ENVUSE MAX	0.67500	18.59236	380.35226	64.94408
66	ENVUSE MAX	0.90000	18.59236	392.84117	38.31159
66	ENVUSE MIN	0.00000	-235.50136	0.00000	-249.57671
66	ENVUSE MIN	0.22500	-235.50136	0.00000	-280.69299
66	ENVUSE MIN	0.45000	-235.50136	0.00000	-312.78635
66	ENVUSE MIN	0.67500	-235.50136	0.00000	-348.12689
66	ENVUSE MIN	0.90000	-235.50136	0.00000	-388.60407
67	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
67	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
68	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
69	ENVUSE MAX	0.10000	0.00000	18.59236	0.00000
69	ENVUSE MAX	0.32500	0.00000	18.59236	0.00000
69	ENVUSE MAX	0.55000	0.00000	18.59236	0.00000
69	ENVUSE MAX	0.77500	0.00000	18.59236	0.00000
69	ENVUSE MAX	1.00000	0.00000	18.59236	0.00000
69	ENVUSE MIN	0.10000	-466.62867	-222.50136	-522.84195
69	ENVUSE MIN	0.32500	-470.39039	-219.05956	-512.79881
69	ENVUSE MIN	0.55000	-473.80055	-215.42792	-502.81894
69	ENVUSE MIN	0.77500	-476.85914	-211.60643	-492.90235
69	ENVUSE MIN	1.00000	-479.56617	-207.59511	-483.04905
70	ENVUSE MAX	0.00000	0.00000	18.59236	0.00000
70	ENVUSE MAX	0.25000	0.00000	18.59236	0.00000
70	ENVUSE MAX	0.50000	0.00000	18.59236	0.00000
70	ENVUSE MAX	0.75000	0.00000	18.59236	0.00000

61	ENVUSE MIN	0.00000	-235.50136	-152.32408	0.00000
61	ENVUSE MIN	0.25000	-235.50136	-125.65409	0.00000
61	ENVUSE MIN	0.50000	-235.50136	-98.98411	0.00000
61	ENVUSE MIN	0.75000	-235.50136	-72.31412	0.00000
61	ENVUSE MIN	1.00000	-235.50136	-49.09835	0.00000
62	ENVUSE MAX	0.00000	18.59236	26.65713	575.32031
FRAME	LOAD	DIST	P	V2	M3
71	ENVUSE MAX	0.00000	0.00000	18.59236	0.00000
71	ENVUSE MAX	0.25000	0.00000	18.59236	0.00000
71	ENVUSE MAX	0.50000	0.00000	18.59236	0.00000
71	ENVUSE MAX	0.75000	0.00000	18.59236	0.00000
71	ENVUSE MAX	1.00000	0.00000	18.59236	11.89799
71	ENVUSE MIN	0.00000	-480.89367	-205.41531	-477.90684
71	ENVUSE MIN	0.25000	-486.57492	-195.49620	-456.09654
71	ENVUSE MIN	0.50000	-492.25617	-184.62131	-434.60502
71	ENVUSE MIN	0.75000	-497.93742	-172.79064	-413.43228
71	ENVUSE MIN	1.00000	-503.61867	-160.00420	-392.57833
72	ENVUSE MAX	0.00000	0.00000	18.59236	11.89801
72	ENVUSE MAX	0.25000	0.00000	18.59236	32.74143
72	ENVUSE MAX	0.50000	0.00000	18.59236	50.31956
72	ENVUSE MAX	0.75000	0.00000	18.59236	64.39154
72	ENVUSE MAX	1.00000	0.00000	19.12789	74.71653
72	ENVUSE MIN	0.00000	-503.61867	-160.00420	-392.57833
72	ENVUSE MIN	0.25000	-509.29430	-146.27562	-372.06333
72	ENVUSE MIN	0.50000	-514.96992	-131.79276	-351.86648
72	ENVUSE MIN	0.75000	-520.64555	-117.41590	-331.98778
72	ENVUSE MIN	1.00000	-526.32117	-103.63070	-312.42723
73	ENVUSE MAX	0.00000	0.00000	19.12789	74.71651
73	ENVUSE MAX	0.25000	0.00000	32.57115	81.05794
73	ENVUSE MAX	0.50000	0.00000	46.61971	83.16230
73	ENVUSE MAX	0.75000	0.00000	61.27358	82.54906
73	ENVUSE MAX	1.00000	0.00000	76.53275	86.97692
73	ENVUSE MIN	0.00000	-526.32117	-103.63076	-312.42723
73	ENVUSE MIN	0.25000	-532.00242	-94.52996	-293.16592
73	ENVUSE MIN	0.50000	-537.68367	-84.79199	-274.22339
73	ENVUSE MIN	0.75000	-543.36492	-78.22652	-264.53506
73	ENVUSE MIN	1.00000	-549.04617	-78.22652	-262.79644
74	ENVUSE MAX	0.00000	0.00000	76.53275	86.97835
74	ENVUSE MAX	0.25000	0.00000	92.38156	91.87206
74	ENVUSE MAX	0.50000	0.00000	108.83513	91.57369
74	ENVUSE MAX	0.75000	0.00000	128.11659	85.84240
74	ENVUSE MAX	1.00000	0.00000	153.23073	74.43858
74	ENVUSE MIN	0.00000	-549.04617	-78.22652	-262.79644
74	ENVUSE MIN	0.25000	-554.72180	-78.22652	-261.33010
74	ENVUSE MIN	0.50000	-560.39742	-78.22652	-260.13419
74	ENVUSE MIN	0.75000	-566.07305	-78.22652	-259.20871
74	ENVUSE MIN	1.00000	-571.74867	-78.22652	-258.55365
75	ENVUSE MAX	0.00000	0.00000	153.23075	74.43881
75	ENVUSE MAX	0.25000	0.00000	179.29965	57.88799
75	ENVUSE MAX	0.50000	0.00000	206.32332	35.18173
75	ENVUSE MAX	0.75000	0.00000	234.30175	6.07919
75	ENVUSE MAX	1.00000	0.00000	263.23496	0.00000
75	ENVUSE MIN	0.00000	-571.74867	-78.22652	-258.55365
75	ENVUSE MIN	0.25000	-577.42430	-78.22652	-258.16902
75	ENVUSE MIN	0.50000	-583.09992	-78.22652	-281.49856
75	ENVUSE MIN	0.75000	-588.77555	-78.22652	-307.63269
75	ENVUSE MIN	1.00000	-594.45117	-78.22652	-358.29878
76	ENVUSE MAX	0.00000	0.00000	263.23490	0.00000
76	ENVUSE MAX	0.25000	0.00000	293.15252	0.00000
76	ENVUSE MAX	0.50000	0.00000	324.02592	0.00000
76	ENVUSE MAX	0.75000	0.00000	355.85509	13.81034
76	ENVUSE MAX	1.00000	0.00000	388.64004	33.56253
76	ENVUSE MIN	0.00000	-594.45117	-78.22652	-358.29878
76	ENVUSE MIN	0.25000	-600.13242	-78.22652	-416.51502
76	ENVUSE MIN	0.50000	-605.81367	-78.22652	-480.03622
76	ENVUSE MIN	0.75000	-611.49492	-78.22652	-549.01522
76	ENVUSE MIN	1.00000	-617.17617	-78.22652	-623.60483
77	ENVUSE MAX	0.00000	0.00000	388.64008	33.56253
77	ENVUSE MAX	0.25000	0.00000	400.52369	40.58336
77	ENVUSE MAX	0.50000	0.00000	412.52825	47.60419
77	ENVUSE MAX	0.75000	0.00000	424.65378	54.62502
77	ENVUSE MAX	1.00000	0.00000	436.90027	61.64585
77	ENVUSE MIN	0.00000	-617.17617	-78.22652	-623.60483
77	ENVUSE MIN	0.25000	-619.19555	-78.22652	-651.49784
77	ENVUSE MIN	0.50000	-621.21492	-78.22652	-680.12589
77	ENVUSE MIN	0.75000	-623.23430	-78.22652	-711.68429
77	ENVUSE MIN	1.00000	-625.25367	-78.22652	-750.34562
78	ENVUSE MAX	0.00000	0.00000	436.90028	61.64585
78	ENVUSE MAX	0.08654	0.00000	444.63729	66.04610
78	ENVUSE MAX	0.17308	0.00000	452.42176	70.44634
78	ENVUSE MAX	0.25962	0.00000	460.25370	74.84658
78	ENVUSE MAX	0.34615	0.00000	468.13309	79.24682
78	ENVUSE MIN	0.00000	-625.25367	-78.22652	-750.34562
78	ENVUSE MIN	0.08654	-626.51930	-78.22652	-775.13864
78	ENVUSE MIN	0.17308	-627.78492	-78.22652	-800.36820
78	ENVUSE MIN	0.25962	-629.05055	-78.22652	-826.03698
78	ENVUSE MIN	0.34615	-630.31617	-78.22652	-852.14763
79	ENVUSE MAX	0.08669	0.00000	46.65757	161.82526
79	ENVUSE MAX	0.29876	0.00000	46.65757	81.92417
70	ENVUSE MAX	1.00000	0.00000	18.59236	0.00000
70	ENVUSE MIN	0.00000	-479.56617	-207.59509	-483.04905
70	ENVUSE MIN	0.25000	-479.89805	-207.05508	-481.76187
70	ENVUSE MIN	0.50000	-480.22992	-206.51177	-480.47577
70	ENVUSE MIN	0.75000	-480.56180	-205.96518	-479.19076
70	ENVUSE MIN	1.00000	-480.89367	-205.41531	-477.90684
FRAME	LOAD	DIST	P	V2	M3
79	ENVUSE MIN	0.93498	-1230.04100	-46.65757	-157.77907

79	ENVUSE MAX	0.51084	0.00000	46.65757	9.09088
79	ENVUSE MAX	0.72291	0.00000	46.65757	77.87799
79	ENVUSE MAX	0.93498	0.00000	46.65757	157.77907
79	ENVUSE MIN	0.08669	-1144.41600	-46.65757	-161.82526
79	ENVUSE MIN	0.29876	-1165.82200	-46.65757	-81.92417
79	ENVUSE MIN	0.51084	-1187.22900	-46.65757	-9.09088
79	ENVUSE MIN	0.72291	-1208.63500	-46.65757	-77.87799

19. OUTPUT DATA (기능수행)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.27778	81.73265	7.32454	338.92609
1	ENVEQ MAX	0.45833	80.76212	4.94798	339.32320
1	ENVEQ MAX	0.63889	79.79159	2.57141	339.97777
1	ENVEQ MAX	0.81944	78.82105	0.19485	340.88981
1	ENVEQ MAX	1.00000	77.85052	0.00000	342.21537
1	ENVEQ MIN	0.27778	-401.39149	-175.86956	-609.19049
1	ENVEQ MIN	0.45833	-400.42095	-179.03831	-594.77263
1	ENVEQ MIN	0.63889	-399.45042	-182.20706	-580.09731
1	ENVEQ MIN	0.81944	-398.47989	-185.37581	-565.16454
1	ENVEQ MIN	1.00000	-397.50936	-188.54456	-553.04889
2	ENVEQ MAX	0.00000	77.85057	0.00000	342.21537
2	ENVEQ MAX	0.25000	76.00806	0.00000	349.62817
2	ENVEQ MAX	0.50000	74.16554	0.00000	357.96889
2	ENVEQ MAX	0.75000	72.32302	0.00000	367.23755
2	ENVEQ MAX	1.00000	70.48051	0.00000	377.43413
2	ENVEQ MIN	0.00000	-397.50936	-188.54447	-553.04889
2	ENVEQ MIN	0.25000	-395.66684	-194.56022	-530.69612
2	ENVEQ MIN	0.50000	-393.82433	-200.57597	-507.64740
2	ENVEQ MIN	0.75000	-391.98181	-206.59172	-483.90274
2	ENVEQ MIN	1.00000	-390.13930	-212.60747	-459.46213
3	ENVEQ MAX	0.00000	69.90684	27.95443	377.43413
3	ENVEQ MAX	0.25000	68.46448	24.09910	376.76079
3	ENVEQ MAX	0.50000	67.02212	20.56716	376.65609
3	ENVEQ MAX	0.75000	65.57976	17.03523	377.12003
3	ENVEQ MAX	1.00000	64.13740	13.50329	378.15261
3	ENVEQ MIN	0.00000	-386.61374	-134.43929	-459.46213
3	ENVEQ MIN	0.25000	-385.17138	-139.14854	-446.01486
3	ENVEQ MIN	0.50000	-383.72902	-143.85779	-432.14110
3	ENVEQ MIN	0.75000	-382.28666	-148.56704	-417.84087
3	ENVEQ MIN	1.00000	-380.84430	-153.27629	-403.11415
4	ENVEQ MAX	0.00000	64.13743	13.93625	378.15261
4	ENVEQ MAX	0.25000	63.24156	12.16438	379.05915
4	ENVEQ MAX	0.50000	62.34568	10.39250	380.14288
4	ENVEQ MAX	0.75000	61.44981	8.62063	381.40379
4	ENVEQ MAX	1.00000	60.55393	6.84875	382.84189
4	ENVEQ MIN	0.00000	-380.84430	-153.27628	-403.11415
4	ENVEQ MIN	0.25000	-379.94843	-155.63878	-393.76823
4	ENVEQ MIN	0.50000	-379.05255	-158.00128	-384.28941
4	ENVEQ MIN	0.75000	-378.15668	-160.36378	-374.67771
4	ENVEQ MIN	1.00000	-377.26080	-162.72628	-364.93311
5	ENVEQ MAX	0.00000	60.55396	7.16219	382.84189
5	ENVEQ MAX	0.25000	59.70885	5.09275	384.37968
5	ENVEQ MAX	0.50000	58.86374	3.02331	386.11269
5	ENVEQ MAX	0.75000	58.01863	0.95388	388.04091
5	ENVEQ MAX	1.00000	57.17352	0.00000	390.16435
5	ENVEQ MIN	0.00000	-377.26080	-162.72628	-364.93311
5	ENVEQ MIN	0.25000	-376.41569	-165.48553	-355.60483
5	ENVEQ MIN	0.50000	-375.57058	-168.24478	-346.13013
5	ENVEQ MIN	0.75000	-374.72547	-171.00403	-336.50901
5	ENVEQ MIN	1.00000	-373.88037	-173.76328	-326.74149
6	ENVEQ MAX	0.00000	56.60955	53.60158	390.16435
6	ENVEQ MAX	0.25000	53.42322	43.19833	379.70574
6	ENVEQ MAX	0.50000	50.23690	32.79508	372.02219
6	ENVEQ MAX	0.75000	47.05057	22.39183	367.11371
6	ENVEQ MAX	1.00000	43.86424	13.79699	364.98030
6	ENVEQ MIN	0.00000	-370.41286	-93.32126	-326.74149
6	ENVEQ MIN	0.25000	-367.22653	-103.72451	-303.02755
6	ENVEQ MIN	0.50000	-364.04020	-114.12776	-277.23231
6	ENVEQ MIN	0.75000	-360.85387	-124.53101	-249.35578
6	ENVEQ MIN	1.00000	-357.66755	-134.93426	-219.39794
7	ENVEQ MAX	0.00000	43.30750	79.10041	364.98030
7	ENVEQ MAX	0.25000	40.12117	68.69716	345.34168
7	ENVEQ MAX	0.50000	36.93484	58.29391	328.47813
7	ENVEQ MAX	0.75000	33.74852	47.89066	314.38964
7	ENVEQ MAX	1.00000	30.56219	37.48741	303.07622
7	ENVEQ MIN	0.00000	-354.25219	-60.35729	-219.39794
7	ENVEQ MIN	0.25000	-351.06586	-68.15973	-202.25698
7	ENVEQ MIN	0.50000	-347.87953	-75.96217	-183.03472
7	ENVEQ MIN	0.75000	-344.69320	-84.40975	-161.73116
7	ENVEQ MIN	1.00000	-341.50687	-94.81300	-138.34630
8	ENVEQ MAX	0.00000	30.01074	114.66064	303.07622
8	ENVEQ MAX	0.25000	26.82740	104.26714	273.90410
8	ENVEQ MAX	0.50000	23.64406	93.87364	247.50184
8	ENVEQ MAX	0.75000	20.46071	83.48014	223.86945
8	ENVEQ MAX	1.00000	17.27737	73.08664	205.27698
8	ENVEQ MIN	0.00000	-338.14135	-35.17527	-138.34630
8	ENVEQ MIN	0.25000	-334.95801	-42.97040	-128.06887
8	ENVEQ MIN	0.50000	-331.77466	-50.76552	-115.71403
8	ENVEQ MIN	0.75000	-328.59132	-58.56065	-101.28179
8	ENVEQ MIN	1.00000	-325.40798	-66.35577	-84.77215
9	ENVEQ MAX	0.00000	16.86503	152.95429	205.27698
9	ENVEQ MAX	0.25000	13.67870	142.55104	169.83402
9	ENVEQ MAX	0.50000	10.49237	132.14779	137.16613
9	ENVEQ MAX	0.75000	7.30604	121.74454	107.27331
9	ENVEQ MAX	1.00000	4.11971	111.34129	80.15645
9	ENVEQ MIN	0.00000	-322.08994	-10.07105	-84.77215
9	ENVEQ MIN	0.25000	-318.90361	-17.87349	-81.50634
9	ENVEQ MIN	0.50000	-315.71728	-25.67593	-76.15922
9	ENVEQ MIN	0.75000	-312.53095	-33.47837	-72.54698
9	ENVEQ MIN	1.00000	-309.34462	-41.28080	-71.26008
10	ENVEQ MAX	0.00000	3.72091	194.30111	80.15645
10	ENVEQ MAX	0.25000	0.53459	183.89786	35.49423
10	ENVEQ MAX	0.50000	0.00000	173.49461	0.00000
10	ENVEQ MAX	0.75000	0.00000	163.09136	0.00000
10	ENVEQ MAX	1.00000	0.00000	152.68811	0.00000
10	ENVEQ MIN	0.00000	-306.29373	0.00000	-71.26008
10	ENVEQ MIN	0.25000	-303.10740	0.00000	-88.80061
10	ENVEQ MIN	0.50000	-299.92107	-0.36541	-103.57108
10	ENVEQ MIN	0.75000	-296.73474	-8.16785	-118.48790
10	ENVEQ MIN	1.00000	-293.54841	-15.97028	-138.52524
11	ENVEQ MAX	0.00000	0.00000	238.95578	0.00000
11	ENVEQ MAX	0.25000	0.00000	228.56228	0.00000
11	ENVEQ MAX	0.50000	0.00000	218.16878	0.00000
11	ENVEQ MAX	0.75000	0.00000	207.77528	0.00000
11	ENVEQ MAX	1.00000	0.00000	197.38178	0.00000
11	ENVEQ MIN	0.00000	-291.40757	0.00000	-138.52524
11	ENVEQ MIN	0.25000	-288.22423	0.00000	-185.41029
11	ENVEQ MIN	0.50000	-285.04088	0.00000	-244.93720
11	ENVEQ MIN	0.75000	-281.85754	0.00000	-301.69425
11	ENVEQ MIN	1.00000	-283.76064	0.00000	-355.68143
12	ENVEQ MAX	0.00000	0.00000	286.56984	0.00000
12	ENVEQ MAX	0.25000	0.00000	284.94159	0.00000
12	ENVEQ MAX	0.50000	0.00000	283.31334	0.00000
12	ENVEQ MAX	0.75000	0.00000	281.68509	0.00000
12	ENVEQ MAX	1.00000	0.00000	280.05684	0.00000
12	ENVEQ MIN	0.00000	-286.86955	0.00000	-355.68143
12	ENVEQ MIN	0.25000	-287.36826	0.00000	-367.61173
12	ENVEQ MIN	0.50000	-287.86696	0.00000	-379.47405
12	ENVEQ MIN	0.75000	-288.36566	0.00000	-391.26839
12	ENVEQ MIN	1.00000	-288.86437	0.00000	-402.99475
13	ENVEQ MAX	0.00000	0.00000	280.05692	0.00000
13	ENVEQ MAX	0.25000	0.00000	277.13192	0.00000
13	ENVEQ MAX	0.50000	0.00000	274.20692	0.00000
13	ENVEQ MAX	0.75000	0.00000	271.28192	0.00000
13	ENVEQ MAX	1.00000	0.00000	268.35692	0.00000
13	ENVEQ MIN	0.00000	-288.86437	0.00000	-402.99475
13	ENVEQ MIN	0.25000	-289.76024	0.00000	-423.88933
13	ENVEQ MIN	0.50000	-290.65612	0.00000	-444.56454
13	ENVEQ MIN	0.75000	-291.55199	0.00000	-465.02037
13	ENVEQ MIN	1.00000	-292.44787	0.00000	-485.25683
14	ENVEQ MAX	0.00000	0.00000	268.35703	0.00000
14	ENVEQ MAX	0.25000	0.00000	264.94453	0.00000
14	ENVEQ MAX	0.50000	0.00000	261.53203	0.00000
14	ENVEQ MAX	0.75000	0.00000	258.11953	0.00000
14	ENVEQ MAX	1.00000	0.00000	254.70703	0.00000
14	ENVEQ MIN	0.00000	-292.44787	0.00000	-485.25683
14	ENVEQ MIN	0.25000	-293.49305	0.00000	-508.58877
14	ENVEQ MIN	0.50000	-294.53824	0.00000	-531.62212
14	ENVEQ MIN	0.75000	-295.58343	0.00000	-554.35687
14	ENVEQ MIN	1.00000	-296.62862	0.00000	-576.79304
15	ENVEQ MAX	0.00000	0.00000	254.70713	0.00000
15	ENVEQ MAX	0.25000	0.00000	252.26963	0.00000
15	ENVEQ MAX	0.50000	0.00000	249.83213	0.00000
15	ENVEQ MAX	0.75000	0.00000	247.39463	0.00000
15	ENVEQ MAX	1.00000	0.00000	244.95713	0.00000
15	ENVEQ MIN	0.00000	-296.62862	0.00000	-576.79304
15	ENVEQ MIN	0.25000	-297.37518	0.00000	-592.63606
15	ENVEQ MIN	0.50000	-298.12174	0.00000	-608.32674
15	ENVEQ MIN	0.75000	-298.86830	0.00000	-623.86508
15	ENVEQ MIN	1.00000	-299.61487	0.00000	-639.25107
16	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
16	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
16	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
16	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
16	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
16	ENVEQ MIN	0.00000	-299.61487	-244.93675	-639.19657
16	ENVEQ MIN	0.25000	-298.86830	-247.37425	-623.81185
16	ENVEQ MIN	0.50000	-298.12174	-249.81175	-608.27479
16	ENVEQ MIN	0.75000	-297.37518	-252.24925	-592.58538
16	ENVEQ MIN	1.00000	-296.62862	-254.68675	-576.74363
17	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
17	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
17	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
17	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
17	ENVEQ MIN	0.00000	-296.62862	-254.68670	-576.74363
17	ENVEQ MIN	0.25000	-295.58343	-258.09920	-554.30925
17	ENVEQ MIN	0.50000	-294.53824	-261.51170	-531.57627
17	ENVEQ MIN	0.75000	-293.49305	-264.92420	-508.54470
17	ENVEQ MIN	1.00000	-292.44787	-268.33670	-485.21454
18	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
18	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
18	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
18	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
18	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
18	ENVEQ MIN	0.00000	-292.44787	-268.33665	-485.21454
18	ENVEQ MIN	0.25000	-291.55199	-271.26165	-464.97960
18	ENVEQ MIN	0.50000	-290.65612	-274.18665	-444.52529
18	ENVEQ MIN	0.75000	-289.76024	-277.11165	-423.85160
18	ENVEQ MIN	1.00000	-288.86437	-280.03665	-402.95854
19	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
19	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
19	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
19	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
19	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
19	ENVEQ MIN	0.00000	-288.86437	-280.03661	-402.95854
19	ENVEQ MIN	0.25000	-288.36566	-281.66486	-391.23303
19	ENVEQ MIN	0.50000	-287.86696	-283.29311	-379.43953
19	ENVEQ MIN	0.75000	-287.36826	-284.92136	-367.57805
19	ENVEQ MIN	1.00000	-286.86955	-286.54961	-355.64859
20	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
20	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
20	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
20	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
20	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
20	ENVEQ MIN	0.00000	-283.76064	-197.36511	-355.64859
20	ENVEQ MIN	0.25000	-281.85754	-207.75861	-301.66586
20	ENVEQ MIN	0.50000	-285.04088	-218.15211	-244.91326
20	ENVEQ MIN	0.75000	-288.22423	-228.54561	-185.39079
20	ENVEQ MIN	1.00000	-291.40757	-238.93911	-138.53661
21	ENVEQ MAX	0.00000	0.00000	15.97028	0.00000
21	ENVEQ MAX	0.25000	0.00000	8.16784	0.00000
21	ENVEQ MAX	0.50000	0.00000	0.36541	0.00000
21	ENVEQ MAX	0.75000	0.53468	0.00000	35.49423
21	ENVEQ MAX	1.00000	3.72101	0.00000	80.15645
21	ENVEQ MIN	0.00000	-293.54841	-152.67487	-138.53661
21	ENVEQ MIN	0.25000	-296.73474	-163.07812	-118.49481
21	ENVEQ MIN	0.50000	-299.92107	-173.48137	-103.57108
21	ENVEQ MIN	0.75000	-303.10740	-183.88462	-88.80061
21	ENVEQ MIN	1.00000	-306.29373	-194.28787	-71.26008
22	ENVEQ MAX	0.00000	4.11957	41.28080	80.15645
22	ENVEQ MAX	0.25000	7.30590	33.47836	107.27159
22	ENVEQ MAX	0.50000	10.49223	25.67592	137.16199
22	ENVEQ MAX	0.75000	13.67856	17.87349	169.82745
22	ENVEQ MAX	1.00000	16.86489	10.07105	205.26798
22	ENVEQ MIN	0.00000	-309.34462	-111.33123	-71.26008
22	ENVEQ MIN	0.25000	-312.53095	-121.73448	-72.54698
22	ENVEQ MIN	0.50000	-315.71728	-132.13773	-76.15922
22	ENVEQ MIN	0.75000	-318.90361	-142.54098	-81.50634
22	ENVEQ MIN	1.00000	-322.08994	-152.94423	-84.77215
23	ENVEQ MAX	0.00000	17.26511	66.35577	205.26798
23	ENVEQ MAX	0.25000	20.44845	58.56064	223.85775
23	ENVEQ MAX	0.50000	23.63180	50.76552	247.48824
23	ENVEQ MAX	0.75000	26.81514	42.97039	273.88859
23	ENVEQ MAX	1.00000	29.99848	35.17527	303.05882
23	ENVEQ MIN	0.00000	-325.40798	-73.07950	-84.77215
23	ENVEQ MIN	0.25000	-328.59132	-83.47300	-101.28179
23	ENVEQ MIN	0.50000	-331.77466	-93.86650	-115.71403
23	ENVEQ MIN	0.75000	-334.95801	-104.26000	-128.06887
23	ENVEQ MIN	1.00000	-338.14135	-114.65350	-138.34630
24	ENVEQ MAX	0.00000	30.54714	94.81300	303.05882
24	ENVEQ MAX	0.25000	33.73346	84.40975	314.37105
24	ENVEQ MAX	0.50000	36.91979	75.96217	328.45836
24	ENVEQ MAX	0.75000	40.10612	68.15973	345.32073
24	ENVEQ MAX	1.00000	43.29245	60.35729	364.95816
24	ENVEQ MIN	0.00000	-341.50687	-37.48398	-138.34630
24	ENVEQ MIN	0.25000	-344.69320	-47.88723	-161.73116
24	ENVEQ MIN	0.50000	-347.87953	-58.29048	-183.03472
24	ENVEQ MIN	0.75000	-351.06586	-68.69373	-202.25698
24	ENVEQ MIN	1.00000	-354.25219	-79.09698	-219.39794
25	ENVEQ MAX	0.00000	43.84974	134.93426	364.95816
25	ENVEQ MAX	0.25000	47.03607	124.53101	367.09107
25	ENVEQ MAX	0.50000	50.22239	114.12776	371.99905
25	ENVEQ MAX	0.75000	53.40872	103.72451	379.68210
25	ENVEQ MAX	1.00000	56.59505	93.32126	390.14021
25	ENVEQ MIN	0.00000	-357.66755	-13.79634	-219.39794
25	ENVEQ MIN	0.25000	-360.85387	-22.39045	-249.35578
25	ENVEQ MIN	0.50000	-364.04020	-32.79370	-277.23231
25	ENVEQ MIN	0.75000	-367.22653	-43.19695	-303.02755
25	ENVEQ MIN	1.00000	-370.41286	-53.60020	-326.74149
26	ENVEQ MAX	0.00000	57.15954	173.76328	390.14021
26	ENVEQ MAX	0.25000	58.00465	171.00403	388.01681
26	ENVEQ MAX	0.75000	59.69487	165.48553	384.35566
26	ENVEQ MAX	1.00000	60.53998	162.72628	382.81791
26	ENVEQ MIN	0.00000	-373.88037	0.00000	-326.74149
26	ENVEQ MIN	0.25000	-374.72547	-0.95314	-336.50901
26	ENVEQ MIN	0.50000	-375.57058	-3.02258	-346.13013
26	ENVEQ MIN	0.75000	-376.41569	-5.09201	-355.60483
26	ENVEQ MIN	1.00000	-377.26080	-7.16145	-364.93311
27	ENVEQ MAX	0.00000	60.53997	162.72628	382.81791
27	ENVEQ MAX	0.25000	61.43585	160.36378	381.37986
27	ENVEQ MAX	0.50000	62.33172	158.00128	380.11899
27	ENVEQ MAX	0.75000	63.22760	155.63878	379.03530
27	ENVEQ MAX	1.00000	64.12347	153.27628	378.12881
27	ENVEQ MIN	0.00000	-377.26080	-6.84987	-364.93311
27	ENVEQ MIN	0.25000	-378.15668	-8.62174	-374.67771
27	ENVEQ MIN	0.50000	-379.05255	-10.39362	-384.28941
27	ENVEQ MIN	0.75000	-379.94843	-12.16549	-393.76823
27	ENVEQ MIN	1.00000	-380.84430	-13.93737	-403.11415
28	ENVEQ MAX	0.00000	64.12346	153.27629	378.12881
28	ENVEQ MAX	0.25000	65.56582	148.56704	377.09630
28	ENVEQ MAX	0.50000	67.00818	143.85779	376.63244
28	ENVEQ MAX	0.75000	68.45054	139.14854	376.73722
28	ENVEQ MAX	1.00000	69.89290	134.43929	377.41064
28	ENVEQ MIN	0.00000	-380.84430	-13.50294	-403.11415
28	ENVEQ MIN	0.25000	-382.28666	-17.03488	-417.84087
28	ENVEQ MIN	0.50000	-383.72902	-20.56682	-432.14110
28	ENVEQ MIN	0.75000	-385.17138	-24.09876	-446.01486
28	ENVEQ MIN	1.00000	-386.61374	-27.95391	-459.46213
29	ENVEQ MAX	0.00000	70.46708	212.60747	377.41064
29	ENVEQ MAX	0.25000	72.30960	206.59172	367.21453
29	ENVEQ MAX	0.50000	74.15211	200.57597	357.94635
29	ENVEQ MAX	0.75000	75.99463	194.56022	349.60610
29	ENVEQ MAX	1.00000	77.83715	188.54447	342.19378
29	ENVEQ MIN	0.00000	-390.13930	0.00000	-459.46213
29	ENVEQ MIN	0.25000	-391.98181	0.00000	-483.90274
29	ENVEQ MIN	0.50000	-393.82433	0.00000	-507.64740
29	ENVEQ MIN	0.75000	-395.66684	0.00000	-530.69612
29	ENVEQ MIN	1.00000	-397.50936	0.00000	-553.04889
30	ENVEQ MAX	0.00000	77.83713	188.54456	342.19378
30	ENVEQ MAX	0.18056	78.80766	185.37581	340.87336
30	ENVEQ MAX	0.36111	79.77819	182.20706	339.96154
30	ENVEQ MAX	0.54167	80.74872	179.03831	339.30718
30	ENVEQ MAX	0.72222	81.71925	175.86956	338.91028
30	ENVEQ MIN	0.00000	-397.50936	0.00000	-553.04889
30	ENVEQ MIN	0.18056	-398.47989	-0.19540	-565.16454
30	ENVEQ MIN	0.36111	-399.45042	-2.57197	-580.09731
30	ENVEQ MIN	0.54167	-400.42095	-4.94853	-594.77263
30	ENVEQ MIN	0.72222	-401.39149	-7.32509	-609.19049
31	ENVEQ MAX	0.65385	0.00000	88.04736	300.93479
31	ENVEQ MAX	0.74038	0.00000	87.66078	295.99283
31	ENVEQ MAX	0.82692	0.00000	87.27116	291.07362
31	ENVEQ MAX	0.91346	0.00000	87.05218	286.17917
31	ENVEQ MAX	1.00000	0.00000	86.79746	281.31149
31	ENVEQ MIN	0.65385	-224.67855	-362.17813	-468.28496
31	ENVEQ MIN	0.74038	-222.70868	-356.77300	-448.06444
31	ENVEQ MIN	0.82692	-220.73880	-351.36377	-428.14807
31	ENVEQ MIN	0.91346	-218.76893	-345.95045	-408.53609
31	ENVEQ MIN	1.00000	-216.79905	-340.53304	-389.22872
32	ENVEQ MAX	0.00000	0.00000	86.79745	281.31149
32	ENVEQ MAX	0.25000	0.00000	86.31933	273.60519
32	ENVEQ MAX	0.50000	0.00000	85.75482	265.97992
32	ENVEQ MAX	0.75000	0.00000	85.10393	258.44342
32	ENVEQ MAX	1.00000	0.00000	84.36666	251.00344
32	ENVEQ MIN	0.00000	-216.79912	-340.53304	-389.22872
32	ENVEQ MIN	0.25000	-213.65607	-331.88311	-359.05400
32	ENVEQ MIN	0.50000	-210.51303	-323.22744	-329.65588
32	ENVEQ MIN	0.75000	-207.36998	-314.56603	-301.03485
32	ENVEQ MIN	1.00000	-204.22694	-305.89887	-273.19145
33	ENVEQ MAX	0.00000	0.00000	96.29701	251.00344
33	ENVEQ MAX	0.25000	0.00000	93.53176	232.06514
33	ENVEQ MAX	0.50000	0.00000	90.38924	240.51778
33	ENVEQ MAX	0.75000	0.00000	86.61554	245.64468
33	ENVEQ MAX	1.00000	0.00000	82.21064	247.76679
33	ENVEQ MIN	0.00000	-246.98545	-305.89887	-273.19145
33	ENVEQ MIN	0.25000	-238.14290	-281.50986	-202.24258
33	ENVEQ MIN	0.50000	-229.30035	-257.12685	-169.31067
33	ENVEQ MIN	0.75000	-220.45780	-233.48161	-140.14447
33	ENVEQ MIN	1.00000	-211.61525	-211.25685	-112.55754
34	ENVEQ MAX	0.00000	0.00000	102.86109	247.76679
34	ENVEQ MAX	0.25000	0.00000	97.86761	242.47907
34	ENVEQ MAX	0.50000	0.00000	92.31880	234.81209
34	ENVEQ MAX	0.75000	0.00000	86.21467	225.06646
34	ENVEQ MAX	1.00000	0.00000	79.55521	213.54284
34	ENVEQ MIN	0.00000	-254.45112	-211.25685	-112.55754
34	ENVEQ MIN	0.25000	-245.61732	-189.09766	-86.72489
34	ENVEQ MIN	0.50000	-236.78353	-167.01964	-62.76274
34	ENVEQ MIN	0.75000	-227.94973	-145.02278	-40.81118
34	ENVEQ MIN	1.00000	-219.11594	-123.10708	-21.01028
35	ENVEQ MAX	0.00000	0.00000	111.37466	213.54284

26	ENVEQ MAX	0.50000	58.84976	168.24478	386.08863
FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	96.54312	213.22331
35	ENVEQ MAX	0.75000	0.00000	97.53763	228.67008
35	ENVEQ MAX	1.00000	0.00000	101.63531	240.65648
35	ENVEQ MIN	0.00000	-262.03157	-123.10708	-21.01028
35	ENVEQ MIN	0.25000	-253.19778	-101.31091	-3.49526
35	ENVEQ MIN	0.50000	-244.36398	-79.67265	-16.50422
35	ENVEQ MIN	0.75000	-235.53019	-64.29343	-37.68222
35	ENVEQ MIN	1.00000	-226.69639	-54.60898	-57.28634
36	ENVEQ MAX	0.00000	0.00000	136.11170	240.65648
36	ENVEQ MAX	0.25000	0.00000	139.13552	247.29135
36	ENVEQ MAX	0.50000	0.00000	141.11979	248.61622
36	ENVEQ MAX	0.75000	0.00000	142.06452	244.69039
36	ENVEQ MAX	1.00000	0.00000	141.96970	235.57313
36	ENVEQ MIN	0.00000	-269.69435	-54.68654	-57.28634
36	ENVEQ MIN	0.25000	-260.85180	-44.55176	-85.77083
36	ENVEQ MIN	0.50000	-252.00925	-34.01462	-111.91644
36	ENVEQ MIN	0.75000	-243.16670	-23.07512	-135.62160
36	ENVEQ MIN	1.00000	-234.32415	-11.73326	-156.78470
37	ENVEQ MAX	0.00000	0.00000	189.28694	235.57313
37	ENVEQ MAX	0.25000	0.00000	188.19432	221.34380
37	ENVEQ MAX	0.50000	0.00000	186.14441	202.07214
37	ENVEQ MAX	0.75000	0.00000	183.13721	177.83777
37	ENVEQ MAX	1.00000	0.00000	179.17272	149.12961
37	ENVEQ MIN	0.00000	-277.40708	-12.82582	-156.78470
37	ENVEQ MIN	0.25000	-268.57328	-1.13381	-188.85013
37	ENVEQ MIN	0.50000	-259.73949	0.00000	-218.19622
37	ENVEQ MIN	0.75000	-250.90569	0.00000	-244.74205
37	ENVEQ MIN	1.00000	-244.98698	0.00000	-268.40669
38	ENVEQ MAX	0.00000	0.00000	238.79879	149.12932
38	ENVEQ MAX	0.25000	0.00000	233.91204	116.09318
38	ENVEQ MAX	0.50000	0.00000	228.14683	78.34405
38	ENVEQ MAX	0.75000	0.00000	230.35511	60.22434
38	ENVEQ MAX	1.00000	0.00000	250.17686	39.73823
38	ENVEQ MIN	0.00000	-289.93021	0.00000	-268.40669
38	ENVEQ MIN	0.25000	-285.13776	0.00000	-306.45960
38	ENVEQ MIN	0.50000	-280.34531	0.00000	-342.83853
38	ENVEQ MIN	0.75000	-275.55286	0.00000	-397.10277
38	ENVEQ MIN	1.00000	-270.76041	0.00000	-452.10114
39	ENVEQ MAX	0.00000	0.00000	282.55494	39.74058
39	ENVEQ MAX	0.25000	0.00000	282.08846	38.44512
39	ENVEQ MAX	0.50000	0.00000	281.61918	37.13778
39	ENVEQ MAX	0.75000	0.00000	281.14707	35.81853
39	ENVEQ MAX	1.00000	0.00000	280.67216	34.48736
39	ENVEQ MIN	0.00000	-315.79812	0.00000	-452.10114
39	ENVEQ MIN	0.25000	-315.51816	0.00000	-456.26538
39	ENVEQ MIN	0.50000	-315.23821	0.00000	-460.42272
39	ENVEQ MIN	0.75000	-314.95825	0.00000	-464.57312
39	ENVEQ MIN	1.00000	-314.67830	0.00000	-468.71653
40	ENVEQ MAX	0.00000	0.00000	280.67216	34.48699
40	ENVEQ MAX	0.22500	0.00000	276.95853	23.97881
40	ENVEQ MAX	0.45000	0.00000	273.08355	12.77324
40	ENVEQ MAX	0.67500	0.00000	280.42305	0.86638
40	ENVEQ MAX	0.90000	0.00000	288.79727	0.00000
40	ENVEQ MIN	0.00000	-314.67834	0.00000	-468.71653
40	ENVEQ MIN	0.22500	-312.33215	0.00000	-500.08470
40	ENVEQ MIN	0.45000	-309.56409	0.00000	-531.02601
40	ENVEQ MIN	0.67500	-306.37415	0.00000	-561.52232
40	ENVEQ MIN	0.90000	-302.76234	0.00000	-591.55546
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
43	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
43	ENVEQ MIN	0.10000	-331.68504	-256.26887	-583.89837
43	ENVEQ MIN	0.32500	-333.22280	-249.84231	-555.53230
43	ENVEQ MIN	0.55000	-334.76056	-243.83762	-527.86550
43	ENVEQ MIN	0.77500	-336.29833	-238.25481	-500.85050

35	ENVEQ MAX	0.25000	0.00000	104.19821	194.13857
FRAME	LOAD	DIST	P	V2	M3
44	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.50000	0.00000	0.00000	0.72905
44	ENVEQ MAX	0.75000	0.00000	0.00000	2.58287
44	ENVEQ MAX	1.00000	0.00000	0.00000	4.41937
44	ENVEQ MIN	0.00000	-337.83609	-233.09394	-474.43983
44	ENVEQ MIN	0.25000	-338.23591	-231.80694	-467.66632
44	ENVEQ MIN	0.50000	-338.63572	-230.51994	-460.93046
44	ENVEQ MIN	0.75000	-339.03554	-229.23294	-454.23225
44	ENVEQ MIN	1.00000	-339.43536	-227.94594	-447.57168
45	ENVEQ MAX	0.00000	0.00000	0.00000	4.41919
45	ENVEQ MAX	0.25000	0.00000	0.00000	20.53471
45	ENVEQ MAX	0.50000	0.00000	0.00000	36.24118
45	ENVEQ MAX	0.75000	0.00000	0.00000	67.71400
45	ENVEQ MAX	1.00000	0.00000	0.00000	99.38963
45	ENVEQ MIN	0.00000	-324.26803	-227.94121	-447.57168
45	ENVEQ MIN	0.25000	-327.91082	-216.21521	-388.62184
45	ENVEQ MIN	0.50000	-331.55361	-204.48921	-332.79904
45	ENVEQ MIN	0.75000	-335.19640	-192.76321	-292.60939
45	ENVEQ MIN	1.00000	-338.83919	-181.03721	-256.82196
46	ENVEQ MAX	0.00000	0.00000	0.00000	99.38963
46	ENVEQ MAX	0.25000	0.00000	0.00000	127.96393
46	ENVEQ MAX	0.50000	0.00000	0.00000	153.40738
46	ENVEQ MAX	0.75000	0.00000	0.00000	175.71998
46	ENVEQ MAX	1.00000	0.00000	0.00000	194.90174
46	ENVEQ MIN	0.00000	-323.74040	-181.03182	-256.82196
46	ENVEQ MIN	0.25000	-327.38660	-169.29482	-222.92127
46	ENVEQ MIN	0.50000	-331.03281	-157.55782	-190.94177
46	ENVEQ MIN	0.75000	-334.67901	-145.82082	-160.88348
46	ENVEQ MIN	1.00000	-338.32522	-134.08382	-132.74638
47	ENVEQ MAX	0.00000	0.00000	0.00000	194.90174
47	ENVEQ MAX	0.25000	0.00000	0.00000	210.95078
47	ENVEQ MAX	0.50000	0.00000	0.00000	223.86897
47	ENVEQ MAX	0.75000	0.00000	0.00000	233.65631
47	ENVEQ MAX	1.00000	0.00000	0.00000	240.31281
47	ENVEQ MIN	0.00000	-323.29492	-134.07777	-132.74638
47	ENVEQ MIN	0.25000	-326.94113	-122.34077	-106.53048
47	ENVEQ MIN	0.50000	-330.58734	-110.60377	-82.23579
47	ENVEQ MIN	0.75000	-334.23354	-98.86677	-60.25929
47	ENVEQ MIN	1.00000	-337.87975	-87.12977	-41.02208
48	ENVEQ MAX	0.00000	0.00000	0.00000	240.31281
48	ENVEQ MAX	0.25000	0.00000	3.74090	243.83463
48	ENVEQ MAX	0.50000	0.00000	10.93640	244.23146
48	ENVEQ MAX	0.75000	0.00000	19.12713	241.50332
48	ENVEQ MAX	1.00000	0.00000	30.85313	235.65019
48	ENVEQ MIN	0.00000	-322.91786	-87.12540	-41.02208
48	ENVEQ MIN	0.25000	-326.56065	-75.39940	-23.19835
48	ENVEQ MIN	0.50000	-330.20343	-63.67340	-7.29222
48	ENVEQ MIN	0.75000	-333.84622	-53.78476	0.00000
48	ENVEQ MIN	1.00000	-337.48901	-48.38814	0.00000
49	ENVEQ MAX	0.00000	0.00000	30.86297	235.65019
49	ENVEQ MAX	0.25000	0.00000	42.59997	226.66017
49	ENVEQ MAX	0.50000	0.00000	54.33697	214.53930
49	ENVEQ MAX	0.75000	0.00000	66.07397	199.28759
49	ENVEQ MAX	1.00000	0.00000	77.81097	186.32726
49	ENVEQ MIN	0.00000	-322.59538	-48.38814	0.00000
49	ENVEQ MIN	0.25000	-326.24159	-42.98645	0.00000
49	ENVEQ MIN	0.50000	-329.88779	-37.58476	0.00000
49	ENVEQ MIN	0.75000	-333.53400	-32.18308	0.00000
49	ENVEQ MIN	1.00000	-337.18020	-26.78139	0.00000
50	ENVEQ MAX	0.00000	0.00000	77.82052	186.32726
50	ENVEQ MAX	0.25000	0.00000	89.55752	172.59988
50	ENVEQ MAX	0.50000	0.00000	101.29452	161.32438
50	ENVEQ MAX	0.75000	0.00000	113.03152	151.69886
50	ENVEQ MAX	1.00000	0.00000	124.76852	138.94434
50	ENVEQ MIN	0.00000	-322.35483	-27.39725	0.00000
50	ENVEQ MIN	0.25000	-326.00104	-21.99556	0.00000
50	ENVEQ MIN	0.50000	-329.64724	-16.59387	0.00000
50	ENVEQ MIN	0.75000	-333.29345	-11.19219	0.00000
50	ENVEQ MIN	1.00000	-336.93965	-5.79050	-13.19638
51	ENVEQ MAX	0.00000	0.00000	124.77748	138.94434
51	ENVEQ MAX	0.25000	0.00000	136.50348	123.07757
51	ENVEQ MAX	0.50000	0.00000	148.22948	104.08582
51	ENVEQ MAX	0.75000	0.00000	159.95548	82.32677
51	ENVEQ MAX	1.00000	0.00000	171.68148	78.67210
51	ENVEQ MIN	0.00000	-322.18249	-7.28915	-13.19638
51	ENVEQ MIN	0.25000	-325.82528	-1.89252	-34.47994
51	ENVEQ MIN	0.50000	-329.46807	0.00000	-59.06418
51	ENVEQ MIN	0.75000	-333.11086	0.00000	-85.96990
51	ENVEQ MIN	1.00000	-336.75364	0.00000	-120.00966
52	ENVEQ MAX	0.00000	0.00000	171.68997	78.67210
52	ENVEQ MAX	0.25000	0.00000	175.17697	77.30787
52	ENVEQ MAX	0.50000	0.00000	178.66397	75.81646
52	ENVEQ MAX	0.75000	0.00000	182.15097	74.19787
52	ENVEQ MAX	1.00000	0.00000	185.63797	72.45209
52	ENVEQ MIN	0.00000	-322.06459	0.00000	-120.00966
52	ENVEQ MIN	0.25000	-323.14786	0.00000	-133.75426
52	ENVEQ MIN	0.50000	-324.23113	0.00000	-147.77521

43	ENVEQ MIN	1.00000	-337.83609	-233.09387	-474.43983
44	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
53	ENVEQ MAX	0.00000	0.00000	185.63782	72.45209
53	ENVEQ MAX	0.22500	0.00000	190.58782	69.93148
53	ENVEQ MAX	0.45000	0.00000	195.53782	67.38125
53	ENVEQ MAX	0.67500	0.00000	200.48782	64.57472
53	ENVEQ MAX	0.90000	0.00000	205.43782	61.51190
53	ENVEQ MIN	0.00000	-326.39766	0.00000	-176.64614
53	ENVEQ MIN	0.22500	-327.93542	0.00000	-197.80883
53	ENVEQ MIN	0.45000	-329.47319	0.00000	-219.52840
53	ENVEQ MIN	0.67500	-331.01095	0.00000	-241.80484
53	ENVEQ MIN	0.90000	-332.54871	0.00000	-264.63816
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
56	ENVEQ MAX	0.10000	0.00000	0.00000	61.51192
56	ENVEQ MAX	0.32500	0.00000	0.00000	64.57472
56	ENVEQ MAX	0.55000	0.00000	0.00000	67.38124
56	ENVEQ MAX	0.77500	0.00000	0.00000	69.93147
56	ENVEQ MAX	1.00000	0.00000	0.00000	72.45209
56	ENVEQ MIN	0.10000	-332.54871	-205.41556	-264.60329
56	ENVEQ MIN	0.32500	-331.01095	-200.46556	-241.77248
56	ENVEQ MIN	0.55000	-329.47319	-195.51556	-219.49854
56	ENVEQ MIN	0.77500	-327.93542	-190.56556	-197.78148
56	ENVEQ MIN	1.00000	-326.39766	-185.61556	-176.62129
57	ENVEQ MAX	0.00000	0.00000	0.00000	72.45209
57	ENVEQ MAX	0.25000	0.00000	0.00000	74.19787
57	ENVEQ MAX	0.50000	0.00000	0.00000	75.81646
57	ENVEQ MAX	0.75000	0.00000	0.00000	77.30787
57	ENVEQ MAX	1.00000	0.00000	0.00000	78.67210
57	ENVEQ MIN	0.00000	-326.39766	-185.61564	-176.62129
57	ENVEQ MIN	0.25000	-325.31439	-182.12864	-162.04942
57	ENVEQ MIN	0.50000	-324.23113	-178.64164	-147.75390
57	ENVEQ MIN	0.75000	-323.14786	-175.15464	-133.73472
57	ENVEQ MIN	1.00000	-322.06459	-171.66764	-119.99189
58	ENVEQ MAX	0.00000	0.00000	0.00000	78.67210
58	ENVEQ MAX	0.25000	0.00000	0.00000	82.32677
58	ENVEQ MAX	0.50000	0.00000	0.00000	104.08582
58	ENVEQ MAX	0.75000	0.00000	1.89253	123.07757
58	ENVEQ MAX	1.00000	0.00000	7.28915	138.94434
58	ENVEQ MIN	0.00000	-336.75364	-171.66360	-119.99189
58	ENVEQ MIN	0.25000	-333.11086	-159.93760	-85.95806
58	ENVEQ MIN	0.50000	-329.46807	-148.21160	-59.05660
58	ENVEQ MIN	0.75000	-325.82528	-136.48560	-34.47994
58	ENVEQ MIN	1.00000	-322.18249	-124.75960	-13.19638
59	ENVEQ MAX	0.00000	0.00000	5.79050	138.94434
59	ENVEQ MAX	0.25000	0.00000	11.19219	151.69886
59	ENVEQ MAX	0.50000	0.00000	16.59387	161.32438
59	ENVEQ MAX	0.75000	0.00000	21.99556	172.59988
59	ENVEQ MAX	1.00000	0.00000	27.39725	186.32726
59	ENVEQ MIN	0.00000	-336.93965	-124.75534	-13.19639
59	ENVEQ MIN	0.25000	-333.29345	-113.01834	0.00000
59	ENVEQ MIN	0.50000	-329.64724	-101.28134	0.00000
59	ENVEQ MIN	0.75000	-326.00104	-89.54434	0.00000
59	ENVEQ MIN	1.00000	-322.35483	-77.80734	0.00000
60	ENVEQ MAX	0.00000	0.00000	26.78139	186.32726
60	ENVEQ MAX	0.25000	0.00000	32.18308	199.27349
60	ENVEQ MAX	0.50000	0.00000	37.58476	214.52349
60	ENVEQ MAX	0.75000	0.00000	42.98645	226.64266
60	ENVEQ MAX	1.00000	0.00000	48.38814	235.63097
60	ENVEQ MIN	0.00000	-337.18020	-77.80280	0.00000
60	ENVEQ MIN	0.25000	-333.53400	-66.06580	0.00000
60	ENVEQ MIN	0.50000	-329.88779	-54.32880	0.00000
60	ENVEQ MIN	0.75000	-326.24159	-42.59180	0.00000
60	ENVEQ MIN	1.00000	-322.59538	-30.85480	0.00000
61	ENVEQ MAX	0.00000	0.00000	48.38814	235.63097
61	ENVEQ MAX	0.25000	0.00000	53.78476	241.48350
61	ENVEQ MAX	0.50000	0.00000	63.67340	244.21105
61	ENVEQ MAX	0.75000	0.00000	75.39940	243.81361
61	ENVEQ MAX	1.00000	0.00000	87.12540	240.29120
61	ENVEQ MIN	0.00000	-337.48901	-30.85010	0.00000
52	ENVEQ MIN	0.75000	-325.31439	0.00000	-162.07250
52	ENVEQ MIN	1.00000	-326.39766	0.00000	-176.64614
FRAME	LOAD	DIST	P	V2	M3
61	ENVEQ MIN	1.00000	-322.91786	0.00000	-41.02208
62	ENVEQ MAX	0.00000	0.00000	87.12977	240.29120
62	ENVEQ MAX	0.25000	0.00000	98.86677	233.63519
62	ENVEQ MAX	0.50000	0.00000	110.60377	223.84834
62	ENVEQ MAX	0.75000	0.00000	122.34077	210.93064
62	ENVEQ MAX	1.00000	0.00000	134.07777	194.88209
62	ENVEQ MIN	0.00000	-337.87975	0.00000	-41.02208
62	ENVEQ MIN	0.25000	-334.23354	0.00000	-60.25929
62	ENVEQ MIN	0.50000	-330.58734	0.00000	-82.23579
62	ENVEQ MIN	0.75000	-326.94113	0.00000	-106.53048
62	ENVEQ MIN	1.00000	-323.29492	0.00000	-132.74638
63	ENVEQ MAX	0.00000	0.00000	134.08382	194.88209
63	ENVEQ MAX	0.25000	0.00000	145.82082	175.70183
63	ENVEQ MAX	0.50000	0.00000	157.55782	153.39073
63	ENVEQ MAX	0.75000	0.00000	169.29482	127.94879
63	ENVEQ MAX	1.00000	0.00000	181.03182	99.37599
63	ENVEQ MIN	0.00000	-338.32522	0.00000	-132.74638
63	ENVEQ MIN	0.25000	-334.67901	0.00000	-160.88348
63	ENVEQ MIN	0.50000	-331.03281	0.00000	-190.94177
63	ENVEQ MIN	0.75000	-327.38660	0.00000	-222.92127
63	ENVEQ MIN	1.00000	-323.74040	0.00000	-256.82196
64	ENVEQ MAX	0.00000	0.00000	181.03721	99.37599
64	ENVEQ MAX	0.25000	0.00000	192.76321	67.70275
64	ENVEQ MAX	0.50000	0.00000	204.48921	36.23697
64	ENVEQ MAX	0.75000	0.00000	216.21521	20.53468
64	ENVEQ MAX	1.00000	0.00000	227.94121	4.41915
64	ENVEQ MIN	0.00000	-338.83919	0.00000	-256.82196
64	ENVEQ MIN	0.25000	-335.19640	0.00000	-292.60939
64	ENVEQ MIN	0.50000	-331.55361	0.00000	-332.79904
64	ENVEQ MIN	0.75000	-327.91082	0.00000	-388.62184
64	ENVEQ MIN	1.00000	-324.26803	0.00000	-447.57168
65	ENVEQ MAX	0.00000	0.00000	227.94594	4.41942
65	ENVEQ MAX	0.25000	0.00000	229.23294	2.58293
65	ENVEQ MAX	0.50000	0.00000	230.51994	0.72912
65	ENVEQ MAX	0.75000	0.00000	231.80694	0.00000
65	ENVEQ MAX	1.00000	0.00000	233.09394	0.00000
65	ENVEQ MIN	0.00000	-339.43536	0.00000	-447.57168
65	ENVEQ MIN	0.25000	-339.03554	0.00000	-454.23225
65	ENVEQ MIN	0.50000	-338.63572	0.00000	-460.93046
65	ENVEQ MIN	0.75000	-338.23591	0.00000	-467.66632
65	ENVEQ MIN	1.00000	-337.83609	0.00000	-474.43983
66	ENVEQ MAX	0.00000	0.00000	233.09387	0.00000
66	ENVEQ MAX	0.22500	0.00000	238.25481	0.00000
66	ENVEQ MAX	0.45000	0.00000	243.83762	0.00000
66	ENVEQ MAX	0.67500	0.00000	249.84231	0.00000
66	ENVEQ MAX	0.90000	0.00000	256.26887	0.00000
66	ENVEQ MIN	0.00000	-337.83609	0.00000	-474.43983
66	ENVEQ MIN	0.22500	-336.29833	0.00000	-500.85050
66	ENVEQ MIN	0.45000	-334.76056	0.00000	-527.86550
66	ENVEQ MIN	0.67500	-333.22280	0.00000	-555.53230
66	ENVEQ MIN	0.90000	-331.68504	0.00000	-583.89837
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
69	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
69	ENVEQ MAX	0.32500	0.00000	0.00000	0.86626
69	ENVEQ MAX	0.55000	0.00000	0.00000	12.77317
69	ENVEQ MAX	0.77500	0.00000	0.00000	23.97878
69	ENVEQ MAX	1.00000	0.00000	0.00000	34.48700
69	ENVEQ MIN	0.10000	-302.76234	-288.79727	-591.55546
69	ENVEQ MIN	0.32500	-306.37415	-280.42305	-561.52232
69	ENVEQ MIN	0.55000	-309.56409	-273.08355	-531.02601
69	ENVEQ MIN	0.77500	-312.33215	-276.95853	-500.08470
69	ENVEQ MIN	1.00000	-314.67834	-280.67216	-468.71653
70	ENVEQ MAX	0.00000	0.00000	0.00000	34.48735
70	ENVEQ MAX	0.25000	0.00000	0.00000	35.81850
70	ENVEQ MAX	0.50000	0.00000	0.00000	37.13772
70	ENVEQ MAX	0.75000	0.00000	0.00000	38.44505
70	ENVEQ MAX	1.00000	0.00000	0.00000	39.74048

61	ENVEQ MIN	0.25000	-333.84622	-19.12410	0.00000
61	ENVEQ MIN	0.50000	-330.20343	-10.93372	-7.29222
61	ENVEQ MIN	0.75000	-326.56065	-3.73822	-23.19835
FRAME	LOAD	DIST	P	V2	M3
70	ENVEQ MIN	0.75000	-315.51816	-282.08846	-456.26538
70	ENVEQ MIN	1.00000	-315.79812	-282.55494	-452.10114
71	ENVEQ MAX	0.00000	0.00000	0.00000	39.73823
71	ENVEQ MAX	0.25000	0.00000	0.00000	60.22435
71	ENVEQ MAX	0.50000	0.00000	0.00000	78.34407
71	ENVEQ MAX	0.75000	0.00000	0.00000	116.09321
71	ENVEQ MAX	1.00000	0.00000	0.00000	149.12935
71	ENVEQ MIN	0.00000	-270.76041	-250.17686	-452.10114
71	ENVEQ MIN	0.25000	-275.55286	-230.35511	-397.10277
71	ENVEQ MIN	0.50000	-280.34531	-228.14683	-342.83853
71	ENVEQ MIN	0.75000	-285.13776	-233.91204	-306.47929
71	ENVEQ MIN	1.00000	-289.93021	-238.79879	-268.42464
72	ENVEQ MAX	0.00000	0.00000	0.00000	149.12958
72	ENVEQ MAX	0.25000	0.00000	0.00000	177.83777
72	ENVEQ MAX	0.50000	0.00000	0.00000	202.07214
72	ENVEQ MAX	0.75000	0.00000	1.13375	221.34380
72	ENVEQ MAX	1.00000	0.00000	12.82576	235.57313
72	ENVEQ MIN	0.00000	-244.98698	-179.17272	-268.42464
72	ENVEQ MIN	0.25000	-250.90569	-183.13721	-244.75947
72	ENVEQ MIN	0.50000	-259.73949	-186.14441	-218.21312
72	ENVEQ MIN	0.75000	-268.57328	-188.19432	-188.86650
72	ENVEQ MIN	1.00000	-277.40708	-189.28694	-156.80054
73	ENVEQ MAX	0.00000	0.00000	11.73318	235.57313
73	ENVEQ MAX	0.25000	0.00000	23.07504	244.69039
73	ENVEQ MAX	0.50000	0.00000	34.01454	248.61622
73	ENVEQ MAX	0.75000	0.00000	44.55168	247.29135
73	ENVEQ MAX	1.00000	0.00000	54.68646	240.65648
73	ENVEQ MIN	0.00000	-234.32415	-141.96970	-156.80054
73	ENVEQ MIN	0.25000	-243.16670	-142.06452	-135.63658
73	ENVEQ MIN	0.50000	-252.00925	-141.11979	-111.93055
73	ENVEQ MIN	0.75000	-260.85180	-139.13552	-85.78407
73	ENVEQ MIN	1.00000	-269.69435	-136.11170	-57.29872
74	ENVEQ MAX	0.00000	0.00000	54.60898	240.65648
74	ENVEQ MAX	0.25000	0.00000	64.29343	228.67008
74	ENVEQ MAX	0.50000	0.00000	79.67265	213.22331
74	ENVEQ MAX	0.75000	0.00000	101.31091	194.13857
74	ENVEQ MAX	1.00000	0.00000	123.10708	213.54284
74	ENVEQ MIN	0.00000	-226.69639	-101.63531	-57.29872
74	ENVEQ MIN	0.25000	-235.53019	-97.53763	-37.68224
74	ENVEQ MIN	0.50000	-244.36398	-96.54840	-16.50421
74	ENVEQ MIN	0.75000	-253.19778	-104.20349	-3.47820
74	ENVEQ MIN	1.00000	-262.03157	-111.37994	-20.99502
75	ENVEQ MAX	0.00000	0.00000	123.10708	213.54284
75	ENVEQ MAX	0.25000	0.00000	145.02278	225.06646
75	ENVEQ MAX	0.50000	0.00000	167.01964	234.81209
75	ENVEQ MAX	0.75000	0.00000	189.09766	242.47907
75	ENVEQ MAX	1.00000	0.00000	211.25685	247.76679
75	ENVEQ MIN	0.00000	-219.11594	-79.56230	-20.99502
75	ENVEQ MIN	0.25000	-227.94973	-86.22176	-40.79871
75	ENVEQ MIN	0.50000	-236.78353	-92.32589	-62.75306
75	ENVEQ MIN	0.75000	-245.61732	-97.87470	-86.71800
75	ENVEQ MIN	1.00000	-254.45112	-102.86818	-112.55344
76	ENVEQ MAX	0.00000	0.00000	211.25685	247.76679
76	ENVEQ MAX	0.25000	0.00000	233.48161	245.64468
76	ENVEQ MAX	0.50000	0.00000	257.12685	240.51778
76	ENVEQ MAX	0.75000	0.00000	281.50986	232.06514
76	ENVEQ MAX	1.00000	0.00000	305.89887	251.00990
76	ENVEQ MIN	0.00000	-211.61525	-82.21991	-112.55344
76	ENVEQ MIN	0.25000	-220.45780	-86.62480	-140.14374
76	ENVEQ MIN	0.50000	-229.30035	-90.39851	-169.31067
76	ENVEQ MIN	0.75000	-238.14290	-93.54103	-202.24258
76	ENVEQ MIN	1.00000	-246.98545	-96.30405	-273.19145
77	ENVEQ MAX	0.00000	0.00000	305.89887	251.00990
77	ENVEQ MAX	0.25000	0.00000	314.56603	258.45068
77	ENVEQ MAX	0.50000	0.00000	323.22744	265.98798
77	ENVEQ MAX	0.75000	0.00000	331.88311	273.61406
77	ENVEQ MAX	1.00000	0.00000	340.53304	281.32116
77	ENVEQ MIN	0.00000	-204.22694	-84.37849	-273.19145
77	ENVEQ MIN	0.25000	-207.36998	-85.11576	-301.03485
77	ENVEQ MIN	0.50000	-210.51303	-85.76665	-329.65588
77	ENVEQ MIN	0.75000	-213.65607	-86.33115	-359.05400
77	ENVEQ MIN	1.00000	-216.79912	-86.80927	-389.22872
78	ENVEQ MAX	0.00000	0.00000	340.53304	281.32116
78	ENVEQ MAX	0.08654	0.00000	345.95045	286.18934
78	ENVEQ MAX	0.17308	0.00000	351.36377	291.08429
78	ENVEQ MAX	0.25962	0.00000	356.77300	296.00400
78	ENVEQ MAX	0.34615	0.00000	362.17813	300.94647
78	ENVEQ MIN	0.00000	-216.79905	-86.80930	-389.22872
78	ENVEQ MIN	0.08654	-218.76893	-87.06402	-408.53609
78	ENVEQ MIN	0.17308	-220.73880	-87.28301	-428.14807
78	ENVEQ MIN	0.25962	-222.70868	-87.66973	-448.06444
78	ENVEQ MIN	0.34615	-224.67855	-88.05631	-468.28496
79	ENVEQ MAX	0.08669	0.00000	34.20301	130.29698
79	ENVEQ MAX	0.29876	0.00000	36.06348	70.12415
79	ENVEQ MAX	0.51084	0.00000	37.87383	6.80818
70	ENVEQ MIN	0.00000	-314.67830	-280.67216	-468.71653
70	ENVEQ MIN	0.25000	-314.95825	-281.14707	-464.57312
70	ENVEQ MIN	0.50000	-315.23821	-281.61918	-460.42272
FRAME	LOAD	DIST	P	V2	M3
79	ENVEQ MIN	0.51084	-455.80384	-37.87362	-6.80787
79	ENVEQ MIN	0.72291	-481.49134	-39.63385	-59.57041
79	ENVEQ MIN	0.93498	-507.17884	-41.34396	-128.90987

79	ENVEQ MAX	0.72291	0.00000	39.63406	59.57030
79	ENVEQ MAX	0.93498	0.00000	41.34417	128.90945
79	ENVEQ MIN	0.08669	-404.42884	-34.20280	-130.29596
79	ENVEQ MIN	0.29876	-430.11634	-36.06327	-70.12348

20. OUTPUT DATA (붕괴방지)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.27778	147.66834	0.00000	727.79588
1	ENVEQ MAX	0.45833	146.66734	0.00000	734.99490
1	ENVEQ MAX	0.63889	145.66634	0.00000	742.45137
1	ENVEQ MAX	0.81944	144.66534	0.00000	750.16531
1	ENVEQ MAX	1.00000	143.66434	0.00000	758.13671
1	ENVEQ MIN	0.27778	-412.88311	-272.59511	-695.68468
1	ENVEQ MIN	0.45833	-411.88211	-275.76386	-678.56820
1	ENVEQ MIN	0.63889	-410.88111	-278.93261	-661.25863
1	ENVEQ MIN	0.81944	-409.88011	-282.10136	-643.75596
1	ENVEQ MIN	1.00000	-408.87911	-285.27011	-626.06019
2	ENVEQ MAX	0.00000	143.41698	0.00000	758.13671
2	ENVEQ MAX	0.25000	141.51662	0.00000	775.04794
2	ENVEQ MAX	0.50000	139.61626	0.00000	796.35168
2	ENVEQ MAX	0.75000	137.71590	0.00000	818.58395
2	ENVEQ MAX	1.00000	135.81554	0.00000	841.74440
2	ENVEQ MIN	0.00000	-408.87911	-285.27009	-626.06019
2	ENVEQ MIN	0.25000	-406.97875	-291.28584	-591.93420
2	ENVEQ MIN	0.50000	-405.07839	-297.30159	-557.11226
2	ENVEQ MIN	0.75000	-403.17803	-303.31734	-521.59437
2	ENVEQ MIN	1.00000	-401.27767	-309.33309	-485.38053
3	ENVEQ MAX	0.00000	130.73049	10.01265	841.74440
3	ENVEQ MAX	0.25000	129.24285	6.48071	844.50769
3	ENVEQ MAX	0.50000	127.75521	2.94877	847.83961
3	ENVEQ MAX	0.75000	126.26757	0.00000	851.74018
3	ENVEQ MAX	1.00000	124.77993	0.00000	856.20939
3	ENVEQ MIN	0.00000	-394.40917	-191.53734	-485.38053
3	ENVEQ MIN	0.25000	-392.92153	-196.24659	-466.18761
3	ENVEQ MIN	0.50000	-391.43389	-200.95584	-446.56821
3	ENVEQ MIN	0.75000	-389.94625	-205.66509	-426.52232
3	ENVEQ MIN	1.00000	-388.45861	-210.37434	-406.09500
4	ENVEQ MAX	0.00000	124.61410	0.00000	856.20939
4	ENVEQ MAX	0.25000	123.69010	0.00000	859.25049
4	ENVEQ MAX	0.50000	122.76610	0.00000	862.46877
4	ENVEQ MAX	0.75000	121.84210	0.00000	865.86424
4	ENVEQ MAX	1.00000	120.91810	0.00000	869.43690
4	ENVEQ MIN	0.00000	-388.45861	-210.37433	-406.09495
4	ENVEQ MIN	0.25000	-387.53461	-212.73683	-393.56879
4	ENVEQ MIN	0.50000	-386.61061	-215.09933	-380.90973
4	ENVEQ MIN	0.75000	-385.68661	-217.46183	-368.11778
4	ENVEQ MIN	1.00000	-384.76261	-219.82433	-355.19294
5	ENVEQ MAX	0.00000	120.79852	0.00000	869.43690
5	ENVEQ MAX	0.25000	119.92688	0.00000	872.98829
5	ENVEQ MAX	0.50000	119.05524	0.00000	876.73489
5	ENVEQ MAX	0.75000	118.18360	0.00000	880.67671
5	ENVEQ MAX	1.00000	117.31196	0.00000	884.81375
5	ENVEQ MIN	0.00000	-384.76261	-219.82433	-355.19315
5	ENVEQ MIN	0.25000	-383.89097	-222.58358	-342.93567
5	ENVEQ MIN	0.50000	-383.01933	-225.34283	-330.53177
5	ENVEQ MIN	0.75000	-382.14769	-228.10208	-317.98146
5	ENVEQ MIN	1.00000	-381.27605	-230.86133	-305.28474
6	ENVEQ MAX	0.00000	112.17965	80.95586	884.81375
6	ENVEQ MAX	0.25000	108.89329	70.55261	867.12200
6	ENVEQ MAX	0.50000	105.60693	60.14936	852.20531
6	ENVEQ MAX	0.75000	102.32057	49.74611	840.06369
6	ENVEQ MAX	1.00000	99.03421	39.34286	830.69714
6	ENVEQ MIN	0.00000	-374.43069	-111.29858	-305.28360
6	ENVEQ MIN	0.25000	-371.14433	-121.70183	-276.85567
6	ENVEQ MIN	0.50000	-367.85797	-132.10508	-246.34644
6	ENVEQ MIN	0.75000	-364.57161	-142.50833	-213.75591
6	ENVEQ MIN	1.00000	-361.28525	-152.91158	-179.08408
7	ENVEQ MAX	0.00000	93.73216	161.64232	830.69714
7	ENVEQ MAX	0.25000	90.44580	151.23907	789.04463
7	ENVEQ MAX	0.50000	87.15944	140.83582	750.16719
7	ENVEQ MAX	0.75000	83.87308	130.43257	714.06482
7	ENVEQ MAX	1.00000	80.58672	120.02932	680.73751
7	ENVEQ MIN	0.00000	-354.46047	-52.81113	-179.08421
7	ENVEQ MIN	0.25000	-351.17411	-60.61356	-163.95619
7	ENVEQ MIN	0.50000	-347.88775	-68.41600	-146.74688
7	ENVEQ MIN	0.75000	-344.60139	-76.21844	-127.45626
7	ENVEQ MIN	1.00000	-341.31503	-84.02088	-106.08434
8	ENVEQ MAX	0.00000	75.29197	252.30733	680.73751
8	ENVEQ MAX	0.25000	72.00869	241.91383	614.88254
8	ENVEQ MAX	0.50000	68.72541	231.52033	551.79744
8	ENVEQ MAX	0.75000	65.44213	221.12683	491.48221
8	ENVEQ MAX	1.00000	62.15885	210.73333	436.09430
8	ENVEQ MIN	0.00000	-334.50971	-1.42389	-106.08435
8	ENVEQ MIN	0.25000	-331.22643	-9.21902	-104.66618
8	ENVEQ MIN	0.50000	-327.94315	-17.01414	-101.17061
8	ENVEQ MIN	0.75000	-324.65987	-24.80927	-95.59764
8	ENVEQ MIN	1.00000	-321.37659	-32.60439	-88.37396
9	ENVEQ MAX	0.00000	56.86904	345.31790	436.09430
9	ENVEQ MAX	0.25000	53.58268	334.91465	350.04105
9	ENVEQ MAX	0.50000	50.29632	324.51140	266.76287
9	ENVEQ MAX	0.75000	47.00996	314.10815	186.25975
9	ENVEQ MAX	1.00000	43.72360	303.70490	108.74556
9	ENVEQ MIN	0.00000	-314.58961	0.00000	-88.37396
9	ENVEQ MIN	0.25000	-311.30325	0.00000	-103.04384
9	ENVEQ MIN	0.50000	-308.01689	0.00000	-115.63243
9	ENVEQ MIN	0.75000	-304.73053	0.00000	-126.13971
9	ENVEQ MIN	1.00000	-301.44417	0.00000	-152.20609
10	ENVEQ MAX	0.00000	38.43639	440.87489	108.74556
10	ENVEQ MAX	0.25000	35.15003	430.47164	13.97459
10	ENVEQ MAX	0.50000	31.86367	420.06839	0.00000
10	ENVEQ MAX	0.75000	28.57731	409.66514	0.00000
10	ENVEQ MAX	1.00000	25.29095	399.26189	0.00000
10	ENVEQ MIN	0.00000	-294.67443	0.00000	-152.20609
10	ENVEQ MIN	0.25000	-291.38807	0.00000	-209.05201
10	ENVEQ MIN	0.50000	-288.10171	0.00000	-269.18006
10	ENVEQ MIN	0.75000	-284.81535	0.00000	-337.43988
10	ENVEQ MIN	1.00000	-281.52899	0.00000	-408.69942
11	ENVEQ MAX	0.00000	20.00469	539.14743	0.00000
11	ENVEQ MAX	0.25000	16.72141	528.75393	0.00000
11	ENVEQ MAX	0.50000	15.11242	518.36043	0.00000
11	ENVEQ MAX	0.75000	18.39570	507.96693	0.00000
11	ENVEQ MAX	1.00000	21.67898	497.57343	0.00000
11	ENVEQ MIN	0.00000	-274.77536	0.00000	-408.69942
11	ENVEQ MIN	0.25000	-273.03454	0.00000	-514.51400
11	ENVEQ MIN	0.50000	-276.31782	0.00000	-642.35564
11	ENVEQ MIN	0.75000	-279.60110	0.00000	-779.11376
11	ENVEQ MIN	1.00000	-282.88438	0.00000	-913.10202
12	ENVEQ MAX	0.00000	27.05292	639.73351	0.00000
12	ENVEQ MAX	0.25000	27.56728	638.10526	0.00000
12	ENVEQ MAX	0.50000	28.08164	636.47701	0.00000
12	ENVEQ MAX	0.75000	28.59600	634.84876	0.00000
12	ENVEQ MAX	1.00000	29.11036	633.22051	0.00000
12	ENVEQ MIN	0.00000	-289.59254	0.00000	-913.10202
12	ENVEQ MIN	0.25000	-290.10690	0.00000	-939.77690
12	ENVEQ MIN	0.50000	-290.62126	0.00000	-966.38381
12	ENVEQ MIN	0.75000	-291.13562	0.00000	-992.92273
12	ENVEQ MIN	1.00000	-291.64998	0.00000	-1019.39400
13	ENVEQ MAX	0.00000	29.11034	633.22053	0.00000
13	ENVEQ MAX	0.25000	30.03434	630.29553	0.00000
13	ENVEQ MAX	0.50000	30.95834	627.37053	0.00000
13	ENVEQ MAX	0.75000	31.88234	624.44553	0.00000
13	ENVEQ MAX	1.00000	32.80634	621.52053	0.00000
13	ENVEQ MIN	0.00000	-291.64998	0.00000	-1019.39400
13	ENVEQ MIN	0.25000	-292.57398	0.00000	-1066.77600
13	ENVEQ MIN	0.50000	-293.49798	0.00000	-1113.93800
13	ENVEQ MIN	0.75000	-294.42198	0.00000	-1160.88100
13	ENVEQ MIN	1.00000	-295.34598	0.00000	-1207.60500
14	ENVEQ MAX	0.00000	32.80631	621.52057	0.00000
14	ENVEQ MAX	0.25000	33.88431	618.10807	0.00000
14	ENVEQ MAX	0.50000	34.96231	614.69557	0.00000
14	ENVEQ MAX	0.75000	36.04031	611.28307	0.00000
14	ENVEQ MAX	1.00000	37.11831	607.87057	0.00000
14	ENVEQ MIN	0.00000	-295.34598	0.00000	-1207.60500
14	ENVEQ MIN	0.25000	-296.42398	0.00000	-1261.83900
14	ENVEQ MIN	0.50000	-297.50198	0.00000	-1315.77400
14	ENVEQ MIN	0.75000	-298.57998	0.00000	-1369.41000
14	ENVEQ MIN	1.00000	-299.65798	0.00000	-1422.74800
15	ENVEQ MAX	0.00000	37.11828	607.87060	0.00000
15	ENVEQ MAX	0.25000	37.88828	605.43310	0.00000
15	ENVEQ MAX	0.50000	38.65828	602.99560	0.00000
15	ENVEQ MAX	0.75000	39.42828	600.55810	0.00000
15	ENVEQ MAX	1.00000	40.19828	598.12060	0.00000
15	ENVEQ MIN	0.00000	-299.65798	0.00000	-1422.74800
15	ENVEQ MIN	0.25000	-300.42798	0.00000	-1460.66400
15	ENVEQ MIN	0.50000	-301.19798	0.00000	-1498.42700
15	ENVEQ MIN	0.75000	-301.96798	0.00000	-1536.03800
15	ENVEQ MIN	1.00000	-302.73798	0.00000	-1573.49700
16	ENVEQ MAX	0.00000	40.21059	0.00000	0.00000
16	ENVEQ MAX	0.25000	39.44059	0.00000	0.00000
16	ENVEQ MAX	0.50000	38.67059	0.00000	0.00000
16	ENVEQ MAX	0.75000	37.90059	0.00000	0.00000
16	ENVEQ MAX	1.00000	37.13059	0.00000	0.00000
16	ENVEQ MIN	0.00000	-302.73798	-598.11519	-1573.48300
16	ENVEQ MIN	0.25000	-301.96798	-600.55269	-1536.02400
16	ENVEQ MIN	0.50000	-301.19798	-602.99019	-1498.41300
16	ENVEQ MIN	0.75000	-300.42798	-605.42769	-1460.65000
16	ENVEQ MIN	1.00000	-299.65798	-607.86519	-1422.73500
17	ENVEQ MAX	0.00000	37.13064	0.00000	0.00000
17	ENVEQ MAX	0.25000	36.05264	0.00000	0.00000
17	ENVEQ MAX	0.50000	34.97464	0.00000	0.00000
17	ENVEQ MAX	0.75000	33.89664	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	32.81864	0.00000	0.00000
17	ENVEQ MIN	0.00000	-299.65798	-607.86517	-1422.73500
17	ENVEQ MIN	0.25000	-298.57998	-611.27767	-1369.39800
17	ENVEQ MIN	0.50000	-297.50198	-614.69017	-1315.76100
17	ENVEQ MIN	0.75000	-296.42398	-618.10267	-1261.82700
17	ENVEQ MIN	1.00000	-295.34598	-621.51517	-1207.59300
18	ENVEQ MAX	0.00000	32.81870	0.00000	0.00000
18	ENVEQ MAX	0.25000	31.89470	0.00000	0.00000
18	ENVEQ MAX	0.50000	30.97070	0.00000	0.00000
18	ENVEQ MAX	0.75000	30.04670	0.00000	0.00000
18	ENVEQ MAX	1.00000	29.12270	0.00000	0.00000
18	ENVEQ MIN	0.00000	-295.34598	-621.51515	-1207.59300
18	ENVEQ MIN	0.25000	-294.42198	-624.44015	-1160.87000
18	ENVEQ MIN	0.50000	-293.49798	-627.36515	-1113.92700
18	ENVEQ MIN	0.75000	-292.57398	-630.29015	-1066.76500
18	ENVEQ MIN	1.00000	-291.64998	-633.21515	-1019.38400
19	ENVEQ MAX	0.00000	29.12274	0.00000	0.00000
19	ENVEQ MAX	0.25000	28.60838	0.00000	0.00000
19	ENVEQ MAX	0.50000	28.09402	0.00000	0.00000
19	ENVEQ MAX	0.75000	27.57966	0.00000	0.00000
19	ENVEQ MAX	1.00000	27.06530	0.00000	0.00000
19	ENVEQ MIN	0.00000	-291.64998	-633.21514	-1019.38400
19	ENVEQ MIN	0.25000	-291.13562	-634.84339	-992.91320
19	ENVEQ MIN	0.50000	-290.62126	-636.47164	-966.37449
19	ENVEQ MIN	0.75000	-290.10690	-638.09989	-939.76781
19	ENVEQ MIN	1.00000	-289.59254	-639.72814	-913.09315
20	ENVEQ MAX	0.00000	21.69176	0.00000	0.00000
20	ENVEQ MAX	0.25000	18.40848	0.00000	0.00000
20	ENVEQ MAX	0.50000	15.12520	0.00000	0.00000
20	ENVEQ MAX	0.75000	16.72234	0.00000	0.00000
20	ENVEQ MAX	1.00000	20.00562	0.00000	0.00000
20	ENVEQ MIN	0.00000	-282.88438	-497.56889	-913.09315
20	ENVEQ MIN	0.25000	-279.60110	-507.96239	-779.10611
20	ENVEQ MIN	0.50000	-276.31782	-518.35589	-642.34920
20	ENVEQ MIN	0.75000	-273.03454	-528.74939	-514.51833
20	ENVEQ MIN	1.00000	-274.77536	-539.14289	-408.70244
21	ENVEQ MAX	0.00000	25.29118	0.00000	0.00000
21	ENVEQ MAX	0.25000	28.57754	0.00000	0.00000
21	ENVEQ MAX	0.50000	31.86390	0.00000	0.00000
21	ENVEQ MAX	0.75000	35.15026	0.00000	13.97459
21	ENVEQ MAX	1.00000	38.43662	0.00000	108.74556
21	ENVEQ MIN	0.00000	-281.52899	-399.25818	-408.70244
21	ENVEQ MIN	0.25000	-284.81535	-409.66143	-337.44180
21	ENVEQ MIN	0.50000	-288.10171	-420.06468	-269.18085
21	ENVEQ MIN	0.75000	-291.38807	-430.46793	-209.05201
21	ENVEQ MIN	1.00000	-294.67443	-440.87118	-152.20609
22	ENVEQ MAX	0.00000	43.72329	0.00000	108.74556
22	ENVEQ MAX	0.25000	47.00965	0.00000	186.25913
22	ENVEQ MAX	0.50000	50.29601	0.00000	266.76151
22	ENVEQ MAX	0.75000	53.58237	0.00000	350.03896
22	ENVEQ MAX	1.00000	56.86873	0.00000	436.09147
22	ENVEQ MIN	0.00000	-301.44417	-303.70199	-152.20609
22	ENVEQ MIN	0.25000	-304.73053	-314.10524	-126.13971
22	ENVEQ MIN	0.50000	-308.01689	-324.50849	-115.63243
22	ENVEQ MIN	0.75000	-311.30325	-334.91174	-103.04384
22	ENVEQ MIN	1.00000	-314.58961	-345.31499	-88.37396
23	ENVEQ MAX	0.00000	62.15821	32.60439	436.09147
23	ENVEQ MAX	0.25000	65.44149	24.80926	491.47859
23	ENVEQ MAX	0.50000	68.72477	17.01414	551.79325
23	ENVEQ MAX	0.75000	72.00805	9.21901	614.87778
23	ENVEQ MAX	1.00000	75.29133	1.42389	680.73218
23	ENVEQ MIN	0.00000	-321.37659	-210.73118	-88.37396
23	ENVEQ MIN	0.25000	-324.65987	-221.12468	-95.59765
23	ENVEQ MIN	0.50000	-327.94315	-231.51818	-101.17062
23	ENVEQ MIN	0.75000	-331.22643	-241.91168	-104.66618
23	ENVEQ MIN	1.00000	-334.50971	-252.30518	-106.08435
24	ENVEQ MAX	0.00000	80.58602	84.02087	680.73218
24	ENVEQ MAX	0.25000	83.87238	76.21843	714.05911
24	ENVEQ MAX	0.50000	87.15874	68.41600	750.16111
24	ENVEQ MAX	0.75000	90.44510	60.61356	789.03818
24	ENVEQ MAX	1.00000	93.73146	52.81112	830.69031
24	ENVEQ MIN	0.00000	-341.31503	-120.02796	-106.08434
24	ENVEQ MIN	0.25000	-344.60139	-130.43121	-127.45626
24	ENVEQ MIN	0.50000	-347.88775	-140.83446	-146.74687
24	ENVEQ MIN	0.75000	-351.17411	-151.23771	-163.95619
24	ENVEQ MIN	1.00000	-354.46047	-161.64096	-179.08421
25	ENVEQ MAX	0.00000	99.03375	152.91158	830.69031
25	ENVEQ MAX	0.25000	102.32011	142.50833	840.05668
25	ENVEQ MAX	0.50000	105.60647	132.10508	852.19813
25	ENVEQ MAX	0.75000	108.89283	121.70183	867.11464
25	ENVEQ MAX	1.00000	112.17919	111.29858	884.80621
25	ENVEQ MIN	0.00000	-361.28525	-39.34129	-179.08407
25	ENVEQ MIN	0.25000	-364.57161	-49.74454	-213.75588
25	ENVEQ MIN	0.50000	-367.85797	-60.14779	-246.34640
25	ENVEQ MIN	0.75000	-371.14433	-70.55104	-276.85561
25	ENVEQ MIN	1.00000	-374.43069	-80.95429	-305.28352
26	ENVEQ MAX	0.00000	117.31188	230.86133	884.80621
26	ENVEQ MAX	0.25000	118.18352	228.10208	880.66918
26	ENVEQ MAX	0.75000	119.92680	222.58358	872.98076
26	ENVEQ MAX	1.00000	120.79844	219.82433	869.42937
26	ENVEQ MIN	0.00000	-381.27605	0.00000	-305.28465
26	ENVEQ MIN	0.25000	-382.14769	0.00000	-317.98149
26	ENVEQ MIN	0.50000	-383.01933	0.00000	-330.53193
26	ENVEQ MIN	0.75000	-383.89097	0.00000	-342.93595
26	ENVEQ MIN	1.00000	-384.76261	0.00000	-355.19356
27	ENVEQ MAX	0.00000	120.91808	219.82433	869.42937
27	ENVEQ MAX	0.25000	121.84208	217.46183	865.85672
27	ENVEQ MAX	0.50000	122.76608	215.09933	862.46125
27	ENVEQ MAX	0.75000	123.69008	212.73683	859.24297
27	ENVEQ MAX	1.00000	124.61408	210.37433	856.20188
27	ENVEQ MIN	0.00000	-384.76261	0.00000	-355.19336
27	ENVEQ MIN	0.25000	-385.68661	0.00000	-368.11800
27	ENVEQ MIN	0.50000	-386.61061	0.00000	-380.90975
27	ENVEQ MIN	0.75000	-387.53461	0.00000	-393.56861
27	ENVEQ MIN	1.00000	-388.45861	0.00000	-406.09458
28	ENVEQ MAX	0.00000	124.78008	210.37434	856.20188
28	ENVEQ MAX	0.25000	126.26772	205.66509	851.73268
28	ENVEQ MAX	0.50000	127.75536	200.95584	847.83212
28	ENVEQ MAX	0.75000	129.24300	196.24659	844.50020
28	ENVEQ MAX	1.00000	130.73064	191.53734	841.73692
28	ENVEQ MIN	0.00000	-388.45861	0.00000	-406.09461
28	ENVEQ MIN	0.25000	-389.94625	0.00000	-426.52232
28	ENVEQ MIN	0.50000	-391.43389	-2.94794	-446.56821
28	ENVEQ MIN	0.75000	-392.92153	-6.47988	-466.18761
28	ENVEQ MIN	1.00000	-394.40917	-10.01182	-485.38053
29	ENVEQ MAX	0.00000	135.81621	309.33309	841.73692
29	ENVEQ MAX	0.25000	137.71657	303.31734	818.57659
29	ENVEQ MAX	0.50000	139.61693	297.30159	796.34419
29	ENVEQ MAX	0.75000	141.51729	291.28584	775.03972
29	ENVEQ MAX	1.00000	143.41765	285.27009	758.12846
29	ENVEQ MIN	0.00000	-401.27767	0.00000	-485.38053
29	ENVEQ MIN	0.25000	-403.17803	0.00000	-521.59437
29	ENVEQ MIN	0.50000	-405.07839	0.00000	-557.11226
29	ENVEQ MIN	0.75000	-406.97875	0.00000	-591.93420
29	ENVEQ MIN	1.00000	-408.87911	0.00000	-626.06019
30	ENVEQ MAX	0.00000	143.66564	285.27011	758.12846
30	ENVEQ MAX	0.18056	144.66664	282.10136	750.15692
30	ENVEQ MAX	0.36111	145.66764	278.93261	742.44285
30	ENVEQ MAX	0.54167	146.66864	275.76386	734.98623
30	ENVEQ MAX	0.72222	147.66964	272.59511	727.78708
30	ENVEQ MIN	0.00000	-408.87911	0.00000	-626.06019
30	ENVEQ MIN	0.18056	-409.88011	0.00000	-643.75596
30	ENVEQ MIN	0.36111	-410.88111	0.00000	-661.25863
30	ENVEQ MIN	0.54167	-411.88211	0.00000	-678.56820
30	ENVEQ MIN	0.72222	-412.88311	0.00000	-695.68468
31	ENVEQ MAX	0.65385	0.00000	180.43614	640.46115
31	ENVEQ MAX	0.74038	0.00000	180.06317	630.42033
31	ENVEQ MAX	0.82692	0.00000	179.64439	620.41522
31	ENVEQ MAX	0.91346	0.00000	179.17980	610.44841
31	ENVEQ MAX	1.00000	0.00000	178.66940	600.52246
31	ENVEQ MIN	0.65385	-358.33994	-375.95140	-553.65744
31	ENVEQ MIN	0.74038	-356.24238	-370.79894	-532.65502
31	ENVEQ MIN	0.82692	-354.14482	-365.63231	-511.94282
31	ENVEQ MIN	0.91346	-352.04726	-360.45151	-491.52165
31	ENVEQ MIN	1.00000	-349.94969	-355.25654	-471.39229
32	ENVEQ MAX	0.00000	0.00000	178.66937	600.52246
32	ENVEQ MAX	0.25000	0.00000	177.76308	584.77600
32	ENVEQ MAX	0.50000	0.00000	176.74603	569.15020
32	ENVEQ MAX	0.75000	0.00000	175.61823	553.65493
32	ENVEQ MAX	1.00000	0.00000	174.37968	538.30009
32	ENVEQ MIN	0.00000	-349.94971	-355.25654	-471.39229
32	ENVEQ MIN	0.25000	-346.60293	-346.94131	-439.88094
32	ENVEQ MIN	0.50000	-343.25615	-338.59598	-409.11723
32	ENVEQ MIN	0.75000	-339.90937	-330.22053	-379.10386
32	ENVEQ MIN	1.00000	-336.56260	-321.81497	-349.84354
33	ENVEQ MAX	0.00000	0.00000	211.47821	538.30009
33	ENVEQ MAX	0.25000	0.00000	207.43212	485.74526
33	ENVEQ MAX	0.50000	0.00000	202.57443	466.21592
33	ENVEQ MAX	0.75000	0.00000	196.90514	448.58274
33	ENVEQ MAX	1.00000	0.00000	190.42425	428.44634
33	ENVEQ MIN	0.00000	-402.88627	-321.81497	-349.84354
33	ENVEQ MIN	0.25000	-393.47054	-298.03745	-276.01389
33	ENVEQ MIN	0.50000	-384.05482	-274.08553	-234.05239
33	ENVEQ MIN	0.75000	-374.63909	-249.95918	-199.80235
33	ENVEQ MIN	1.00000	-365.22337	-225.65842	-174.36000
34	ENVEQ MAX	0.00000	0.00000	235.51727	428.44634
34	ENVEQ MAX	0.25000	0.00000	228.28047	394.27073
34	ENVEQ MAX	0.50000	0.00000	220.32980	358.30172
34	ENVEQ MAX	0.75000	0.00000	211.66526	320.87994
34	ENVEQ MAX	1.00000	0.00000	202.28686	282.34601
34	ENVEQ MIN	0.00000	-431.59764	-225.65842	-174.36000
34	ENVEQ MIN	0.25000	-422.19124	-201.25592	-152.29420
34	ENVEQ MIN	0.50000	-412.78483	-176.77603	-132.68477
34	ENVEQ MIN	0.75000	-403.37843	-152.21877	-115.71179
34	ENVEQ MIN	1.00000	-393.97203	-127.58413	-101.55533
35	ENVEQ MAX	0.00000	0.00000	257.21932	282.34601

26	ENVEQ MAX	0.50000	119.05516	225.34283	876.72736
FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	236.51717	175.60351
35	ENVEQ MAX	0.75000	0.00000	225.24247	174.58674
35	ENVEQ MAX	1.00000	0.00000	222.18325	185.07711
35	ENVEQ MIN	0.00000	-463.63978	-127.81549	-101.55533
35	ENVEQ MIN	0.25000	-454.23338	-103.15257	-90.38947
35	ENVEQ MIN	0.50000	-444.82697	-78.51045	-82.37552
35	ENVEQ MIN	0.75000	-435.42057	-57.94336	-109.98237
35	ENVEQ MIN	1.00000	-426.01417	-39.85886	-162.11603
36	ENVEQ MAX	0.00000	0.00000	282.87537	185.07661
36	ENVEQ MAX	0.25000	0.00000	282.49255	189.93128
36	ENVEQ MAX	0.50000	0.00000	280.95675	188.60146
36	ENVEQ MAX	0.75000	0.00000	278.26797	181.11779
36	ENVEQ MAX	1.00000	0.00000	274.42622	167.51092
36	ENVEQ MIN	0.00000	-497.33035	-41.44959	-162.11603
36	ENVEQ MIN	0.25000	-487.91462	-27.90817	-228.18228
36	ENVEQ MIN	0.50000	-478.49890	-13.85096	-291.03542
36	ENVEQ MIN	0.75000	-469.12643	0.00000	-350.54510
36	ENVEQ MIN	1.00000	-464.90715	0.00000	-406.58095
37	ENVEQ MAX	0.00000	0.00000	345.21325	167.51052
37	ENVEQ MAX	0.25000	0.00000	340.27429	148.41503
37	ENVEQ MAX	0.50000	0.00000	334.28515	123.29526
37	ENVEQ MAX	0.75000	0.00000	327.24583	92.20741
37	ENVEQ MAX	1.00000	0.00000	319.15633	55.20767
37	ENVEQ MIN	0.00000	-542.61113	0.00000	-406.58095
37	ENVEQ MIN	0.25000	-538.39604	0.00000	-477.47292
37	ENVEQ MIN	0.50000	-534.18094	0.00000	-544.66360
37	ENVEQ MIN	0.75000	-529.96584	0.00000	-610.63927
37	ENVEQ MIN	1.00000	-525.75074	0.00000	-673.20919
38	ENVEQ MAX	0.00000	0.00000	398.59959	55.20734
38	ENVEQ MAX	0.25000	0.00000	389.50230	12.86304
38	ENVEQ MAX	0.50000	0.00000	379.45668	0.00000
38	ENVEQ MAX	0.75000	0.00000	368.46273	0.00000
38	ENVEQ MAX	1.00000	0.00000	356.52046	0.00000
38	ENVEQ MIN	0.00000	-603.52502	0.00000	-673.20919
38	ENVEQ MIN	0.25000	-599.30574	0.00000	-752.51176
38	ENVEQ MIN	0.50000	-595.08647	0.00000	-827.71344
38	ENVEQ MIN	0.75000	-590.86719	0.00000	-898.73568
38	ENVEQ MIN	1.00000	-586.64792	0.00000	-967.79950
39	ENVEQ MAX	0.00000	0.00000	441.19929	0.00000
39	ENVEQ MAX	0.25000	0.00000	440.47243	0.00000
39	ENVEQ MAX	0.50000	0.00000	439.74252	0.00000
39	ENVEQ MAX	0.75000	0.00000	439.00953	0.00000
39	ENVEQ MAX	1.00000	0.00000	438.27348	0.00000
39	ENVEQ MIN	0.00000	-664.50056	0.00000	-967.79950
39	ENVEQ MIN	0.25000	-664.25409	0.00000	-972.99369
39	ENVEQ MIN	0.50000	-664.00761	0.00000	-978.17399
39	ENVEQ MIN	0.75000	-663.76114	0.00000	-983.34039
39	ENVEQ MIN	1.00000	-663.51467	0.00000	-988.49288
40	ENVEQ MAX	0.00000	0.00000	438.27348	0.00000
40	ENVEQ MAX	0.22500	0.00000	432.56200	0.00000
40	ENVEQ MAX	0.45000	0.00000	426.67894	0.00000
40	ENVEQ MAX	0.67500	0.00000	420.62428	0.00000
40	ENVEQ MAX	0.90000	0.00000	414.39803	0.00000
40	ENVEQ MIN	0.00000	-663.51468	0.00000	-988.49288
40	ENVEQ MIN	0.22500	-661.42387	0.00000	-1035.76800
40	ENVEQ MIN	0.45000	-658.91118	0.00000	-1084.10200
40	ENVEQ MIN	0.67500	-655.97662	0.00000	-1131.76400
40	ENVEQ MIN	0.90000	-652.62018	0.00000	-1178.73600
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
43	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
43	ENVEQ MIN	0.10000	-455.99753	-570.91879	-1087.25600
43	ENVEQ MIN	0.32500	-453.76114	-556.31460	-1025.84900
43	ENVEQ MIN	0.55000	-451.52475	-542.13229	-965.92556
43	ENVEQ MIN	0.77500	-449.28836	-528.37185	-907.43684

35	ENVEQ MAX	0.25000	0.00000	247.17612	229.20258
FRAME	LOAD	DIST	P	V2	M3
44	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
44	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
44	ENVEQ MIN	0.00000	-447.05198	-515.03331	-850.33575
44	ENVEQ MIN	0.25000	-446.47052	-511.62012	-835.71105
44	ENVEQ MIN	0.50000	-445.88906	-508.20694	-821.17694
44	ENVEQ MIN	0.75000	-445.30759	-504.79376	-806.73342
44	ENVEQ MIN	1.00000	-444.72613	-501.38058	-792.38050
45	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.25000	0.00000	0.00000	39.08247
45	ENVEQ MAX	0.50000	0.00000	0.00000	95.23903
45	ENVEQ MAX	0.75000	0.00000	0.00000	175.29759
45	ENVEQ MAX	1.00000	0.00000	0.00000	256.17490
45	ENVEQ MIN	0.00000	-461.37828	-501.37888	-792.38050
45	ENVEQ MIN	0.25000	-456.08052	-470.28100	-665.78333
45	ENVEQ MIN	0.50000	-450.78277	-439.18311	-552.57260
45	ENVEQ MIN	0.75000	-445.48502	-408.08523	-455.68270
45	ENVEQ MIN	1.00000	-444.24626	-376.98734	-365.10597
46	ENVEQ MAX	0.00000	0.00000	0.00000	256.17490
46	ENVEQ MAX	0.25000	0.00000	0.00000	328.82883
46	ENVEQ MAX	0.50000	0.00000	0.00000	393.17961
46	ENVEQ MAX	0.75000	0.00000	0.00000	449.22725
46	ENVEQ MAX	1.00000	0.00000	0.00000	496.97286
46	ENVEQ MIN	0.00000	-456.87581	-376.98557	-365.10597
46	ENVEQ MIN	0.25000	-451.57309	-348.02026	-280.76632
46	ENVEQ MIN	0.50000	-446.27036	-319.77411	-209.37517
46	ENVEQ MIN	0.75000	-442.96641	-291.52795	-149.89230
46	ENVEQ MIN	1.00000	-448.26913	-263.28179	-95.15318
47	ENVEQ MAX	0.00000	0.00000	0.00000	496.97286
47	ENVEQ MAX	0.25000	0.00000	0.00000	536.41522
47	ENVEQ MAX	0.50000	0.00000	0.00000	567.55444
47	ENVEQ MAX	0.75000	0.00000	0.00000	590.39052
47	ENVEQ MAX	1.00000	0.00000	0.00000	604.92345
47	ENVEQ MIN	0.00000	-452.38953	-263.27916	-95.15318
47	ENVEQ MIN	0.25000	-447.08681	-235.03301	-45.15783
47	ENVEQ MIN	0.50000	-441.78409	-206.78685	-0.59673
47	ENVEQ MIN	0.75000	-447.02465	-178.54069	0.00000
47	ENVEQ MIN	1.00000	-452.32737	-150.29453	0.00000
48	ENVEQ MAX	0.00000	0.00000	0.00000	604.92345
48	ENVEQ MAX	0.25000	0.00000	5.83312	611.15049
48	ENVEQ MAX	0.50000	0.00000	27.86042	609.08995
48	ENVEQ MAX	0.75000	0.00000	56.19959	598.74182
48	ENVEQ MAX	1.00000	0.00000	87.29748	580.10610
48	ENVEQ MIN	0.00000	-447.93897	-150.29311	0.00000
48	ENVEQ MIN	0.25000	-442.64122	-122.07343	0.00000
48	ENVEQ MIN	0.50000	-445.80594	-93.85374	0.00000
48	ENVEQ MIN	0.75000	-451.10369	-71.88088	0.00000
48	ENVEQ MIN	1.00000	-456.40144	-54.11399	0.00000
49	ENVEQ MAX	0.00000	0.00000	86.71082	580.10610
49	ENVEQ MAX	0.25000	0.00000	117.83788	553.15285
49	ENVEQ MAX	0.50000	0.00000	148.96494	517.89645
49	ENVEQ MAX	0.75000	0.00000	180.09200	474.33692
49	ENVEQ MAX	1.00000	0.00000	211.21905	422.47424
49	ENVEQ MIN	0.00000	-443.54360	-54.11399	0.00000
49	ENVEQ MIN	0.25000	-444.62322	-36.33044	0.00000
49	ENVEQ MIN	0.50000	-449.92595	-18.54688	0.00000
49	ENVEQ MIN	0.75000	-455.22867	-0.76333	0.00000
49	ENVEQ MIN	1.00000	-460.53139	0.00000	0.00000
50	ENVEQ MAX	0.00000	0.00000	211.22228	422.47424
50	ENVEQ MAX	0.25000	0.00000	242.34933	362.45800
50	ENVEQ MAX	0.50000	0.00000	273.47639	299.24046
50	ENVEQ MAX	0.75000	0.00000	304.60345	248.65658
50	ENVEQ MAX	1.00000	0.00000	335.73051	201.74519
50	ENVEQ MIN	0.00000	-443.48682	0.00000	0.00000
50	ENVEQ MIN	0.25000	-448.78954	0.00000	0.00000
50	ENVEQ MIN	0.50000	-454.09226	0.00000	0.00000
50	ENVEQ MIN	0.75000	-459.39499	0.00000	0.00000
50	ENVEQ MIN	1.00000	-464.69771	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	335.73361	201.74519
51	ENVEQ MAX	0.25000	0.00000	366.83150	147.35440
51	ENVEQ MAX	0.50000	0.00000	397.92938	85.44307
51	ENVEQ MAX	0.75000	0.00000	429.02727	43.82256
51	ENVEQ MAX	1.00000	0.00000	460.12515	3.75733
51	ENVEQ MIN	0.00000	-447.68984	0.00000	0.00000
51	ENVEQ MIN	0.25000	-452.98759	0.00000	-41.30786
51	ENVEQ MIN	0.50000	-458.28534	0.00000	-126.03237
51	ENVEQ MIN	0.75000	-463.58310	0.00000	-221.86547
51	ENVEQ MIN	1.00000	-468.88085	0.00000	-329.12052
52	ENVEQ MAX	0.00000	0.00000	460.12818	3.75733
52	ENVEQ MAX	0.25000	0.00000	469.37587	0.00000
52	ENVEQ MAX	0.50000	0.00000	478.62355	0.00000
52	ENVEQ MAX	0.75000	0.00000	487.87123	0.00000
52	ENVEQ MAX	1.00000	0.00000	497.11891	0.00000
52	ENVEQ MIN	0.00000	-451.90999	0.00000	-329.12052
52	ENVEQ MIN	0.25000	-453.48540	0.00000	-365.95211
52	ENVEQ MIN	0.50000	-455.06081	0.00000	-403.51659

43	ENVEQ MIN	1.00000	-447.05198	-515.03329	-850.33575
44	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
53	ENVEQ MAX	0.00000	0.00000	497.11887	0.00000
53	ENVEQ MAX	0.22500	0.00000	510.24650	0.00000
53	ENVEQ MAX	0.45000	0.00000	523.37412	0.00000
53	ENVEQ MAX	0.67500	0.00000	536.50175	0.00000
53	ENVEQ MAX	0.90000	0.00000	549.62937	0.00000
53	ENVEQ MIN	0.00000	-458.21163	0.00000	-480.84418
53	ENVEQ MIN	0.22500	-460.44802	0.00000	-537.50848
53	ENVEQ MIN	0.45000	-462.68440	0.00000	-595.64964
53	ENVEQ MIN	0.67500	-464.92079	0.00000	-655.26766
53	ENVEQ MIN	0.90000	-467.15718	0.00000	-716.36254
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
56	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
56	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
56	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
56	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
56	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
56	ENVEQ MIN	0.10000	-467.15718	-549.62356	-716.35302
56	ENVEQ MIN	0.32500	-464.92079	-536.49594	-655.25880
56	ENVEQ MIN	0.55000	-462.68440	-523.36831	-595.64144
56	ENVEQ MIN	0.77500	-460.44802	-510.24069	-537.50093
56	ENVEQ MIN	1.00000	-458.21163	-497.11306	-480.83728
57	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
57	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
57	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
57	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
57	ENVEQ MAX	1.00000	0.00000	0.00000	3.75733
57	ENVEQ MIN	0.00000	-458.21163	-497.11309	-480.83728
57	ENVEQ MIN	0.25000	-456.63622	-487.86541	-441.80751
57	ENVEQ MIN	0.50000	-455.06081	-478.61772	-403.51061
57	ENVEQ MIN	0.75000	-453.48540	-469.37004	-365.94660
57	ENVEQ MIN	1.00000	-451.90999	-460.12236	-329.11546
58	ENVEQ MAX	0.00000	0.00000	0.00000	3.75733
58	ENVEQ MAX	0.25000	0.00000	0.00000	43.82256
58	ENVEQ MAX	0.50000	0.00000	0.00000	85.44307
58	ENVEQ MAX	0.75000	0.00000	0.00000	147.35440
58	ENVEQ MAX	1.00000	0.00000	0.00000	201.74519
58	ENVEQ MIN	0.00000	-468.88085	-460.12047	-329.11546
58	ENVEQ MIN	0.25000	-463.58310	-429.02258	-221.86190
58	ENVEQ MIN	0.50000	-458.28534	-397.92470	-126.02999
58	ENVEQ MIN	0.75000	-452.98759	-366.82681	-41.30787
58	ENVEQ MIN	1.00000	-447.68984	-335.72893	0.00000
59	ENVEQ MAX	0.00000	0.00000	0.00000	201.74519
59	ENVEQ MAX	0.25000	0.00000	0.00000	248.65658
59	ENVEQ MAX	0.50000	0.00000	0.00000	299.24046
59	ENVEQ MAX	0.75000	0.00000	0.00000	362.45558
59	ENVEQ MAX	1.00000	0.00000	0.00000	422.47093
59	ENVEQ MIN	0.00000	-464.69771	-335.72699	0.00000
59	ENVEQ MIN	0.25000	-459.39499	-304.59993	0.00000
59	ENVEQ MIN	0.50000	-454.09226	-273.47287	0.00000
59	ENVEQ MIN	0.75000	-448.78954	-242.34582	0.00000
59	ENVEQ MIN	1.00000	-443.48682	-211.21876	0.00000
60	ENVEQ MAX	0.00000	0.00000	0.00000	422.47093
60	ENVEQ MAX	0.25000	0.00000	0.76333	474.33304
60	ENVEQ MAX	0.50000	0.00000	18.54688	517.89201
60	ENVEQ MAX	0.75000	0.00000	36.33044	553.14784
60	ENVEQ MAX	1.00000	0.00000	54.11399	580.10053
60	ENVEQ MIN	0.00000	-460.53139	-211.21675	0.00000
60	ENVEQ MIN	0.25000	-455.22867	-180.08970	0.00000
60	ENVEQ MIN	0.50000	-449.92595	-148.96264	0.00000
60	ENVEQ MIN	0.75000	-444.62322	-117.83558	0.00000
60	ENVEQ MIN	1.00000	-443.54360	-86.70852	0.00000
61	ENVEQ MAX	0.00000	0.00000	54.11399	580.10053
61	ENVEQ MAX	0.25000	0.00000	71.88088	598.73598
61	ENVEQ MAX	0.50000	0.00000	93.85374	609.08385
61	ENVEQ MAX	0.75000	0.00000	122.07343	611.14414
61	ENVEQ MAX	1.00000	0.00000	150.29311	604.91683
61	ENVEQ MIN	0.00000	-456.40144	-87.29748	0.00000
52	ENVEQ MIN	0.75000	-456.63622	0.00000	-441.81395
52	ENVEQ MIN	1.00000	-458.21163	0.00000	-480.84418
FRAME	LOAD	DIST	P	V2	M3
61	ENVEQ MIN	1.00000	-447.93897	0.00000	0.00000
62	ENVEQ MAX	0.00000	0.00000	150.29453	604.91683
62	ENVEQ MAX	0.25000	0.00000	178.54069	590.38394
62	ENVEQ MAX	0.50000	0.00000	206.78685	567.54790
62	ENVEQ MAX	0.75000	0.00000	235.03301	536.40873
62	ENVEQ MAX	1.00000	0.00000	263.27916	496.96641
62	ENVEQ MIN	0.00000	-452.32737	0.00000	0.00000
62	ENVEQ MIN	0.25000	-447.02465	0.00000	0.00000
62	ENVEQ MIN	0.50000	-441.78409	0.00000	-0.59673
62	ENVEQ MIN	0.75000	-447.08681	0.00000	-45.15783
62	ENVEQ MIN	1.00000	-452.38953	0.00000	-95.15318
63	ENVEQ MAX	0.00000	0.00000	263.28179	496.96641
63	ENVEQ MAX	0.25000	0.00000	291.52795	449.22051
63	ENVEQ MAX	0.50000	0.00000	319.77411	393.17234
63	ENVEQ MAX	0.75000	0.00000	348.02026	328.82102
63	ENVEQ MAX	1.00000	0.00000	376.98715	256.16656
63	ENVEQ MIN	0.00000	-448.26913	0.00000	-95.15318
63	ENVEQ MIN	0.25000	-442.96641	0.00000	-149.89230
63	ENVEQ MIN	0.50000	-446.27036	0.00000	-209.37517
63	ENVEQ MIN	0.75000	-451.57309	0.00000	-280.76632
63	ENVEQ MIN	1.00000	-456.87581	0.00000	-365.10597
64	ENVEQ MAX	0.00000	0.00000	376.99000	256.16656
64	ENVEQ MAX	0.25000	0.00000	408.08789	175.28864
64	ENVEQ MAX	0.50000	0.00000	439.18577	95.23169
64	ENVEQ MAX	0.75000	0.00000	470.28366	39.08241
64	ENVEQ MAX	1.00000	0.00000	501.38154	0.00000
64	ENVEQ MIN	0.00000	-444.24626	0.00000	-365.10597
64	ENVEQ MIN	0.25000	-445.48502	0.00000	-455.68270
64	ENVEQ MIN	0.50000	-450.78277	0.00000	-552.57260
64	ENVEQ MIN	0.75000	-456.08052	0.00000	-665.78333
64	ENVEQ MIN	1.00000	-461.37828	0.00000	-792.38050
65	ENVEQ MAX	0.00000	0.00000	501.38426	0.00000
65	ENVEQ MAX	0.25000	0.00000	504.79745	0.00000
65	ENVEQ MAX	0.50000	0.00000	508.21063	0.00000
65	ENVEQ MAX	0.75000	0.00000	511.62381	0.00000
65	ENVEQ MAX	1.00000	0.00000	515.03699	0.00000
65	ENVEQ MIN	0.00000	-444.72613	0.00000	-792.38050
65	ENVEQ MIN	0.25000	-445.30759	0.00000	-806.73342
65	ENVEQ MIN	0.50000	-445.88906	0.00000	-821.17694
65	ENVEQ MIN	0.75000	-446.47052	0.00000	-835.71105
65	ENVEQ MIN	1.00000	-447.05198	0.00000	-850.33575
66	ENVEQ MAX	0.00000	0.00000	515.03696	0.00000
66	ENVEQ MAX	0.22500	0.00000	528.37553	0.00000
66	ENVEQ MAX	0.45000	0.00000	542.13596	0.00000
66	ENVEQ MAX	0.67500	0.00000	556.31828	0.00000
66	ENVEQ MAX	0.90000	0.00000	570.92246	0.00000
66	ENVEQ MIN	0.00000	-447.05198	0.00000	-850.33575
66	ENVEQ MIN	0.22500	-449.28836	0.00000	-907.43684
66	ENVEQ MIN	0.45000	-451.52475	0.00000	-965.92556
66	ENVEQ MIN	0.67500	-453.76114	0.00000	-1025.84900
66	ENVEQ MIN	0.90000	-455.99753	0.00000	-1087.25600
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
68	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
69	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
69	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
69	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
69	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
69	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
69	ENVEQ MIN	0.10000	-652.62470	-414.39803	-1178.73600
69	ENVEQ MIN	0.32500	-655.98113	-420.62428	-1131.76400
69	ENVEQ MIN	0.55000	-658.91570	-426.67894	-1084.10200
69	ENVEQ MIN	0.77500	-661.42838	-432.56200	-1035.76800
69	ENVEQ MIN	1.00000	-663.51920	-438.27348	-988.49798
70	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
70	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
70	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
70	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
70	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000

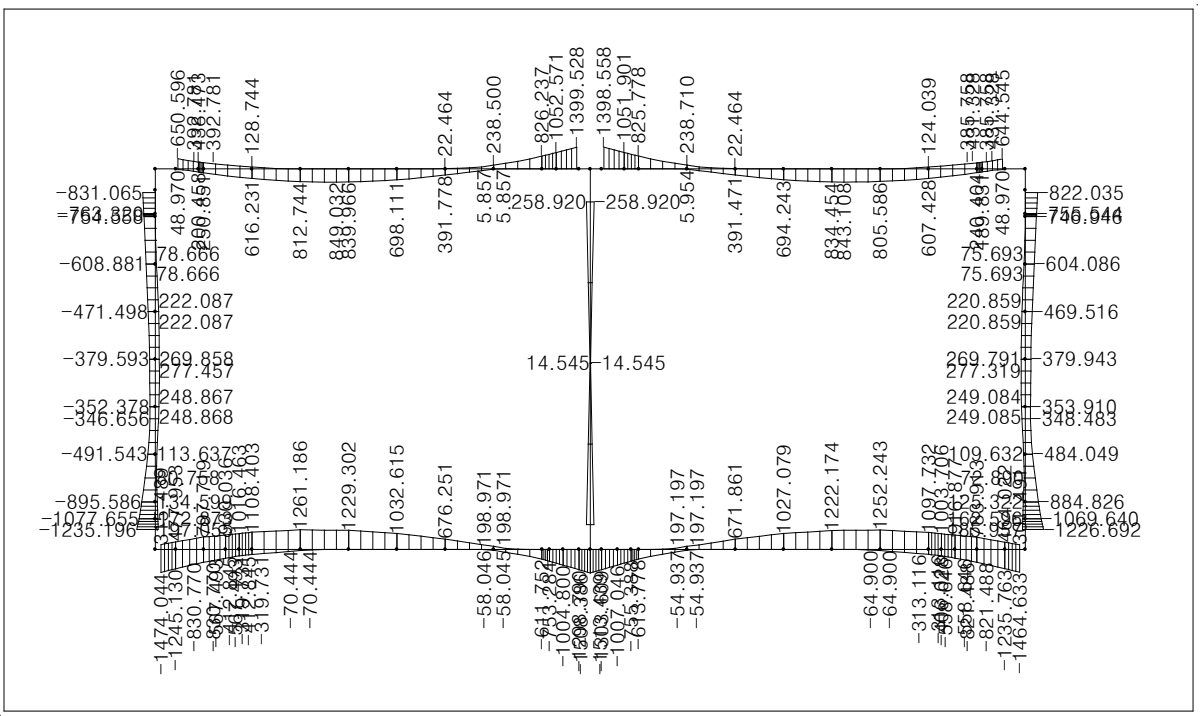
61	ENVEQ MIN	0.25000	-451.10369	-56.19959	0.00000
61	ENVEQ MIN	0.50000	-445.80594	-27.86042	0.00000
61	ENVEQ MIN	0.75000	-442.64122	-5.83312	0.00000
FRAME	LOAD	DIST	P	V2	M3
70	ENVEQ MIN	0.75000	-664.25859	-440.47243	-972.99885
70	ENVEQ MIN	1.00000	-664.50506	-441.19929	-967.80468
71	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
71	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
71	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
71	ENVEQ MAX	0.75000	0.00000	0.00000	12.86309
71	ENVEQ MAX	1.00000	0.00000	0.00000	55.20740
71	ENVEQ MIN	0.00000	-586.65200	-356.52046	-967.80468
71	ENVEQ MIN	0.25000	-590.87127	-368.46273	-898.74102
71	ENVEQ MIN	0.50000	-595.09055	-379.45668	-827.71892
71	ENVEQ MIN	0.75000	-599.30982	-389.50230	-752.51738
71	ENVEQ MIN	1.00000	-603.52910	-398.59959	-673.21495
72	ENVEQ MAX	0.00000	0.00000	0.00000	55.20761
72	ENVEQ MAX	0.25000	0.00000	0.00000	92.20739
72	ENVEQ MAX	0.50000	0.00000	0.00000	123.29527
72	ENVEQ MAX	0.75000	0.00000	0.00000	148.41508
72	ENVEQ MAX	1.00000	0.00000	0.00000	167.51059
72	ENVEQ MIN	0.00000	-525.75439	-319.15633	-673.21495
72	ENVEQ MIN	0.25000	-529.96948	-327.24583	-610.64499
72	ENVEQ MIN	0.50000	-534.18458	-334.28515	-544.66892
72	ENVEQ MIN	0.75000	-538.39968	-340.27429	-477.47820
72	ENVEQ MIN	1.00000	-542.61478	-345.21325	-406.58618
73	ENVEQ MAX	0.00000	0.00000	0.00000	167.51085
73	ENVEQ MAX	0.25000	0.00000	0.00000	181.11776
73	ENVEQ MAX	0.50000	0.00000	13.85080	188.60147
73	ENVEQ MAX	0.75000	0.00000	27.90802	189.93133
73	ENVEQ MAX	1.00000	0.00000	41.44943	185.07670
73	ENVEQ MIN	0.00000	-464.91036	-274.42622	-406.58618
73	ENVEQ MIN	0.25000	-469.12964	-278.26797	-350.55012
73	ENVEQ MIN	0.50000	-478.49616	-280.95675	-291.04050
73	ENVEQ MIN	0.75000	-487.91188	-282.49255	-228.18776
73	ENVEQ MIN	1.00000	-497.32761	-282.87537	-162.12166
74	ENVEQ MAX	0.00000	0.00000	39.85868	185.07702
74	ENVEQ MAX	0.25000	0.00000	57.94318	174.58670
74	ENVEQ MAX	0.50000	0.00000	78.51026	175.60351
74	ENVEQ MAX	0.75000	0.00000	103.15237	229.20258
74	ENVEQ MAX	1.00000	0.00000	127.81530	282.34601
74	ENVEQ MIN	0.00000	-426.01186	-222.18325	-162.12166
74	ENVEQ MIN	0.25000	-435.41826	-225.24410	-109.98242
74	ENVEQ MIN	0.50000	-444.82466	-236.51879	-82.36344
74	ENVEQ MIN	0.75000	-454.23106	-247.17774	-90.37802
74	ENVEQ MIN	1.00000	-463.63747	-257.22095	-101.54451
75	ENVEQ MAX	0.00000	0.00000	127.58413	282.34601
75	ENVEQ MAX	0.25000	0.00000	152.21877	320.87994
75	ENVEQ MAX	0.50000	0.00000	176.77603	358.30172
75	ENVEQ MAX	0.75000	0.00000	201.25592	394.27073
75	ENVEQ MAX	1.00000	0.00000	225.65842	428.44634
75	ENVEQ MIN	0.00000	-393.97203	-202.28979	-101.54451
75	ENVEQ MIN	0.25000	-403.37843	-211.66819	-115.70251
75	ENVEQ MIN	0.50000	-412.78483	-220.33273	-132.67704
75	ENVEQ MIN	0.75000	-422.19124	-228.28340	-152.28801
75	ENVEQ MIN	1.00000	-431.59764	-235.52020	-174.35536
76	ENVEQ MAX	0.00000	0.00000	225.65842	428.44634
76	ENVEQ MAX	0.25000	0.00000	249.95918	448.58274
76	ENVEQ MAX	0.50000	0.00000	274.08553	466.21592
76	ENVEQ MAX	0.75000	0.00000	298.03745	485.74684
76	ENVEQ MAX	1.00000	0.00000	321.81497	538.30243
76	ENVEQ MIN	0.00000	-365.22337	-190.42903	-174.35536
76	ENVEQ MIN	0.25000	-374.63909	-196.90992	-199.80065
76	ENVEQ MIN	0.50000	-384.05482	-202.57921	-234.05239
76	ENVEQ MIN	0.75000	-393.47054	-207.43690	-276.01389
76	ENVEQ MIN	1.00000	-402.88627	-211.48299	-349.84354
77	ENVEQ MAX	0.00000	0.00000	321.81497	538.30243
77	ENVEQ MAX	0.25000	0.00000	330.22053	553.65772
77	ENVEQ MAX	0.50000	0.00000	338.59598	569.15373
77	ENVEQ MAX	0.75000	0.00000	346.94131	584.78023
77	ENVEQ MAX	1.00000	0.00000	355.25654	600.52727
77	ENVEQ MIN	0.00000	-336.56260	-174.38637	-349.84354
77	ENVEQ MIN	0.25000	-339.90937	-175.62492	-379.10386
77	ENVEQ MIN	0.50000	-343.25615	-176.75272	-409.11723
77	ENVEQ MIN	0.75000	-346.60293	-177.76976	-439.88094
77	ENVEQ MIN	1.00000	-349.94971	-178.67606	-471.39229
78	ENVEQ MAX	0.00000	0.00000	355.25654	600.52727
78	ENVEQ MAX	0.08654	0.00000	360.45151	610.45357
78	ENVEQ MAX	0.17308	0.00000	365.63231	620.42075
78	ENVEQ MAX	0.25962	0.00000	370.79894	630.42622
78	ENVEQ MAX	0.34615	0.00000	375.95140	640.46741
78	ENVEQ MIN	0.00000	-349.94969	-178.67611	-471.39229
78	ENVEQ MIN	0.08654	-352.04726	-179.18651	-491.52165
78	ENVEQ MIN	0.17308	-354.14482	-179.65110	-511.94282
78	ENVEQ MIN	0.25962	-356.24238	-180.06988	-532.65502
78	ENVEQ MIN	0.34615	-358.33994	-180.44285	-553.65744
79	ENVEQ MAX	0.08669	0.00000	58.03186	224.88014
79	ENVEQ MAX	0.29876	0.00000	62.61051	121.56256
79	ENVEQ MAX	0.51084	0.00000	67.06605	10.50950
70	ENVEQ MIN	0.00000	-663.51917	-438.27348	-988.49798
70	ENVEQ MIN	0.25000	-663.76565	-439.00953	-983.34551
70	ENVEQ MIN	0.50000	-664.01212	-439.74252	-978.17913
FRAME	LOAD	DIST	P	V2	M3
79	ENVEQ MIN	0.51084	-1143.54500	-67.06599	-10.50939
79	ENVEQ MIN	0.72291	-1169.23300	-71.39841	-108.07560
79	ENVEQ MIN	0.93498	-1194.92000	-75.60771	-233.96004

79	ENVEQ MAX	0.72291	0.00000	71.39847	108.07558
79	ENVEQ MAX	0.93498	0.00000	75.60777	233.95992
79	ENVEQ MIN	0.08669	-1092.17000	-58.03180	-224.87987
79	ENVEQ MIN	0.29876	-1117.85800	-62.61045	-121.56238

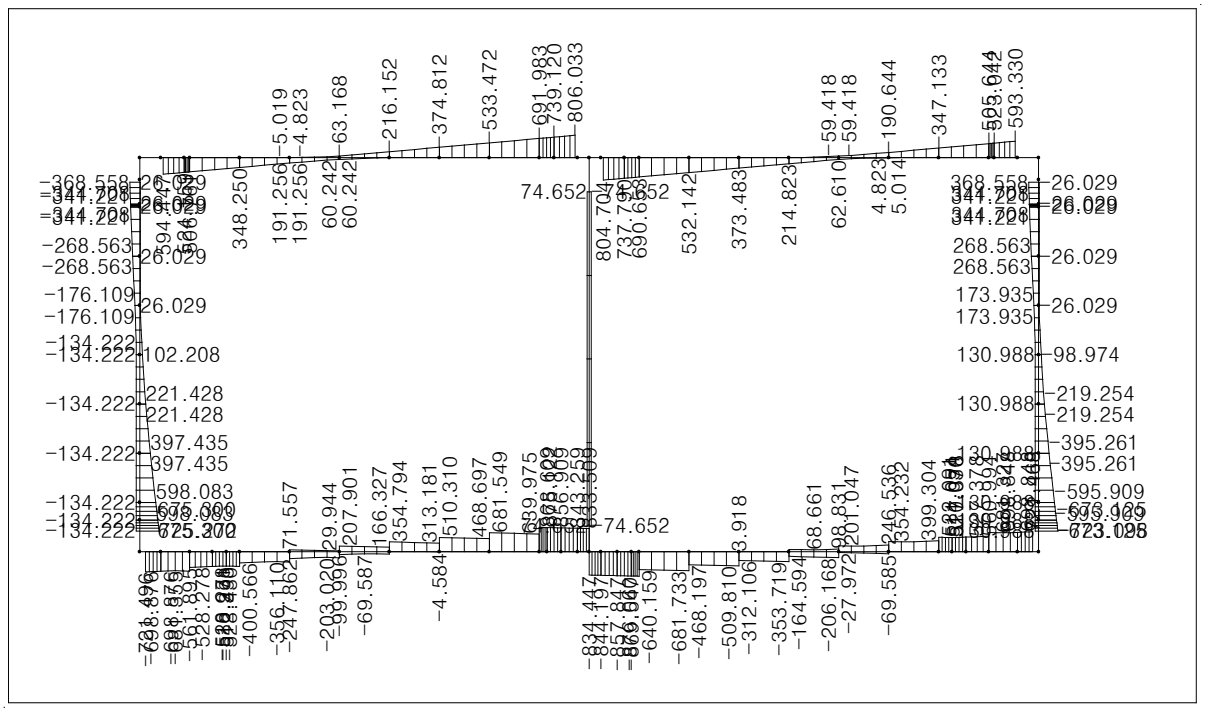
21. 단면력정리

21.1 상시

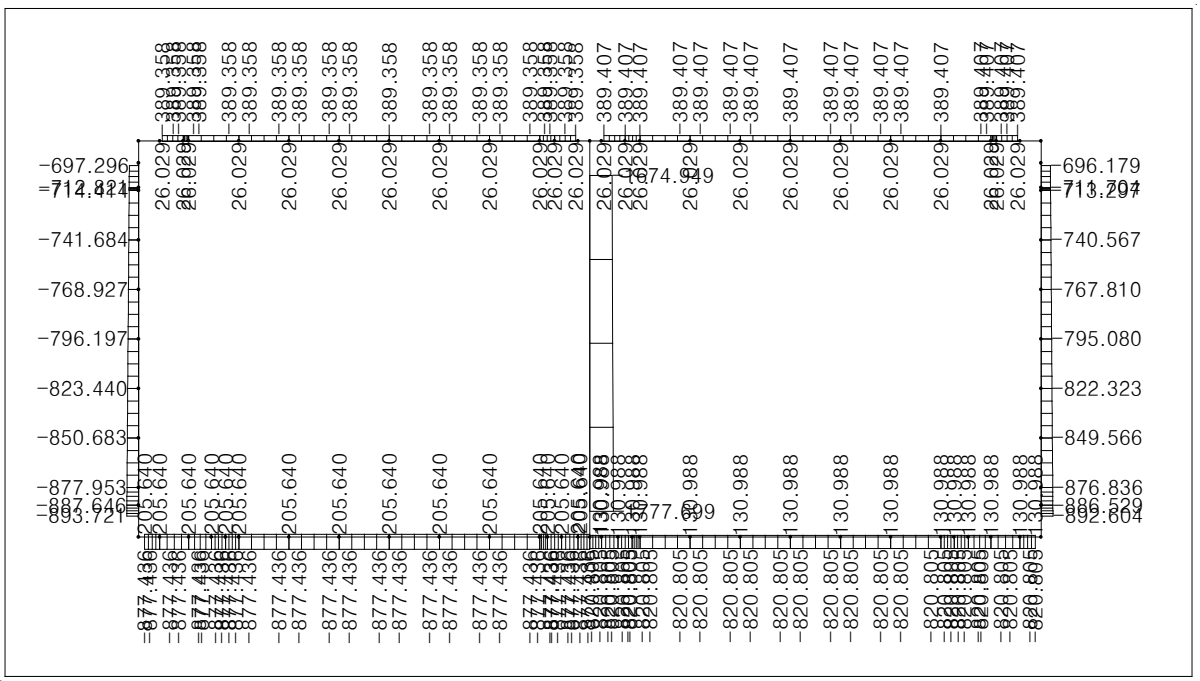
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



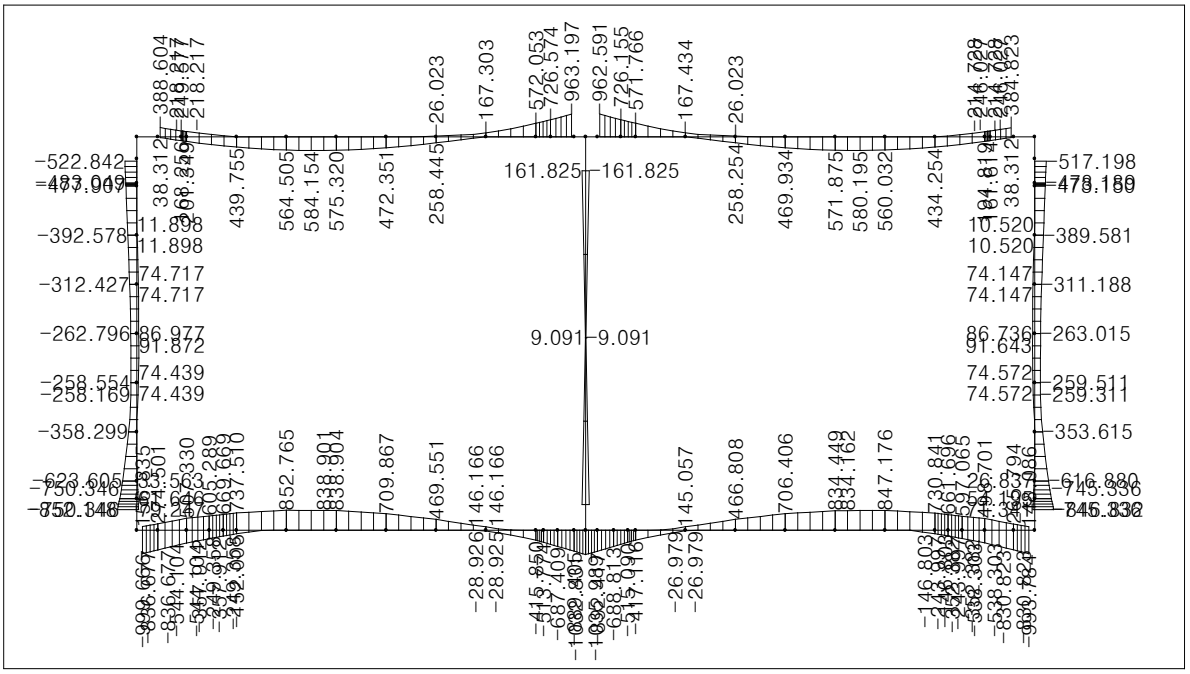
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

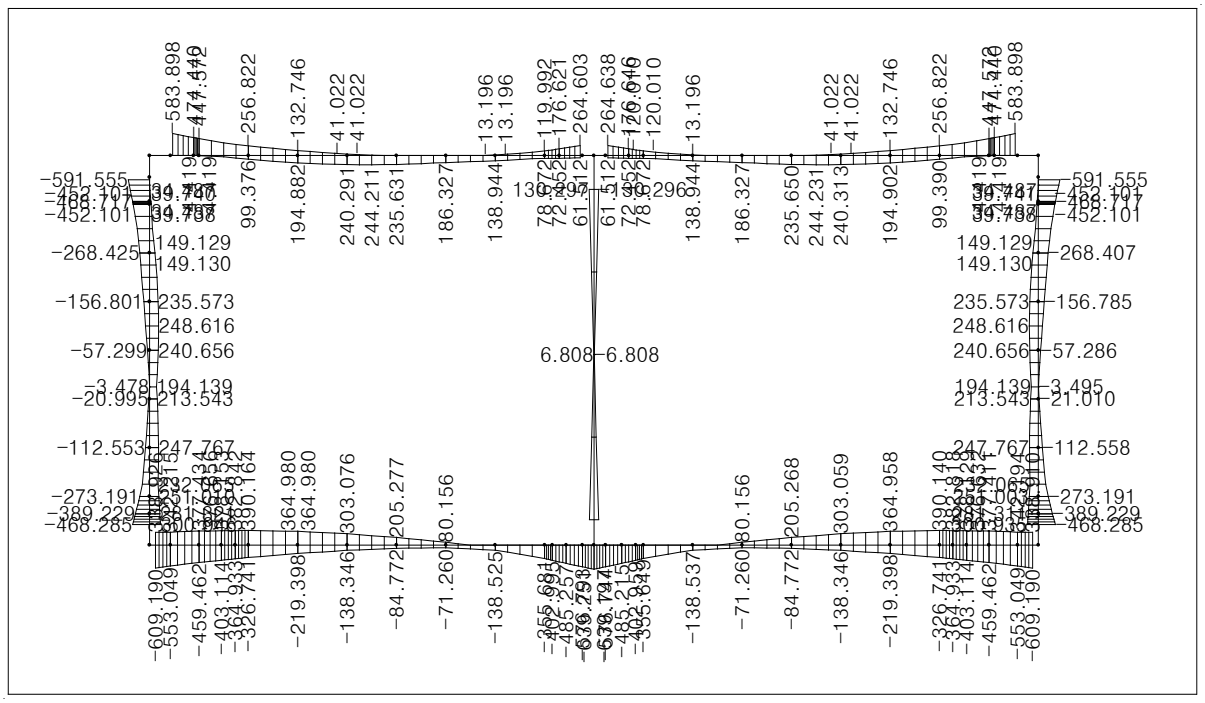


5) 단면력 정리

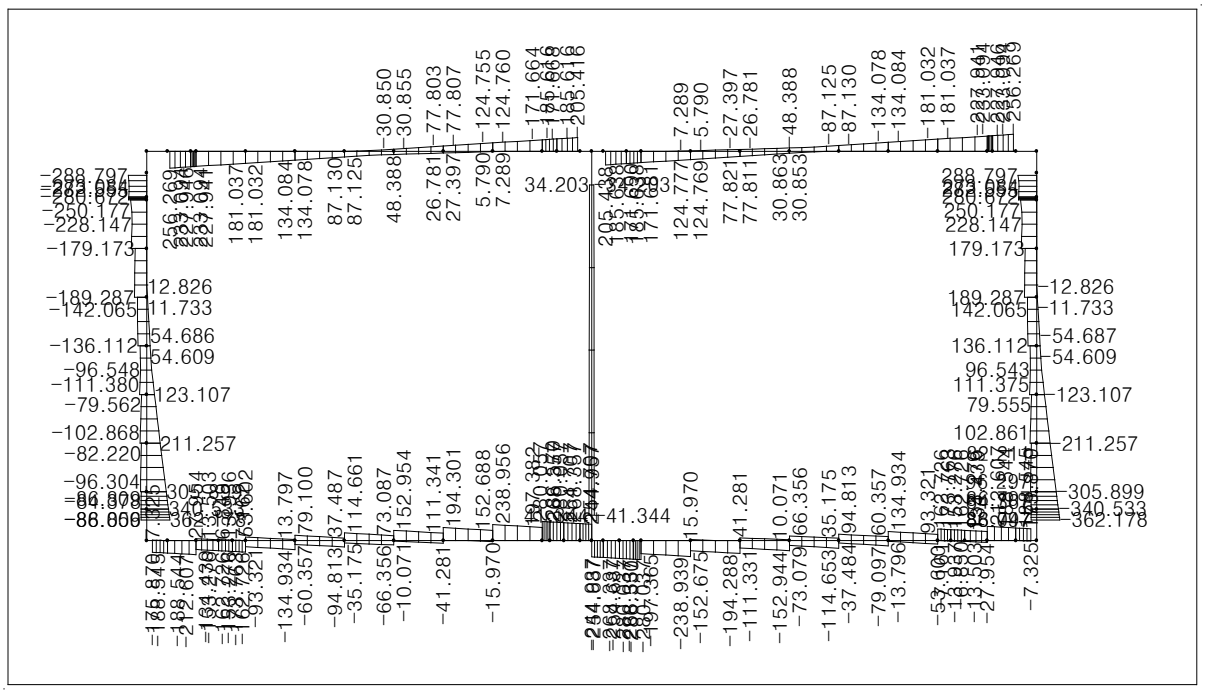
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	650.60	479.52	389.36	388.60	1000.00	1050.00	
		중앙부	2	849.03	83.50	389.36	583.30	1000.00	900.00	
		우측	3	1399.53	694.46	389.36	963.20	1000.00	1050.00	
	2 경간	좌측	4	1398.56	693.14	389.41	962.59	1000.00	1050.00	
		중앙부	5	843.11	82.89	389.41	579.60	1000.00	900.00	
		우측	6	644.55	478.40	389.41	384.82	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	1245.13	520.57	877.44	836.68	1000.00	1300.00	
		측구부	8	567.49	520.57	877.44	357.91	1000.00	1300.00	
		중앙부	9	1261.19	366.51	877.44	852.77	1000.00	1300.00	
		우측	10	1298.79	654.92	877.44	889.41	1000.00	1300.00	
	2 경간	좌측	11	1303.61	655.10	820.81	892.42	1000.00	1300.00	
		중앙부	12	1252.24	364.64	820.81	847.18	1000.00	1300.00	
		측구부	13	558.65	519.67	820.81	352.38	1000.00	1300.00	
		우측	14	1235.76	519.67	820.81	830.82	1000.00	1300.00	
좌측 벽체	1 층	상부	15	831.07	316.30	697.30	522.84	1000.00	1050.00	
		중앙부	16	89.95	445.30	857.50	0.00	1000.00	900.00	
		하부	17	1077.66	511.26	887.65	750.35	1000.00	900.00	
우측 벽체	1 층	상부	18	822.04	316.30	696.18	517.20	1000.00	1050.00	
		중앙부	19	85.51	443.13	856.38	0.00	1000.00	900.00	
		하부	20	1069.64	509.09	886.53	745.34	1000.00	900.00	
중간 벽체	1 련	상부	21	258.92	74.65	1674.95	161.83	1000.00	500.00	
		중앙부	22	131.08	74.65	1700.64	81.92	1000.00	500.00	
		하부	23	252.45	74.65	1777.70	157.78	1000.00	500.00	

21.2 지진시(기능수행)

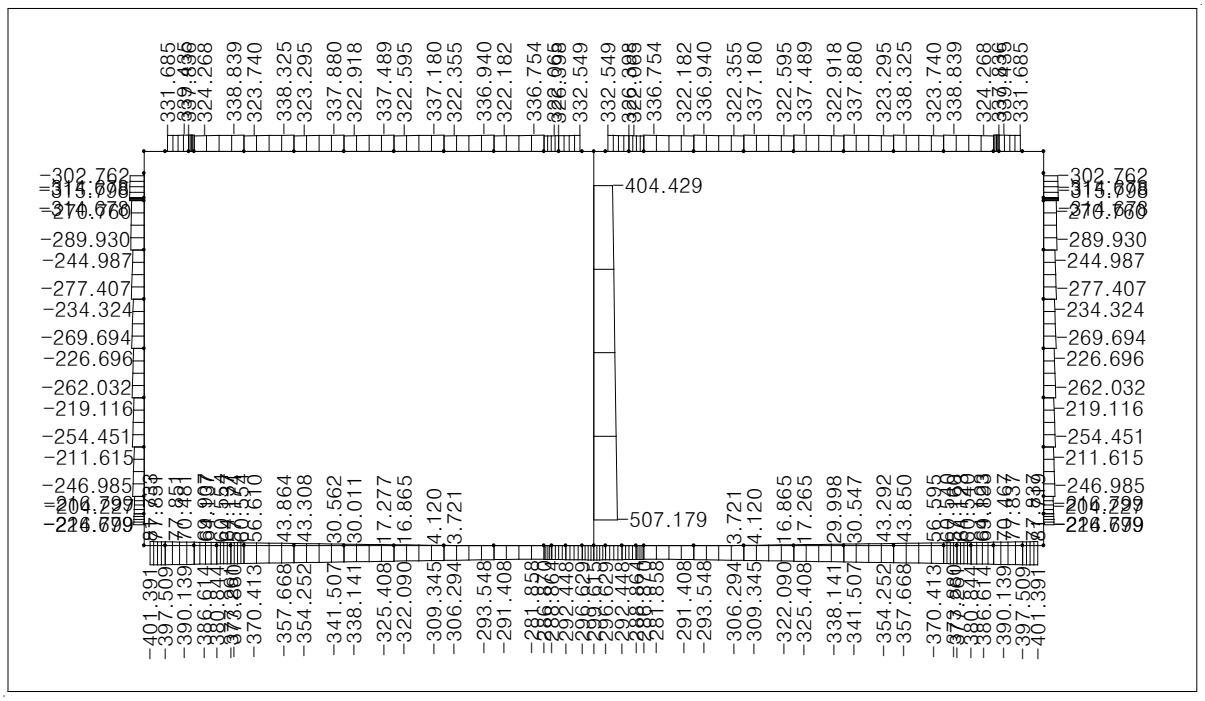
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

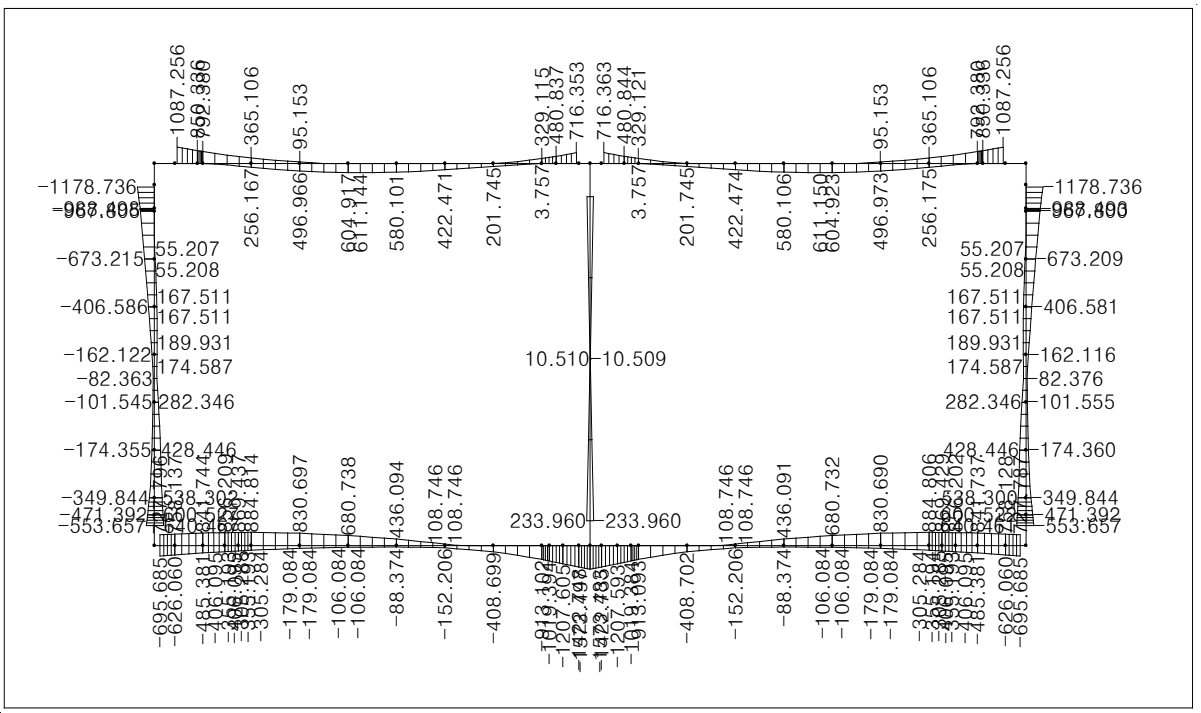


4) 단면력 정리

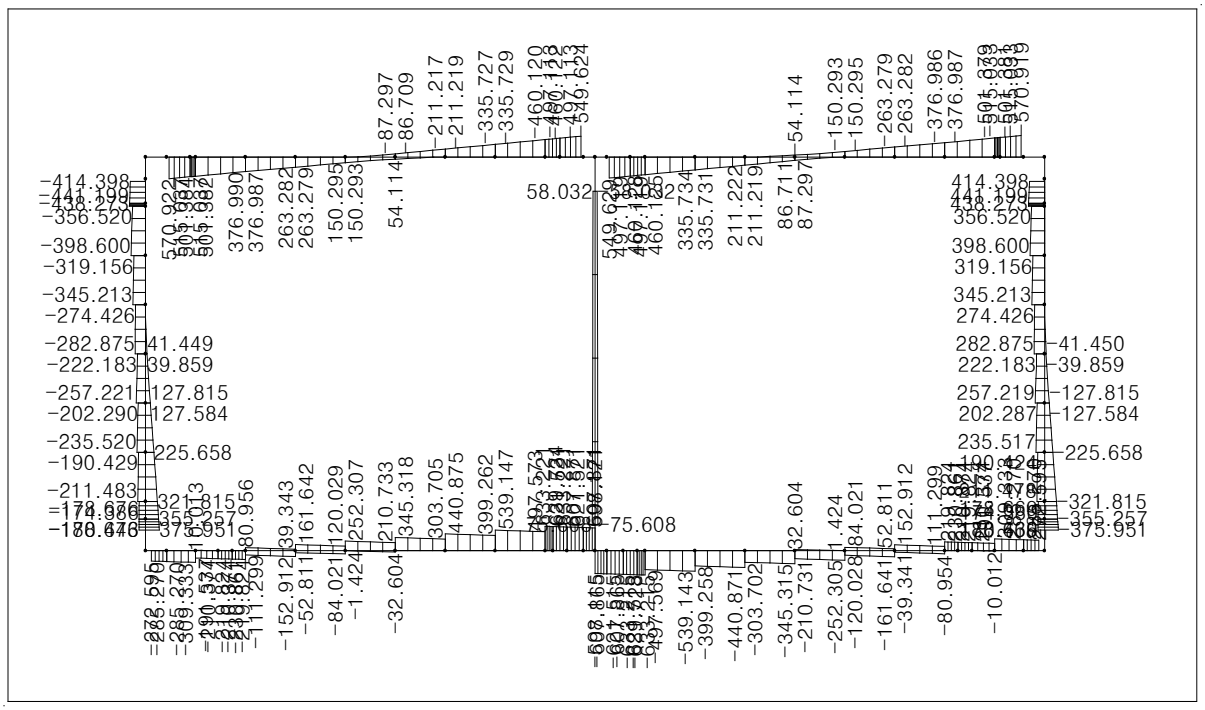
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	583.90	219.88	331.69	1000.00	1050.00	
		중앙부	2	233.64	98.87	334.23	1000.00	900.00	
		우측	3	264.60	172.40	332.55	1000.00	1050.00	
	2 경간	좌측	4	264.64	172.42	332.55	1000.00	1050.00	
		중앙부	5	233.66	98.87	334.23	1000.00	900.00	
		우측	6	583.90	219.88	331.69	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	553.05	156.43	397.51	1000.00	1300.00	
		측구부	8	403.11	156.43	401.39	1000.00	1300.00	
		중앙부	9	364.98	134.93	357.67	1000.00	1300.00	
		우측	10	576.79	212.32	296.63	1000.00	1300.00	
	2 경간	좌측	11	576.74	212.31	296.63	1000.00	1300.00	
		중앙부	12	364.96	134.93	354.25	1000.00	1300.00	
		측구부	13	403.11	156.43	380.84	1000.00	1300.00	
		우측	14	553.05	156.43	397.51	1000.00	1300.00	
좌측 벽체	1 층	상부	15	591.56	229.21	302.76	1000.00	1050.00	
		중앙부	16	245.65	233.48	220.46	1000.00	900.00	
		하부	17	389.23	265.06	216.80	1000.00	900.00	
우측 벽체	1 층	상부	18	591.56	229.21	302.76	1000.00	1050.00	
		중앙부	19	245.65	233.48	220.46	1000.00	900.00	
		하부	20	389.23	265.06	216.80	1000.00	900.00	
중간 벽체	1 련	상부	21	130.30	34.98	404.43	1000.00	500.00	
		중앙부	22	70.12	36.06	430.12	1000.00	500.00	
		하부	23	128.91	40.42	507.18	1000.00	500.00	

21.3 지진시(붕괴방지)

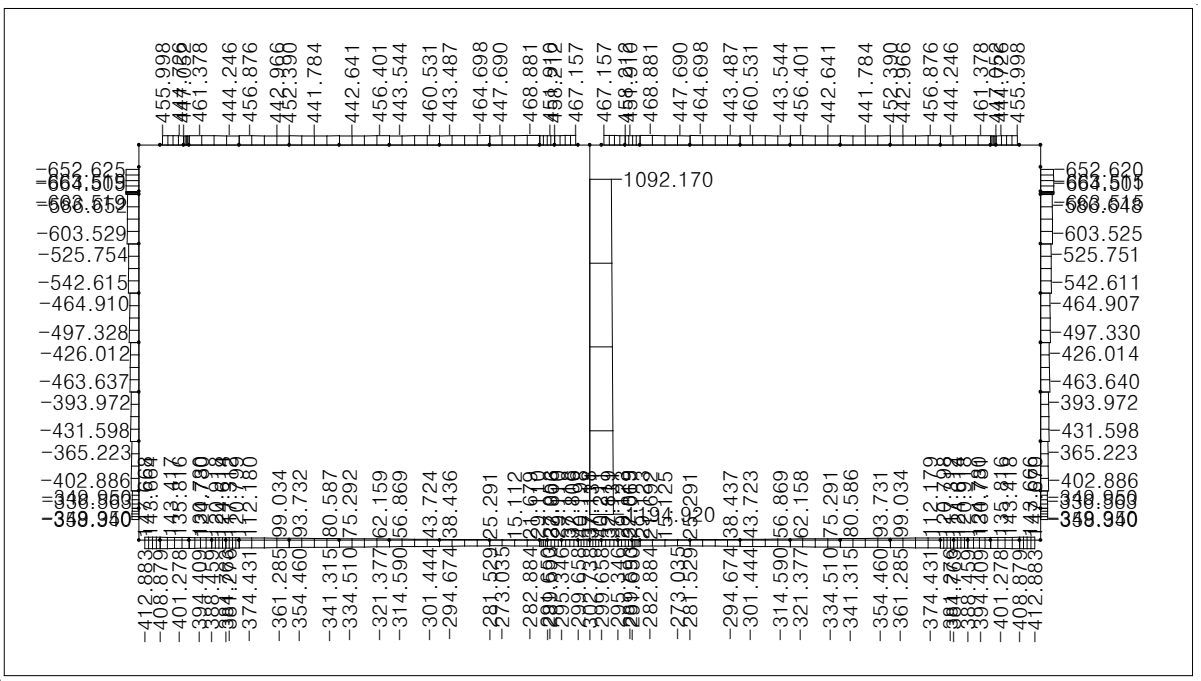
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	1087.26	480.00	456.00	1000.00	1050.00	
		중앙부	2	590.38	178.54	447.03	1000.00	900.00	
		우측	3	716.35	462.07	467.16	1000.00	1050.00	
	2 경간	좌측	4	716.36	462.08	467.16	1000.00	1050.00	
		중앙부	5	590.39	178.54	447.03	1000.00	900.00	
		우측	6	1087.26	480.00	456.00	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	626.06	213.52	408.88	1000.00	1300.00	
		측구부	8	406.10	213.52	412.88	1000.00	1300.00	
		중앙부	9	830.70	161.64	361.29	1000.00	1300.00	
		우측	10	1422.75	512.51	299.66	1000.00	1300.00	
	2 경간	좌측	11	1422.74	512.51	299.66	1000.00	1300.00	
		중앙부	12	830.69	161.64	354.46	1000.00	1300.00	
		측구부	13	406.10	213.52	388.46	1000.00	1300.00	
		우측	14	626.06	213.52	408.88	1000.00	1300.00	
좌측 벽체	1 층	상부	15	1178.74	374.18	652.63	1000.00	1050.00	
		중앙부	16	448.58	249.96	374.64	1000.00	900.00	
		하부	17	471.39	281.88	349.95	1000.00	900.00	
우측 벽체	1 층	상부	18	1178.74	374.18	652.62	1000.00	1050.00	
		중앙부	19	448.58	249.96	374.64	1000.00	900.00	
		하부	20	471.39	281.88	349.95	1000.00	900.00	
중간 벽체	1 련	상부	21	224.88	59.94	1092.17	1000.00	500.00	
		중앙부	22	121.56	62.61	1117.86	1000.00	500.00	
		하부	23	233.96	73.33	1194.92	1000.00	500.00	

21.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-650.60	-	-1087.26	-583.90	-1087.26	
		중앙부	2	849.03	-	590.38	233.64	849.03	
		우측	3	-1399.53	-	-716.35	-264.60	-1399.53	
	2 경간	좌측	4	-1398.56	-	-716.36	-264.64	-1398.56	
		중앙부	5	843.11	-	590.39	233.66	843.11	
		우측	6	-644.55	-	-1087.26	-583.90	-1087.26	
하부 슬래브	1 경간	좌측	7	-1245.13	-	-626.06	-553.05	-1245.13	
		측구부	8	-567.49	-	-406.10	-403.11	-567.49	
		중앙부	9	1261.19	-	830.70	364.98	1261.19	
		우측	10	-1298.79	-	-1422.75	-576.79	-1422.75	
	2 경간	좌측	11	-1303.61	-	-1422.74	-576.74	-1422.74	
		중앙부	12	1252.24	-	830.69	364.96	1252.24	
		측구부	13	-558.65	-	-406.10	-403.11	-558.65	
		우측	14	-1235.76	-	-626.06	-553.05	-1235.76	
좌측 벽체	1 층	상부	15	-831.07	-	-1178.74	-591.56	-1178.74	
		중앙부	16	89.95	-	448.58	245.65	448.58	
		하부	17	-1077.66	-	-471.39	-389.23	-1077.66	
우측 벽체	1 층	상부	18	-822.04	-	-1178.74	-591.56	-1178.74	
		중앙부	19	85.51	-	448.58	245.65	448.58	
		하부	20	-1069.64	-	-471.39	-389.23	-1069.64	
중간 벽체	1 련	상부	21	-258.92	-	-224.88	-130.30	-258.92	
		중앙부	22	131.08	-	121.56	70.12	131.08	
		하부	23	-252.45	-	-233.96	-128.91	-252.45	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	479.52	-	480.00	219.88	480.00	
		중앙부	2	83.50	-	178.54	98.87	178.54	
		우측	3	-694.46	-	-462.07	-172.40	-694.46	
	2 경간	좌측	4	693.14	-	462.08	172.42	693.14	
		중앙부	5	-82.89	-	-178.54	-98.87	-178.54	
		우측	6	-478.40	-	-480.00	-219.88	-480.00	
하부 슬래브	1 경간	좌측	7	-520.57	-	-213.52	-156.43	-520.57	
		측구부	8	-520.57	-	-213.52	-156.43	-520.57	
		중앙부	9	-366.51	-	161.64	-134.93	-366.51	
		우측	10	654.92	-	512.51	212.32	654.92	
	2 경간	좌측	11	-655.10	-	-512.51	-212.31	-655.10	
		중앙부	12	364.64	-	-161.64	134.93	364.64	
		측구부	13	519.67	-	213.52	156.43	519.67	
		우측	14	519.67	-	213.52	156.43	519.67	
좌측 벽체	1 층	상부	15	-316.30	-	-374.18	-229.21	-374.18	
		중앙부	16	445.30	-	249.96	233.48	445.30	
		하부	17	511.26	-	281.88	265.06	511.26	
우측 벽체	1 층	상부	18	316.30	-	374.18	229.21	374.18	
		중앙부	19	-443.13	-	-249.96	-233.48	-443.13	
		하부	20	-509.09	-	-281.88	-265.06	-509.09	
중간 벽체	1 련	상부	21	-74.65	-	59.94	34.98	-74.65	
		중앙부	22	-74.65	-	62.61	36.06	-74.65	
		하부	23	-74.65	-	73.33	40.42	-74.65	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-389.36	-	-456.00	-331.69	-456.00	
		중앙부	2	-389.36	-	-447.03	-334.23	-447.03	
		우측	3	-389.36	-	-467.16	-332.55	-467.16	
	2 경간	좌측	4	-389.41	-	-467.16	-332.55	-467.16	
		중앙부	5	-389.41	-	-447.03	-334.23	-447.03	
		우측	6	-389.41	-	-456.00	-331.69	-456.00	
하부 슬래브	1 경간	좌측	7	-877.44	-	-408.88	-397.51	-877.44	
		측구부	8	-877.44	-	-412.88	-401.39	-877.44	
		중앙부	9	-877.44	-	-361.29	-357.67	-877.44	
		우측	10	-877.44	-	-299.66	-296.63	-877.44	
	2 경간	좌측	11	-820.81	-	-299.66	-296.63	-820.81	
		중앙부	12	-820.81	-	-354.46	-354.25	-820.81	
		측구부	13	-820.81	-	-388.46	-380.84	-820.81	
		우측	14	-820.81	-	-408.88	-397.51	-820.81	
좌측 벽체	1 층	상부	15	-697.30	-	-652.63	-302.76	-697.30	
		중앙부	16	-857.50	-	-374.64	-220.46	-857.50	
		하부	17	-887.65	-	-349.95	-216.80	-887.65	
우측 벽체	1 층	상부	18	-696.18	-	-652.62	-302.76	-696.18	
		중앙부	19	-856.38	-	-374.64	-220.46	-856.38	
		하부	20	-886.53	-	-349.95	-216.80	-886.53	
중간 벽체	1 련	상부	21	-1674.95	-	-1092.17	-404.43	-1674.95	
		중앙부	22	-1700.64	-	-1117.86	-430.12	-1700.64	
		하부	23	-1777.70	-	-1194.92	-507.18	-1777.70	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-388.60	-	-	-	-388.60	
		중앙부	2	583.30	-	-	-	583.30	
		우측	3	-963.20	-	-	-	-963.20	
	2 경간	좌측	4	-962.59	-	-	-	-962.59	
		중앙부	5	579.60	-	-	-	579.60	
		우측	6	-384.82	-	-	-	-384.82	
하부 슬래브	1 경간	좌측	7	-836.68	-	-	-	-836.68	
		측구부	8	-357.91	-	-	-	-357.91	
		중앙부	9	852.77	-	-	-	852.77	
		우측	10	-889.41	-	-	-	-889.41	
	2 경간	좌측	11	-892.42	-	-	-	-892.42	
		중앙부	12	847.18	-	-	-	847.18	
		측구부	13	-352.38	-	-	-	-352.38	
		우측	14	-830.82	-	-	-	-830.82	
좌측 벽체	1 층	상부	15	-522.84	-	-	-	-522.84	
		중앙부	16	-	-	-	-	-	
		하부	17	-750.35	-	-	-	-750.35	
우측 벽체	1 층	상부	18	-517.20	-	-	-	-517.20	
		중앙부	19	-	-	-	-	-	
		하부	20	-745.34	-	-	-	-745.34	
중간 벽체	1 련	상부	21	-161.83	-	-	-	-161.83	
		중앙부	22	81.92	-	-	-	81.92	
		하부	23	-157.78	-	-	-	-157.78	

22. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	950	1087.26	1581.71	3477.02	H29 - 8.0EA	5139.20	1.45
		중앙부	2	1000	820	849.03	1081.46	3150.81	H25 - 8.0EA	4053.60	1.27
		우측	3	1000	950	1399.53	1581.71	4520.35	H29 - 8.0EA	5139.20	1.13
	2경간	좌측	4	1000	950	1398.56	1581.71	4517.07	H29 - 8.0EA	5139.20	1.13
		중앙부	5	1000	820	843.11	1081.46	3128.05	H25 - 8.0EA	4053.60	1.28
		우측	6	1000	950	1087.26	1581.71	3477.02	H29 - 8.0EA	5139.20	1.45
하부슬래브	1경간	좌측	7	1000	1200	1245.13	2018.54	3122.60	H29 - 8.0EA	5139.20	1.62
		측구부	8	1000	950	567.49	1581.71	1786.21	H29 - 8.0EA	5139.20	2.79
		중앙부	9	1000	1220	1261.19	2053.48	3109.54	H29 - 8.0EA	5139.20	1.63
		우측	10	1000	1200	1422.75	2018.54	3580.21	H29 - 8.0EA	5139.20	1.42
	2경간	좌측	11	1000	1200	1422.73	2018.54	3580.18	H29 - 8.0EA	5139.20	1.42
		중앙부	12	1000	1220	1252.24	2053.48	3086.98	H29 - 8.0EA	5139.20	1.64
		측구부	13	1000	950	558.65	1581.71	1757.90	H29 - 8.0EA	5139.20	2.83
		우측	14	1000	1200	1235.76	2018.54	3098.56	H29 - 8.0EA	5139.20	1.63
좌측벽체	1층	상부	15	1000	950	1178.74	1581.71	3780.44	H29 - 8.0EA	5139.20	1.34
		중앙부	16	1000	820	448.58	623.44	1637.47	H19 - 8.0EA	2292.00	1.39
		하부	17	1000	800	1077.66	1319.61	4149.53	H29 - 8.0EA	5139.20	1.22
우측벽체	1층	상부	18	1000	950	1178.74	1581.71	3780.44	H29 - 8.0EA	5139.20	1.34
		중앙부	19	1000	820	448.58	623.44	1637.47	H19 - 8.0EA	2292.00	1.39
		하부	20	1000	800	1069.64	1319.61	4117.15	H29 - 8.0EA	5139.20	1.23

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	519.6	480.0	925.06	2.00	131.25	H13	150	253.40	O.K
		중앙부	2	532.6	178.5	740.39	2.00	-	H13	300	253.40	O.K
		우측	3	519.6	694.5	925.06	2.00	109.28	H13	150	253.40	O.K
	2경간	좌측	4	519.6	693.1	925.06	2.00	108.45	H13	150	253.40	O.K
		중앙부	5	532.6	178.5	740.39	2.00	-	H13	300	253.40	O.K
		우측	6	519.6	480.0	925.06	2.00	131.25	H13	150	253.40	O.K
하부슬래브	1경간	좌측	7	779.4	520.6	1387.58	2.00	131.25	H13	150	253.40	O.K
		측구부	8	617.0	520.6	1098.50	2.00	131.25	H13	150	253.40	O.K
		중앙부	9	792.4	366.5	1101.56	2.00	-	H13	300	253.40	O.K
		우측	10	779.4	654.9	1387.58	2.00	131.25	H13	150	253.40	O.K
	2경간	좌측	11	779.4	655.1	1387.58	2.00	131.25	H13	150	253.40	O.K
		중앙부	12	792.4	364.6	1101.56	2.00	-	H13	300	253.40	O.K
		측구부	13	617.0	519.7	1098.50	2.00	131.25	H13	150	253.40	O.K
		우측	14	779.4	519.7	1387.58	2.00	131.25	H13	150	253.40	O.K
좌측벽체	1층	상부	15	519.6	374.2	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	16	532.6	445.3	948.18	2.00	-	H13	150	253.40	O.K
		하부	17	519.6	511.3	925.06	2.00	-	H13	150	253.40	O.K
우측벽체	1층	상부	18	519.6	374.2	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	19	532.6	443.1	948.18	2.00	-	H13	150	253.40	O.K
		하부	20	519.6	509.1	925.06	2.00	-	H13	150	253.40	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1087.26	480.00

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3477.019 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.478]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1087.256 kN.m) ∴ O.K [안전률 1.455]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

ΦVc/2 < Vu (= 480.002 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 상부슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	849.03	178.54

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 83.119) / 83.119 = 0.02660

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3150.813 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.287]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00494

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (820.00 - a/2) = 1081.457 kN.m

≥ Mu (= 849.032 kN.m) ∴ O.K [안전률 1.274]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

ΦVc/2 ≥ Vu (= 178.541 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1399.53	694.46

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4520.346 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.137]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1399.528 kN.m) ∴ O.K [안전률 1.130]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 694.464 kN) , 전단보강 필요.

Av_req = (694.464-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 109.280 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 694.464 kN ∴ O.K

▣ TITLE : 상부슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1398.56	693.14

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4517.072 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.138]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1398.558 kN.m) ∴ O.K [안전률 1.131]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 693.135 kN) , 전단보강 필요.

Av_req = (693.135-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 108.450 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 693.135 kN ∴ O.K

▣ TITLE : 상부슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	843.11	178.54

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 83.119) / 83.119 = 0.02660

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3128.047 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.296]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00494

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (820.00 - a/2) = 1081.457 kN.m

≥ Mu (= 843.108 kN.m) ∴ O.K [안전률 1.283]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

ΦVc/2 ≥ Vu (= 178.541 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1087.26	480.00

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3477.019 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.478]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1087.256 kN.m) ∴ O.K [안전률 1.455]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

ΦVc/2 < Vu (= 479.999 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1200.00	100.00	1245.13	520.57

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1200.00 - 105.379) / 105.379 = 0.03116

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3122.600 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.646]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00428

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1200.00 - a/2) = 2018.538 kN.m

≥ Mu (= 1245.130 kN.m) ∴ O.K [안전률 1.621]

* 전단에 대한 검토 (d = 1200.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1200.00 = 779.423 kN

ΦVc/2 < Vu (= 520.568 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 1경간(측구)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	567.49	520.57

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1786.213 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 2.877]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 567.493 kN.m) ∴ O.K [안전률 2.787]

* 전단에 대한 검토 (d = 950.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 950.00 = 617.043 kN

ΦVc/2 < Vu (= 520.568 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1220.00	80.00	1261.19	366.51

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1220.00 - 105.379) / 105.379 = 0.03173

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3109.536 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm), [사용률 = 1.653]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00421

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1220.00 - a/2) = 2053.484 kN.m

≥ Mu (= 1261.186 kN.m) ∴ O.K [안전률 1.628]

* 전단에 대한 검토 (d = 1220.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1220.00 = 792.413 kN

ΦVc/2 ≥ Vu (= 366.513 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1200.00	100.00	1422.75	654.92

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1200.00 - 105.379) / 105.379 = 0.03116

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3580.213 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.435]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00428

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1200.00 - a/2) = 2018.538 kN.m

≥ Mu (= 1422.748 kN.m) ∴ O.K [안전률 1.419]

* 전단에 대한 검토 (d = 1200.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1200.00 = 779.423 kN

ΦVc/2 < Vu (= 654.916 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1200.00	100.00	1422.74	655.10

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1200.00 - 105.379) / 105.379 = 0.03116

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3580.180 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.435]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00428

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1200.00 - a/2) = 2018.538 kN.m

≥ Mu (= 1422.735 kN.m) ∴ O.K [안전률 1.419]

* 전단에 대한 검토 (d = 1200.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1200.00 = 779.423 kN

ΦVc/2 < Vu (= 655.099 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1220.00	80.00	1252.24	364.64

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1220.00 - 105.379) / 105.379 = 0.03173

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3086.978 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm), [사용률 = 1.665]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00421

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1220.00 - a/2) = 2053.484 kN.m

≥ Mu (= 1252.243 kN.m) ∴ O.K [안전률 1.640]

* 전단에 대한 검토 (d = 1220.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1220.00 = 792.413 kN

ΦVc/2 ≥ Vu (= 364.635 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 2경간(측구)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	558.65	519.67

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1757.902 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 2.923]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 558.646 kN.m) ∴ O.K [안전률 2.831]

* 전단에 대한 검토 (d = 950.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 950.00 = 617.043 kN

ΦVc/2 < Vu (= 519.668 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1200.00	100.00	1235.76	519.67

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1200.00 - 105.379) / 105.379 = 0.03116

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3098.555 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.659]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00428

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1200.00 - a/2) = 2018.538 kN.m

≥ Mu (= 1235.763 kN.m) ∴ O.K [안전률 1.633]

* 전단에 대한 검토 (d = 1200.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1200.00 = 779.423 kN

ΦVc/2 < Vu (= 519.668 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 좌측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1178.74	374.18

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3780.439 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.359]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1178.736 kN.m) ∴ O.K [안전률 1.342]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 374.182 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	448.58	445.30

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 46.997) / 46.997 = 0.04934

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1637.473 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm), [사용률 = 1.400]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00280

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (820.00 - a/2) = 623.444 kN.m

≥ Mu (= 448.583 kN.m) ∴ O.K [안전률 1.390]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

≥ Vu (= 445.303 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	800.00	100.00	1077.66	511.26

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (800.00 - 105.379) / 105.379 = 0.01977

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4149.534 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.239]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00642

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (800.00 - a/2) = 1319.606 kN.m

≥ Mu (= 1077.655 kN.m) ∴ O.K [안전률 1.225]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 511.262 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1178.74	374.18

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3780.439 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.359]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1178.736 kN.m) ∴ O.K [안전률 1.342]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 374.182 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	448.58	443.13

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 46.997) / 46.997 = 0.04934

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1637.473 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm), [사용률 = 1.400]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00280

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (820.00 - a/2) = 623.444 kN.m

≥ Mu (= 448.583 kN.m) ∴ O.K [안전률 1.390]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

≥ Vu (= 443.129 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	800.00	100.00	1069.64	509.09

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (800.00 - 105.379) / 105.379 = 0.01977

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4117.151 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.248]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00642

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (800.00 - a/2) = 1319.606 kN.m

≥ Mu (= 1069.640 kN.m) ∴ O.K [안전률 1.234]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 509.088 kN) , 전단보강 불필요.

23. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

2) 상부슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

4) 상부슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

5) 상부슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

6) 상부슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

7) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

8) 하부슬래브 : 1경간(측구)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

9) 하부슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 3310.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 6.7EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 2648.662 ㎟ ≥ 1027.840 ∴ O.K
H16 - 6.7EA

10) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

11) 하부슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

12) 하부슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 3310.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 6.7EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 2648.662 ㎟ ≥ 1027.840 ∴ O.K
H16 - 6.7EA

13) 하부슬래브 : 2경간(측구)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

14) 하부슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

15) 좌측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

16) 좌측벽체 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 2292.000 × 0.20 = 458.40 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 458.400 ∴ O.K

17) 좌측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

18) 우측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

19) 우측벽체 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 2292.000 × 0.20 = 458.40 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 458.400 ∴ O.K

20) 우측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

24. 거더,기둥검토,내측벽체 검토

24.1 내측벽체 검토

(단위 : kN,m)

부재	폭	두께	높이	CTC	축력	모멘트	축력×CTC	모멘트×CTC	해석모델	조합
W1	1.00	0.50	6.35	-	1777.70	92.70	1777.70	92.70	상시	26
					1467.08	258.92	1467.08	258.92	상시(ULT)	10

* 벽체와 기둥의 판별 (W1)

$0.4Agfck = 0.4 \times 1000 \times 500 \times 27$

$= 5400000\ N = 5400.00\ kN \quad \geq 1777.70\ kN$

∴ 벽체로 검토한다

(1) 벽체 1

1) 축력최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	80	420	1777.699	92.699	52.1

* 철근비 검토

As = 2292.000 mm² (인장중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0092) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 252.00 mm, ab = k1 x cb = 214.20 mm

Cc = 0.85 x 27.0 x 214200.000 = 4915.890 kN, ∑Csi = 864.199 kN, ∑Tsi = 916.800 kN

Pb = 4915.890 + 864.199 - 916.800 = 4863.289 kN

Mb = Cc x 142.900 + ∑(Csi*di) + ∑(Tsi*di) = 1005.250 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 206.702 mm, e = Mu/Pu = 52.145 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 481.29 mm, a = k1 x c = 409.10 mm 를 사용.

Cc = 0.85 x 27.0 x 409098.816 = 9388.818 kN

∑Csi = 1039.331 kN, ∑Tsi = 0.000 kN

Pn = 9388.818 + 1039.331 - 0.000 = 10428.148 kN

Mn = Cc x 45.451 + ∑(Csi*di) + ∑(Tsi*di) = 543.869 kN.m

- 편심오차 : |e - Mn/Pn(=52.154)| = 0.0086 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 500.00 - 80.00 = 420.000 mm

c = 481.293 mm, a = k1 x c = 409.099 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (420.00-481.29) / 481.29 = -0.00038

εt ≤ εy 이므로 압축지배단면이며, Φ = 0.65 를 적용한다.

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10562.718 kN ≥ Pn = 10428.148 kN

ΦPn = 0.65 x 10428.148 = 6778.296 kN ≥ Pu = 1777.699 kN ∴ O.K

ΦMn = ΦPn x 0.052 = 353.457 kN.m ≥ Mu = 92.699 kN.m ∴ O.K

* 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 420.00 = 342.077 kN

≥ Vu (= 75.608 kN) , 전단보강 불필요.

2) 모멘트최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	80	420	1467.077	258.92	176.5

* 철근비 검토

As = 2292.000 mm² (인장중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0092) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 252.00 mm, ab = k1 x cb = 214.20 mm

Cc = 0.85 x 27.0 x 214200.000 = 4915.890 kN, ∑Csi = 864.199 kN, ∑Tsi = 916.800 kN

Pb = 4915.890 + 864.199 - 916.800 = 4863.289 kN

Mb = Cc x 142.900 + ∑(Csi*di) + ∑(Tsi*di) = 1005.250 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 206.702 mm, e = Mu/Pu = 176.487 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 277.26 mm, a = k1 x c = 235.67 mm 를 사용.

Cc = 0.85 x 27.0 x 235667.610 = 5408.572 kN

∑Csi = 864.199 kN, ∑Tsi = 708.015 kN

Pn = 5408.572 + 864.199 - 708.015 = 5564.755 kN

Mn = Cc x 132.166 + ∑(Csi*di) + ∑(Tsi*di) = 982.107 kN.m

- 편심오차 : |e - Mn/Pn(=176.487)| = 0.0003 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 500.00 - 80.00 = 420.000 mm

c = 277.256 mm, a = k1 x c = 235.668 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (420.00-277.26) / 277.26 = 0.00154

εt ≤ εy 이므로 압축지배단면이며, Φ = 0.65 를 적용한다.

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10562.718 kN ≥ Pn = 5564.755 kN

ΦPn = 0.65 x 5564.755 = 3617.091 kN ≥ Pu = 1467.077 kN ∴ O.K

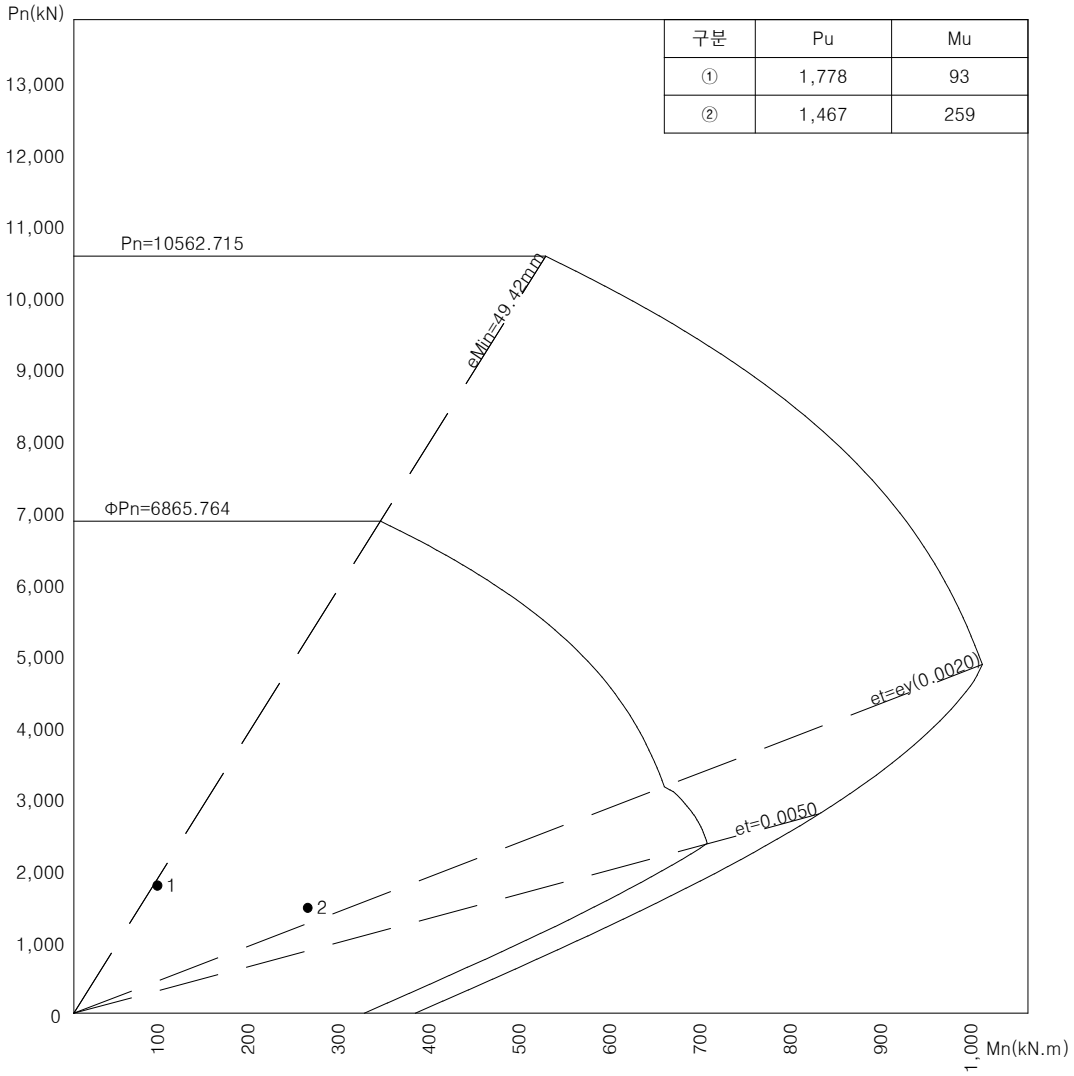
ΦMn = ΦPn x 0.176 = 638.370 kN.m ≥ Mu = 258.920 kN.m ∴ O.K

* 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 420.00 = 329.972 kN

≥ Vu (= 75.608 kN) , 전단보강 불필요.

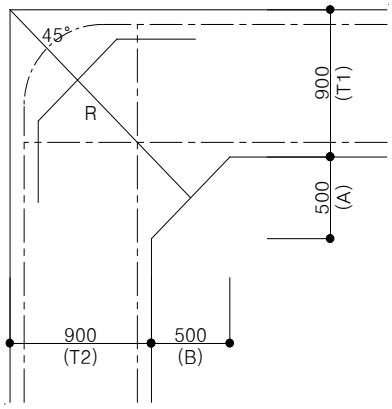
4) PM 상관도



구분	Pu	Mu
①	1,778	93
②	1,467	259

25. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 522.842 kN.m
- 절점부 휨모멘트 : Mo = 522.842 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 1626.346 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 522.84 \times 10^6}{1626.346^2 \times 1000} = 0.988 \text{ MPa} > 0.13\sqrt{fck}\ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 522.84 \times 10^6}{1626.346 \times 180} = 3572.030 \text{ mm}^2$$

Asb = 2569.600 mm²

Req'd As = As - Asb

= 3572.030 mm² - 2569.600 mm²

= 1002.430 mm²

- 사용보강철근

Use'd As = H19 - 4EA

∴ Total As = 1146.000 mm² > Req'd As (= 1002.430 mm²) ----------> O.K !!!

② 내측인장 휨모멘트 보강검토

- 수평부재 내측에 배근된 주철근량 : 2026.8 ㎟

  k = -np + √(2 x np + (np)²) [∵ n = 7]

  = - 7 x 0.0024717 + √(2 x 0.0173 + (0.0173)²) = 0.170

  j = 1 - k / 3 = 1 - 0.170 /3 = 0.943

  fs = Mo / (As x d x j) = 38311588.000 / (2026.800 x 820.000 x 0.943)

  = 24.432 MPa

  인장력 Th1 = fs x As = 24.432 x 2026.800 = 49519.677 N

- 연직부재 내측에 배근된 주철근량 : 1146 ㎟

  k = -np + √(2 x np + (np)²) [∵ n = 7]

  = - 7 x 0.0013976 + √(2 x 0.0098 + (0.0098)²) = 0.130

  j = 1 - k / 3 = 1 - 0.130 /3 = 0.957

  fs = Mo / (As x d x j) = 38311588.000 / (1146.000 x 820.000 x 0.957)

  = 42.622 MPa

  인장력 Th2 = fs x As = 42.622 x 1146.000 = 48845.185 N

- 보강철근량 산정

  T = √(Th1² + Th2²) = fsa x As T : 대각선 방향의 인장력

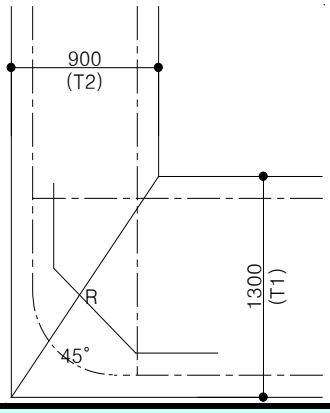
  Th : 수평부재 또는 연직부재에 작용하는 인장력

  As = √(Th1² + Th2²) / fsa = √(49519.677² + 48845.185²) / 180.0

  As = 386.423 ㎟

  사용철근량 : H13 @ 500, 2EA = 506.800 ㎟ ∴ O.K

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 999.666 kN.m
- 절점부 휨모멘트 : Mo = 999.666 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 1581.139$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 999.67 \times 10^6}{1581.139^2 \times 1000} = 1.999 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 999.67 \times 10^6}{1581.139 \times 180} = 7024.935 \text{ mm}^2$$

Asb = 2569.600 mm²

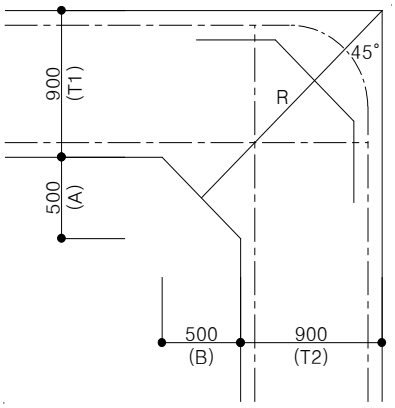
Req'd As = As - Asb
= 7024.935 mm² - 2569.600 mm²
= 4455.335 mm²

- 사용보강철근

Use'd As = H29 - 4EA , H25 - 4EA

∴ Total As = 4596.400 mm² > Req'd As (= 4455.335 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 517.198 kN.m
- 절점부 휨모멘트 : Mo = 517.198 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

= 1626.346 mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 517.20 \times 10^6}{1626.346^2 \times 1000} = 0.978 \text{ MPa} > 0.13\sqrt{fck}\ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 517.20 \times 10^6}{1626.346 \times 180} = 3533.471 \text{ mm}^2$$

Asb = 2569.600 mm²

Req'd As = As - Asb
= 3533.471 mm² - 2569.600 mm²
= 963.871 mm²

- 사용보강철근

Use'd As = H19 - 4EA

∴ Total As = 1146.000 mm² > Req'd As (= 963.871 mm²) ----------> O.K !!!

② 내측인장 휨모멘트 보강검토

- 수평부재 내측에 배근된 주철근량 : 2026.8 ㎟

  k = -np + √(2 x np + (np)²) [∵ n = 7]

  = - 7 x 0.0024717 + √(2 x 0.0173 + (0.0173)²) = 0.170

  j = 1 - k / 3 = 1 - 0.170 /3 = 0.943

  fs = Mo / (As x d x j) = 38311588.000 / (2026.800 x 820.000 x 0.943)

  = 24.432 MPa

  인장력 Th1 = fs x As = 24.432 x 2026.800 = 49519.677 N

- 연직부재 내측에 배근된 주철근량 : 1146 ㎟

  k = -np + √(2 x np + (np)²) [∵ n = 7]

  = - 7 x 0.0013976 + √(2 x 0.0098 + (0.0098)²) = 0.130

  j = 1 - k / 3 = 1 - 0.130 /3 = 0.957

  fs = Mo / (As x d x j) = 38311588.000 / (1146.000 x 820.000 x 0.957)

  = 42.622 MPa

  인장력 Th2 = fs x As = 42.622 x 1146.000 = 48845.185 N

- 보강철근량 산정

  T = √(Th1² + Th2²) = fsa x As T : 대각선 방향의 인장력

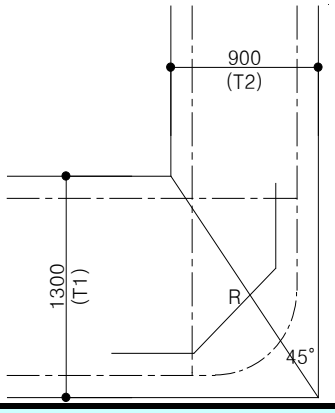
  Th : 수평부재 또는 연직부재에 작용하는 인장력

  As = √(Th1² + Th2²) / fsa = √(49519.677² + 48845.185²) / 180.0

  As = 386.423 ㎟

  사용철근량 : H13 @ 500, 2EA = 506.800 ㎟ ∴ O.K

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 993.784 kN.m
- 절점부 휨모멘트 : Mo = 993.784 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 1581.139$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 993.78 \times 10^6}{1581.139^2 \times 1000} = 1.988 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 993.78 \times 10^6}{1581.139 \times 180} = 6983.599 \text{ mm}^2$$

Asb = 2569.600 mm²

Req'd As = As - Asb
= 6983.599 mm² - 2569.600 mm²
= 4413.999 mm²

- 사용보강철근

Use'd As = H29 - 4EA , H25 - 4EA

∴ Total As = 4596.400 mm² > Req'd As (= 4413.999 mm²) ----------> O.K !!!

26. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	950	H29 - 8.0EA	125	696.502	O.K	5.572
		중앙부	2	820	H25 - 8.0EA	125	245.496	O.K	1.964
		우측	3	950	H29 - 8.0EA	125	153.493	O.K	1.228
	2경간	좌측	4	950	H29 - 8.0EA	125	153.725	O.K	1.230
		중앙부	5	820	H25 - 8.0EA	125	248.142	O.K	1.985
		우측	6	950	H29 - 8.0EA	125	705.447	O.K	5.644
하부슬래브	1경간	좌측	7	1200	H29 - 8.0EA	125	324.776	O.K	2.598
		측구부	8	950	H29 - 8.0EA	125	774.560	O.K	6.196
		중앙부	9	1220	H29 - 8.0EA	125	373.725	O.K	2.990
		우측	10	1200	H29 - 8.0EA	125	292.849	O.K	2.343
	2경간	좌측	11	1200	H29 - 8.0EA	125	291.140	O.K	2.329
		중앙부	12	1220	H29 - 8.0EA	125	377.271	O.K	3.018
		측구부	13	950	H29 - 8.0EA	125	790.068	O.K	6.321
		우측	14	1200	H29 - 8.0EA	125	328.570	O.K	2.629
좌측벽체	1층	상부	15	950	H29 - 8.0EA	125	462.798	O.K	3.702
		중앙부	16	820	H19 - 8.0EA	-	-	-	-
		하부	17	800	H29 - 8.0EA	125	180.595	O.K	1.445
우측벽체	1층	상부	18	950	H29 - 8.0EA	125	470.181	O.K	3.761
		중앙부	19	820	H19 - 8.0EA	-	-	-	-
		하부	20	800	H29 - 8.0EA	125	183.246	O.K	1.466

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 388.604 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 86.514 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 86.51) - 2.5 x 85.50 = 696.50 mm
300 x (Kcr / fs) = 300 x (210 / 86.51) = 728.20 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 696.50 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 696.50 mm) ∴ O.K

2) 상부슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 583.298 x 1000000 / [4053.600 x (820.000 - 189.203/3)]
= 190.105 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x820.0/(7x4053.600)]
= 189.203 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 190.10) - 2.5 x 67.50 = 245.50 mm
300 x (Kcr / fs) = 300 x (210 / 190.10) = 331.40 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 245.50 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 245.50 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 963.197 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 214.435 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 214.44) - 2.5 x 85.50 = 153.49 mm
300 x (Kcr / fs) = 300 x (210 / 214.44) = 293.79 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 153.49 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 153.49 mm) ∴ O.K

4) 상부슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 962.591 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 214.301 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 214.30) - 2.5 x 85.50 = 153.72 mm
300 x (Kcr / fs) = 300 x (210 / 214.30) = 293.98 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 153.72 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 153.72 mm) ∴ O.K

5) 상부슬래브 2경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 579.596 x 1000000 / [4053.600 x (820.000 - 189.203/3)]
= 188.898 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x820.0/(7x4053.600)]
= 189.203 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 188.90) - 2.5 x 67.50 = 248.14 mm
300 x (Kcr / fs) = 300 x (210 / 188.90) = 333.51 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 248.14 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 248.14 mm) ∴ O.K

6) 상부슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 384.823 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 85.673 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 85.67) - 2.5 x 85.50 = 705.45 mm
300 x (Kcr / fs) = 300 x (210 / 85.67) = 735.36 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 705.45 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 705.45 mm) ∴ O.K

7) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 836.677 x 1000000 / [5139.200 x (1200.000 - 260.054/3)]
= 146.233 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1200.0/(7x5139.200)]
= 260.054 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 146.23) - 2.5 x 85.50 = 324.78 mm
300 x (Kcr / fs) = 300 x (210 / 146.23) = 430.82 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 324.78 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 324.78 mm) ∴ O.K

8) 하부슬래브 1경간(측구)

① 응력 산정

fs = M / [As x (d - χ/3)] = 357.912 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 79.682 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 79.68) - 2.5 x 85.50 = 774.56 mm
300 x (Kcr / fs) = 300 x (210 / 79.68) = 790.65 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 774.56 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 774.56 mm) ∴ O.K

9) 하부슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 852.765 x 1000000 / [5139.200 x (1220.000 - 262.474/3)]
= 146.518 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1220.0/(7x5139.200)]
= 262.474 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 146.52) - 2.5 x 65.50 = 373.72 mm
300 x (Kcr / fs) = 300 x (210 / 146.52) = 429.98 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 373.72 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 373.72 mm) ∴ O.K

10) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 889.405 x 1000000 / [5139.200 x (1200.000 - 260.054/3)]
= 155.448 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1200.0/(7x5139.200)]
= 260.054 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 155.45) - 2.5 x 85.50 = 292.85 mm
300 x (Kcr / fs) = 300 x (210 / 155.45) = 405.28 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 292.85 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 292.85 mm) ∴ O.K

11) 하부슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 892.417 x 1000000 / [5139.200 x (1200.000 - 260.054/3)]
= 155.975 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1200.0/(7x5139.200)]
= 260.054 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 155.97) - 2.5 x 85.50 = 291.14 mm
300 x (Kcr / fs) = 300 x (210 / 155.97) = 403.91 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 291.14 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 291.14 mm) ∴ O.K

12) 하부슬래브 2경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 847.176 x 1000000 / [5139.200 x (1220.000 - 262.474/3)]
= 145.558 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1220.0/(7x5139.200)]
= 262.474 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 145.56) - 2.5 x 65.50 = 377.27 mm
300 x (Kcr / fs) = 300 x (210 / 145.56) = 432.82 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 377.27 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 377.27 mm) ∴ O.K

13) 하부슬래브 2경간(측구)

① 응력 산정

fs = M / [As x (d - χ/3)] = 352.382 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 78.450 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 78.45) - 2.5 x 85.50 = 790.07 mm
300 x (Kcr / fs) = 300 x (210 / 78.45) = 803.05 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 790.07 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 790.07 mm) ∴ O.K

14) 하부슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 830.823 x 1000000 / [5139.200 x (1200.000 - 260.054/3)]
= 145.209 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1200.0/(7x5139.200)]
= 260.054 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 145.21) - 2.5 x 85.50 = 328.57 mm
300 x (Kcr / fs) = 300 x (210 / 145.21) = 433.86 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 328.57 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 328.57 mm) ∴ O.K

15) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 522.842 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 116.400 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 116.40) - 2.5 x 85.50 = 462.80 mm
300 x (Kcr / fs) = 300 x (210 / 116.40) = 541.24 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 462.80 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 462.80 mm) ∴ O.K

16) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 750.346 x 1000000 / [5139.200 x (800.000 - 206.622/3)]
= 199.698 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x800.0/(7x5139.200)]
= 206.622 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 199.70) - 2.5 x 85.50 = 180.60 mm
300 x (Kcr / fs) = 300 x (210 / 199.70) = 315.48 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 180.60 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 180.60 mm) ∴ O.K

17) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 517.198 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 115.143 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 115.14) - 2.5 x 85.50 = 470.18 mm
300 x (Kcr / fs) = 300 x (210 / 115.14) = 547.14 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 470.18 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 470.18 mm) ∴ O.K

18) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 745.336 x 1000000 / [5139.200 x (800.000 - 206.622/3)]
= 198.365 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x800.0/(7x5139.200)]
= 206.622 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 198.36) - 2.5 x 85.50 = 183.25 mm
300 x (Kcr / fs) = 300 x (210 / 198.36) = 317.60 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 183.25 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 183.25 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 9.600 m
- fy = 400 MPa
- 부재두께(T) = 0.90 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28

T = 9.600 / 28

T = 0.343 m < 0.900 m ----------> O.K

27. 기초 지지력 검토

(1) 하중산정

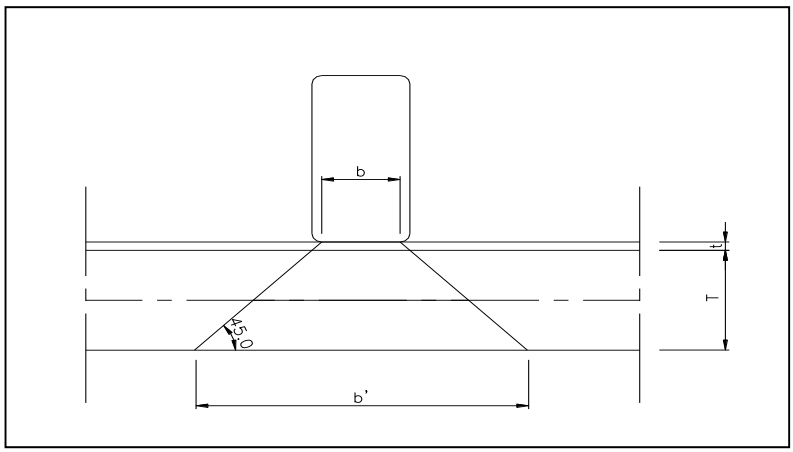
1) 고정하중

- 구체자중 = 1511.875 / 20.100 = 75.218 kN/m²
- 상부연직하중 = 21.125 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.08 × 23.00 = 1.840 kN/m²

2) 활하중

- 도로 노면 활하중 = 17.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중

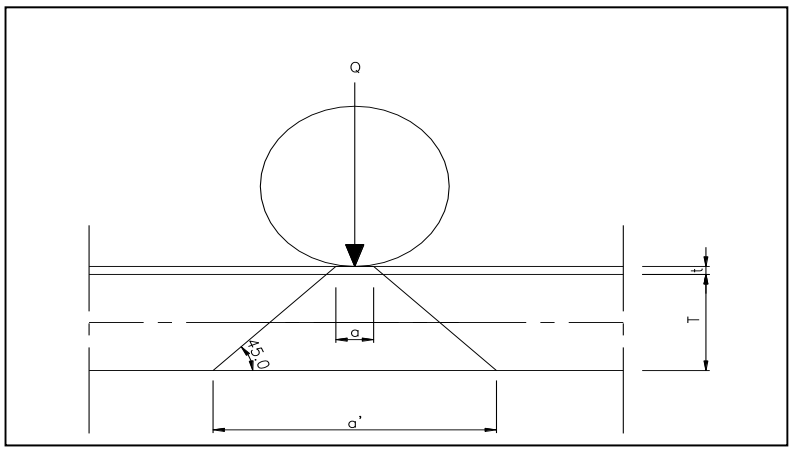


t = 80 mm (암거내부 포장두께)

T = 1300 mm (하부 슬래브 두께)

b' = 0.500 + 2 × (1.300 + 0.080) × cot 45°

= 3.260 m



a' = 0.200 + 2 × (1.300 + 0.080) × cot 45°

= 2.960 m

Qz = 96.0 / (3.260 × 2.960)= 9.949 kN/m²

3) 내부 고정하중

- 암거내부 고정하중 = 10.000 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 75.22 + 21.13 + 17.00 + 1.84 + 9.95 + 10.00

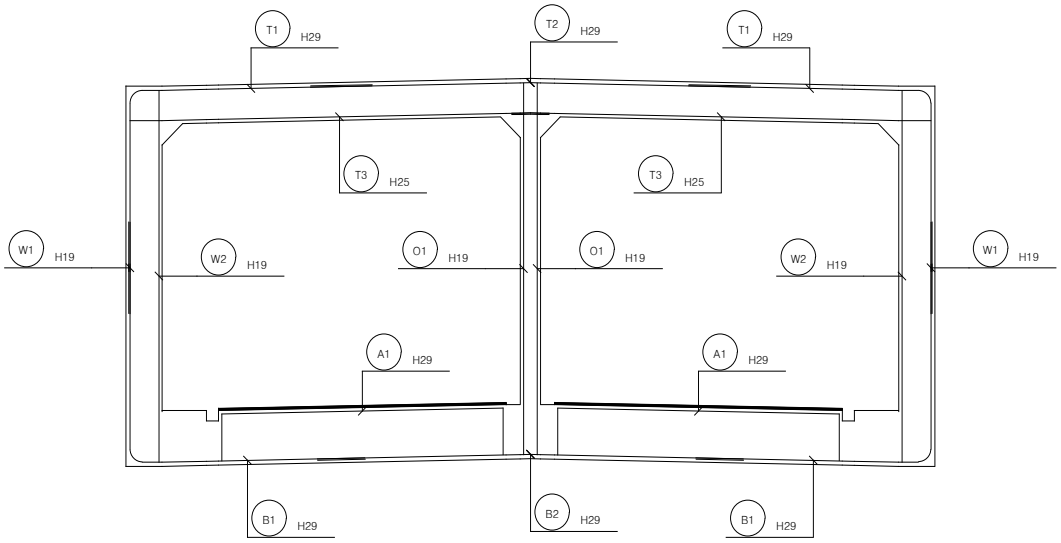
= 135.131 kN/m²

2) 지반의 허용연직지지력

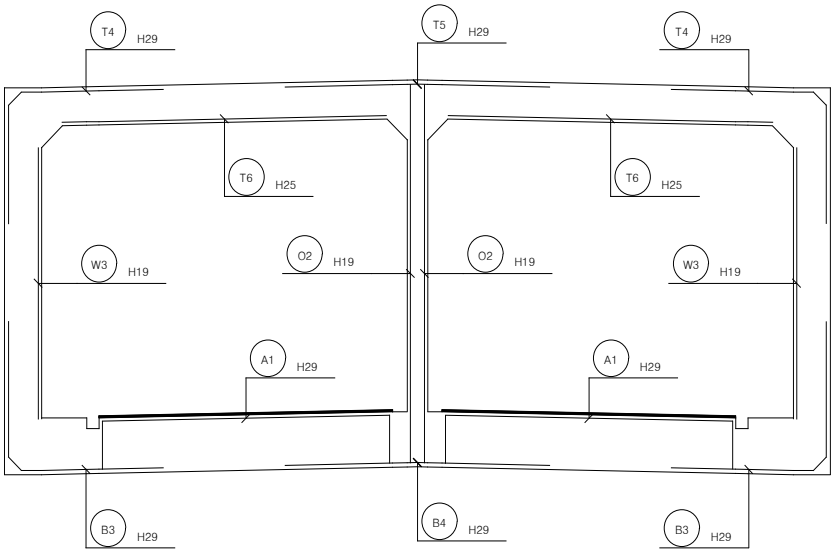
Qa = 200.000 kN/m² ≥ Qmax = 135.131 kN/m² ..... O.K

28. 주철근 조립도

CYCLE-1(@250)



CYCLE-2(@250)



1.20 B7(STA.0+740.0)

- 램 프 -

1.21 B8(STA.0+780.0)
- 본 선 -

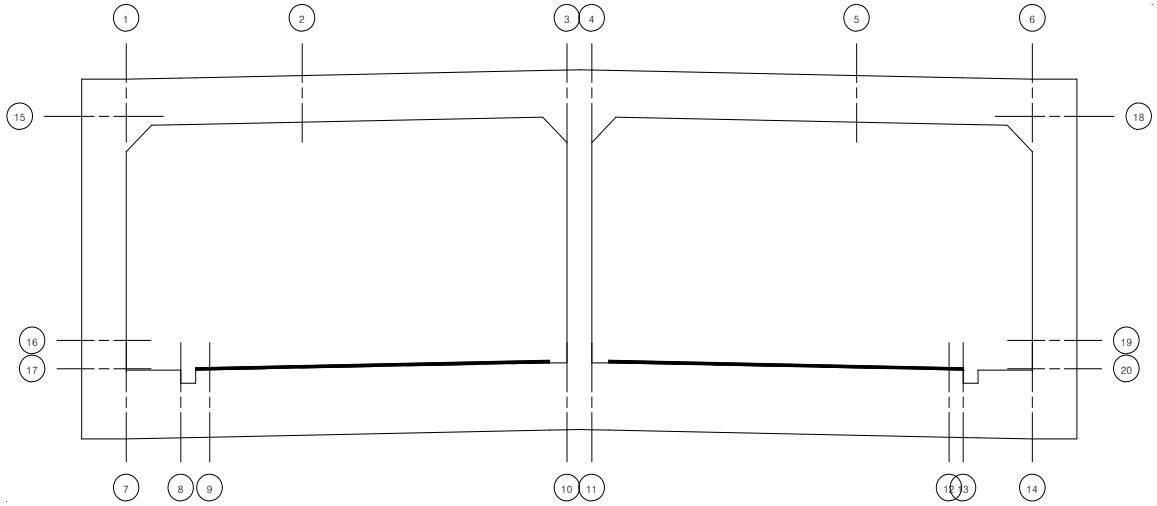
국회대로 지하차도

STA.0+780.000

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. INPUT DATA(상시)
16. INPUT DATA(기능수행)
17. INPUT DATA(붕괴방지)
18. OUTPUT DATA(상시)
19. OUTPUT DATA(기능수행)
20. OUTPUT DATA(붕괴방지)
21. 단면력정리
22. 단면검토 및 철근량 산정
23. 수평철근 검토
24. 거더,기둥,내측벽체 검토
25. 절점부 검토
26. 사용성 검토
27. 기초 지지력 검토
28. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qa(kN)	비 고
직접기초	165.174	400.000	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	1839.15	2892.325	1.573	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	950	1082.89	1260.63	3462.57	H25 - 8.0EA	4053.60	1.16
		중앙부	2	1000	820	839.41	1081.46	3113.84	H25 - 8.0EA	4053.60	1.29
		우측	3	1000	950	1444.68	1581.71	4673.01	H29 - 8.0EA	5139.20	1.09
	2경간	좌측	4	1000	950	1437.05	1581.71	4647.17	H29 - 8.0EA	5139.20	1.10
		중앙부	5	1000	820	831.06	1081.46	3081.78	H25 - 8.0EA	4053.60	1.30
		우측	6	1000	950	1082.89	1260.63	3462.57	H25 - 8.0EA	4053.60	1.16
하부슬래브	1경간	좌측	7	1000	1200	891.75	1605.18	2221.50	H25 - 8.0EA	4053.60	1.80
		측구부	8	1000	950	379.94	1260.63	1189.27	H25 - 8.0EA	4053.60	3.32
		중앙부	9	1000	1220	1042.58	1632.75	2560.28	H25 - 8.0EA	4053.60	1.57
		우측	10	1000	1200	1368.14	2018.54	3439.19	H29 - 8.0EA	5139.20	1.48
	2경간	좌측	11	1000	1200	1368.14	2018.54	3439.19	H29 - 8.0EA	5139.20	1.48
		중앙부	12	1000	1220	1042.58	1632.75	2560.28	H25 - 8.0EA	4053.60	1.57
		측구부	13	1000	950	295.88	1260.63	923.88	H25 - 8.0EA	4053.60	4.26
		우측	14	1000	1200	875.92	1605.18	2181.43	H25 - 8.0EA	4053.60	1.83
좌측벽체	1층	상부	15	1000	950	1205.93	1260.63	3870.98	H25 - 8.0EA	4053.60	1.05
		중앙부	16	1000	820	370.58	623.44	1348.53	H19 - 8.0EA	2292.00	1.68
		하부	17	1000	800	850.54	1053.89	3241.42	H25 - 8.0EA	4053.60	1.24
우측벽체	1층	상부	18	1000	950	1205.93	1260.63	3870.98	H25 - 8.0EA	4053.60	1.05
		중앙부	19	1000	820	370.58	623.44	1348.53	H19 - 8.0EA	2292.00	1.68
		하부	20	1000	800	829.31	1053.89	3157.55	H25 - 8.0EA	4053.60	1.27

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부 슬래브	1 경간	좌측	1	1800.0	1986.0	O.K	810.7	1324.7	O.K
		중앙부	2	1800.0	1986.0	O.K	810.7	1324.7	O.K
		우측	3	1800.0	1986.0	O.K	1027.8	1324.7	O.K
	2 경간	좌측	4	1800.0	1986.0	O.K	1027.8	1324.7	O.K
		중앙부	5	1800.0	1986.0	O.K	810.7	1324.7	O.K
		우측	6	1800.0	1986.0	O.K	810.7	1324.7	O.K
하부 슬래브	1 경간	좌측	7	1800.0	1986.0	O.K	810.7	1324.7	O.K
		측구부	8	1800.0	1986.0	O.K	810.7	1324.7	O.K
		중앙부	9	1800.0	2648.0	O.K	810.7	1323.3	O.K
		우측	10	1800.0	2648.0	O.K	1027.8	1324.7	O.K
	2 경간	좌측	11	1800.0	2648.0	O.K	1027.8	1324.7	O.K
		중앙부	12	1800.0	2648.0	O.K	810.7	1323.3	O.K
		측구부	13	1800.0	2648.0	O.K	810.7	1324.7	O.K
		우측	14	1800.0	1986.0	O.K	810.7	1324.7	O.K
좌측 벽체	1 층	상부	15	1800.0	1986.0	O.K	810.7	1324.7	O.K
		중앙부	16	1800.0	1986.0	O.K	458.4	661.3	O.K
		하부	17	1800.0	1986.0	O.K	810.7	1324.7	O.K
우측 벽체	1 층	상부	18	1800.0	1986.0	O.K	810.7	1324.7	O.K
		중앙부	19	1800.0	1986.0	O.K	458.4	661.3	O.K
		하부	20	1800.0	1986.0	O.K	810.7	1324.7	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	519.6	545.1	925.06	2.00	15.90	H13	150	253.40	O.K
		중앙부	2	532.6	165.8	740.39	2.00	-	H13	300	253.40	O.K
		우측	3	519.6	726.8	925.06	2.00	129.49	H13	150	253.40	O.K
	2경간	좌측	4	519.6	723.9	925.06	2.00	127.68	H13	150	253.40	O.K
		중앙부	5	532.6	165.8	740.39	2.00	-	H13	300	253.40	O.K
		우측	6	519.6	543.6	925.06	2.00	14.97	H13	150	253.40	O.K
하부슬래브	1경간	좌측	7	779.4	436.8	1387.58	2.00	131.25	H13	150	253.40	O.K
		측구부	8	617.0	436.8	1098.50	2.00	131.25	H13	150	253.40	O.K
		중앙부	9	792.4	435.6	1410.71	2.00	131.25	H13	150	253.40	O.K
		우측	10	779.4	554.3	1387.58	2.00	131.25	H13	150	253.40	O.K
	2경간	좌측	11	779.4	554.3	1387.58	2.00	131.25	H13	150	253.40	O.K
		중앙부	12	792.4	429.8	1410.71	2.00	131.25	H13	150	253.40	O.K
		측구부	13	617.0	433.1	1098.50	2.00	131.25	H13	150	253.40	O.K
		우측	14	779.4	433.1	1387.58	2.00	131.25	H13	150	253.40	O.K
좌측벽체	1층	상부	15	519.6	428.5	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	16	532.6	389.4	948.18	2.00	-	H13	150	253.40	O.K
		하부	17	519.6	344.7	925.06	2.00	-	H13	150	253.40	O.K
우측벽체	1층	상부	18	519.6	428.5	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	19	532.6	384.4	948.18	2.00	-	H13	150	253.40	O.K
		하부	20	519.6	344.7	925.06	2.00	-	H13	150	253.40	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	950	H25 - 8.0EA	125	359.464	O.K	2.876
		중앙부	2	820	H25 - 8.0EA	125	245.109	O.K	1.961
		우측	3	950	H29 - 8.0EA	125	141.860	O.K	1.135
	2경간	좌측	4	950	H29 - 8.0EA	125	143.574	O.K	1.149
		중앙부	5	820	H25 - 8.0EA	125	248.843	O.K	1.991
		우측	6	950	H25 - 8.0EA	125	367.555	O.K	2.940
하부슬래브	1경간	좌측	7	1200	H25 - 8.0EA	125	343.639	O.K	2.749
		측구부	8	950	H25 - 8.0EA	125	1047.306	O.K	8.378
		중앙부	9	1220	H25 - 8.0EA	125	529.356	O.K	4.235
		우측	10	1200	H29 - 8.0EA	125	384.817	O.K	3.079
	2경간	좌측	11	1200	H29 - 8.0EA	125	384.004	O.K	3.072
		중앙부	12	1220	H25 - 8.0EA	125	542.480	O.K	4.340
		측구부	13	950	H25 - 8.0EA	125	1966.231	O.K	15.730
		우측	14	1200	H25 - 8.0EA	125	352.492	O.K	2.820
좌측벽체	1층	상부	15	950	H25 - 8.0EA	125	247.836	O.K	1.983
		중앙부	16	820	H19 - 8.0EA	-	-	-	-
		하부	17	800	H25 - 8.0EA	125	163.632	O.K	1.309
우측벽체	1층	상부	18	950	H25 - 8.0EA	125	255.501	O.K	2.044
		중앙부	19	820	H19 - 8.0EA	-	-	-	-
		하부	20	800	H25 - 8.0EA	125	172.048	O.K	1.376

2. 설 계 조 건

1) 구조형식

- 지중 2 련 지하차도 (내공 : 2@(8.9M × 4.75M), 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (γ_c) = 25.00 kN/m³
- Mortar (γ_{mot}) = 21.50 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sd
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 11.250 kN/m² (∵ 토피 : 3.200 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

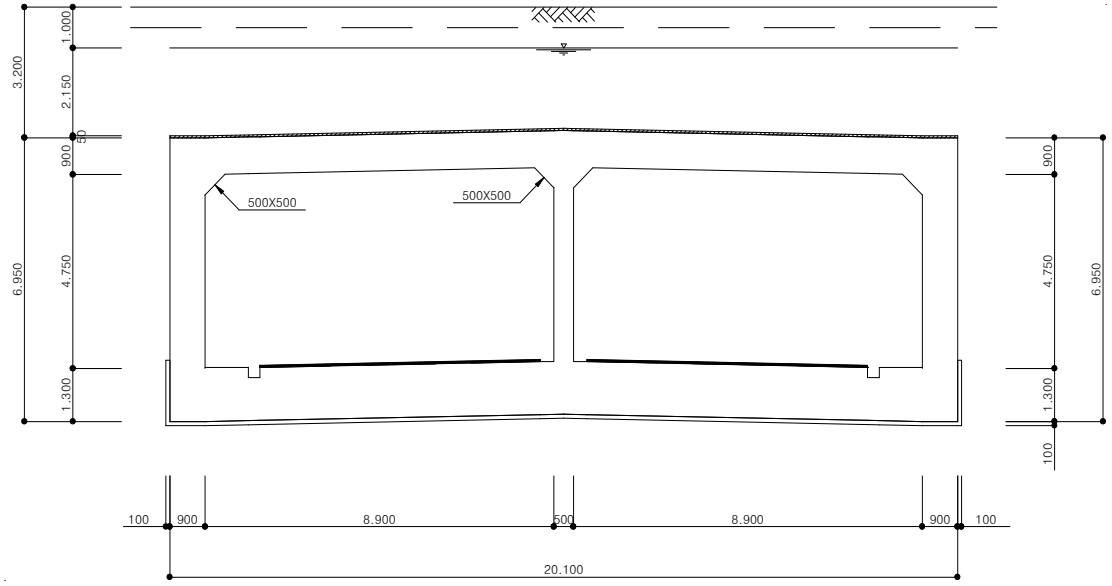
- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

10) 사용프로그램 : SAP2000

11) 참고문헌

- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정


1.000
3.200
2.150
50
900
6.950
4.750
1.300
500X500
500X500
900
4.750
6.950
1.300
100
100
900
8.900
500
8.900
900
100
20.100

4. 부 력 검 토

4.1 시공중 부력검토 (지하수위:G.L -9.6m) -상부슬래브 폐합전

: 부력에 대한 안전률 Fs = 1.10 (R/B)

1) 구체자중

- 하부슬래브	:	20.100 × 1.300 × 25.0	=	653.250	kN/m
- 좌측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 우측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 중간벽체 1	:	0.500 × 4.750 × 25.0	=	59.375	kN/m
		∴ Σ	=	926.375	kN/m

2) 상재 하중

∴ Σ	=	0.000	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 0.000^2 \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

∴ Σ = 0.000 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 0.550 \times 10.000$

$= 110.550$ kN/m

6) 안정검토

$R = 926.375 + 0.000 + 0.000 = 926.375$ kN/m

$Fs = R / U$

$= 926.375 / 110.550 = 8.380$

$\geq 1.100 \Rightarrow H \leq 7.618$ m

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 7.618m이하로 유지.

4.2 완공후 부력검토 (지하수위:G.L -9.6m)

: 부력에 대한 안전률 Fs = 1.20 (R/B)

부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려

1) 구체자중

- 상부슬래브	:	20.100 × 0.900 × 25.0	=	452.250	kN/m
- 하부슬래브	:	20.100 × 1.300 × 25.0	=	653.250	kN/m
- 좌측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 우측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 중간벽체 1	:	0.500 × 4.750 × 25.0	=	59.375	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 4EA × 25.0	=	12.500	kN/m
		∴ Σ	=	1391.125	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 20.100 × 23.0	=	231.150	kN/m
- 흙의 자중(지하수위 이상	:	2.650 × 20.100 × 19.0	=	1012.035	kN/m
- 수목하중	:	20.100 × 10.0	=	201.000	kN/m
- 방수 Mortal	:	0.050 × 20.100 × 21.5	=	21.608	kN/m
		∴ Σ	=	1465.793	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 3.200^2 \times \tan(30.0 \times 2/3)$

$= 35.407$ kN/m

∴ Σ = 35.407 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 0.550 \times 10.000$

$= 110.550$ kN/m

6) 안정검토

$R = 1391.125 + 1465.793 + 0.000 = 2856.918$ kN/m

$Fs = R / U$

$= 2856.918 / 110.550$

$= 25.843 > 1.200$ ∴O.K

4.3 완공후 부력검토 (극한수위:G.L -1.0m)

: 부력에 대한 안전률 Fs = 1.05 (R/B)
부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려
(최소토피 H = 0.993 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	20.100 × 0.900 × 25.0	=	452.250	kN/m
- 하부슬래브	:	20.100 × 1.300 × 25.0	=	653.250	kN/m
- 좌측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 우측외벽	:	0.900 × 4.750 × 25.0	=	106.875	kN/m
- 중간벽체 1	:	0.500 × 4.750 × 25.0	=	59.375	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 4EA × 25.0	=	12.500	kN/m
		∴ Σ	=	1391.125	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 20.100 × 23.0	=	231.150	kN/m
- 흙의 자중(지하수위 이상	:	2.650 × 20.100 × 19.0	=	1012.035	kN/m
- 수목하중	:	20.100 × 10.0	=	201.000	kN/m
- 방수 Mortal	:	0.050 × 20.100 × 21.5	=	21.608	kN/m
		∴ Σ	=	1465.793	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 3.200^2 \times \tan(30.0 \times 2/3)$

$= 35.407$ kN/m

∴ Σ = 35.407 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 20.100 \times 9.150 \times 10.000$

$= 1839.150$ kN/m

6) 안정검토

$R = 1391.125 + 1465.793 + 0.000 = 2892.325$ kN/m

$Fs = R / U$

$= 2892.325 / 1839.150$

$= 1.573 > 1.200$ ∴O.K

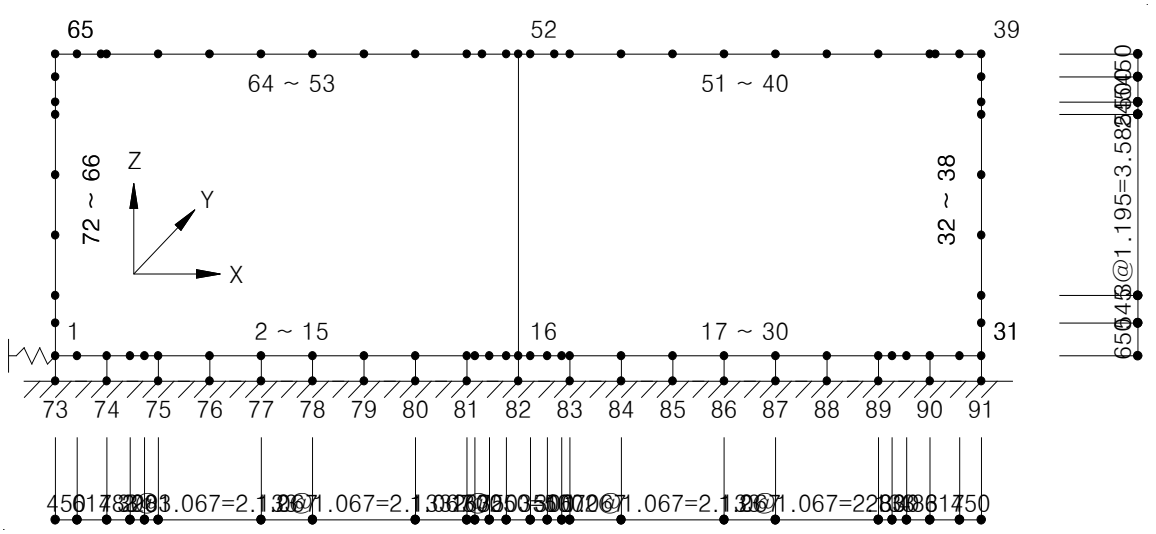
5. 해석모델 및 단면제원 (상시)

1) Modeling

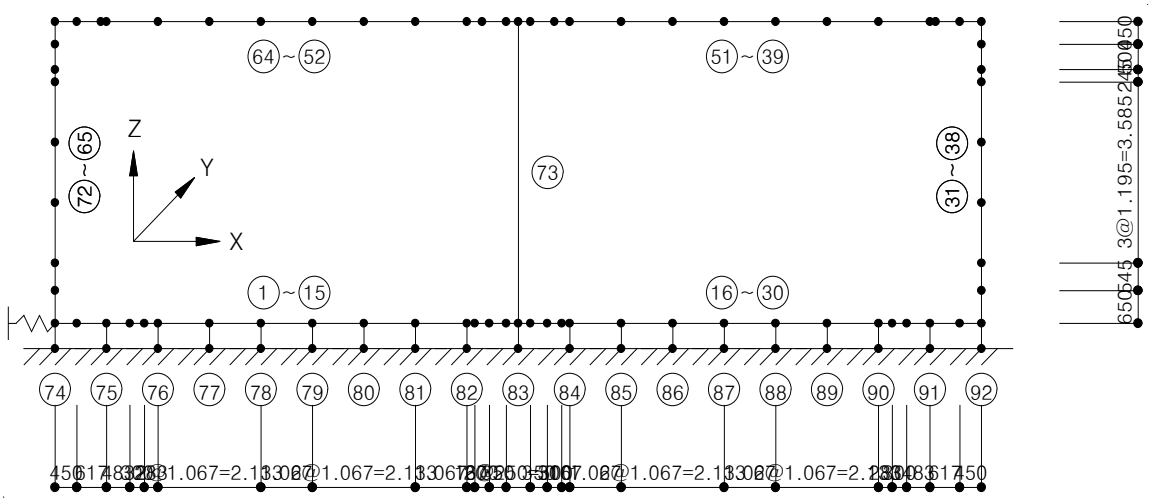
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.300 × 1.000	= 1.300	0.18308	1~3,5~26,28~30
2	1.050 × 1.000	= 1.050	0.09647	4,27
3	0.900 × 1.000	= 0.900	0.06075	31~36,41~62,67~72
4	1.400 × 1.000	= 1.400	0.22867	38~39,64~65
5	0.500 × 1.000	= 0.500	0.01042	73

NO	Section(Tapper)	부 재
6	SEC 3 ~ 4	37,63
7	SEC 4 ~ 3	40,66

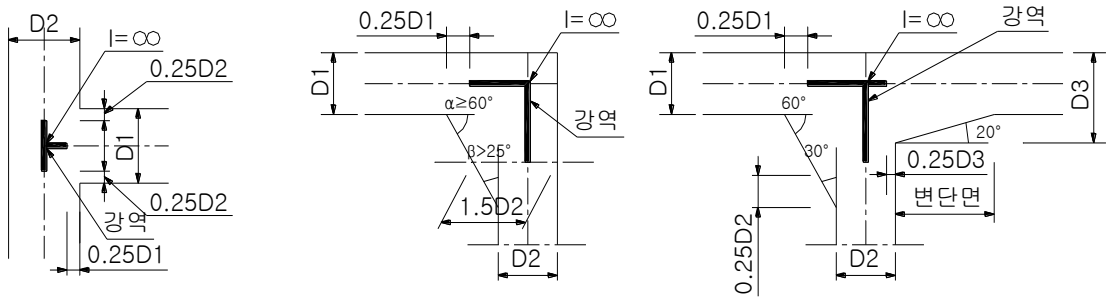
3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	47	12.800	6.475
2	0.450	0.500	48	11.733	6.475
3	1.067	0.500	49	10.667	6.475
4	1.550	0.500	50	10.350	6.475
5	1.850	0.500	51	9.850	6.475
6	2.133	0.500	52	9.600	6.475
7	3.200	0.500	53	9.350	6.475
8	4.267	0.500	54	8.850	6.475
9	5.333	0.500	55	8.533	6.475
10	6.400	0.500	56	7.467	6.475
11	7.467	0.500	57	6.400	6.475
12	8.533	0.500	58	5.333	6.475
13	8.700	0.500	59	4.267	6.475
14	9.000	0.500	60	3.200	6.475
15	9.350	0.500	61	2.133	6.475
16	9.600	0.500	62	1.067	6.475
17	9.850	0.500	63	0.950	6.475
18	10.200	0.500	64	0.450	6.475
19	10.500	0.500	65	0.000	6.475
20	10.667	0.500	66	0.000	6.025
21	11.733	0.500	67	0.000	5.525
22	12.800	0.500	68	0.000	5.280
23	13.867	0.500	69	0.000	4.085
24	14.933	0.500	70	0.000	2.890
25	16.000	0.500	71	0.000	1.695
26	17.067	0.500	72	0.000	1.150
27	17.350	0.500	73	0.000	0.000
28	17.650	0.500	74	1.067	0.000
29	18.133	0.500	75	2.133	0.000
30	18.750	0.500	76	3.200	0.000

31	19.200	0.500	77	4.267	0.000
32	19.200	1.150	78	5.333	0.000
33	19.200	1.695	79	6.400	0.000
34	19.200	2.890	80	7.467	0.000
35	19.200	4.085	81	8.533	0.000
36	19.200	5.280	82	9.600	0.000
37	19.200	5.525	83	10.667	0.000
38	19.200	6.025	84	11.733	0.000
39	19.200	6.475	85	12.800	0.000
40	18.750	6.475	86	13.867	0.000
41	18.250	6.475	87	14.933	0.000
42	18.133	6.475	88	16.000	0.000
43	17.067	6.475	89	17.067	0.000
44	16.000	6.475	90	18.133	0.000
45	14.933	6.475	91	19.200	0.000
46	13.867	6.475			

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

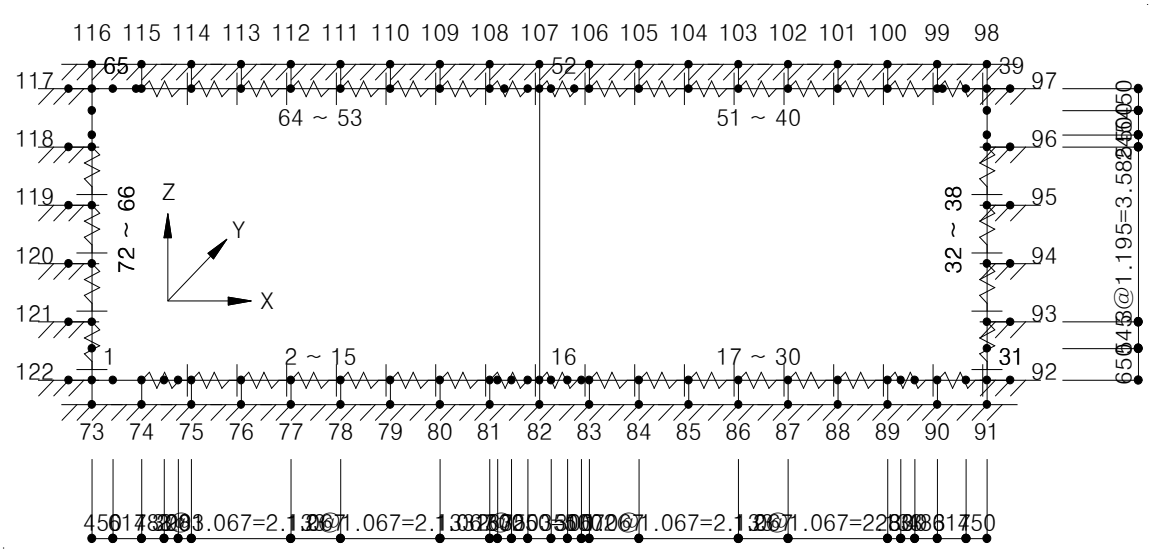
(1) 65 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(2) 65 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(3) 52 지점 - 슬래브 상면 좌측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(4) 52 지점 - 슬래브 상면 우측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(5) 52 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (500 × 500) / (2 × 500) = 700 mm
(6) 39 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(7) 39 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(8) 1 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1300 = 125 mm
(9) 1 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 900 = 425 mm
(10) 16 지점 - 슬래브 하면 좌측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1300 <= 0 mm
(11) 16 지점 - 슬래브 하면 우측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1300 <= 0 mm
(12) 16 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 500 = 525 mm
(13) 31 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1300 = 125 mm
(14) 31 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 900 = 425 mm

6. 해석모델 및 단면제원 (지진시)

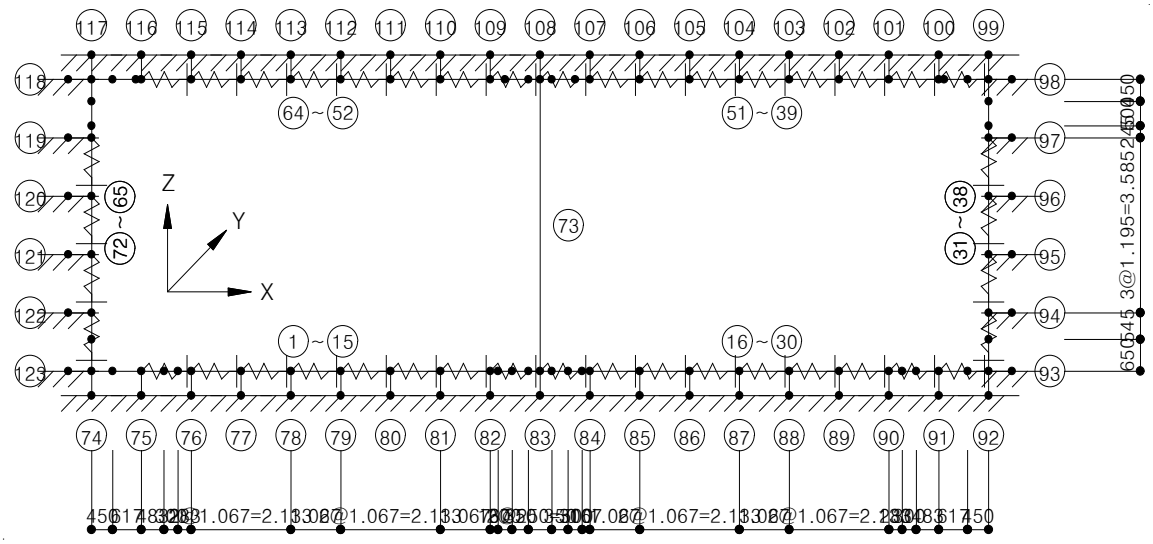
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.300 × 1.000	= 1.300	0.18308	1~3,5~26,28~30
2	1.050 × 1.000	= 1.050	0.09647	4,27
3	0.900 × 1.000	= 0.900	0.06075	31~36,41~62,67~72
4	1.400 × 1.000	= 1.400	0.22867	38~39,64~65
5	0.500 × 1.000	= 0.500	0.01042	73

NO	Section(Tapper)	부 재
6	SEC 3 ~ 4	37,63
7	SEC 4 ~ 3	40,66

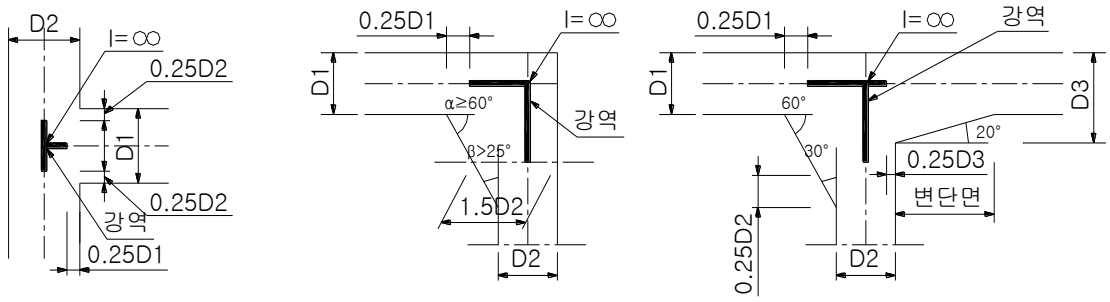
3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.500	0.500	62	1.567	6.475
2	0.950	0.500	63	1.450	6.475
3	1.567	0.500	64	0.950	6.475
4	2.050	0.500	65	0.500	6.475
5	2.350	0.500	66	0.500	6.025
6	2.633	0.500	67	0.500	5.525
7	3.700	0.500	68	0.500	5.280
8	4.767	0.500	69	0.500	4.085
9	5.833	0.500	70	0.500	2.890
10	6.900	0.500	71	0.500	1.695
11	7.967	0.500	72	0.500	1.150
12	9.033	0.500	73	0.500	0.000
13	9.200	0.500	74	1.567	0.000
14	9.500	0.500	75	2.633	0.000
15	9.850	0.500	76	3.700	0.000
16	10.100	0.500	77	4.767	0.000
17	10.350	0.500	78	5.833	0.000
18	10.700	0.500	79	6.900	0.000
19	11.000	0.500	80	7.967	0.000
20	11.167	0.500	81	9.033	0.000
21	12.233	0.500	82	10.100	0.000
22	13.300	0.500	83	11.167	0.000
23	14.367	0.500	84	12.233	0.000
24	15.433	0.500	85	13.300	0.000
25	16.500	0.500	86	14.367	0.000
26	17.567	0.500	87	15.433	0.000
27	17.850	0.500	88	16.500	0.000
28	18.150	0.500	89	17.567	0.000
29	18.633	0.500	90	18.633	0.000
30	19.250	0.500	91	19.700	0.000
31	19.700	0.500	92	20.200	0.500
32	19.700	1.150	93	20.200	1.695
33	19.700	1.695	94	20.200	2.890
34	19.700	2.890	95	20.200	4.085
35	19.700	4.085	96	20.200	5.280
36	19.700	5.280	97	20.200	6.475
37	19.700	5.525	98	19.700	6.975
38	19.700	6.025	99	18.633	6.975
39	19.700	6.475	100	17.567	6.975
40	19.250	6.475	101	16.500	6.975
41	18.750	6.475	102	15.433	6.975

42	18.633	6.475	103	14.367	6.975
43	17.567	6.475	104	13.300	6.975
44	16.500	6.475	105	12.233	6.975
45	15.433	6.475	106	11.167	6.975
46	14.367	6.475	107	10.100	6.975
47	13.300	6.475	108	9.033	6.975
48	12.233	6.475	109	7.967	6.975
49	11.167	6.475	110	6.900	6.975
50	10.850	6.475	111	5.833	6.975
51	10.350	6.475	112	4.767	6.975
52	10.100	6.475	113	3.700	6.975
53	9.850	6.475	114	2.633	6.975
54	9.350	6.475	115	1.567	6.975
55	9.033	6.475	116	0.500	6.975
56	7.967	6.475	117	0.000	6.475
57	6.900	6.475	118	0.000	5.280
58	5.833	6.475	119	0.000	4.085
59	4.767	6.475	120	0.000	2.890
60	3.700	6.475	121	0.000	1.695
61	2.633	6.475	122	0.000	0.500

8) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 65 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(2) 65 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(3) 52 지점 - 슬래브 상면 좌측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(4) 52 지점 - 슬래브 상면 우측
D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 500 - (900 × 500) / (2 × 500) = 300 mm
(5) 52 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (500 × 500) / (2 × 500) = 700 mm
(6) 39 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(7) 39 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 900 / 2 + 500 - (900 × 500) / (2 × 500) = 500 mm
(8) 1 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1300 = 125 mm
(9) 1 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 900 = 425 mm
(10) 16 지점 - 슬래브 하면 좌측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1300 <= 0 mm
(11) 16 지점 - 슬래브 하면 우측
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 1300 <= 0 mm
(12) 16 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 500 = 525 mm
(13) 31 지점 - 슬래브 하면
D2 / 2 - 0.25 × D1 = 900 / 2 - 0.25 × 1300 = 125 mm
(14) 31 지점 - 슬래브 벽체 연결부
D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 900 = 425 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 2000000.00 kN/m²

Bv = √(B × B) = √(20.100 × 20.100) = 20.10 m (L > B)

Kvo = 1 / 0.3 × 1 × 2000000 = 6666670.00 kN/m³

Kv = 6666670.000 × (20.100 / 0.3) $^{-3 / 4}$ = 284677.31 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 279933 kN/m	1,31
Kv2	Kv x (1.067/2 + 1.067/2) = 303657 kN/m	3,6~12,16,20~26,29
Kh	1E10 kN/m (무한강성)	16

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 점토 (EL. : 9.830 ~ 4.314, N=7)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8^2 = 31753.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0^2 = 12404.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m^2

(2) 점토질 자갈 (EL. : 4.314 ~ 2.714, N=9)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 156.0 = 124.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 124.8^2 = 31753.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 31753.0 = 92083.7 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 156.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 156.0 = 78.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 78.0^2 = 12404.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 12404.0 = 35971.6 kN/m^2

(3) 실트 (EL. : 2.714 ~ 0.714, N=16)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 289.0 = 231.2 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 231.2^2 = 108977.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 108977.0 = 316033.3 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 289.0 = 144.5 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 144.5^2 = 42569.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 42569.0 = 123450.1 kN/m^2

(4) 자갈 (EL. : 0.714 ~ -1.286, N=18)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 289.0 = 231.2 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 231.2^2 = 108977.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 108977.0 = 316033.3 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 289.0 = 144.5 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 144.5^2 = 42569.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 42569.0 = 123450.1 kN/m^2

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제2토층 ,점토

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m^3

Kv = 306945.670 × (20.100 / 0.3)$^{-3/4}$ = 13107.06 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 13107.060 = 4369.02 kN/m^3

(2) 하부슬래브 : 제5토층 , 자갈

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 316033.3 = 1053444.33 kN/m³

Kv = 1053444.330 × (20.100 / 0.3)$^{-3 / 4}$ = 44983.73 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 44983.730 = 14994.58 kN/m³

(3) 측벽 : 제2토층 , 점토

① 수평방향 지반반력계수

Bv = √(H × H) = √(6.950 × 6.950) = 6.950 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m³

Kh = 306945.670 × (6.950 / 0.3)$^{-3 / 4}$ = 29067.91 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 29067.910 = 9689.30 kN/m³

(4) 측벽 : 제3토층 , 점토질 자갈

① 수평방향 지반반력계수

Bv = √(H × H) = √(6.950 × 6.950) = 6.950 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 92083.7 = 306945.67 kN/m³

Kh = 306945.670 × (6.950 / 0.3)$^{-3 / 4}$ = 29067.91 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 29067.910 = 9689.30 kN/m³

(5) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 13981 kN/m	42~49,52,55~62
Ksb1	Ksb x (1.067/2 + 1.067/2) = 4660 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.195/2 + 1.195/2) = 119215 kN/m	33~34,70,71
Kss1	Kss x (1.195/2 + 1.195/2) = 39738 kN/m	
Kh2	Kh x (1.195/2 + 1.195/2) = 34736 kN/m	35~36,68,69
Kss2	Kss x (1.195/2 + 1.195/2) = 11579 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 47983 kN/m	3,6~12,16,20~26,29
Ksb1	Ksb x (1.067/2 + 1.067/2) = 15994 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 44234 kN/m	1,31
Ksb1	Kh x (1.195/2 + 1.300/2) = 124453 kN/m	
Kv2	Kv x (1.067/2 + 0.900/2) = 12889 kN/m	39,65
Ksb2	Kh x (1.195/2 + 0.900/2) = 30449 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제2토층 ,점토

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kv = 119905.330 × (20.100 / 0.3)$^{-3/4}$ = 5120.15 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 5120.150 = 1706.72 kN/m³

(2) 하부슬래브 : 제5토층 , 자갈

① 연직방향 지반반력계수

Bv = √(B × B) = √(20.100 × 20.100) = 20.100 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 123450.1 = 411500.33 kN/m³

Kv = 411500.330 × (20.100 / 0.3)$^{-3/4}$ = 17571.71 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 17571.710 = 5857.24 kN/m³

(3) 측벽 : 제2토층 , 점토

① 수평방향 지반반력계수

Bv = √(H × H) = √(6.950 × 6.950) = 6.950 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kh = 119905.330 × (6.950 / 0.3)$^{-3/4}$ = 11355.10 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 11355.100 = 3785.03 kN/m³

(4) 측벽 : 제3토층 , 점토질 자갈

① 수평방향 지반반력계수

Bv = √(H × H) = √(6.950 × 6.950) = 6.950 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 35971.6 = 119905.33 kN/m³

Kh = 119905.330 × (6.950 / 0.3)$^{-3/4}$ = 11355.10 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 11355.100 = 3785.03 kN/m³

(5) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 5462 kN/m	42~49,52,55~62
Ksb1	Ksb x (1.067/2 + 1.067/2) = 1821 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.195/2 + 1.195/2) = 46568 kN/m	33~34,70,71
Kss1	Kss x (1.195/2 + 1.195/2) = 15523 kN/m	
Kh2	Kh x (1.195/2 + 1.195/2) = 13569 kN/m	35~36,68,69
Kss2	Kss x (1.195/2 + 1.195/2) = 4523 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.067/2 + 1.067/2) = 18743 kN/m	3,6~12,16,20~26,29
Ksb1	Ksb x (1.067/2 + 1.067/2) = 6248 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.900/2 + 1.067/2) = 17279 kN/m	1,31
Ksb1	Kh x (1.195/2 + 1.300/2) = 48614 kN/m	
Kv2	Kv x (1.067/2 + 0.900/2) = 5035 kN/m	39,65
Ksb2	Kh x (1.195/2 + 0.900/2) = 11894 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

	성능기 / 준 재현주기	기 능 수 행	붕 괴 방 지
설계지진	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.16 = 0.091
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.16 = 0.224

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 토 사	: 2.650 × 19.00	=	50.350	kN/m²
- 수목하중	:	=	10.000	kN/m²
- 방 수	: 0.050 × 21.50	=	1.075	kN/m²
	∴ Total Wd1	=	72.925	kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00	=	9.500	kN/m²
- 흙(지하수위 이하)	: 2.150 × 10.00	=	21.500	kN/m²
- 수목하중	:	=	10.000	kN/m²
- 방수	: 0.050 × 21.50	=	1.075	kN/m²
	∴ Total Wd2	=	53.575	kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

D / Bo	도로면의 활하중 (kN/m²)	D / Bo	도로면의 활하중 (kN/m²)
0.1	5.3	0.2	8.4
0.3	10.3	0.4	11.3

주) 토피고의 중간값은 Pvl 의 상위값을 적용한다.

① 상부 슬래브에 작용하는 하중 (Wl1) - 토피 3.200m

- Wl1 = 11.250 kN/m²

② 측벽에 작용하는 하중 (Wl2)

- Wl2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 3.150 × 19.000) × 0.500 = 35.675 kN/m²
Wh2 = 35.675 + 0.450 × 19.000 × 0.500 = 39.950 kN/m²
Wh3 = 39.950 + 0.500 × 19.000 × 0.500 = 44.700 kN/m²
Wh4 = 44.700 + 0.245 × 19.000 × 0.500 = 47.028 kN/m²
Wh5 = 47.028 + 1.195 × 19.000 × 0.500 = 58.380 kN/m²
Wh6 = 58.380 + 1.195 × 19.000 × 0.500 = 69.733 kN/m²
Wh7 = 69.733 + 1.195 × 19.000 × 0.500 = 81.085 kN/m²
Wh8 = 81.085 + 0.545 × 19.000 × 0.500 = 86.263 kN/m²
Wh9 = 86.263 + 0.650 × 19.000 × 0.500 = 92.437 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 2.650 × 10.000 = 23.750 kN/m²
Wh2 = 23.750 + 0.450 × 10.000 × 0.500 = 26.000 kN/m²
Wh3 = 26.000 + 0.500 × 10.000 × 0.500 = 28.500 kN/m²
Wh4 = 28.500 + 0.245 × 10.000 × 0.500 = 29.725 kN/m²
Wh5 = 29.725 + 1.195 × 10.000 × 0.500 = 35.700 kN/m²
Wh6 = 35.700 + 1.195 × 10.000 × 0.500 = 41.675 kN/m²
Wh7 = 41.675 + 1.195 × 10.000 × 0.500 = 47.650 kN/m²
Wh8 = 47.650 + 0.545 × 10.000 × 0.500 = 50.375 kN/m²
Wh9 = 50.375 + 0.650 × 10.000 × 0.500 = 53.625 kN/m²

6) 지하수압 (지하수위 : GL = -1.000 m)

① 상부슬래브에 작용하는 하중

- Ww1 = 2.150 × 10.000 = 21.500 kN/m²

② 측벽에 작용하는 하중

- Ww2 = 2.650 × 10.000 = 26.500 kN/m²
Ww3 = 26.500 + 0.450 × 10.000 = 31.000 kN/m²
Ww4 = 31.000 + 0.500 × 10.000 = 36.000 kN/m²
Ww5 = 36.000 + 0.245 × 10.000 = 38.450 kN/m²
Ww6 = 38.450 + 1.195 × 10.000 = 50.400 kN/m²
Ww7 = 50.400 + 1.195 × 10.000 = 62.350 kN/m²
Ww8 = 62.350 + 1.195 × 10.000 = 74.300 kN/m²
Ww9 = 74.300 + 0.545 × 10.000 = 79.750 kN/m²
Ww10 = 79.750 + 0.650 × 10.000 = 86.250 kN/m²

③ 하부슬래브에 작용하는 하중

- Ww11 = (3.200 + 6.950 - 1.000) × 10.000 = 91.500 kN/m²

7) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

8) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 1510^{-5}$
- 온도선팽창 계수 $\alpha = 1.010^{-5}$
- $\Delta T = \frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
성토재	0.203	198.900	124.300	19.000	0.004	0.007
자갈	2.713	124.800	78.000	20.000	0.087	0.139
점토	2.600	124.800	78.000	20.000	0.083	0.133
점토질 자갈	1.600	124.800	78.000	20.000	0.051	0.082
실트	2.000	231.200	144.500	20.000	0.035	0.055
자갈	2.000	231.200	144.500	20.000	0.035	0.055
와 자갈 섞인 호	0.600	231.200	144.500	20.000	0.010	0.017
자갈	1.100	339.200	212.000	20.000	0.013	0.021
점토	8.700	504.800	315.500	20.000	0.069	0.110
풍화암	8.484	1647.200	1029.500	20.000	0.021	0.033
계					0.408	0.652

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.408 = 0.510	1.25 Tg' = 1.25 × 0.652 = 0.815

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575
To(sec)	To = 0.2 × Ts = 0.2 × 0.575 = 0.115	To = 0.2 × Ts = 0.2 × 0.575 = 0.115

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $C_d = \frac{1.5}{40h+1} + 0.5$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa) - 붕괴방지수준시(재현주기 1000년적용)

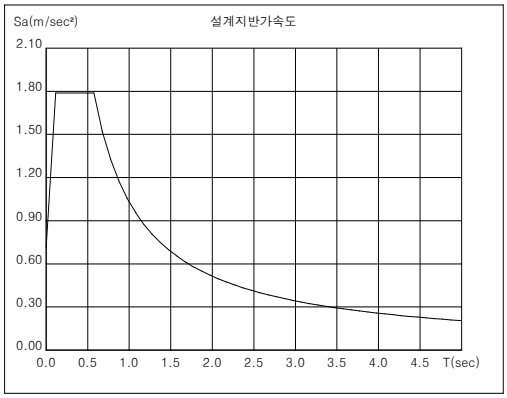
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 1.789 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg = 2.585 m/s²

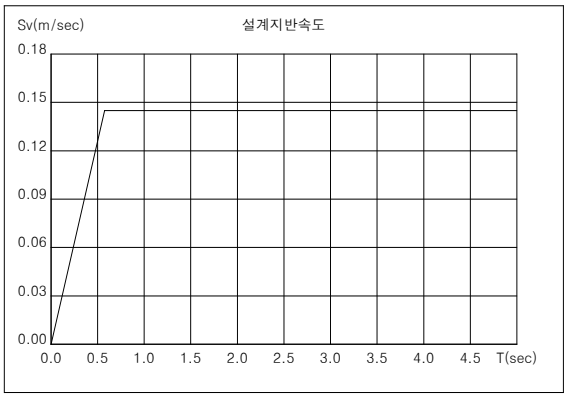
5) 속도 응답스펙트럼(Sv) - 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.510 / 2π × 1.789 = 0.145 m/s	Sv = Tg/2π × Sa = 0.815 / 2π × 2.585 = 0.335 m/s

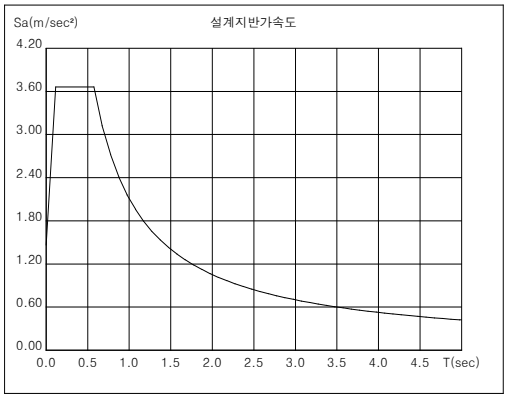
6) 설계응답 응답스펙트럼

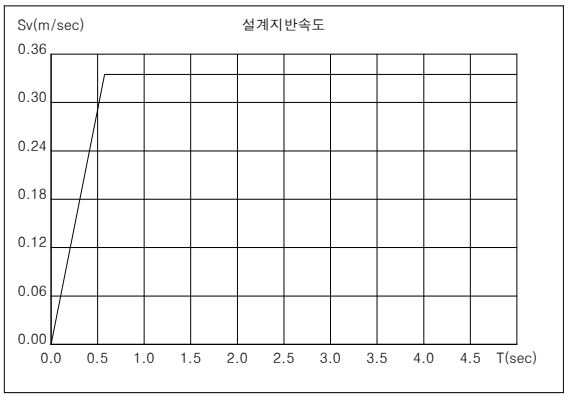
(1) 기능수행수준





(2) 붕괴방지수준





7) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 3.650 m
- 하부슬래브 EL. = 9.625 m
- 기반암 심도(H) = 30.000 m

(1) 기능수행 수준

$U(z) = 2 / \pi^2 \times Sv \times Tg \times \cos(\pi Z / 2H)$

$U(Zu) = 2 / \pi^2 \times 0.145 \times 0.510 \times \cos(\pi \times 3.650 / (2 \times 30.000)) = 0.014713$

$U(Zb) = 2 / \pi^2 \times 0.145 \times 0.510 \times \cos(\pi \times 9.625 / (2 \times 30.000)) = 0.013122$

(2) 붕괴방지 수준

$U(Zu) = 2 / \pi^2 \times 0.335 \times 0.815 \times \cos(\pi \times 3.650 / (2 \times 30.000)) = 0.054319$

$U(Zb) = 2 / \pi^2 \times 0.335 \times 0.815 \times \cos(\pi \times 9.625 / (2 \times 30.000)) = 0.048448$

$Po = Ksb,top \times (U(Zu) - U(Zb))$

기능수행수준	붕괴방지수준
$Po = 4369.020 \times (0.014713 - 0.013122)$ $= 6.951\ kN/m^2$	$Po = 1706.720 \times (0.054319 - 0.048448)$ $= 10.020\ kN/m^2$

8) 측벽 지반변위 하중

$P(z) = Kh \times (Uh(z) - Uh(b))$

(1) 기능수행수준

z(m)	Kh (kN/m^3)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m^2)
3.650	29067.910	0.014713	0.001591	46.247
4.100	29067.910	0.014641	0.001519	44.154
4.600	29067.910	0.014553	0.001431	41.596
4.845	29067.910	0.014506	0.001384	40.230
6.040	29067.910	0.014242	0.001120	32.556
7.235	99761.720	0.013923	0.000801	23.283
8.430	99761.720	0.013549	0.000427	42.598
8.975	99761.720	0.013361	0.000239	23.843
9.625	99761.720	0.013122	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m^3)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m^2)
3.650	11355.100	0.054319	0.005871	66.666
4.100	11355.100	0.054056	0.005608	63.679
4.600	11355.100	0.053729	0.005281	59.966
4.845	11355.100	0.053556	0.005108	58.002
6.040	11355.100	0.052583	0.004135	46.953
7.235	38969.290	0.051404	0.002956	33.566
8.430	38969.290	0.050024	0.001576	61.416
8.975	38969.290	0.049329	0.000881	34.332
9.625	38969.290	0.048448	0.000000	0.000

9) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

Uh1 = 1 /(π×H) × Sv × Tg × sin(π×Zu/(2 × H))

Uh2 = 1 /(π×H) × Sv × Tg × sin(π×Zb/(2 × H))

구분	기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
Vu	31753.000 × 0.000128 = 4.060	12404.000 × 0.000472 = 5.850
Vb	108977.000 × 0.000355 = 38.690	42569.000 × 0.001312 = 55.850
Vs	(4.060 + 38.690) / 2 = 21.380	(5.850 + 55.850) / 2 = 30.850

10) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fu = 0.900×25.000×0.091×(1 - 0.015×3.650) = 1.935	fu = 0.900×25.000×0.224×(1 - 0.015×3.650) = 4.764

② 하부슬래브

기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fb = 1.300×25.000×0.091×(1 - 0.015×9.625) = 2.531	fb = 1.300×25.000×0.224×(1 - 0.015×9.625) = 6.229

③ 중간벽체

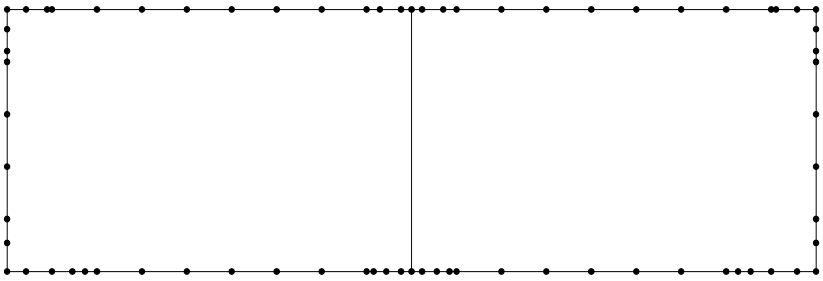
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fu1 = 0.500×25.000×0.091×(1-0.015×3.125) = 1.075	fu1 = 0.500×25.000×0.224×(1-0.015×3.125) = 2.647
fb1 = 0.500×25.000×0.091×(1-0.015×9.625) = 0.973	fb1 = 0.500×25.000×0.224×(1-0.015×9.625) = 2.396

④ 측벽

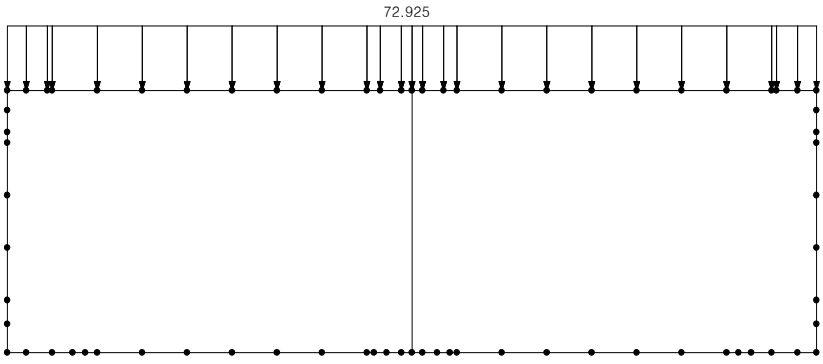
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
f1 = 0.900×25.000×0.091×(1-0.015×3.650) = 1.935	f1 = 0.900×25.000×0.224×(1-0.015×3.650) = 4.764
f2 = 0.900×25.000×0.091×(1-0.015×4.100) = 1.922	f2 = 0.900×25.000×0.224×(1-0.015×4.100) = 4.730
f3 = 0.900×25.000×0.091×(1-0.015×4.600) = 1.906	f3 = 0.900×25.000×0.224×(1-0.015×4.600) = 4.692
f4 = 0.900×25.000×0.091×(1-0.015×4.845) = 1.899	f4 = 0.900×25.000×0.224×(1-0.015×4.845) = 4.674
f5 = 0.900×25.000×0.091×(1-0.015×6.040) = 1.862	f5 = 0.900×25.000×0.224×(1-0.015×6.040) = 4.583
f6 = 0.900×25.000×0.091×(1-0.015×7.235) = 1.825	f6 = 0.900×25.000×0.224×(1-0.015×7.235) = 4.493
f7 = 0.900×25.000×0.091×(1-0.015×8.430) = 1.789	f7 = 0.900×25.000×0.224×(1-0.015×8.430) = 4.403
f8 = 0.900×25.000×0.091×(1-0.015×8.975) = 1.772	f8 = 0.900×25.000×0.224×(1-0.015×8.975) = 4.361
f9 = 0.900×25.000×0.091×(1-0.015×9.625) = 1.752	f9 = 0.900×25.000×0.224×(1-0.015×9.625) = 4.312

11. 하 중 재 하 (상시)

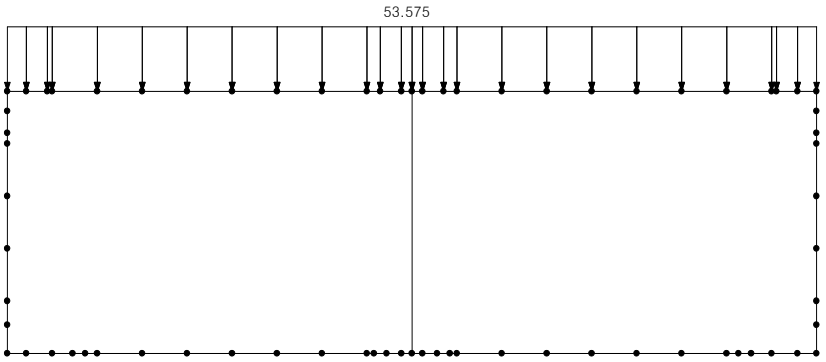
1) CASE1 - 구체자중(SW)



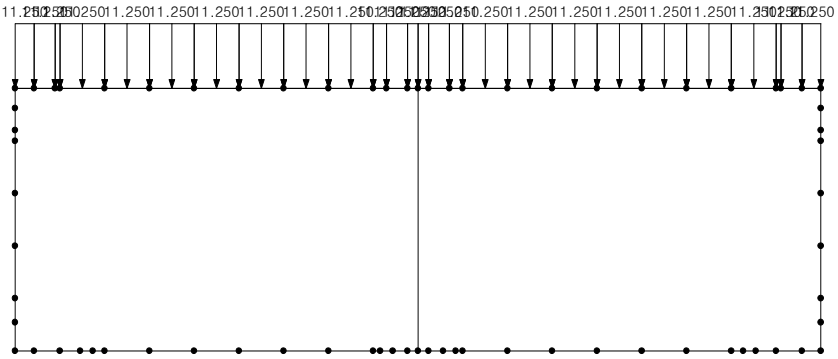
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



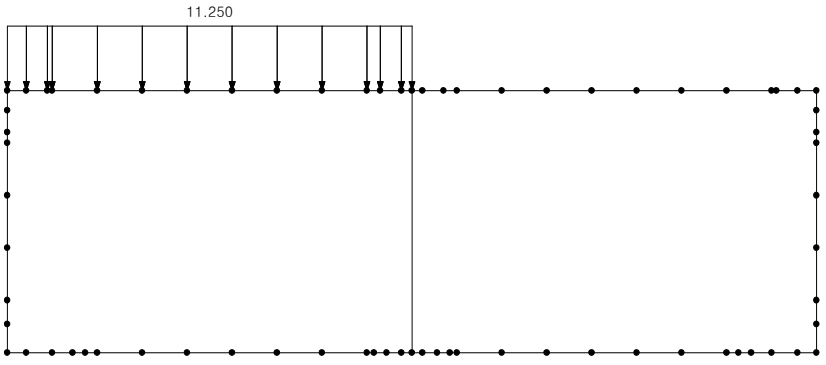
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



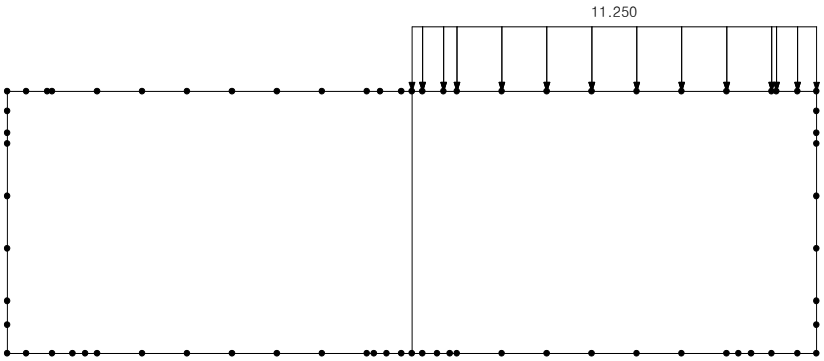
4) CASE4 - 만재활하중(LIVEFU)



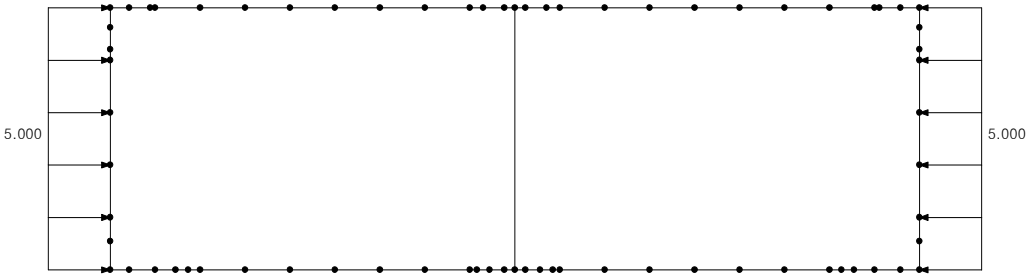
5) CASE5 - 편재활하중(좌측)(LIVELE)



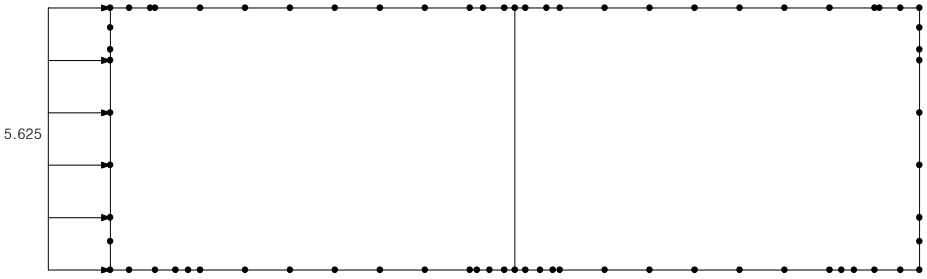
6) CASE6 - 편재활하중(우측)(LIVERI)



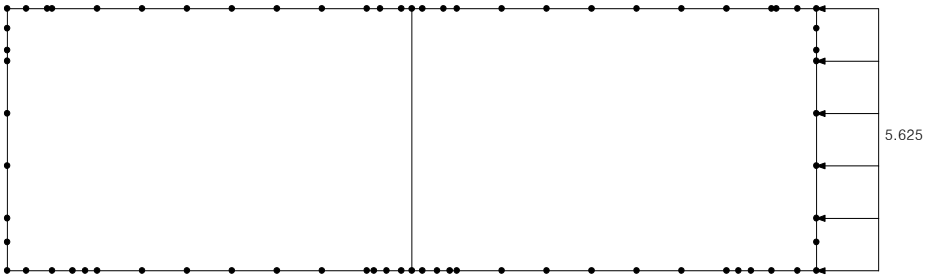
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



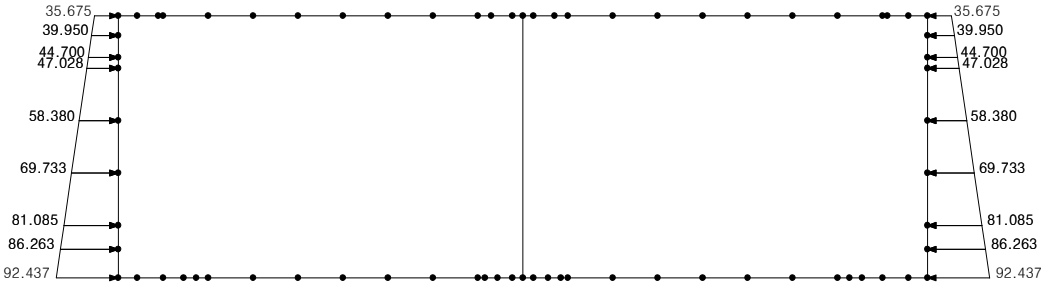
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



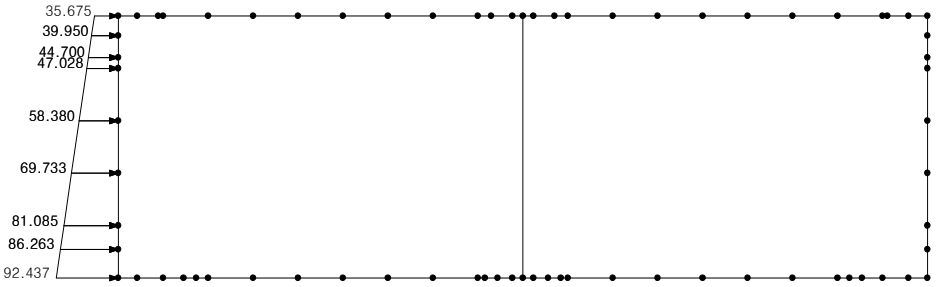
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



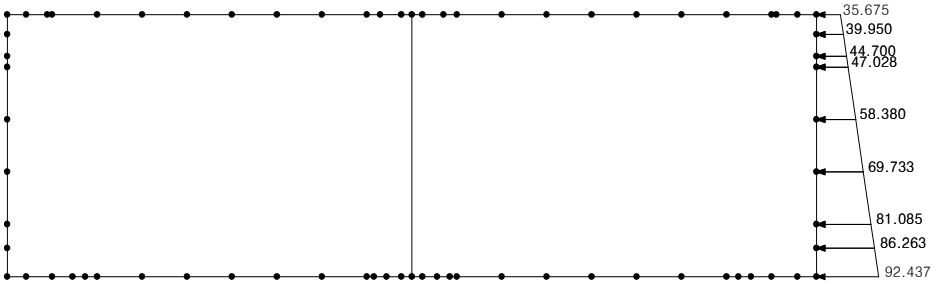
10) CASE10 - 양토압 : 지하수無(SOILB)



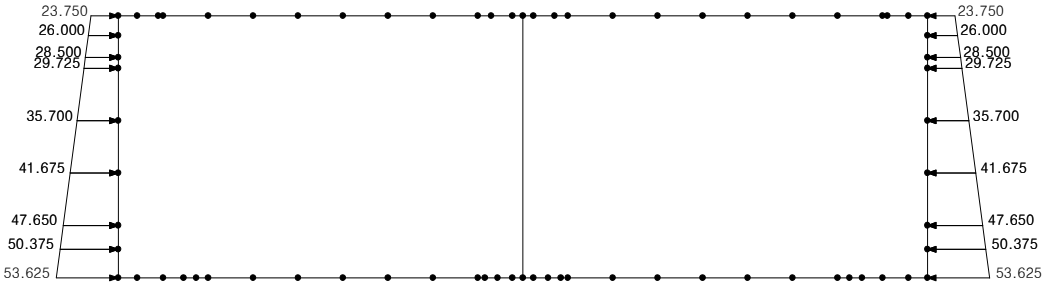
11) CASE11 - 편토압(좌측) : 지하수無(SOILL)



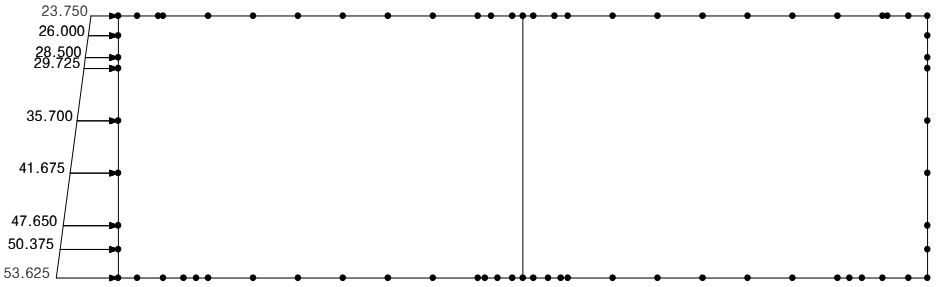
12) CASE12 - 편토압(우측) : 지하수無(SOILR)



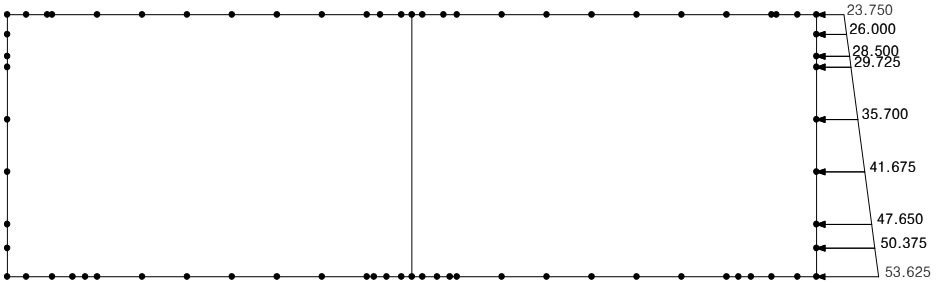
13) CASE13 - 양토압 : 지하수有(SOILBW)



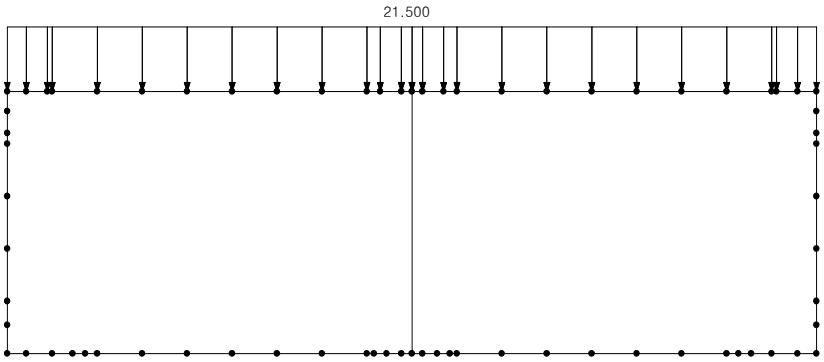
14) CASE14 - 편토압(좌측) : 지하수有(SOILLW)



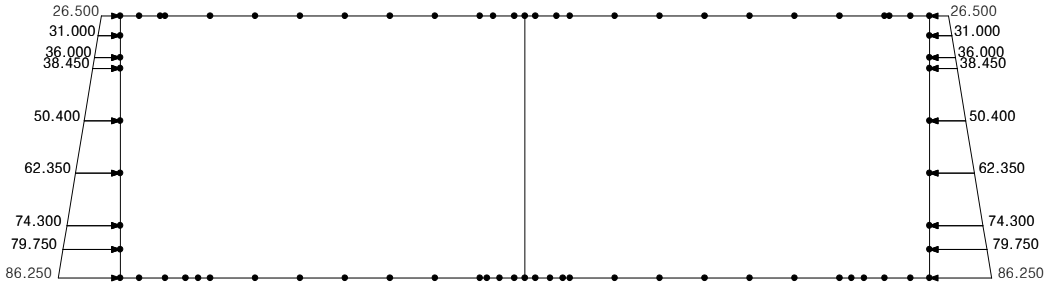
15) CASE15 - 편토압(우측) : 지하수有(SOILRW)



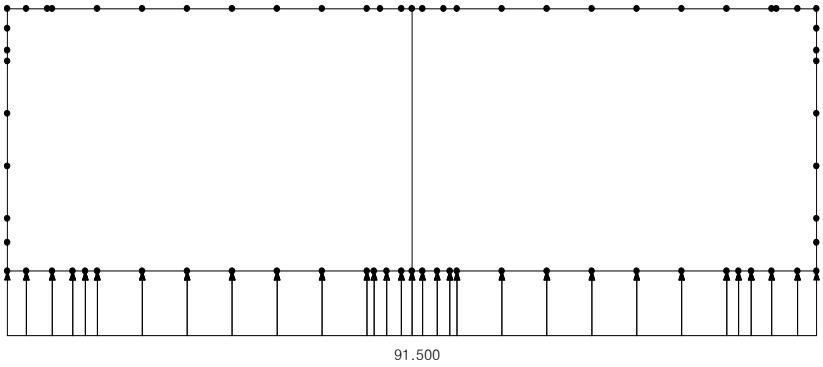
16) CASE16 - 연직수압(WATERV)



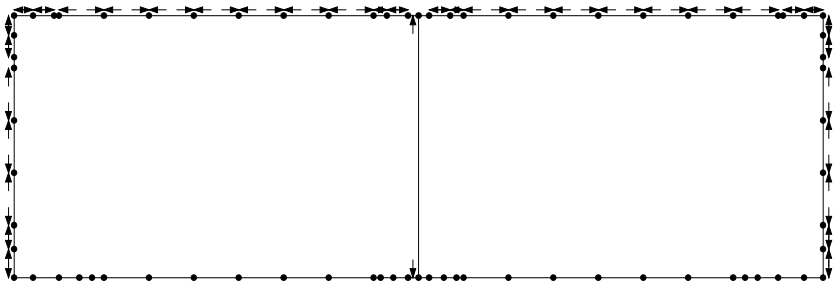
17) CASE17 - 수평수압(WATERH)



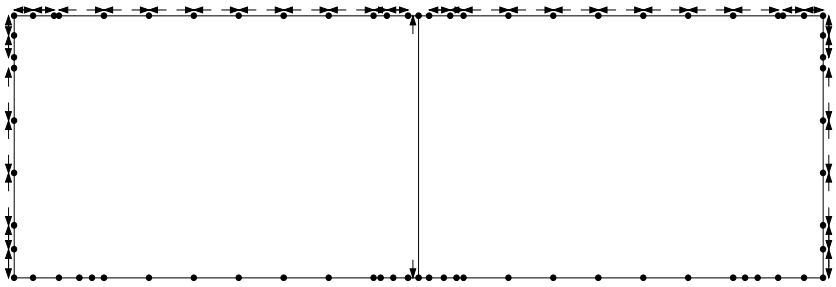
18) CASE18 - 부력(BUOYANCY)



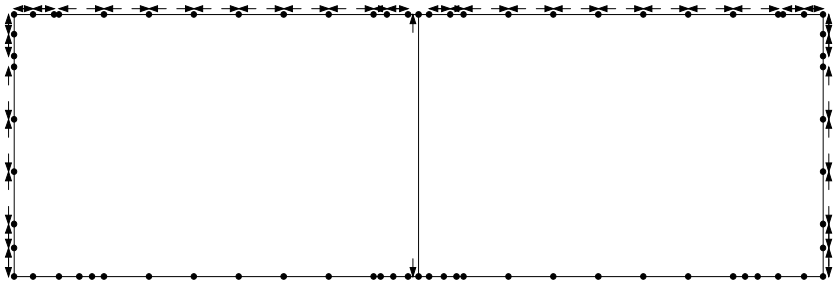
19) CASE19 - 온도변화(+) +10° C(TEMPPLUS)



20) CASE20 - 온도변화(-) -10° C(TEMPMINU)

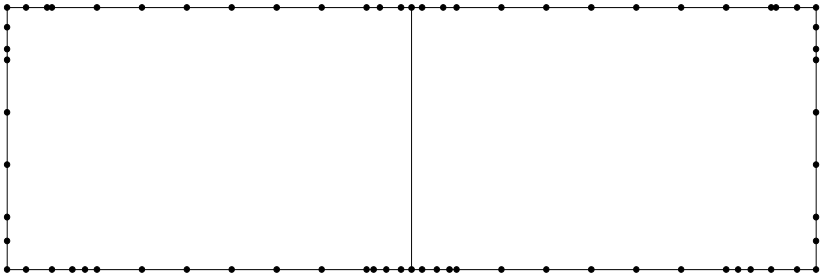


21) CASE21 - 건조수축 -15° C(SHRINK)

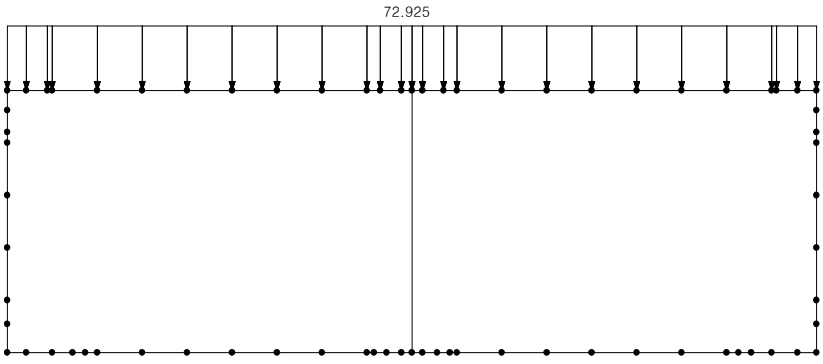


12. 하중 재하 (기능수행)

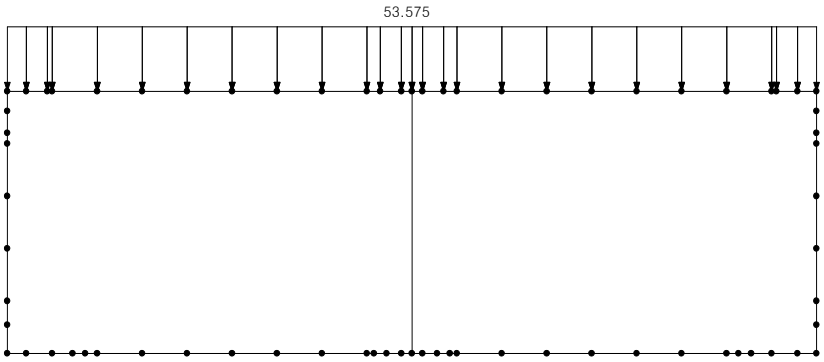
1) CASE1 - 구체자중(SW)



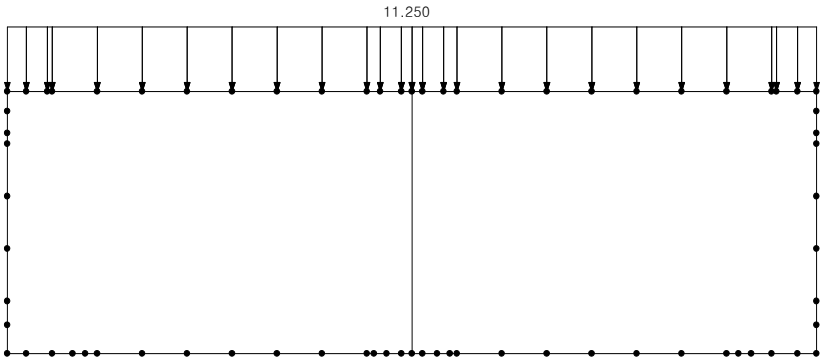
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



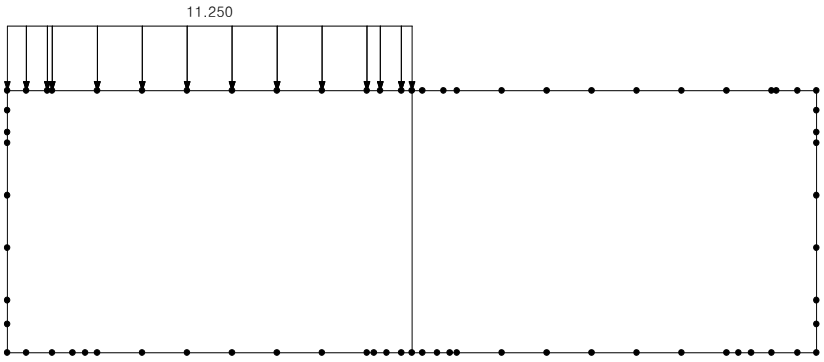
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



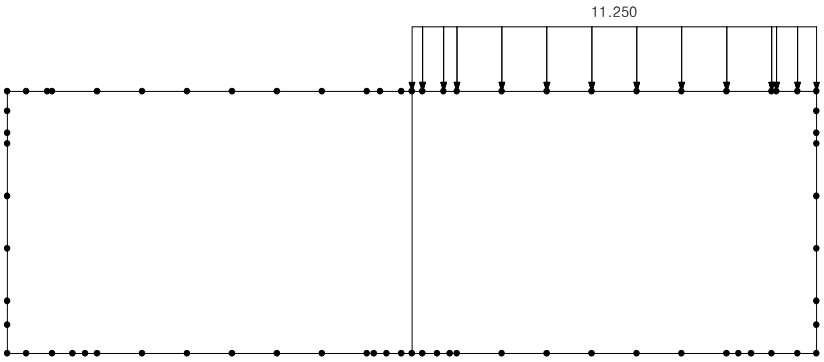
4) CASE4 - 지진시 만재활하중(LIVEFUE)



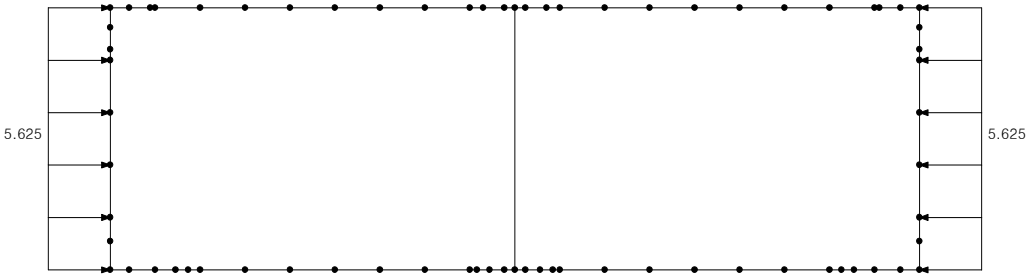
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



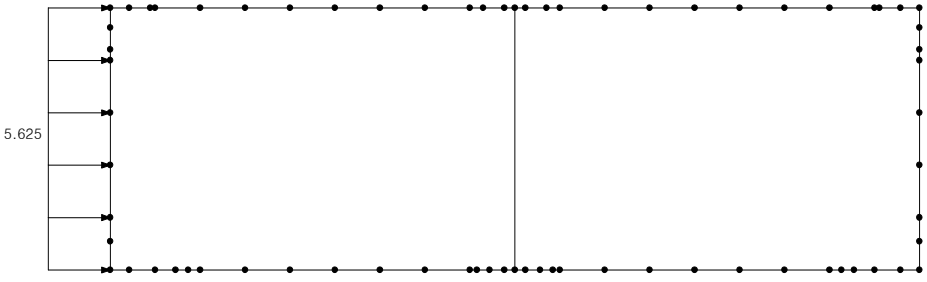
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



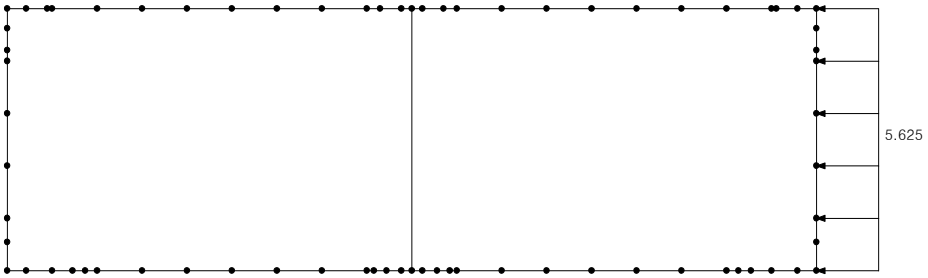
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



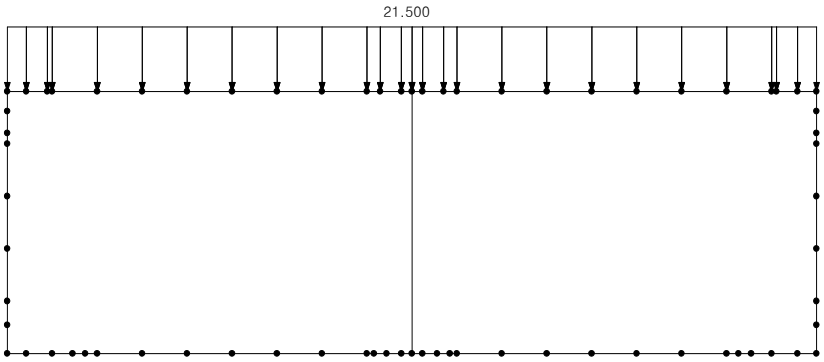
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



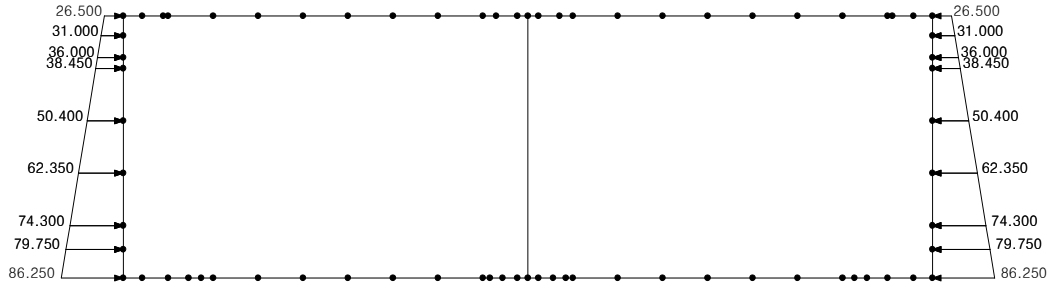
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



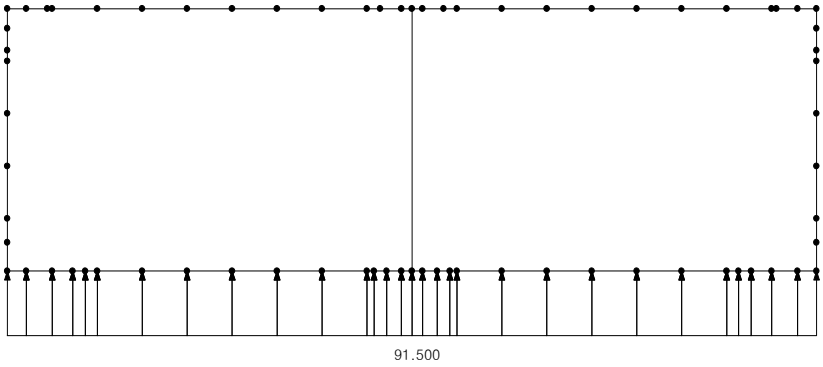
10) CASE10 - 연직수압(WATERV)



11) CASE11 - 수평수압(WATERH)

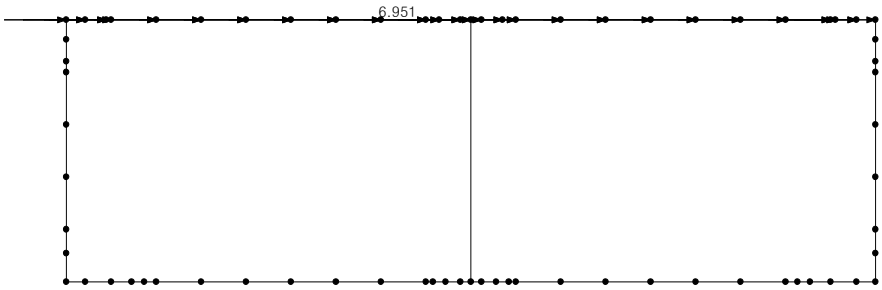


12) CASE12 - 부력(BUOYANCY)

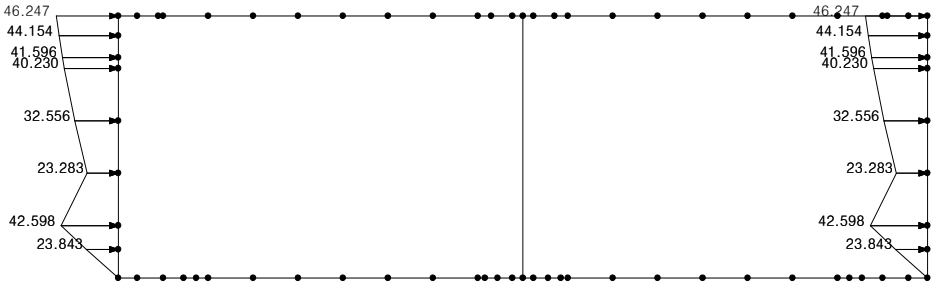


- 지진재하방향(좌측에서 우측으로)

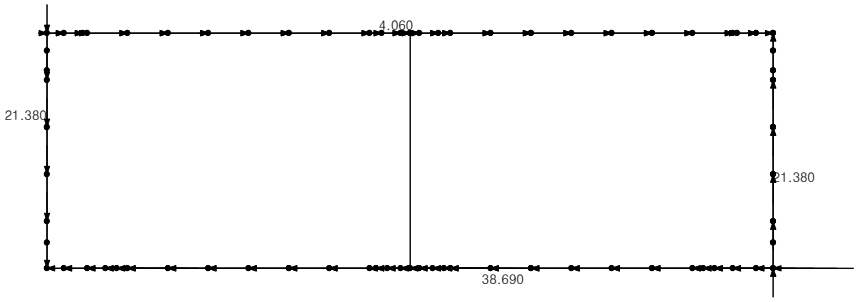
13) CASE13 - 슬래브 지반변위(기능수행)(FUNSLAB)



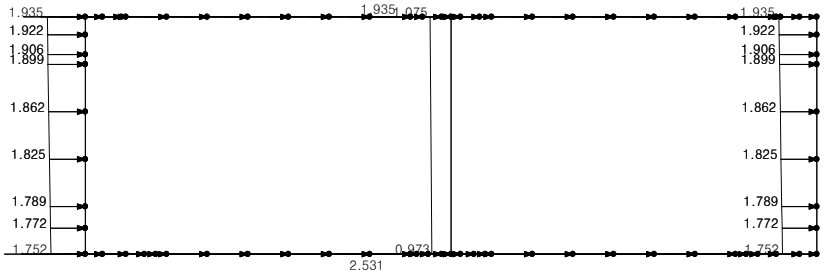
14) CASE14 - 벽체 지반변위(기능수행)(FUNWALL)



15) CASE15 - 주면전단력(기능수행)(FUNMS)

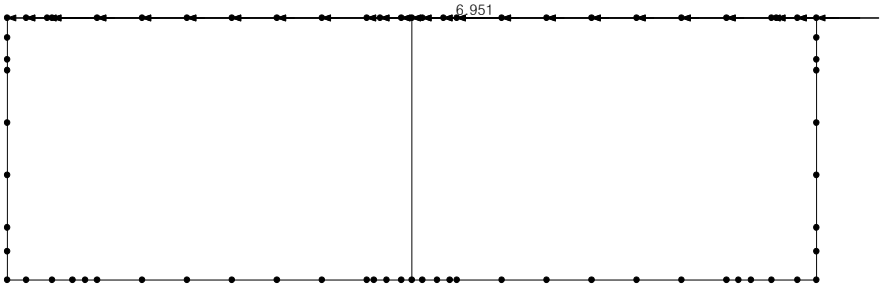


16) CASE16 - 구체 관성력(기능수행)(FUNINER)

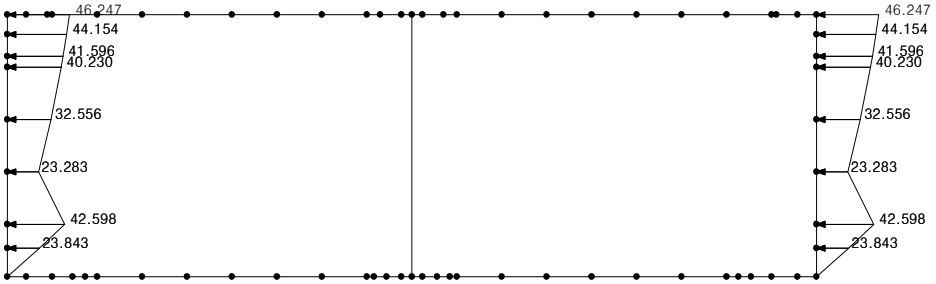


- 지진재하방향(우측에서 좌측으로)

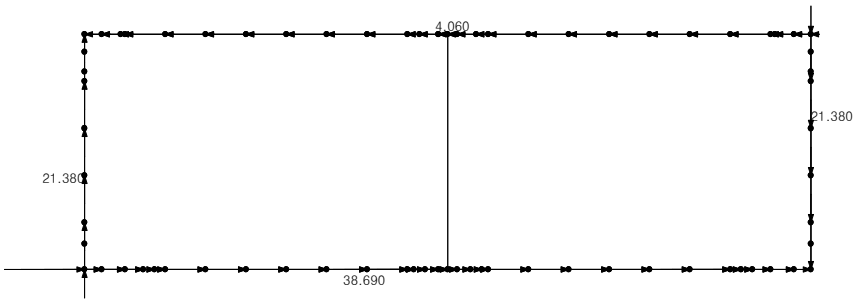
17) CASE17 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



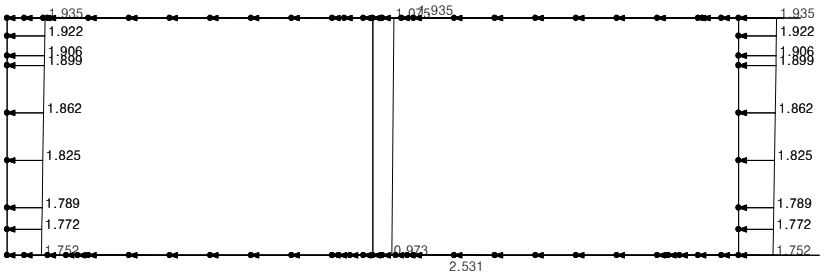
18) CASE18 - 벽체 지반변위(기능수행)2(FUNWALL2)



19) CASE19 - 주면전단력(기능수행)2(FUNMS2)

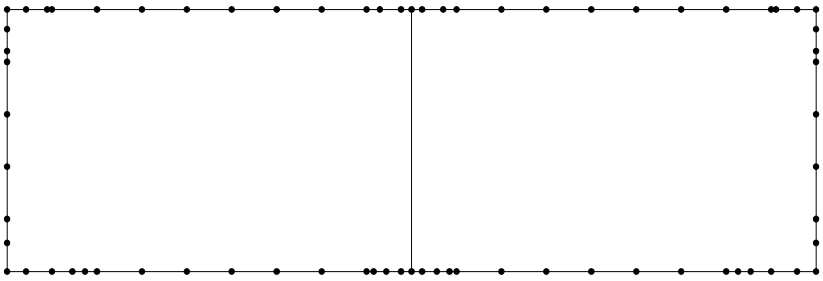


20) CASE20 - 구체 관성력(기능수행)2(FUNINER2)

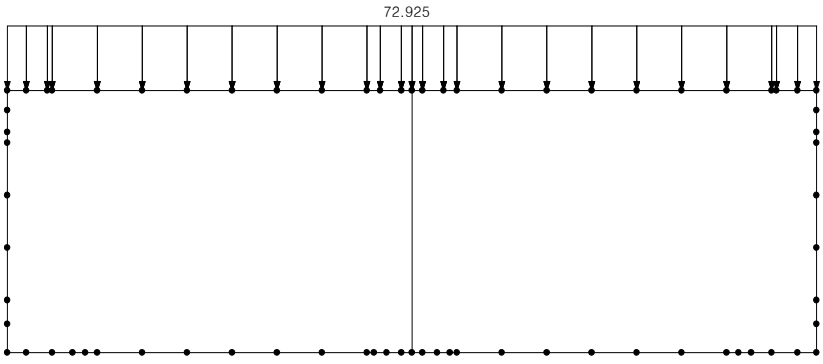


13. 하중 재하 (붕괴방지)

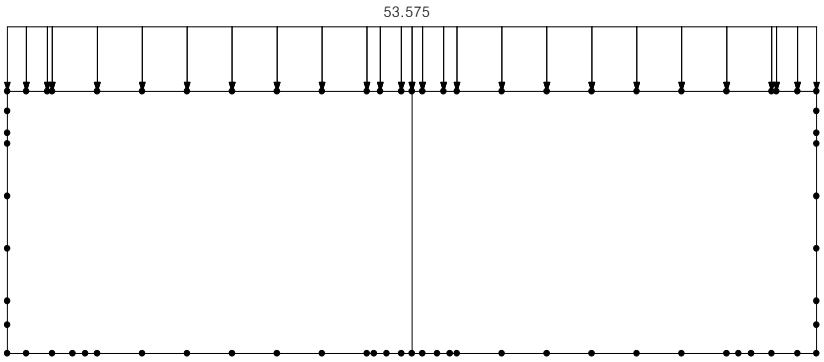
1) CASE1 - 구체자중(SW)



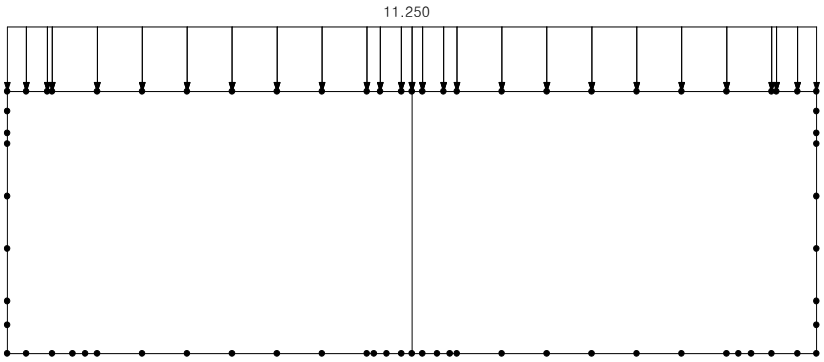
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



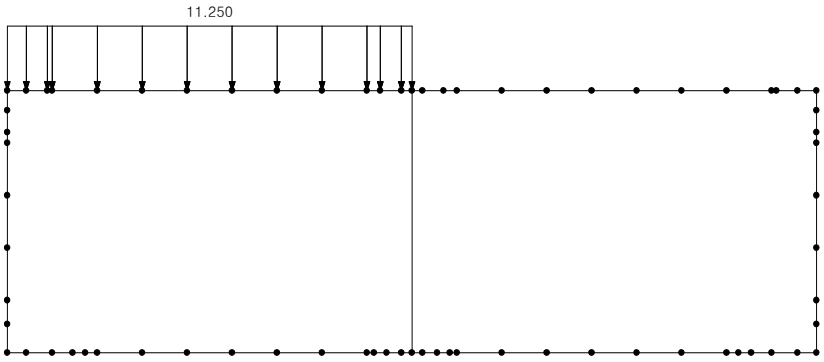
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



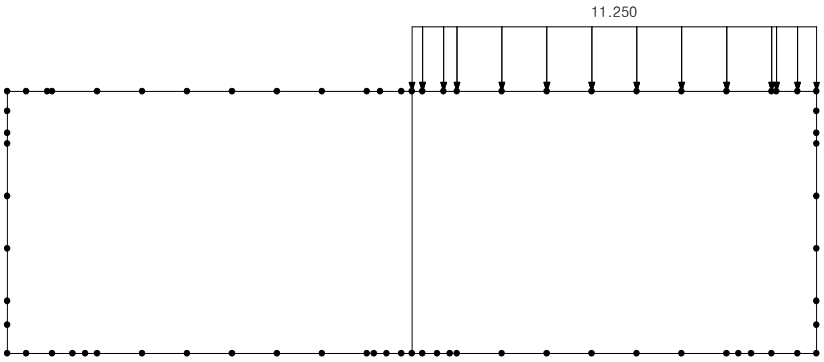
4) CASE4 - 지진시 만재활하중(LIVEFUE)



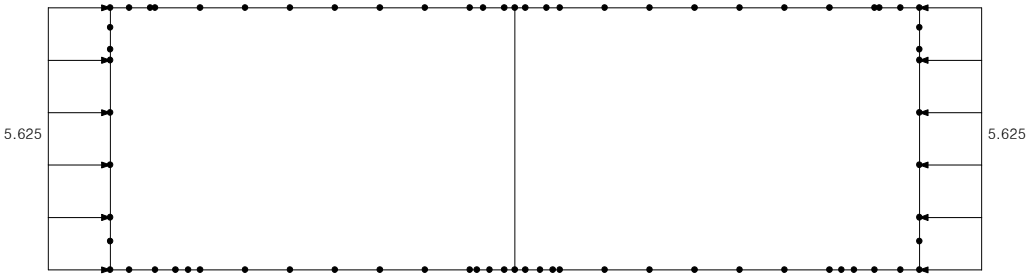
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



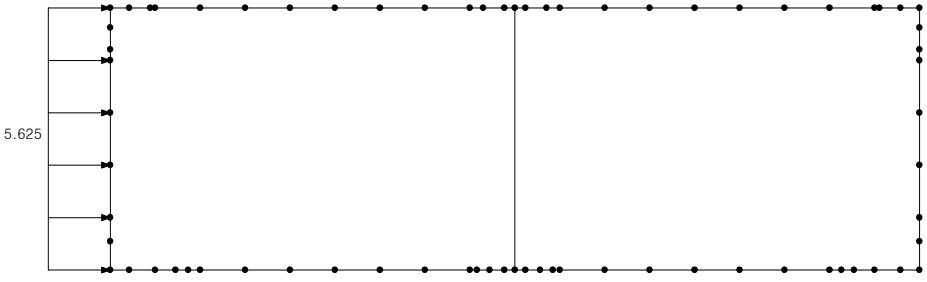
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



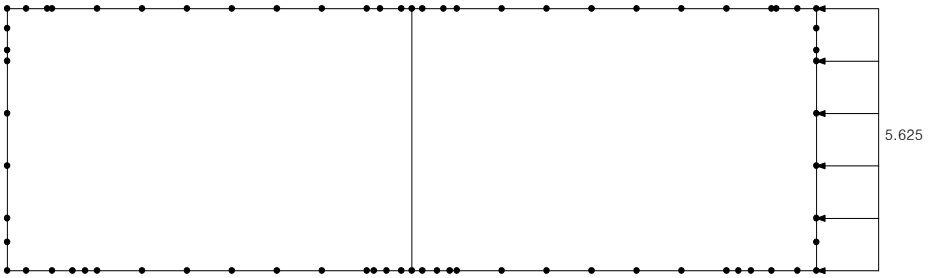
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



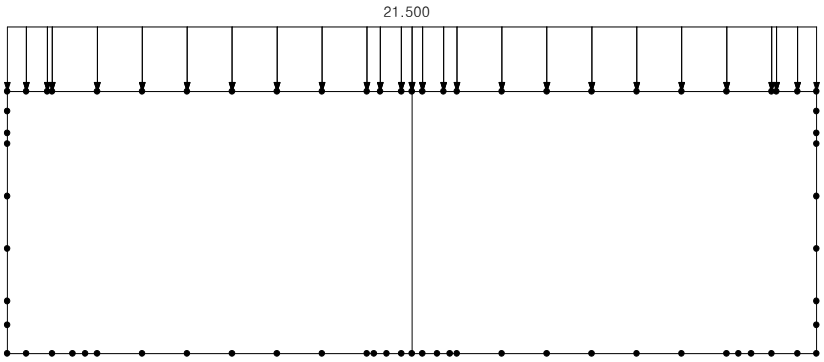
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



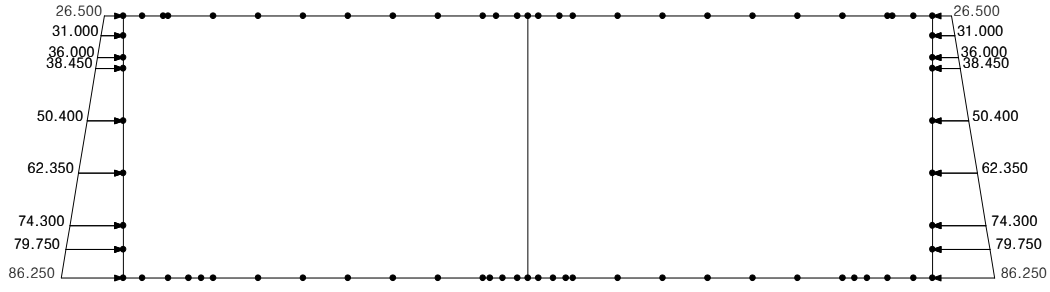
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



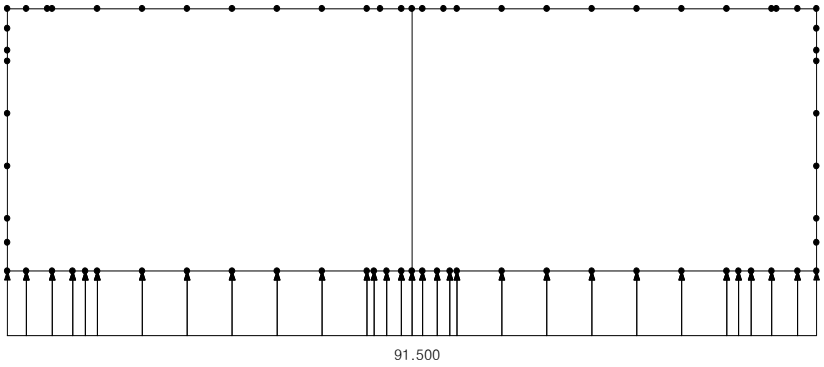
10) CASE10 - 연직수압(WATERV)



11) CASE11 - 수평수압(WATERH)

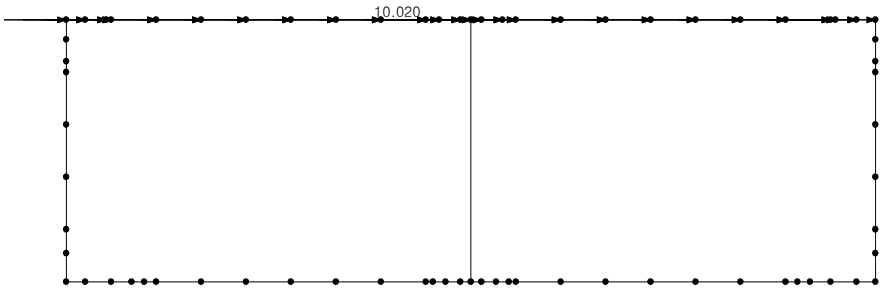


12) CASE12 - 부력(BUOYANCY)

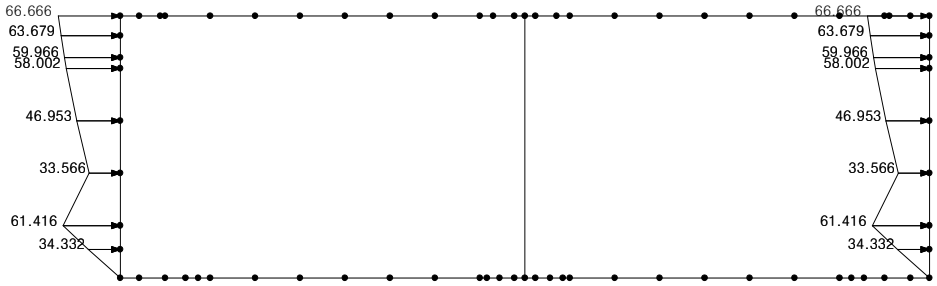


- 지진재하방향(좌측에서 우측으로)

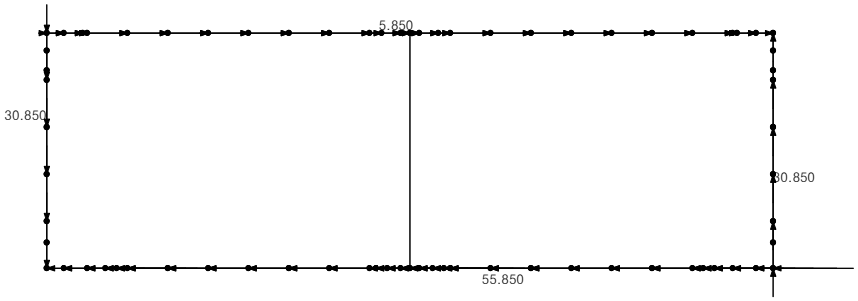
13) CASE13 - 슬래브 지반변위(붕괴방지)(COLSLAB)



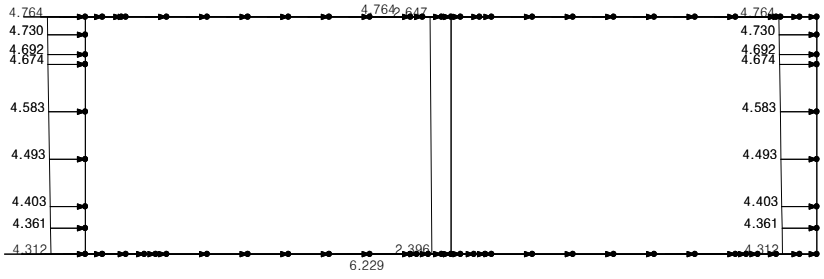
14) CASE14 - 벽체 지반변위(붕괴방지)(COLWALL)



15) CASE15 - 주면전단력(붕괴방지)(COLMS)

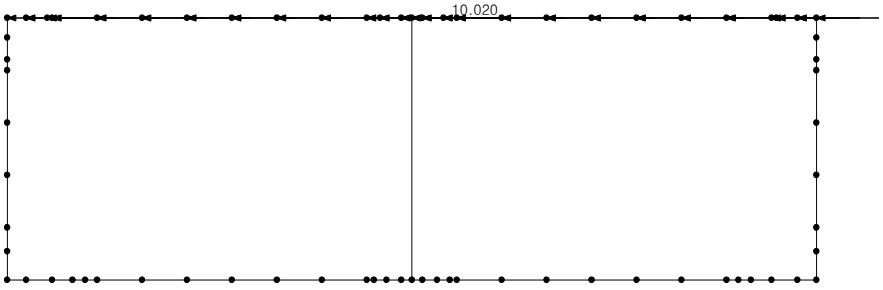


16) CASE16 - 구체 관성력(붕괴방지)(COLINER)

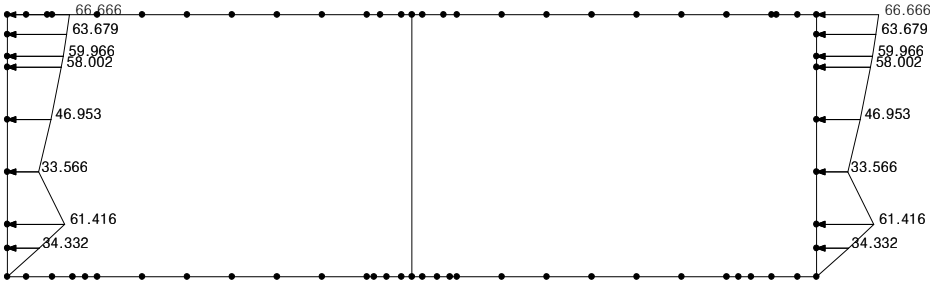


- 지진재하방향(우측에서 좌측으로)

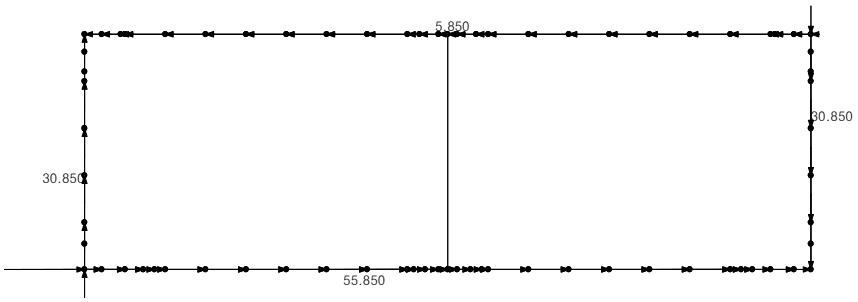
17) CASE17 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



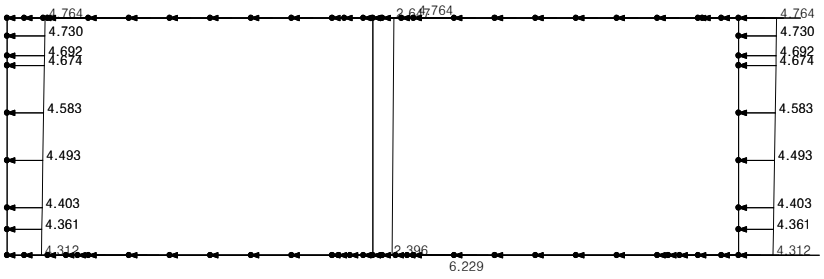
18) CASE18 - 벽체 지반변위(붕괴방지)2(COLWALL2)



19) CASE19 - 주면전단력(붕괴방지)2(COLMS2)



20) CASE20 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 0.975, h = 3.200 m

1) 계수하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.400						
LC2	1.200	1.560	1.600	1.600	1.200		
LC3	1.200		1.000				
LC4	1.200	1.560	1.600	0.800	1.200		
LC5	0.900	0.900		1.600			
LC6	0.900	0.900		0.800			
LC7	1.200	1.560	1.600	1.600	1.200	1.200	●
LC8	1.200	1.560	1.600	0.800	1.200	1.200	●
LC9	0.900	0.900		1.600			●
LC10	0.900	0.900		0.800			●

2) 사용하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.000						
LC2	1.000	1.000	1.000	1.000	1.000		
LC3	1.000		1.000				
LC4	1.000	1.000	1.000	0.500	1.000		
LC5	1.000	1.000		1.000			
LC6	1.000	1.000		0.500			
LC7	1.000	1.000	1.000	1.000	1.000	1.000	●
LC8	1.000	1.000	1.000	0.500	1.000	1.000	●
LC9	1.000	1.000		1.000			●
LC10	1.000	1.000		0.500			●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

15. INPUT DATA (상시)

```
; ACulvert SAP2000 데이터파일 : 평상시
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.000 Y=     0.000 Z=     0.500
  2    X=     0.450 Y=     0.000 Z=     0.500
  3    X=     1.067 Y=     0.000 Z=     0.500
  4    X=     1.550 Y=     0.000 Z=     0.500
  5    X=     1.850 Y=     0.000 Z=     0.500
  6    X=     2.133 Y=     0.000 Z=     0.500
  7    X=     3.200 Y=     0.000 Z=     0.500
  8    X=     4.267 Y=     0.000 Z=     0.500
  9    X=     5.333 Y=     0.000 Z=     0.500
  10   X=     6.400 Y=     0.000 Z=     0.500
  11   X=     7.467 Y=     0.000 Z=     0.500
  12   X=     8.533 Y=     0.000 Z=     0.500
  13   X=     8.700 Y=     0.000 Z=     0.500
  14   X=     9.000 Y=     0.000 Z=     0.500
  15   X=     9.350 Y=     0.000 Z=     0.500
  16   X=     9.600 Y=     0.000 Z=     0.500
  17   X=     9.850 Y=     0.000 Z=     0.500
  18   X=    10.200 Y=     0.000 Z=     0.500
  19   X=    10.500 Y=     0.000 Z=     0.500
  20   X=    10.667 Y=     0.000 Z=     0.500
  21   X=    11.733 Y=     0.000 Z=     0.500
  22   X=    12.800 Y=     0.000 Z=     0.500
  23   X=    13.867 Y=     0.000 Z=     0.500
  24   X=    14.933 Y=     0.000 Z=     0.500
  25   X=    16.000 Y=     0.000 Z=     0.500
  26   X=    17.067 Y=     0.000 Z=     0.500
  27   X=    17.350 Y=     0.000 Z=     0.500
  28   X=    17.650 Y=     0.000 Z=     0.500
  29   X=    18.133 Y=     0.000 Z=     0.500
  30   X=    18.750 Y=     0.000 Z=     0.500
  31   X=    19.200 Y=     0.000 Z=     0.500
  32   X=    19.200 Y=     0.000 Z=     1.150
  33   X=    19.200 Y=     0.000 Z=     1.695
  34   X=    19.200 Y=     0.000 Z=     2.890
  35   X=    19.200 Y=     0.000 Z=     4.085
  36   X=    19.200 Y=     0.000 Z=     5.280
  37   X=    19.200 Y=     0.000 Z=     5.525
  38   X=    19.200 Y=     0.000 Z=     6.025
  39   X=    19.200 Y=     0.000 Z=     6.475
  40   X=    18.750 Y=     0.000 Z=     6.475
  41   X=    18.250 Y=     0.000 Z=     6.475
  42   X=    18.133 Y=     0.000 Z=     6.475
  43   X=    17.067 Y=     0.000 Z=     6.475
  44   X=    16.000 Y=     0.000 Z=     6.475
  45   X=    14.933 Y=     0.000 Z=     6.475
  46   X=    13.867 Y=     0.000 Z=     6.475
  47   X=    12.800 Y=     0.000 Z=     6.475
  48   X=    11.733 Y=     0.000 Z=     6.475
  49   X=    10.667 Y=     0.000 Z=     6.475
  50   X=    10.350 Y=     0.000 Z=     6.475
  51   X=     9.850 Y=     0.000 Z=     6.475
  52   X=     9.600 Y=     0.000 Z=     6.475
  53   X=     9.350 Y=     0.000 Z=     6.475
  54   X=     8.850 Y=     0.000 Z=     6.475
  55   X=     8.533 Y=     0.000 Z=     6.475
  56   X=     7.467 Y=     0.000 Z=     6.475
  57   X=     6.400 Y=     0.000 Z=     6.475
  58   X=     5.333 Y=     0.000 Z=     6.475
  59   X=     4.267 Y=     0.000 Z=     6.475
  60   X=     3.200 Y=     0.000 Z=     6.475
  61   X=     2.133 Y=     0.000 Z=     6.475
  62   X=     1.067 Y=     0.000 Z=     6.475
  63   X=     0.950 Y=     0.000 Z=     6.475
  64   X=     0.450 Y=     0.000 Z=     6.475
  65   X=     0.000 Y=     0.000 Z=     6.475
  66   X=     0.000 Y=     0.000 Z=     6.025
  67   X=     0.000 Y=     0.000 Z=     5.525
  68   X=     0.000 Y=     0.000 Z=     5.280
  69   X=     0.000 Y=     0.000 Z=     4.085
  70   X=     0.000 Y=     0.000 Z=     2.890
  71   X=     0.000 Y=     0.000 Z=     1.695
  72   X=     0.000 Y=     0.000 Z=     1.150
  73   X=     0.000 Y=     0.000 Z=     0.000
  74   X=     1.067 Y=     0.000 Z=     0.000
  75   X=     2.133 Y=     0.000 Z=     0.000
  76   X=     3.200 Y=     0.000 Z=     0.000
  77   X=     4.267 Y=     0.000 Z=     0.000
  78   X=     5.333 Y=     0.000 Z=     0.000
  79   X=     6.400 Y=     0.000 Z=     0.000
  80   X=     7.467 Y=     0.000 Z=     0.000
  81   X=     8.533 Y=     0.000 Z=     0.000
  82   X=     9.600 Y=     0.000 Z=     0.000
  83   X=    10.667 Y=     0.000 Z=     0.000
  84   X=    11.733 Y=     0.000 Z=     0.000
  85   X=    12.800 Y=     0.000 Z=     0.000
  86   X=    13.867 Y=     0.000 Z=     0.000
  87   X=    14.933 Y=     0.000 Z=     0.000
  88   X=    16.000 Y=     0.000 Z=     0.000
  89   X=    17.067 Y=     0.000 Z=     0.000
  90   X=    18.133 Y=     0.000 Z=     0.000
  91   X=    19.200 Y=     0.000 Z=     0.000
RESTRAINT
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=1 UX=1e+010
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=279933. CE=0.99999 K=279933. OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=303657. CE=0.99999 K=303657. OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.3,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.05,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.125 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.125 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.425 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    38 J= 38,  39 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    39 J= 39,  40 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 3 NSEG= 4 ANG=0
```

```
    42 J= 42,  43 SEC= 3 NSEG= 4 ANG=0
    43 J= 43,  44 SEC= 3 NSEG= 4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    51 J= 51,  52 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    52 J= 52,  53 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 NSEG= 4 ANG=0
    55 J= 55,  56 SEC= 3 NSEG= 4 ANG=0
    56 J= 56,  57 SEC= 3 NSEG= 4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    64 J= 64,  65 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    65 J= 65,  66 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    66 J= 66,  67 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    67 J= 67,  68 SEC= 3 NSEG= 4 ANG=180
    68 J= 68,  69 SEC= 3 NSEG= 4 ANG=180
    69 J= 69,  70 SEC= 3 NSEG= 4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,   1 SEC= 3 IOFF=0 JOFF=0.425 RIGID=1 NSEG=4 ANG=180
    73 J= 52,  16 SEC= 5 IOFF=0.7 JOFF=0.525 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,73 NLP=1 ANG=0
     2 J= 3,74 NLP=2 ANG=0
     3 J= 6,75 NLP=2 ANG=0
     4 J= 7,76 NLP=2 ANG=0
     5 J= 8,77 NLP=2 ANG=0
     6 J= 9,78 NLP=2 ANG=0
     7 J=10,79 NLP=2 ANG=0
     8 J=11,80 NLP=2 ANG=0
     9 J=12,81 NLP=2 ANG=0
    10 J=16,82 NLP=2 ANG=0
    11 J=20,83 NLP=2 ANG=0
    12 J=21,84 NLP=2 ANG=0
    13 J=22,85 NLP=2 ANG=0
    14 J=23,86 NLP=2 ANG=0
    15 J=24,87 NLP=2 ANG=0
    16 J=25,88 NLP=2 ANG=0
    17 J=26,89 NLP=2 ANG=0
    18 J=29,90 NLP=2 ANG=0
    19 J=31,91 NLP=1 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-72.925, -72.925
      ADD=40 RD=0,1 UZ=-72.925, -72.925
      ADD=41 RD=0,1 UZ=-72.925, -72.925
      ADD=42 RD=0,1 UZ=-72.925, -72.925
      ADD=43 RD=0,1 UZ=-72.925, -72.925
      ADD=44 RD=0,1 UZ=-72.925, -72.925
      ADD=45 RD=0,1 UZ=-72.925, -72.925
      ADD=46 RD=0,1 UZ=-72.925, -72.925
      ADD=47 RD=0,1 UZ=-72.925, -72.925
      ADD=48 RD=0,1 UZ=-72.925, -72.925
      ADD=49 RD=0,1 UZ=-72.925, -72.925
      ADD=50 RD=0,1 UZ=-72.925, -72.925
      ADD=51 RD=0,1 UZ=-72.925, -72.925
      ADD=52 RD=0,1 UZ=-72.925, -72.925
      ADD=53 RD=0,1 UZ=-72.925, -72.925
      ADD=54 RD=0,1 UZ=-72.925, -72.925
      ADD=55 RD=0,1 UZ=-72.925, -72.925
      ADD=56 RD=0,1 UZ=-72.925, -72.925
      ADD=57 RD=0,1 UZ=-72.925, -72.925
      ADD=58 RD=0,1 UZ=-72.925, -72.925
      ADD=59 RD=0,1 UZ=-72.925, -72.925
      ADD=60 RD=0,1 UZ=-72.925, -72.925
      ADD=61 RD=0,1 UZ=-72.925, -72.925
      ADD=62 RD=0,1 UZ=-72.925, -72.925
      ADD=63 RD=0,1 UZ=-72.925, -72.925
      ADD=64 RD=0,1 UZ=-72.925, -72.925
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-53.575, -53.575
      ADD=40 RD=0,1 UZ=-53.575, -53.575
      ADD=41 RD=0,1 UZ=-53.575, -53.575
      ADD=42 RD=0,1 UZ=-53.575, -53.575
      ADD=43 RD=0,1 UZ=-53.575, -53.575
      ADD=44 RD=0,1 UZ=-53.575, -53.575
      ADD=45 RD=0,1 UZ=-53.575, -53.575
      ADD=46 RD=0,1 UZ=-53.575, -53.575
      ADD=47 RD=0,1 UZ=-53.575, -53.575
      ADD=48 RD=0,1 UZ=-53.575, -53.575
      ADD=49 RD=0,1 UZ=-53.575, -53.575
      ADD=50 RD=0,1 UZ=-53.575, -53.575
      ADD=51 RD=0,1 UZ=-53.575, -53.575
      ADD=52 RD=0,1 UZ=-53.575, -53.575
      ADD=53 RD=0,1 UZ=-53.575, -53.575
      ADD=54 RD=0,1 UZ=-53.575, -53.575
      ADD=55 RD=0,1 UZ=-53.575, -53.575
      ADD=56 RD=0,1 UZ=-53.575, -53.575
      ADD=57 RD=0,1 UZ=-53.575, -53.575
      ADD=58 RD=0,1 UZ=-53.575, -53.575
      ADD=59 RD=0,1 UZ=-53.575, -53.575
      ADD=60 RD=0,1 UZ=-53.575, -53.575
      ADD=61 RD=0,1 UZ=-53.575, -53.575
      ADD=62 RD=0,1 UZ=-53.575, -53.575
      ADD=63 RD=0,1 UZ=-53.575, -53.575
      ADD=64 RD=0,1 UZ=-53.575, -53.575
NAME=LIVEFU  ; 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11.25, -11.25
      ADD=40 RD=0,1 UZ=-11.25, -11.25
      ADD=41 RD=0,1 UZ=-11.25, -11.25
      ADD=42 RD=0,1 UZ=-11.25, -11.25
      ADD=43 RD=0,1 UZ=-11.25, -11.25
      ADD=44 RD=0,1 UZ=-11.25, -11.25
      ADD=45 RD=0,1 UZ=-11.25, -11.25
      ADD=46 RD=0,1 UZ=-11.25, -11.25
      ADD=47 RD=0,1 UZ=-11.25, -11.25
      ADD=48 RD=0,1 UZ=-11.25, -11.25
      ADD=49 RD=0,1 UZ=-11.25, -11.25
      ADD=50 RD=0,1 UZ=-11.25, -11.25
      ADD=51 RD=0,1 UZ=-11.25, -11.25
      ADD=52 RD=0,1 UZ=-11.25, -11.25
      ADD=53 RD=0,1 UZ=-11.25, -11.25
      ADD=54 RD=0,1 UZ=-11.25, -11.25
      ADD=55 RD=0,1 UZ=-11.25, -11.25
      ADD=56 RD=0,1 UZ=-11.25, -11.25
      ADD=57 RD=0,1 UZ=-11.25, -11.25
      ADD=58 RD=0,1 UZ=-11.25, -11.25
      ADD=59 RD=0,1 UZ=-11.25, -11.25
      ADD=60 RD=0,1 UZ=-11.25, -11.25
      ADD=61 RD=0,1 UZ=-11.25, -11.25
      ADD=62 RD=0,1 UZ=-11.25, -11.25
      ADD=63 RD=0,1 UZ=-11.25, -11.25
      ADD=64 RD=0,1 UZ=-11.25, -11.25
NAME=LIVELE  ; 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=52 RD=0,1 UZ=-11.25, -11.25
      ADD=53 RD=0,1 UZ=-11.25, -11.25
      ADD=54 RD=0,1 UZ=-11.25, -11.25
      ADD=55 RD=0,1 UZ=-11.25, -11.25
      ADD=56 RD=0,1 UZ=-11.25, -11.25
      ADD=57 RD=0,1 UZ=-11.25, -11.25
      ADD=58 RD=0,1 UZ=-11.25, -11.25
      ADD=59 RD=0,1 UZ=-11.25, -11.25
      ADD=60 RD=0,1 UZ=-11.25, -11.25
      ADD=61 RD=0,1 UZ=-11.25, -11.25
      ADD=62 RD=0,1 UZ=-11.25, -11.25
      ADD=63 RD=0,1 UZ=-11.25, -11.25
      ADD=64 RD=0,1 UZ=-11.25, -11.25
NAME=LIVERI  ; 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11.25, -11.25
      ADD=40 RD=0,1 UZ=-11.25, -11.25
      ADD=41 RD=0,1 UZ=-11.25, -11.25
      ADD=42 RD=0,1 UZ=-11.25, -11.25
      ADD=43 RD=0,1 UZ=-11.25, -11.25
      ADD=44 RD=0,1 UZ=-11.25, -11.25
      ADD=45 RD=0,1 UZ=-11.25, -11.25
      ADD=46 RD=0,1 UZ=-11.25, -11.25
      ADD=47 RD=0,1 UZ=-11.25, -11.25
      ADD=48 RD=0,1 UZ=-11.25, -11.25
      ADD=49 RD=0,1 UZ=-11.25, -11.25
      ADD=50 RD=0,1 UZ=-11.25, -11.25
      ADD=51 RD=0,1 UZ=-11.25, -11.25
NAME=LIVEFUH  ; 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5, 5
      ADD=66 RD=0,1 UX=5, 5
      ADD=67 RD=0,1 UX=5, 5
      ADD=68 RD=0,1 UX=5, 5
      ADD=69 RD=0,1 UX=5, 5
      ADD=70 RD=0,1 UX=5, 5
      ADD=71 RD=0,1 UX=5, 5
      ADD=72 RD=0,1 UX=5, 5
      ADD=31 RD=0,1 UX=-5, -5
      ADD=32 RD=0,1 UX=-5, -5
```

```
      ADD=33 RD=0,1 UX=-5, -5
      ADD=34 RD=0,1 UX=-5, -5
      ADD=35 RD=0,1 UX=-5, -5
      ADD=36 RD=0,1 UX=-5, -5
      ADD=37 RD=0,1 UX=-5, -5
      ADD=38 RD=0,1 UX=-5, -5
NAME=LIVELEH  ; 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.625, 5.625
      ADD=66 RD=0,1 UX=5.625, 5.625
      ADD=67 RD=0,1 UX=5.625, 5.625
      ADD=68 RD=0,1 UX=5.625, 5.625
      ADD=69 RD=0,1 UX=5.625, 5.625
      ADD=70 RD=0,1 UX=5.625, 5.625
      ADD=71 RD=0,1 UX=5.625, 5.625
      ADD=72 RD=0,1 UX=5.625, 5.625
NAME=LIVERIH  ; 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-5.625, -5.625
      ADD=32 RD=0,1 UX=-5.625, -5.625
      ADD=33 RD=0,1 UX=-5.625, -5.625
      ADD=34 RD=0,1 UX=-5.625, -5.625
      ADD=35 RD=0,1 UX=-5.625, -5.625
      ADD=36 RD=0,1 UX=-5.625, -5.625
      ADD=37 RD=0,1 UX=-5.625, -5.625
      ADD=38 RD=0,1 UX=-5.625, -5.625
NAME=SOILB  ; 양토압 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=35.675, 39.95
      ADD=66 RD=0,1 UX=39.95, 44.7
      ADD=67 RD=0,1 UX=44.7, 47.028
      ADD=68 RD=0,1 UX=47.028, 58.38
      ADD=69 RD=0,1 UX=58.38, 69.733
      ADD=70 RD=0,1 UX=69.733, 81.085
      ADD=71 RD=0,1 UX=81.085, 86.263
      ADD=72 RD=0,1 UX=86.263, 92.437
      ADD=31 RD=0,1 UX=-92.437, -86.263
      ADD=32 RD=0,1 UX=-86.263, -81.085
      ADD=33 RD=0,1 UX=-81.085, -69.733
      ADD=34 RD=0,1 UX=-69.733, -58.38
      ADD=35 RD=0,1 UX=-58.38, -47.028
      ADD=36 RD=0,1 UX=-47.028, -44.7
      ADD=37 RD=0,1 UX=-44.7, -39.95
      ADD=38 RD=0,1 UX=-39.95, -35.675
NAME=SOILL  ; 편토압(좌측) : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=35.675, 39.95
      ADD=66 RD=0,1 UX=39.95, 44.7
      ADD=67 RD=0,1 UX=44.7, 47.028
      ADD=68 RD=0,1 UX=47.028, 58.38
      ADD=69 RD=0,1 UX=58.38, 69.733
      ADD=70 RD=0,1 UX=69.733, 81.085
      ADD=71 RD=0,1 UX=81.085, 86.263
      ADD=72 RD=0,1 UX=86.263, 92.437
NAME=SOILR  ; 편토압(우측) : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-92.437, -86.263
      ADD=32 RD=0,1 UX=-86.263, -81.085
      ADD=33 RD=0,1 UX=-81.085, -69.733
      ADD=34 RD=0,1 UX=-69.733, -58.38
      ADD=35 RD=0,1 UX=-58.38, -47.028
      ADD=36 RD=0,1 UX=-47.028, -44.7
      ADD=37 RD=0,1 UX=-44.7, -39.95
      ADD=38 RD=0,1 UX=-39.95, -35.675
NAME=SOILBW  ; 양토압 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=23.75, 26
      ADD=66 RD=0,1 UX=26, 28.5
      ADD=67 RD=0,1 UX=28.5, 29.725
      ADD=68 RD=0,1 UX=29.725, 35.7
      ADD=69 RD=0,1 UX=35.7, 41.675
      ADD=70 RD=0,1 UX=41.675, 47.65
      ADD=71 RD=0,1 UX=47.65, 50.375
      ADD=72 RD=0,1 UX=50.375, 53.625
      ADD=31 RD=0,1 UX=-53.625, -50.375
      ADD=32 RD=0,1 UX=-50.375, -47.65
      ADD=33 RD=0,1 UX=-47.65, -41.675
      ADD=34 RD=0,1 UX=-41.675, -35.7
      ADD=35 RD=0,1 UX=-35.7, -29.725
      ADD=36 RD=0,1 UX=-29.725, -28.5
      ADD=37 RD=0,1 UX=-28.5, -26
      ADD=38 RD=0,1 UX=-26, -23.75
NAME=SOILLW  ; 편토압(좌측) : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=23.75, 26
      ADD=66 RD=0,1 UX=26, 28.5
      ADD=67 RD=0,1 UX=28.5, 29.725
      ADD=68 RD=0,1 UX=29.725, 35.7
      ADD=69 RD=0,1 UX=35.7, 41.675
      ADD=70 RD=0,1 UX=41.675, 47.65
      ADD=71 RD=0,1 UX=47.65, 50.375
      ADD=72 RD=0,1 UX=50.375, 53.625
NAME=SOILRW  ; 편토압(우측) : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-53.625, -50.375
      ADD=32 RD=0,1 UX=-50.375, -47.65
      ADD=33 RD=0,1 UX=-47.65, -41.675
      ADD=34 RD=0,1 UX=-41.675, -35.7
      ADD=35 RD=0,1 UX=-35.7, -29.725
      ADD=36 RD=0,1 UX=-29.725, -28.5
      ADD=37 RD=0,1 UX=-28.5, -26
      ADD=38 RD=0,1 UX=-26, -23.75
NAME=WATERV  ; 연직수압
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-21.5, -21.5
      ADD=40 RD=0,1 UZ=-21.5, -21.5
      ADD=41 RD=0,1 UZ=-21.5, -21.5
      ADD=42 RD=0,1 UZ=-21.5, -21.5
      ADD=43 RD=0,1 UZ=-21.5, -21.5
      ADD=44 RD=0,1 UZ=-21.5, -21.5
      ADD=45 RD=0,1 UZ=-21.5, -21.5
      ADD=46 RD=0,1 UZ=-21.5, -21.5
      ADD=47 RD=0,1 UZ=-21.5, -21.5
      ADD=48 RD=0,1 UZ=-21.5, -21.5
      ADD=49 RD=0,1 UZ=-21.5, -21.5
      ADD=50 RD=0,1 UZ=-21.5, -21.5
      ADD=51 RD=0,1 UZ=-21.5, -21.5
      ADD=52 RD=0,1 UZ=-21.5, -21.5
      ADD=53 RD=0,1 UZ=-21.5, -21.5
      ADD=54 RD=0,1 UZ=-21.5, -21.5
      ADD=55 RD=0,1 UZ=-21.5, -21.5
      ADD=56 RD=0,1 UZ=-21.5, -21.5
      ADD=57 RD=0,1 UZ=-21.5, -21.5
      ADD=58 RD=0,1 UZ=-21.5, -21.5
      ADD=59 RD=0,1 UZ=-21.5, -21.5
      ADD=60 RD=0,1 UZ=-21.5, -21.5
      ADD=61 RD=0,1 UZ=-21.5, -21.5
      ADD=62 RD=0,1 UZ=-21.5, -21.5
      ADD=63 RD=0,1 UZ=-21.5, -21.5
      ADD=64 RD=0,1 UZ=-21.5, -21.5
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=26.5, 31
      ADD=66 RD=0,1 UX=31, 36
      ADD=67 RD=0,1 UX=36, 38.45
      ADD=68 RD=0,1 UX=38.45, 50.4
      ADD=69 RD=0,1 UX=50.4, 62.35
      ADD=70 RD=0,1 UX=62.35, 74.3
      ADD=71 RD=0,1 UX=74.3, 79.75
      ADD=72 RD=0,1 UX=79.75, 86.25
      ADD=31 RD=0,1 UX=-86.25, -79.75
      ADD=32 RD=0,1 UX=-79.75, -74.3
      ADD=33 RD=0,1 UX=-74.3, -62.35
      ADD=34 RD=0,1 UX=-62.35, -50.4
      ADD=35 RD=0,1 UX=-50.4, -38.45
      ADD=36 RD=0,1 UX=-38.45, -36
      ADD=37 RD=0,1 UX=-36, -31
      ADD=38 RD=0,1 UX=-31, -26.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=91.5, 91.5
      ADD=2 RD=0,1 UZ=91.5, 91.5
      ADD=3 RD=0,1 UZ=91.5, 91.5
      ADD=4 RD=0,1 UZ=91.5, 91.5
      ADD=5 RD=0,1 UZ=91.5, 91.5
      ADD=6 RD=0,1 UZ=91.5, 91.5
      ADD=7 RD=0,1 UZ=91.5, 91.5
      ADD=8 RD=0,1 UZ=91.5, 91.5
      ADD=9 RD=0,1 UZ=91.5, 91.5
      ADD=10 RD=0,1 UZ=91.5, 91.5
      ADD=11 RD=0,1 UZ=91.5, 91.5
      ADD=12 RD=0,1 UZ=91.5, 91.5
      ADD=13 RD=0,1 UZ=91.5, 91.5
      ADD=14 RD=0,1 UZ=91.5, 91.5
      ADD=15 RD=0,1 UZ=91.5, 91.5
      ADD=16 RD=0,1 UZ=91.5, 91.5
      ADD=17 RD=0,1 UZ=91.5, 91.5
      ADD=18 RD=0,1 UZ=91.5, 91.5
      ADD=19 RD=0,1 UZ=91.5, 91.5
      ADD=20 RD=0,1 UZ=91.5, 91.5
      ADD=21 RD=0,1 UZ=91.5, 91.5
      ADD=22 RD=0,1 UZ=91.5, 91.5
      ADD=23 RD=0,1 UZ=91.5, 91.5
      ADD=24 RD=0,1 UZ=91.5, 91.5
      ADD=25 RD=0,1 UZ=91.5, 91.5
      ADD=26 RD=0,1 UZ=91.5, 91.5
      ADD=27 RD=0,1 UZ=91.5, 91.5
      ADD=28 RD=0,1 UZ=91.5, 91.5
      ADD=29 RD=0,1 UZ=91.5, 91.5
      ADD=30 RD=0,1 UZ=91.5, 91.5
```

```
NAME=TEMPPLUS  ; 온도변화(+)
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=10
      ADD=32 T=10
      ADD=33 T=10
      ADD=34 T=10
      ADD=35 T=10
      ADD=36 T=10
      ADD=37 T=10
      ADD=38 T=10
      ADD=39 T=10
      ADD=40 T=10
      ADD=41 T=10
      ADD=42 T=10
      ADD=43 T=10
      ADD=44 T=10
      ADD=45 T=10
      ADD=46 T=10
      ADD=47 T=10
      ADD=48 T=10
      ADD=49 T=10
      ADD=50 T=10
      ADD=51 T=10
      ADD=52 T=10
      ADD=53 T=10
      ADD=54 T=10
      ADD=55 T=10
      ADD=56 T=10
      ADD=57 T=10
      ADD=58 T=10
      ADD=59 T=10
      ADD=60 T=10
      ADD=61 T=10
      ADD=62 T=10
      ADD=63 T=10
      ADD=64 T=10
      ADD=65 T=10
      ADD=66 T=10
      ADD=67 T=10
      ADD=68 T=10
      ADD=69 T=10
      ADD=70 T=10
      ADD=71 T=10
      ADD=72 T=10
      ADD=73 T=10
NAME=TEMPMINU  ; 온도변화(-)
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=-10
      ADD=32 T=-10
      ADD=33 T=-10
      ADD=34 T=-10
      ADD=35 T=-10
      ADD=36 T=-10
      ADD=37 T=-10
      ADD=38 T=-10
      ADD=39 T=-10
      ADD=40 T=-10
      ADD=41 T=-10
      ADD=42 T=-10
      ADD=43 T=-10
      ADD=44 T=-10
      ADD=45 T=-10
      ADD=46 T=-10
      ADD=47 T=-10
      ADD=48 T=-10
      ADD=49 T=-10
      ADD=50 T=-10
      ADD=51 T=-10
      ADD=52 T=-10
      ADD=53 T=-10
      ADD=54 T=-10
      ADD=55 T=-10
      ADD=56 T=-10
      ADD=57 T=-10
      ADD=58 T=-10
      ADD=59 T=-10
      ADD=60 T=-10
      ADD=61 T=-10
      ADD=62 T=-10
      ADD=63 T=-10
      ADD=64 T=-10
      ADD=65 T=-10
      ADD=66 T=-10
      ADD=67 T=-10
      ADD=68 T=-10
      ADD=69 T=-10
      ADD=70 T=-10
      ADD=71 T=-10
      ADD=72 T=-10
      ADD=73 T=-10
NAME=SHRINK  ; 건조수축
   TYPE=Temperature ELEM=FRAME
      ADD=31 T=-15
      ADD=32 T=-15
      ADD=33 T=-15
      ADD=34 T=-15
      ADD=35 T=-15
      ADD=36 T=-15
      ADD=37 T=-15
      ADD=38 T=-15
      ADD=39 T=-15
      ADD=40 T=-15
      ADD=41 T=-15
      ADD=42 T=-15
      ADD=43 T=-15
      ADD=44 T=-15
      ADD=45 T=-15
      ADD=46 T=-15
      ADD=47 T=-15
      ADD=48 T=-15
      ADD=49 T=-15
      ADD=50 T=-15
      ADD=51 T=-15
      ADD=52 T=-15
      ADD=53 T=-15
      ADD=54 T=-15
      ADD=55 T=-15
      ADD=56 T=-15
      ADD=57 T=-15
      ADD=58 T=-15
      ADD=59 T=-15
      ADD=60 T=-15
      ADD=61 T=-15
      ADD=62 T=-15
      ADD=63 T=-15
      ADD=64 T=-15
      ADD=65 T=-15
      ADD=66 T=-15
      ADD=67 T=-15
      ADD=68 T=-15
      ADD=69 T=-15
      ADD=70 T=-15
      ADD=71 T=-15
      ADD=72 T=-15
      ADD=73 T=-15
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFU
      LOAD=LIVELE
      LOAD=LIVERI
      LOAD=LIVEFUH
      LOAD=LIVELEH
      LOAD=LIVERIH
      LOAD=SOILB
      LOAD=SOILL
      LOAD=SOILR
      LOAD=SOILBW
      LOAD=SOILLW
      LOAD=SOILRW
      LOAD=WATERV
      LOAD=WATERH
      LOAD=BUOYANCY
      LOAD=TEMPPLUS
      LOAD=TEMPMINU
      LOAD=SHRINK
      NLLINK=*
HISTORY
    NAME=UL01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
       LOAD= SW             SF=1.400   AT=1
    NAME=UL02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
       LOAD= SW             SF=1.200   AT=1
       LOAD= PAVE           SF=1.560   AT=1
       LOAD= LIVEFU         SF=1.600   AT=1
       LOAD= LIVEFUH        SF=1.600   AT=1
       LOAD= SOILB          SF=1.600   AT=1
       LOAD= TEMPPLUS       SF=1.200   AT=1
       LOAD= SHRINK         SF=1.200   AT=1
    NAME=UL03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
       LOAD= SW             SF=1.200   AT=1
       LOAD= PAVE           SF=1.560   AT=1
       LOAD= LIVEFU         SF=1.600   AT=1
       LOAD= LIVEFUH        SF=1.600   AT=1
       LOAD= SOILB          SF=1.600   AT=1
       LOAD= TEMPMINU       SF=1.200   AT=1
       LOAD= SHRINK         SF=1.200   AT=1
    NAME=UL04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
       LOAD= SW             SF=1.200   AT=1
```

```
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILB         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILL         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=1.600   AT=1
   LOAD= SOILR         SF=1.600   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
NAME=UL21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
NAME=UL22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
NAME=UL23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILB         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILL         SF=0.800   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILR         SF=0.800   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
```

```
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL29     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILB          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL30     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILB          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL31     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILL          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL32     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILL          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL33     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL34     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=0.800   AT=1
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL35     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILB          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL36     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILB          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL37     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILL          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL38     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILL          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL39     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL40     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVE           SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=0.800   AT=1
   LOAD= SOILR          SF=0.800   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL41     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILB          SF=1.600   AT=1
NAME=UL42     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILL          SF=1.600   AT=1
NAME=UL43     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILR          SF=1.600   AT=1
NAME=UL44     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILB          SF=0.800   AT=1
NAME=UL45     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILL          SF=0.800   AT=1
NAME=UL46     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=0.900   AT=1
   LOAD= PAVE           SF=0.900   AT=1
   LOAD= SOILR          SF=0.800   AT=1
NAME=UL47     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL48     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL49     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL50     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL51     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL52     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW             SF=1.200   AT=1
```

```
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL53    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL54    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL55    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL56    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL57    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL58    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVELE         SF=1.600   AT=1
   LOAD= LIVELEH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL59    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL60    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILBW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL61    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL62    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILLW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL63    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL64    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVERI         SF=1.600   AT=1
   LOAD= LIVERIH        SF=1.600   AT=1
   LOAD= SOILRW         SF=1.600   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=1.600   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL65    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL66    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILBW         SF=0.800   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPMINU       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL67    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
   LOAD= WATERV         SF=1.560   AT=1
   LOAD= WATERH         SF=0.800   AT=1
   LOAD= BUOYANCY       SF=1.200   AT=1
   LOAD= TEMPPLUS       SF=1.200   AT=1
   LOAD= SHRINK         SF=1.200   AT=1
NAME=UL68    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= PAVEW          SF=1.560   AT=1
   LOAD= LIVEFU         SF=1.600   AT=1
   LOAD= LIVEFUH        SF=0.800   AT=1
   LOAD= SOILLW         SF=0.800   AT=1
```

```
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL69    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILRW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL70    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVEFU        SF=1.600   AT=1
   LOAD= LIVEFUH       SF=0.800   AT=1
   LOAD= SOILRW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL71    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL72    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL73    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILLW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL74    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILLW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL75    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILRW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL76    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVELE        SF=1.600   AT=1
   LOAD= LIVELEH       SF=0.800   AT=1
   LOAD= SOILRW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL77    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL78    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILBW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL79    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILLW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL80    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILLW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL81    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILRW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPPLUS      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL82    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.560   AT=1
   LOAD= LIVERI        SF=1.600   AT=1
   LOAD= LIVERIH       SF=0.800   AT=1
   LOAD= SOILRW        SF=0.800   AT=1
   LOAD= WATERV        SF=1.560   AT=1
   LOAD= WATERH        SF=0.800   AT=1
   LOAD= BUOYANCY      SF=1.200   AT=1
   LOAD= TEMPMINU      SF=1.200   AT=1
   LOAD= SHRINK        SF=1.200   AT=1
NAME=UL83    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
   LOAD= SOILBW        SF=1.600   AT=1
   LOAD= WATERV        SF=0.900   AT=1
   LOAD= WATERH        SF=1.600   AT=1
NAME=UL84    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
   LOAD= SOILLW        SF=1.600   AT=1
   LOAD= WATERV        SF=0.900   AT=1
   LOAD= WATERH        SF=1.600   AT=1
NAME=UL85    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
   LOAD= SOILRW        SF=1.600   AT=1
   LOAD= WATERV        SF=0.900   AT=1
   LOAD= WATERH        SF=1.600   AT=1
NAME=UL86    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVEW         SF=0.900   AT=1
```

```
   LOAD= SOILBW          SF=0.800    AT=1
   LOAD= WATERV          SF=0.900    AT=1
   LOAD= WATERH          SF=0.800    AT=1
NAME=UL87     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=0.900    AT=1
   LOAD= PAVEW           SF=0.900    AT=1
   LOAD= SOILLW          SF=0.800    AT=1
   LOAD= WATERV          SF=0.900    AT=1
   LOAD= WATERH          SF=0.800    AT=1
NAME=UL88     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=0.900    AT=1
   LOAD= PAVEW           SF=0.900    AT=1
   LOAD= SOILRW          SF=0.800    AT=1
   LOAD= WATERV          SF=0.900    AT=1
   LOAD= WATERH          SF=0.800    AT=1
NAME=SV01     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
NAME=SV02     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILB           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV03     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILB           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV04     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILL           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV05     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILL           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV06     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILR           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV07     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILR           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV08     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILB           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV09     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILB           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV10     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILL           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV11     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILL           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV12     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILR           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV13     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILR           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV14     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILB           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV15     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILB           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV16     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILL           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV17     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILL           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV18     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILR           SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV19     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILR           SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV20     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
NAME=SV21     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
NAME=SV22     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
NAME=SV23     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVE            SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=0.500    AT=1
   LOAD= SOILB           SF=0.500    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV24     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
```

```
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV33    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV34    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVELE        SF=1.000   AT=1
   LOAD= LIVELEH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV35    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV36    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILB         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV37    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV38    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILL         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV39    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV40    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= LIVERI        SF=1.000   AT=1
   LOAD= LIVERIH       SF=0.500   AT=1
   LOAD= SOILR         SF=0.500   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV41    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILB         SF=1.000   AT=1
NAME=SV42    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILL         SF=1.000   AT=1
NAME=SV43    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILR         SF=1.000   AT=1
NAME=SV44    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILB         SF=0.500   AT=1
NAME=SV45    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILL         SF=0.500   AT=1
NAME=SV46    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVE          SF=1.000   AT=1
   LOAD= SOILR         SF=0.500   AT=1
NAME=SV47    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVEW         SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILBW        SF=1.000   AT=1
   LOAD= WATERV        SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= BUOYANCY      SF=1.000   AT=1
   LOAD= TEMPPLUS      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
NAME=SV48    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.000   AT=1
   LOAD= PAVEW         SF=1.000   AT=1
   LOAD= LIVEFU        SF=1.000   AT=1
   LOAD= LIVEFUH       SF=1.000   AT=1
   LOAD= SOILBW        SF=1.000   AT=1
   LOAD= WATERV        SF=1.000   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= BUOYANCY      SF=1.000   AT=1
   LOAD= TEMPMINU      SF=1.000   AT=1
   LOAD= SHRINK        SF=1.000   AT=1
```

```
NAME=SV49     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV50     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV51     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV52     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
   LOAD= LIVEFUH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV53     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILBW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV54     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILBW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV55     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV56     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV57     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV58     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVELE          SF=1.000    AT=1
   LOAD= LIVELEH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV59     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILBW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV60     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILBW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV61     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV62     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILLW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV63     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPPLUS        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV64     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVERI          SF=1.000    AT=1
   LOAD= LIVERIH         SF=1.000    AT=1
   LOAD= SOILRW          SF=1.000    AT=1
   LOAD= WATERV          SF=1.000    AT=1
   LOAD= WATERH          SF=1.000    AT=1
   LOAD= BUOYANCY        SF=1.000    AT=1
   LOAD= TEMPMINU        SF=1.000    AT=1
   LOAD= SHRINK          SF=1.000    AT=1
NAME=SV65     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
   LOAD= SW              SF=1.000    AT=1
   LOAD= PAVEW           SF=1.000    AT=1
   LOAD= LIVEFU          SF=1.000    AT=1
```

```
    LOAD= LIVEFUH        SF=0.500    AT=1
    LOAD= SOILBW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPPLUS       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV66     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVEFU         SF=1.000    AT=1
    LOAD= LIVEFUH        SF=0.500    AT=1
    LOAD= SOILBW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPMINU       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV67     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVEFU         SF=1.000    AT=1
    LOAD= LIVEFUH        SF=0.500    AT=1
    LOAD= SOILLW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPPLUS       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV68     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVEFU         SF=1.000    AT=1
    LOAD= LIVEFUH        SF=0.500    AT=1
    LOAD= SOILLW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPMINU       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV69     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVEFU         SF=1.000    AT=1
    LOAD= LIVEFUH        SF=0.500    AT=1
    LOAD= SOILRW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPPLUS       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV70     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVEFU         SF=1.000    AT=1
    LOAD= LIVEFUH        SF=0.500    AT=1
    LOAD= SOILRW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPMINU       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV71     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVELE         SF=1.000    AT=1
    LOAD= LIVELEH        SF=0.500    AT=1
    LOAD= SOILBW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPPLUS       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV72     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVELE         SF=1.000    AT=1
    LOAD= LIVELEH        SF=0.500    AT=1
    LOAD= SOILBW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPMINU       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV73     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVELE         SF=1.000    AT=1
    LOAD= LIVELEH        SF=0.500    AT=1
    LOAD= SOILLW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPPLUS       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV74     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVELE         SF=1.000    AT=1
    LOAD= LIVELEH        SF=0.500    AT=1
    LOAD= SOILLW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPMINU       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV75     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVELE         SF=1.000    AT=1
    LOAD= LIVELEH        SF=0.500    AT=1
    LOAD= SOILRW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPPLUS       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV76     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVELE         SF=1.000    AT=1
    LOAD= LIVELEH        SF=0.500    AT=1
    LOAD= SOILRW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPMINU       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV77     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVERI         SF=1.000    AT=1
    LOAD= LIVERIH        SF=0.500    AT=1
    LOAD= SOILBW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPPLUS       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV78     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVERI         SF=1.000    AT=1
    LOAD= LIVERIH        SF=0.500    AT=1
    LOAD= SOILBW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPMINU       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV79     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVERI         SF=1.000    AT=1
    LOAD= LIVERIH        SF=0.500    AT=1
    LOAD= SOILLW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPPLUS       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV80     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVERI         SF=1.000    AT=1
    LOAD= LIVERIH        SF=0.500    AT=1
    LOAD= SOILLW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
    LOAD= BUOYANCY       SF=1.000    AT=1
    LOAD= TEMPMINU       SF=1.000    AT=1
    LOAD= SHRINK         SF=1.000    AT=1
NAME=SV81     TYPE=NON     NSTEP=100     DT=1     DAMP=0.99     DTMAX=1     ENVE
    LOAD= SW             SF=1.000    AT=1
    LOAD= PAVEW          SF=1.000    AT=1
    LOAD= LIVERI         SF=1.000    AT=1
    LOAD= LIVERIH        SF=0.500    AT=1
    LOAD= SOILRW         SF=0.500    AT=1
    LOAD= WATERV         SF=1.000    AT=1
    LOAD= WATERH         SF=0.500    AT=1
```

```
      LOAD= BUOYANCY       SF=1.000   AT=1
      LOAD= TEMPPLUS       SF=1.000   AT=1
      LOAD= SHRINK         SF=1.000   AT=1
   NAME=SV82    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= LIVERI         SF=1.000   AT=1
      LOAD= LIVERIH        SF=0.500   AT=1
      LOAD= SOILRW         SF=0.500   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=0.500   AT=1
      LOAD= BUOYANCY       SF=1.000   AT=1
      LOAD= TEMPMINU       SF=1.000   AT=1
      LOAD= SHRINK         SF=1.000   AT=1
   NAME=SV83    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILBW         SF=1.000   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=1.000   AT=1
   NAME=SV84    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILLW         SF=1.000   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=1.000   AT=1
   NAME=SV85    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILRW         SF=1.000   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=1.000   AT=1
   NAME=SV86    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILBW         SF=0.500   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=0.500   AT=1
   NAME=SV87    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILLW         SF=0.500   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=0.500   AT=1
   NAME=SV88    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW             SF=1.000   AT=1
      LOAD= PAVEW          SF=1.000   AT=1
      LOAD= SOILRW         SF=0.500   AT=1
      LOAD= WATERV         SF=1.000   AT=1
      LOAD= WATERH         SF=0.500   AT=1
COMBO
   NAME=ENVUSE  TYPE=ENVE
      HIST=SV01 SF=1
      HIST=SV02 SF=1
      HIST=SV03 SF=1
      HIST=SV04 SF=1
      HIST=SV05 SF=1
      HIST=SV06 SF=1
      HIST=SV07 SF=1
      HIST=SV08 SF=1
      HIST=SV09 SF=1
      HIST=SV10 SF=1
      HIST=SV11 SF=1
      HIST=SV12 SF=1
      HIST=SV13 SF=1
      HIST=SV14 SF=1
      HIST=SV15 SF=1
      HIST=SV16 SF=1
      HIST=SV17 SF=1
      HIST=SV18 SF=1
      HIST=SV19 SF=1
      HIST=SV20 SF=1
      HIST=SV21 SF=1
      HIST=SV22 SF=1
      HIST=SV23 SF=1
      HIST=SV24 SF=1
      HIST=SV25 SF=1
      HIST=SV26 SF=1
      HIST=SV27 SF=1
      HIST=SV28 SF=1
      HIST=SV29 SF=1
      HIST=SV30 SF=1
      HIST=SV31 SF=1
      HIST=SV32 SF=1
      HIST=SV33 SF=1
      HIST=SV34 SF=1
      HIST=SV35 SF=1
      HIST=SV36 SF=1
      HIST=SV37 SF=1
      HIST=SV38 SF=1
      HIST=SV39 SF=1
      HIST=SV40 SF=1
      HIST=SV41 SF=1
      HIST=SV42 SF=1
      HIST=SV43 SF=1
      HIST=SV44 SF=1
      HIST=SV45 SF=1
      HIST=SV46 SF=1
      HIST=SV47 SF=1
      HIST=SV48 SF=1
      HIST=SV49 SF=1
      HIST=SV50 SF=1
      HIST=SV51 SF=1
      HIST=SV52 SF=1
      HIST=SV53 SF=1
      HIST=SV54 SF=1
      HIST=SV55 SF=1
      HIST=SV56 SF=1
      HIST=SV57 SF=1
      HIST=SV58 SF=1
      HIST=SV59 SF=1
      HIST=SV60 SF=1
      HIST=SV61 SF=1
      HIST=SV62 SF=1
      HIST=SV63 SF=1
      HIST=SV64 SF=1
      HIST=SV65 SF=1
      HIST=SV66 SF=1
      HIST=SV67 SF=1
      HIST=SV68 SF=1
      HIST=SV69 SF=1
      HIST=SV70 SF=1
      HIST=SV71 SF=1
      HIST=SV72 SF=1
      HIST=SV73 SF=1
      HIST=SV74 SF=1
      HIST=SV75 SF=1
      HIST=SV76 SF=1
      HIST=SV77 SF=1
      HIST=SV78 SF=1
      HIST=SV79 SF=1
      HIST=SV80 SF=1
      HIST=SV81 SF=1
      HIST=SV82 SF=1
      HIST=SV83 SF=1
      HIST=SV84 SF=1
      HIST=SV85 SF=1
      HIST=SV86 SF=1
      HIST=SV87 SF=1
      HIST=SV88 SF=1
   NAME=ENVULT  TYPE=ENVE
      HIST=UL01 SF=1
      HIST=UL02 SF=1
      HIST=UL03 SF=1
      HIST=UL04 SF=1
      HIST=UL05 SF=1
      HIST=UL06 SF=1
      HIST=UL07 SF=1
      HIST=UL08 SF=1
      HIST=UL09 SF=1
      HIST=UL10 SF=1
      HIST=UL11 SF=1
      HIST=UL12 SF=1
      HIST=UL13 SF=1
      HIST=UL14 SF=1
      HIST=UL15 SF=1
      HIST=UL16 SF=1
      HIST=UL17 SF=1
      HIST=UL18 SF=1
      HIST=UL19 SF=1
      HIST=UL20 SF=1
      HIST=UL21 SF=1
      HIST=UL22 SF=1
      HIST=UL23 SF=1
      HIST=UL24 SF=1
      HIST=UL25 SF=1
      HIST=UL26 SF=1
      HIST=UL27 SF=1
      HIST=UL28 SF=1
      HIST=UL29 SF=1
      HIST=UL30 SF=1
      HIST=UL31 SF=1
      HIST=UL32 SF=1
      HIST=UL33 SF=1
      HIST=UL34 SF=1
      HIST=UL35 SF=1
      HIST=UL36 SF=1
      HIST=UL37 SF=1
      HIST=UL38 SF=1
      HIST=UL39 SF=1
```

```
      HIST=UL40 SF=1
      HIST=UL41 SF=1
      HIST=UL42 SF=1
      HIST=UL43 SF=1
      HIST=UL44 SF=1
      HIST=UL45 SF=1
      HIST=UL46 SF=1
      HIST=UL47 SF=1
      HIST=UL48 SF=1
      HIST=UL49 SF=1
      HIST=UL50 SF=1
      HIST=UL51 SF=1
      HIST=UL52 SF=1
      HIST=UL53 SF=1
      HIST=UL54 SF=1
      HIST=UL55 SF=1
      HIST=UL56 SF=1
      HIST=UL57 SF=1
      HIST=UL58 SF=1
      HIST=UL59 SF=1
      HIST=UL60 SF=1
      HIST=UL61 SF=1
      HIST=UL62 SF=1
      HIST=UL63 SF=1
      HIST=UL64 SF=1
      HIST=UL65 SF=1
      HIST=UL66 SF=1
      HIST=UL67 SF=1
      HIST=UL68 SF=1
      HIST=UL69 SF=1
      HIST=UL70 SF=1
      HIST=UL71 SF=1
      HIST=UL72 SF=1
      HIST=UL73 SF=1
      HIST=UL74 SF=1
      HIST=UL75 SF=1
      HIST=UL76 SF=1
      HIST=UL77 SF=1
      HIST=UL78 SF=1
      HIST=UL79 SF=1
      HIST=UL80 SF=1
      HIST=UL81 SF=1
      HIST=UL82 SF=1
      HIST=UL83 SF=1
      HIST=UL84 SF=1
      HIST=UL85 SF=1
      HIST=UL86 SF=1
      HIST=UL87 SF=1
      HIST=UL88 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

16. INPUT DATA (기능수행)

```
; ACulvert SAP2000 데이터파일 : 내진(기능)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     0.950 Y=     0.000 Z=     0.500
  3    X=     1.567 Y=     0.000 Z=     0.500
  4    X=     2.050 Y=     0.000 Z=     0.500
  5    X=     2.350 Y=     0.000 Z=     0.500
  6    X=     2.633 Y=     0.000 Z=     0.500
  7    X=     3.700 Y=     0.000 Z=     0.500
  8    X=     4.767 Y=     0.000 Z=     0.500
  9    X=     5.833 Y=     0.000 Z=     0.500
  10   X=     6.900 Y=     0.000 Z=     0.500
  11   X=     7.967 Y=     0.000 Z=     0.500
  12   X=     9.033 Y=     0.000 Z=     0.500
  13   X=     9.200 Y=     0.000 Z=     0.500
  14   X=     9.500 Y=     0.000 Z=     0.500
  15   X=     9.850 Y=     0.000 Z=     0.500
  16   X=    10.100 Y=     0.000 Z=     0.500
  17   X=    10.350 Y=     0.000 Z=     0.500
  18   X=    10.700 Y=     0.000 Z=     0.500
  19   X=    11.000 Y=     0.000 Z=     0.500
  20   X=    11.167 Y=     0.000 Z=     0.500
  21   X=    12.233 Y=     0.000 Z=     0.500
  22   X=    13.300 Y=     0.000 Z=     0.500
  23   X=    14.367 Y=     0.000 Z=     0.500
  24   X=    15.433 Y=     0.000 Z=     0.500
  25   X=    16.500 Y=     0.000 Z=     0.500
  26   X=    17.567 Y=     0.000 Z=     0.500
  27   X=    17.850 Y=     0.000 Z=     0.500
  28   X=    18.150 Y=     0.000 Z=     0.500
  29   X=    18.633 Y=     0.000 Z=     0.500
  30   X=    19.250 Y=     0.000 Z=     0.500
  31   X=    19.700 Y=     0.000 Z=     0.500
  32   X=    19.700 Y=     0.000 Z=     1.150
  33   X=    19.700 Y=     0.000 Z=     1.695
  34   X=    19.700 Y=     0.000 Z=     2.890
  35   X=    19.700 Y=     0.000 Z=     4.085
  36   X=    19.700 Y=     0.000 Z=     5.280
  37   X=    19.700 Y=     0.000 Z=     5.525
  38   X=    19.700 Y=     0.000 Z=     6.025
  39   X=    19.700 Y=     0.000 Z=     6.475
  40   X=    19.250 Y=     0.000 Z=     6.475
  41   X=    18.750 Y=     0.000 Z=     6.475
  42   X=    18.633 Y=     0.000 Z=     6.475
  43   X=    17.567 Y=     0.000 Z=     6.475
  44   X=    16.500 Y=     0.000 Z=     6.475
  45   X=    15.433 Y=     0.000 Z=     6.475
  46   X=    14.367 Y=     0.000 Z=     6.475
  47   X=    13.300 Y=     0.000 Z=     6.475
  48   X=    12.233 Y=     0.000 Z=     6.475
  49   X=    11.167 Y=     0.000 Z=     6.475
  50   X=    10.850 Y=     0.000 Z=     6.475
  51   X=    10.350 Y=     0.000 Z=     6.475
  52   X=    10.100 Y=     0.000 Z=     6.475
  53   X=     9.850 Y=     0.000 Z=     6.475
  54   X=     9.350 Y=     0.000 Z=     6.475
  55   X=     9.033 Y=     0.000 Z=     6.475
  56   X=     7.967 Y=     0.000 Z=     6.475
  57   X=     6.900 Y=     0.000 Z=     6.475
  58   X=     5.833 Y=     0.000 Z=     6.475
  59   X=     4.767 Y=     0.000 Z=     6.475
  60   X=     3.700 Y=     0.000 Z=     6.475
  61   X=     2.633 Y=     0.000 Z=     6.475
  62   X=     1.567 Y=     0.000 Z=     6.475
  63   X=     1.450 Y=     0.000 Z=     6.475
  64   X=     0.950 Y=     0.000 Z=     6.475
  65   X=     0.500 Y=     0.000 Z=     6.475
  66   X=     0.500 Y=     0.000 Z=     6.025
  67   X=     0.500 Y=     0.000 Z=     5.525
  68   X=     0.500 Y=     0.000 Z=     5.280
  69   X=     0.500 Y=     0.000 Z=     4.085
  70   X=     0.500 Y=     0.000 Z=     2.890
  71   X=     0.500 Y=     0.000 Z=     1.695
  72   X=     0.500 Y=     0.000 Z=     1.150
  73   X=     0.500 Y=     0.000 Z=     0.000
  74   X=     1.567 Y=     0.000 Z=     0.000
  75   X=     2.633 Y=     0.000 Z=     0.000
  76   X=     3.700 Y=     0.000 Z=     0.000
  77   X=     4.767 Y=     0.000 Z=     0.000
  78   X=     5.833 Y=     0.000 Z=     0.000
  79   X=     6.900 Y=     0.000 Z=     0.000
  80   X=     7.967 Y=     0.000 Z=     0.000
  81   X=     9.033 Y=     0.000 Z=     0.000
  82   X=    10.100 Y=     0.000 Z=     0.000
  83   X=    11.167 Y=     0.000 Z=     0.000
  84   X=    12.233 Y=     0.000 Z=     0.000
  85   X=    13.300 Y=     0.000 Z=     0.000
  86   X=    14.367 Y=     0.000 Z=     0.000
  87   X=    15.433 Y=     0.000 Z=     0.000
  88   X=    16.500 Y=     0.000 Z=     0.000
  89   X=    17.567 Y=     0.000 Z=     0.000
  90   X=    18.633 Y=     0.000 Z=     0.000
  91   X=    19.700 Y=     0.000 Z=     0.000
  92   X=    20.200 Y=     0.000 Z=     0.500
  93   X=    20.200 Y=     0.000 Z=     1.695
  94   X=    20.200 Y=     0.000 Z=     2.890
  95   X=    20.200 Y=     0.000 Z=     4.085
  96   X=    20.200 Y=     0.000 Z=     5.280
  97   X=    20.200 Y=     0.000 Z=     6.475
  98   X=    19.700 Y=     0.000 Z=     6.975
  99   X=    18.633 Y=     0.000 Z=     6.975
  100  X=    17.567 Y=     0.000 Z=     6.975
  101  X=    16.500 Y=     0.000 Z=     6.975
  102  X=    15.433 Y=     0.000 Z=     6.975
  103  X=    14.367 Y=     0.000 Z=     6.975
  104  X=    13.300 Y=     0.000 Z=     6.975
  105  X=    12.233 Y=     0.000 Z=     6.975
  106  X=    11.167 Y=     0.000 Z=     6.975
  107  X=    10.100 Y=     0.000 Z=     6.975
  108  X=     9.033 Y=     0.000 Z=     6.975
  109  X=     7.967 Y=     0.000 Z=     6.975
  110  X=     6.900 Y=     0.000 Z=     6.975
  111  X=     5.833 Y=     0.000 Z=     6.975
  112  X=     4.767 Y=     0.000 Z=     6.975
  113  X=     3.700 Y=     0.000 Z=     6.975
  114  X=     2.633 Y=     0.000 Z=     6.975
  115  X=     1.567 Y=     0.000 Z=     6.975
  116  X=     0.500 Y=     0.000 Z=     6.975
  117  X=     0.000 Y=     0.000 Z=     6.475
  118  X=     0.000 Y=     0.000 Z=     5.280
  119  X=     0.000 Y=     0.000 Z=     4.085
  120  X=     0.000 Y=     0.000 Z=     2.890
  121  X=     0.000 Y=     0.000 Z=     1.695
  122  X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=92 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=93 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=94 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=95 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=96 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=97 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=98 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=99 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=100 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=101 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=102 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=103 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=104 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=105 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=106 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=107 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=108 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=109 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=110 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=111 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=112 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=113 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=114 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=115 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=116 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=117 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=118 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=119 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=120 DOF=UX,UY,UZ,RX,RY,RZ
```

```
  ADD=121 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=122 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=15994.3
  ADD=6 UX=15994.3
  ADD=7 UX=15994.3
  ADD=8 UX=15994.3
  ADD=9 UX=15994.3
  ADD=10 UX=15994.3
  ADD=11 UX=15994.3
  ADD=12 UX=15994.3
  ADD=16 UX=15994.3
  ADD=20 UX=15994.3
  ADD=21 UX=15994.3
  ADD=22 UX=15994.3
  ADD=23 UX=15994.3
  ADD=24 UX=15994.3
  ADD=25 UX=15994.3
  ADD=26 UX=15994.3
  ADD=29 UX=15994.3
  ADD=33 UZ=39738.4
  ADD=34 UZ=39738.4
  ADD=35 UZ=11578.7
  ADD=36 UZ=11578.7
  ADD=42 UX=4660.3
  ADD=43 UX=4660.3
  ADD=44 UX=4660.3
  ADD=45 UX=4660.3
  ADD=46 UX=4660.3
  ADD=47 UX=4660.3
  ADD=48 UX=4660.3
  ADD=49 UX=4660.3
  ADD=52 UX=4660.3
  ADD=55 UX=4660.3
  ADD=56 UX=4660.3
  ADD=57 UX=4660.3
  ADD=58 UX=4660.3
  ADD=59 UX=4660.3
  ADD=60 UX=4660.3
  ADD=61 UX=4660.3
  ADD=62 UX=4660.3
  ADD=68 UZ=11578.7
  ADD=69 UZ=11578.7
  ADD=70 UZ=39738.4
  ADD=71 UZ=39738.4
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=44234.1 CE=0.99999 K=44234.1 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=47982.8 CE=0.99999 K=47982.8 OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=124453. CE=0.99999 K=124453. OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=119215. CE=0.99999 K=119215. OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=34736.2 CE=0.99999 K=34736.2 OPEN=0
  NAME=6 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=30448.6 CE=0.99999 K=30448.6 OPEN=0
  NAME=7 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=12888.6 CE=0.99999 K=12888.6 OPEN=0
  NAME=8 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=13980.9 CE=0.99999 K=13980.9 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.3,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.05,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.125 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.125 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.425 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    38 J= 38,  39 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    39 J= 39,  40 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 3 NSEG= 4 ANG=0
    42 J= 42,  43 SEC= 3 NSEG= 4 ANG=0
    43 J= 43,  44 SEC= 3 NSEG= 4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    51 J= 51,  52 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    52 J= 52,  53 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 NSEG= 4 ANG=0
    55 J= 55,  56 SEC= 3 NSEG= 4 ANG=0
    56 J= 56,  57 SEC= 3 NSEG= 4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    64 J= 64,  65 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    65 J= 65,  66 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    66 J= 66,  67 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    67 J= 67,  68 SEC= 3 NSEG= 4 ANG=180
    68 J= 68,  69 SEC= 3 NSEG= 4 ANG=180
    69 J= 69,  70 SEC= 3 NSEG= 4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,   1 SEC= 3 IOFF=0 JOFF=0.425 RIGID=1 NSEG=4 ANG=180
    73 J= 52,  16 SEC= 5 IOFF=0.7 JOFF=0.525 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,73 NLP=1 ANG=0
     2 J= 3,74 NLP=2 ANG=0
     3 J= 6,75 NLP=2 ANG=0
     4 J= 7,76 NLP=2 ANG=0
     5 J= 8,77 NLP=2 ANG=0
     6 J= 9,78 NLP=2 ANG=0
     7 J=10,79 NLP=2 ANG=0
     8 J=11,80 NLP=2 ANG=0
     9 J=12,81 NLP=2 ANG=0
    10 J=16,82 NLP=2 ANG=0
    11 J=20,83 NLP=2 ANG=0
    12 J=21,84 NLP=2 ANG=0
    13 J=22,85 NLP=2 ANG=0
    14 J=23,86 NLP=2 ANG=0
    15 J=24,87 NLP=2 ANG=0
    16 J=25,88 NLP=2 ANG=0
    17 J=26,89 NLP=2 ANG=0
    18 J=29,90 NLP=2 ANG=0
    19 J=31,91 NLP=1 ANG=0
    20 J=31,92 NLP=3 ANG=0
    21 J=33,93 NLP=4 ANG=0
    22 J=34,94 NLP=4 ANG=0
    23 J=35,95 NLP=5 ANG=0
    24 J=36,96 NLP=5 ANG=0
    25 J=39,97 NLP=6 ANG=0
    26 J=39,98 NLP=7 ANG=0
    27 J=42,99 NLP=8 ANG=0
    28 J=43,100 NLP=8 ANG=0
    29 J=44,101 NLP=8 ANG=0
    30 J=45,102 NLP=8 ANG=0
    31 J=46,103 NLP=8 ANG=0
    32 J=47,104 NLP=8 ANG=0
```

```
     33 J=48,105 NLP=8 ANG=0
     34 J=49,106 NLP=8 ANG=0
     35 J=52,107 NLP=8 ANG=0
     36 J=55,108 NLP=8 ANG=0
     37 J=56,109 NLP=8 ANG=0
     38 J=57,110 NLP=8 ANG=0
     39 J=58,111 NLP=8 ANG=0
     40 J=59,112 NLP=8 ANG=0
     41 J=60,113 NLP=8 ANG=0
     42 J=61,114 NLP=8 ANG=0
     43 J=62,115 NLP=8 ANG=0
     44 J=65,116 NLP=7 ANG=0
     45 J=65,117 NLP=6 ANG=0
     46 J=68,118 NLP=5 ANG=0
     47 J=69,119 NLP=5 ANG=0
     48 J=70,120 NLP=4 ANG=0
     49 J=71,121 NLP=4 ANG=0
     50 J= 1,122 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-72.925, -72.925
      ADD=40 RD=0,1 UZ=-72.925, -72.925
      ADD=41 RD=0,1 UZ=-72.925, -72.925
      ADD=42 RD=0,1 UZ=-72.925, -72.925
      ADD=43 RD=0,1 UZ=-72.925, -72.925
      ADD=44 RD=0,1 UZ=-72.925, -72.925
      ADD=45 RD=0,1 UZ=-72.925, -72.925
      ADD=46 RD=0,1 UZ=-72.925, -72.925
      ADD=47 RD=0,1 UZ=-72.925, -72.925
      ADD=48 RD=0,1 UZ=-72.925, -72.925
      ADD=49 RD=0,1 UZ=-72.925, -72.925
      ADD=50 RD=0,1 UZ=-72.925, -72.925
      ADD=51 RD=0,1 UZ=-72.925, -72.925
      ADD=52 RD=0,1 UZ=-72.925, -72.925
      ADD=53 RD=0,1 UZ=-72.925, -72.925
      ADD=54 RD=0,1 UZ=-72.925, -72.925
      ADD=55 RD=0,1 UZ=-72.925, -72.925
      ADD=56 RD=0,1 UZ=-72.925, -72.925
      ADD=57 RD=0,1 UZ=-72.925, -72.925
      ADD=58 RD=0,1 UZ=-72.925, -72.925
      ADD=59 RD=0,1 UZ=-72.925, -72.925
      ADD=60 RD=0,1 UZ=-72.925, -72.925
      ADD=61 RD=0,1 UZ=-72.925, -72.925
      ADD=62 RD=0,1 UZ=-72.925, -72.925
      ADD=63 RD=0,1 UZ=-72.925, -72.925
      ADD=64 RD=0,1 UZ=-72.925, -72.925
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-53.575, -53.575
      ADD=40 RD=0,1 UZ=-53.575, -53.575
      ADD=41 RD=0,1 UZ=-53.575, -53.575
      ADD=42 RD=0,1 UZ=-53.575, -53.575
      ADD=43 RD=0,1 UZ=-53.575, -53.575
      ADD=44 RD=0,1 UZ=-53.575, -53.575
      ADD=45 RD=0,1 UZ=-53.575, -53.575
      ADD=46 RD=0,1 UZ=-53.575, -53.575
      ADD=47 RD=0,1 UZ=-53.575, -53.575
      ADD=48 RD=0,1 UZ=-53.575, -53.575
      ADD=49 RD=0,1 UZ=-53.575, -53.575
      ADD=50 RD=0,1 UZ=-53.575, -53.575
      ADD=51 RD=0,1 UZ=-53.575, -53.575
      ADD=52 RD=0,1 UZ=-53.575, -53.575
      ADD=53 RD=0,1 UZ=-53.575, -53.575
      ADD=54 RD=0,1 UZ=-53.575, -53.575
      ADD=55 RD=0,1 UZ=-53.575, -53.575
      ADD=56 RD=0,1 UZ=-53.575, -53.575
      ADD=57 RD=0,1 UZ=-53.575, -53.575
      ADD=58 RD=0,1 UZ=-53.575, -53.575
      ADD=59 RD=0,1 UZ=-53.575, -53.575
      ADD=60 RD=0,1 UZ=-53.575, -53.575
      ADD=61 RD=0,1 UZ=-53.575, -53.575
      ADD=62 RD=0,1 UZ=-53.575, -53.575
      ADD=63 RD=0,1 UZ=-53.575, -53.575
      ADD=64 RD=0,1 UZ=-53.575, -53.575
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11.25, -11.25
      ADD=40 RD=0,1 UZ=-11.25, -11.25
      ADD=41 RD=0,1 UZ=-11.25, -11.25
      ADD=42 RD=0,1 UZ=-11.25, -11.25
      ADD=43 RD=0,1 UZ=-11.25, -11.25
      ADD=44 RD=0,1 UZ=-11.25, -11.25
      ADD=45 RD=0,1 UZ=-11.25, -11.25
      ADD=46 RD=0,1 UZ=-11.25, -11.25
      ADD=47 RD=0,1 UZ=-11.25, -11.25
      ADD=48 RD=0,1 UZ=-11.25, -11.25
      ADD=49 RD=0,1 UZ=-11.25, -11.25
      ADD=50 RD=0,1 UZ=-11.25, -11.25
      ADD=51 RD=0,1 UZ=-11.25, -11.25
      ADD=52 RD=0,1 UZ=-11.25, -11.25
      ADD=53 RD=0,1 UZ=-11.25, -11.25
      ADD=54 RD=0,1 UZ=-11.25, -11.25
      ADD=55 RD=0,1 UZ=-11.25, -11.25
      ADD=56 RD=0,1 UZ=-11.25, -11.25
      ADD=57 RD=0,1 UZ=-11.25, -11.25
      ADD=58 RD=0,1 UZ=-11.25, -11.25
      ADD=59 RD=0,1 UZ=-11.25, -11.25
      ADD=60 RD=0,1 UZ=-11.25, -11.25
      ADD=61 RD=0,1 UZ=-11.25, -11.25
      ADD=62 RD=0,1 UZ=-11.25, -11.25
      ADD=63 RD=0,1 UZ=-11.25, -11.25
      ADD=64 RD=0,1 UZ=-11.25, -11.25
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=52 RD=0,1 UZ=-11.25, -11.25
      ADD=53 RD=0,1 UZ=-11.25, -11.25
      ADD=54 RD=0,1 UZ=-11.25, -11.25
      ADD=55 RD=0,1 UZ=-11.25, -11.25
      ADD=56 RD=0,1 UZ=-11.25, -11.25
      ADD=57 RD=0,1 UZ=-11.25, -11.25
      ADD=58 RD=0,1 UZ=-11.25, -11.25
      ADD=59 RD=0,1 UZ=-11.25, -11.25
      ADD=60 RD=0,1 UZ=-11.25, -11.25
      ADD=61 RD=0,1 UZ=-11.25, -11.25
      ADD=62 RD=0,1 UZ=-11.25, -11.25
      ADD=63 RD=0,1 UZ=-11.25, -11.25
      ADD=64 RD=0,1 UZ=-11.25, -11.25
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11.25, -11.25
      ADD=40 RD=0,1 UZ=-11.25, -11.25
      ADD=41 RD=0,1 UZ=-11.25, -11.25
      ADD=42 RD=0,1 UZ=-11.25, -11.25
      ADD=43 RD=0,1 UZ=-11.25, -11.25
      ADD=44 RD=0,1 UZ=-11.25, -11.25
      ADD=45 RD=0,1 UZ=-11.25, -11.25
      ADD=46 RD=0,1 UZ=-11.25, -11.25
      ADD=47 RD=0,1 UZ=-11.25, -11.25
      ADD=48 RD=0,1 UZ=-11.25, -11.25
      ADD=49 RD=0,1 UZ=-11.25, -11.25
      ADD=50 RD=0,1 UZ=-11.25, -11.25
      ADD=51 RD=0,1 UZ=-11.25, -11.25
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.625, 5.625
      ADD=66 RD=0,1 UX=5.625, 5.625
      ADD=67 RD=0,1 UX=5.625, 5.625
      ADD=68 RD=0,1 UX=5.625, 5.625
      ADD=69 RD=0,1 UX=5.625, 5.625
      ADD=70 RD=0,1 UX=5.625, 5.625
      ADD=71 RD=0,1 UX=5.625, 5.625
      ADD=72 RD=0,1 UX=5.625, 5.625
      ADD=31 RD=0,1 UX=-5.625, -5.625
      ADD=32 RD=0,1 UX=-5.625, -5.625
      ADD=33 RD=0,1 UX=-5.625, -5.625
      ADD=34 RD=0,1 UX=-5.625, -5.625
      ADD=35 RD=0,1 UX=-5.625, -5.625
      ADD=36 RD=0,1 UX=-5.625, -5.625
      ADD=37 RD=0,1 UX=-5.625, -5.625
      ADD=38 RD=0,1 UX=-5.625, -5.625
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.625, 5.625
      ADD=66 RD=0,1 UX=5.625, 5.625
      ADD=67 RD=0,1 UX=5.625, 5.625
      ADD=68 RD=0,1 UX=5.625, 5.625
      ADD=69 RD=0,1 UX=5.625, 5.625
      ADD=70 RD=0,1 UX=5.625, 5.625
      ADD=71 RD=0,1 UX=5.625, 5.625
      ADD=72 RD=0,1 UX=5.625, 5.625
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-5.625, -5.625
      ADD=32 RD=0,1 UX=-5.625, -5.625
      ADD=33 RD=0,1 UX=-5.625, -5.625
      ADD=34 RD=0,1 UX=-5.625, -5.625
      ADD=35 RD=0,1 UX=-5.625, -5.625
      ADD=36 RD=0,1 UX=-5.625, -5.625
      ADD=37 RD=0,1 UX=-5.625, -5.625
      ADD=38 RD=0,1 UX=-5.625, -5.625
NAME=WATERV  ; 연직수압
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-21.5, -21.5
      ADD=40 RD=0,1 UZ=-21.5, -21.5
      ADD=41 RD=0,1 UZ=-21.5, -21.5
      ADD=42 RD=0,1 UZ=-21.5, -21.5
      ADD=43 RD=0,1 UZ=-21.5, -21.5
      ADD=44 RD=0,1 UZ=-21.5, -21.5
```

```
      ADD=45 RD=0,1 UZ=-21.5, -21.5
      ADD=46 RD=0,1 UZ=-21.5, -21.5
      ADD=47 RD=0,1 UZ=-21.5, -21.5
      ADD=48 RD=0,1 UZ=-21.5, -21.5
      ADD=49 RD=0,1 UZ=-21.5, -21.5
      ADD=50 RD=0,1 UZ=-21.5, -21.5
      ADD=51 RD=0,1 UZ=-21.5, -21.5
      ADD=52 RD=0,1 UZ=-21.5, -21.5
      ADD=53 RD=0,1 UZ=-21.5, -21.5
      ADD=54 RD=0,1 UZ=-21.5, -21.5
      ADD=55 RD=0,1 UZ=-21.5, -21.5
      ADD=56 RD=0,1 UZ=-21.5, -21.5
      ADD=57 RD=0,1 UZ=-21.5, -21.5
      ADD=58 RD=0,1 UZ=-21.5, -21.5
      ADD=59 RD=0,1 UZ=-21.5, -21.5
      ADD=60 RD=0,1 UZ=-21.5, -21.5
      ADD=61 RD=0,1 UZ=-21.5, -21.5
      ADD=62 RD=0,1 UZ=-21.5, -21.5
      ADD=63 RD=0,1 UZ=-21.5, -21.5
      ADD=64 RD=0,1 UZ=-21.5, -21.5
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=26.5, 31
      ADD=66 RD=0,1 UX=31, 36
      ADD=67 RD=0,1 UX=36, 38.45
      ADD=68 RD=0,1 UX=38.45, 50.4
      ADD=69 RD=0,1 UX=50.4, 62.35
      ADD=70 RD=0,1 UX=62.35, 74.3
      ADD=71 RD=0,1 UX=74.3, 79.75
      ADD=72 RD=0,1 UX=79.75, 86.25
      ADD=31 RD=0,1 UX=-86.25, -79.75
      ADD=32 RD=0,1 UX=-79.75, -74.3
      ADD=33 RD=0,1 UX=-74.3, -62.35
      ADD=34 RD=0,1 UX=-62.35, -50.4
      ADD=35 RD=0,1 UX=-50.4, -38.45
      ADD=36 RD=0,1 UX=-38.45, -36
      ADD=37 RD=0,1 UX=-36, -31
      ADD=38 RD=0,1 UX=-31, -26.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=91.5, 91.5
      ADD=2 RD=0,1 UZ=91.5, 91.5
      ADD=3 RD=0,1 UZ=91.5, 91.5
      ADD=4 RD=0,1 UZ=91.5, 91.5
      ADD=5 RD=0,1 UZ=91.5, 91.5
      ADD=6 RD=0,1 UZ=91.5, 91.5
      ADD=7 RD=0,1 UZ=91.5, 91.5
      ADD=8 RD=0,1 UZ=91.5, 91.5
      ADD=9 RD=0,1 UZ=91.5, 91.5
      ADD=10 RD=0,1 UZ=91.5, 91.5
      ADD=11 RD=0,1 UZ=91.5, 91.5
      ADD=12 RD=0,1 UZ=91.5, 91.5
      ADD=13 RD=0,1 UZ=91.5, 91.5
      ADD=14 RD=0,1 UZ=91.5, 91.5
      ADD=15 RD=0,1 UZ=91.5, 91.5
      ADD=16 RD=0,1 UZ=91.5, 91.5
      ADD=17 RD=0,1 UZ=91.5, 91.5
      ADD=18 RD=0,1 UZ=91.5, 91.5
      ADD=19 RD=0,1 UZ=91.5, 91.5
      ADD=20 RD=0,1 UZ=91.5, 91.5
      ADD=21 RD=0,1 UZ=91.5, 91.5
      ADD=22 RD=0,1 UZ=91.5, 91.5
      ADD=23 RD=0,1 UZ=91.5, 91.5
      ADD=24 RD=0,1 UZ=91.5, 91.5
      ADD=25 RD=0,1 UZ=91.5, 91.5
      ADD=26 RD=0,1 UZ=91.5, 91.5
      ADD=27 RD=0,1 UZ=91.5, 91.5
      ADD=28 RD=0,1 UZ=91.5, 91.5
      ADD=29 RD=0,1 UZ=91.5, 91.5
      ADD=30 RD=0,1 UZ=91.5, 91.5
NAME=FUNSLAB  ; 슬래브 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=6.951, 6.951
      ADD=40 RD=0,1 UX=6.951, 6.951
      ADD=41 RD=0,1 UX=6.951, 6.951
      ADD=42 RD=0,1 UX=6.951, 6.951
      ADD=43 RD=0,1 UX=6.951, 6.951
      ADD=44 RD=0,1 UX=6.951, 6.951
      ADD=45 RD=0,1 UX=6.951, 6.951
      ADD=46 RD=0,1 UX=6.951, 6.951
      ADD=47 RD=0,1 UX=6.951, 6.951
      ADD=48 RD=0,1 UX=6.951, 6.951
      ADD=49 RD=0,1 UX=6.951, 6.951
      ADD=50 RD=0,1 UX=6.951, 6.951
      ADD=51 RD=0,1 UX=6.951, 6.951
      ADD=52 RD=0,1 UX=6.951, 6.951
      ADD=53 RD=0,1 UX=6.951, 6.951
      ADD=54 RD=0,1 UX=6.951, 6.951
      ADD=55 RD=0,1 UX=6.951, 6.951
      ADD=56 RD=0,1 UX=6.951, 6.951
      ADD=57 RD=0,1 UX=6.951, 6.951
      ADD=58 RD=0,1 UX=6.951, 6.951
      ADD=59 RD=0,1 UX=6.951, 6.951
      ADD=60 RD=0,1 UX=6.951, 6.951
      ADD=61 RD=0,1 UX=6.951, 6.951
      ADD=62 RD=0,1 UX=6.951, 6.951
      ADD=63 RD=0,1 UX=6.951, 6.951
      ADD=64 RD=0,1 UX=6.951, 6.951
NAME=FUNWALL  ; 벽체 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=46.247, 44.154
      ADD=66 RD=0,1 UX=44.154, 41.596
      ADD=67 RD=0,1 UX=41.596, 40.23
      ADD=68 RD=0,1 UX=40.23, 32.556
      ADD=69 RD=0,1 UX=32.556, 23.283
      ADD=70 RD=0,1 UX=23.283, 42.598
      ADD=71 RD=0,1 UX=42.598, 23.843
      ADD=72 RD=0,1 UX=23.843, 0
      ADD=31 RD=0,1 UX=0, 23.843
      ADD=32 RD=0,1 UX=23.843, 42.598
      ADD=33 RD=0,1 UX=42.598, 23.283
      ADD=34 RD=0,1 UX=23.283, 32.556
      ADD=35 RD=0,1 UX=32.556, 40.23
      ADD=36 RD=0,1 UX=40.23, 41.596
      ADD=37 RD=0,1 UX=41.596, 44.154
      ADD=38 RD=0,1 UX=44.154, 46.247
NAME=FUNMS  ; 주면전단력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=4.06, 4.06
      ADD=40 RD=0,1 UX=4.06, 4.06
      ADD=41 RD=0,1 UX=4.06, 4.06
      ADD=42 RD=0,1 UX=4.06, 4.06
      ADD=43 RD=0,1 UX=4.06, 4.06
      ADD=44 RD=0,1 UX=4.06, 4.06
      ADD=45 RD=0,1 UX=4.06, 4.06
      ADD=46 RD=0,1 UX=4.06, 4.06
      ADD=47 RD=0,1 UX=4.06, 4.06
      ADD=48 RD=0,1 UX=4.06, 4.06
      ADD=49 RD=0,1 UX=4.06, 4.06
      ADD=50 RD=0,1 UX=4.06, 4.06
      ADD=51 RD=0,1 UX=4.06, 4.06
      ADD=52 RD=0,1 UX=4.06, 4.06
      ADD=53 RD=0,1 UX=4.06, 4.06
      ADD=54 RD=0,1 UX=4.06, 4.06
      ADD=55 RD=0,1 UX=4.06, 4.06
      ADD=56 RD=0,1 UX=4.06, 4.06
      ADD=57 RD=0,1 UX=4.06, 4.06
      ADD=58 RD=0,1 UX=4.06, 4.06
      ADD=59 RD=0,1 UX=4.06, 4.06
      ADD=60 RD=0,1 UX=4.06, 4.06
      ADD=61 RD=0,1 UX=4.06, 4.06
      ADD=62 RD=0,1 UX=4.06, 4.06
      ADD=63 RD=0,1 UX=4.06, 4.06
      ADD=64 RD=0,1 UX=4.06, 4.06
      ADD=65 RD=0,1 UZ=-21.38, -21.38
      ADD=66 RD=0,1 UZ=-21.38, -21.38
      ADD=67 RD=0,1 UZ=-21.38, -21.38
      ADD=68 RD=0,1 UZ=-21.38, -21.38
      ADD=69 RD=0,1 UZ=-21.38, -21.38
      ADD=70 RD=0,1 UZ=-21.38, -21.38
      ADD=71 RD=0,1 UZ=-21.38, -21.38
      ADD=72 RD=0,1 UZ=-21.38, -21.38
      ADD=31 RD=0,1 UZ=21.38, 21.38
      ADD=32 RD=0,1 UZ=21.38, 21.38
      ADD=33 RD=0,1 UZ=21.38, 21.38
      ADD=34 RD=0,1 UZ=21.38, 21.38
      ADD=35 RD=0,1 UZ=21.38, 21.38
      ADD=36 RD=0,1 UZ=21.38, 21.38
      ADD=37 RD=0,1 UZ=21.38, 21.38
      ADD=38 RD=0,1 UZ=21.38, 21.38
      ADD=1 RD=0,1 UX=-38.69, -38.69
      ADD=2 RD=0,1 UX=-38.69, -38.69
      ADD=3 RD=0,1 UX=-38.69, -38.69
      ADD=4 RD=0,1 UX=-38.69, -38.69
      ADD=5 RD=0,1 UX=-38.69, -38.69
      ADD=6 RD=0,1 UX=-38.69, -38.69
      ADD=7 RD=0,1 UX=-38.69, -38.69
      ADD=8 RD=0,1 UX=-38.69, -38.69
      ADD=9 RD=0,1 UX=-38.69, -38.69
      ADD=10 RD=0,1 UX=-38.69, -38.69
      ADD=11 RD=0,1 UX=-38.69, -38.69
      ADD=12 RD=0,1 UX=-38.69, -38.69
      ADD=13 RD=0,1 UX=-38.69, -38.69
      ADD=14 RD=0,1 UX=-38.69, -38.69
      ADD=15 RD=0,1 UX=-38.69, -38.69
      ADD=16 RD=0,1 UX=-38.69, -38.69
      ADD=17 RD=0,1 UX=-38.69, -38.69
      ADD=18 RD=0,1 UX=-38.69, -38.69
      ADD=19 RD=0,1 UX=-38.69, -38.69
      ADD=20 RD=0,1 UX=-38.69, -38.69
```

```
      ADD=21 RD=0,1 UX=-38.69, -38.69
      ADD=22 RD=0,1 UX=-38.69, -38.69
      ADD=23 RD=0,1 UX=-38.69, -38.69
      ADD=24 RD=0,1 UX=-38.69, -38.69
      ADD=25 RD=0,1 UX=-38.69, -38.69
      ADD=26 RD=0,1 UX=-38.69, -38.69
      ADD=27 RD=0,1 UX=-38.69, -38.69
      ADD=28 RD=0,1 UX=-38.69, -38.69
      ADD=29 RD=0,1 UX=-38.69, -38.69
      ADD=30 RD=0,1 UX=-38.69, -38.69
NAME=FUNINER  ; 구체 관성력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=1.935, 1.935
      ADD=40 RD=0,1 UX=1.935, 1.935
      ADD=41 RD=0,1 UX=1.935, 1.935
      ADD=42 RD=0,1 UX=1.935, 1.935
      ADD=43 RD=0,1 UX=1.935, 1.935
      ADD=44 RD=0,1 UX=1.935, 1.935
      ADD=45 RD=0,1 UX=1.935, 1.935
      ADD=46 RD=0,1 UX=1.935, 1.935
      ADD=47 RD=0,1 UX=1.935, 1.935
      ADD=48 RD=0,1 UX=1.935, 1.935
      ADD=49 RD=0,1 UX=1.935, 1.935
      ADD=50 RD=0,1 UX=1.935, 1.935
      ADD=51 RD=0,1 UX=1.935, 1.935
      ADD=52 RD=0,1 UX=1.935, 1.935
      ADD=53 RD=0,1 UX=1.935, 1.935
      ADD=54 RD=0,1 UX=1.935, 1.935
      ADD=55 RD=0,1 UX=1.935, 1.935
      ADD=56 RD=0,1 UX=1.935, 1.935
      ADD=57 RD=0,1 UX=1.935, 1.935
      ADD=58 RD=0,1 UX=1.935, 1.935
      ADD=59 RD=0,1 UX=1.935, 1.935
      ADD=60 RD=0,1 UX=1.935, 1.935
      ADD=61 RD=0,1 UX=1.935, 1.935
      ADD=62 RD=0,1 UX=1.935, 1.935
      ADD=63 RD=0,1 UX=1.935, 1.935
      ADD=64 RD=0,1 UX=1.935, 1.935
      ADD=65 RD=0,1 UX=1.935, 1.922
      ADD=66 RD=0,1 UX=1.922, 1.906
      ADD=67 RD=0,1 UX=1.906, 1.899
      ADD=68 RD=0,1 UX=1.899, 1.862
      ADD=69 RD=0,1 UX=1.862, 1.825
      ADD=70 RD=0,1 UX=1.825, 1.789
      ADD=71 RD=0,1 UX=1.789, 1.772
      ADD=72 RD=0,1 UX=1.772, 1.752
      ADD=73 RD=0,1 UX=1.075, 0.973
      ADD=31 RD=0,1 UX=1.752, 1.772
      ADD=32 RD=0,1 UX=1.772, 1.789
      ADD=33 RD=0,1 UX=1.789, 1.825
      ADD=34 RD=0,1 UX=1.825, 1.862
      ADD=35 RD=0,1 UX=1.862, 1.899
      ADD=36 RD=0,1 UX=1.899, 1.906
      ADD=37 RD=0,1 UX=1.906, 1.922
      ADD=38 RD=0,1 UX=1.922, 1.935
      ADD=1 RD=0,1 UX=2.531, 2.531
      ADD=2 RD=0,1 UX=2.531, 2.531
      ADD=3 RD=0,1 UX=2.531, 2.531
      ADD=4 RD=0,1 UX=2.531, 2.531
      ADD=5 RD=0,1 UX=2.531, 2.531
      ADD=6 RD=0,1 UX=2.531, 2.531
      ADD=7 RD=0,1 UX=2.531, 2.531
      ADD=8 RD=0,1 UX=2.531, 2.531
      ADD=9 RD=0,1 UX=2.531, 2.531
      ADD=10 RD=0,1 UX=2.531, 2.531
      ADD=11 RD=0,1 UX=2.531, 2.531
      ADD=12 RD=0,1 UX=2.531, 2.531
      ADD=13 RD=0,1 UX=2.531, 2.531
      ADD=14 RD=0,1 UX=2.531, 2.531
      ADD=15 RD=0,1 UX=2.531, 2.531
      ADD=16 RD=0,1 UX=2.531, 2.531
      ADD=17 RD=0,1 UX=2.531, 2.531
      ADD=18 RD=0,1 UX=2.531, 2.531
      ADD=19 RD=0,1 UX=2.531, 2.531
      ADD=20 RD=0,1 UX=2.531, 2.531
      ADD=21 RD=0,1 UX=2.531, 2.531
      ADD=22 RD=0,1 UX=2.531, 2.531
      ADD=23 RD=0,1 UX=2.531, 2.531
      ADD=24 RD=0,1 UX=2.531, 2.531
      ADD=25 RD=0,1 UX=2.531, 2.531
      ADD=26 RD=0,1 UX=2.531, 2.531
      ADD=27 RD=0,1 UX=2.531, 2.531
      ADD=28 RD=0,1 UX=2.531, 2.531
      ADD=29 RD=0,1 UX=2.531, 2.531
      ADD=30 RD=0,1 UX=2.531, 2.531
NAME=FUNSLAB2  ; 슬래브 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-6.951, -6.951
      ADD=40 RD=0,1 UX=-6.951, -6.951
      ADD=41 RD=0,1 UX=-6.951, -6.951
      ADD=42 RD=0,1 UX=-6.951, -6.951
      ADD=43 RD=0,1 UX=-6.951, -6.951
      ADD=44 RD=0,1 UX=-6.951, -6.951
      ADD=45 RD=0,1 UX=-6.951, -6.951
      ADD=46 RD=0,1 UX=-6.951, -6.951
      ADD=47 RD=0,1 UX=-6.951, -6.951
      ADD=48 RD=0,1 UX=-6.951, -6.951
      ADD=49 RD=0,1 UX=-6.951, -6.951
      ADD=50 RD=0,1 UX=-6.951, -6.951
      ADD=51 RD=0,1 UX=-6.951, -6.951
      ADD=52 RD=0,1 UX=-6.951, -6.951
      ADD=53 RD=0,1 UX=-6.951, -6.951
      ADD=54 RD=0,1 UX=-6.951, -6.951
      ADD=55 RD=0,1 UX=-6.951, -6.951
      ADD=56 RD=0,1 UX=-6.951, -6.951
      ADD=57 RD=0,1 UX=-6.951, -6.951
      ADD=58 RD=0,1 UX=-6.951, -6.951
      ADD=59 RD=0,1 UX=-6.951, -6.951
      ADD=60 RD=0,1 UX=-6.951, -6.951
      ADD=61 RD=0,1 UX=-6.951, -6.951
      ADD=62 RD=0,1 UX=-6.951, -6.951
      ADD=63 RD=0,1 UX=-6.951, -6.951
      ADD=64 RD=0,1 UX=-6.951, -6.951
NAME=FUNWALL2  ; 벽체 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=-46.247, -44.154
      ADD=66 RD=0,1 UX=-44.154, -41.596
      ADD=67 RD=0,1 UX=-41.596, -40.23
      ADD=68 RD=0,1 UX=-40.23, -32.556
      ADD=69 RD=0,1 UX=-32.556, -23.283
      ADD=70 RD=0,1 UX=-23.283, -42.598
      ADD=71 RD=0,1 UX=-42.598, -23.843
      ADD=72 RD=0,1 UX=-23.843, -0
      ADD=31 RD=0,1 UX=-0, -23.843
      ADD=32 RD=0,1 UX=-23.843, -42.598
      ADD=33 RD=0,1 UX=-42.598, -23.283
      ADD=34 RD=0,1 UX=-23.283, -32.556
      ADD=35 RD=0,1 UX=-32.556, -40.23
      ADD=36 RD=0,1 UX=-40.23, -41.596
      ADD=37 RD=0,1 UX=-41.596, -44.154
      ADD=38 RD=0,1 UX=-44.154, -46.247
NAME=FUNMS2  ; 주면전단력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-4.06, -4.06
      ADD=40 RD=0,1 UX=-4.06, -4.06
      ADD=41 RD=0,1 UX=-4.06, -4.06
      ADD=42 RD=0,1 UX=-4.06, -4.06
      ADD=43 RD=0,1 UX=-4.06, -4.06
      ADD=44 RD=0,1 UX=-4.06, -4.06
      ADD=45 RD=0,1 UX=-4.06, -4.06
      ADD=46 RD=0,1 UX=-4.06, -4.06
      ADD=47 RD=0,1 UX=-4.06, -4.06
      ADD=48 RD=0,1 UX=-4.06, -4.06
      ADD=49 RD=0,1 UX=-4.06, -4.06
      ADD=50 RD=0,1 UX=-4.06, -4.06
      ADD=51 RD=0,1 UX=-4.06, -4.06
      ADD=52 RD=0,1 UX=-4.06, -4.06
      ADD=53 RD=0,1 UX=-4.06, -4.06
      ADD=54 RD=0,1 UX=-4.06, -4.06
      ADD=55 RD=0,1 UX=-4.06, -4.06
      ADD=56 RD=0,1 UX=-4.06, -4.06
      ADD=57 RD=0,1 UX=-4.06, -4.06
      ADD=58 RD=0,1 UX=-4.06, -4.06
      ADD=59 RD=0,1 UX=-4.06, -4.06
      ADD=60 RD=0,1 UX=-4.06, -4.06
      ADD=61 RD=0,1 UX=-4.06, -4.06
      ADD=62 RD=0,1 UX=-4.06, -4.06
      ADD=63 RD=0,1 UX=-4.06, -4.06
      ADD=64 RD=0,1 UX=-4.06, -4.06
      ADD=65 RD=0,1 UZ=21.38, 21.38
      ADD=66 RD=0,1 UZ=21.38, 21.38
      ADD=67 RD=0,1 UZ=21.38, 21.38
      ADD=68 RD=0,1 UZ=21.38, 21.38
      ADD=69 RD=0,1 UZ=21.38, 21.38
      ADD=70 RD=0,1 UZ=21.38, 21.38
      ADD=71 RD=0,1 UZ=21.38, 21.38
      ADD=72 RD=0,1 UZ=21.38, 21.38
      ADD=31 RD=0,1 UZ=-21.38, -21.38
      ADD=32 RD=0,1 UZ=-21.38, -21.38
      ADD=33 RD=0,1 UZ=-21.38, -21.38
      ADD=34 RD=0,1 UZ=-21.38, -21.38
      ADD=35 RD=0,1 UZ=-21.38, -21.38
      ADD=36 RD=0,1 UZ=-21.38, -21.38
      ADD=37 RD=0,1 UZ=-21.38, -21.38
      ADD=38 RD=0,1 UZ=-21.38, -21.38
      ADD=1 RD=0,1 UX=38.69, 38.69
      ADD=2 RD=0,1 UX=38.69, 38.69
      ADD=3 RD=0,1 UX=38.69, 38.69
      ADD=4 RD=0,1 UX=38.69, 38.69
      ADD=5 RD=0,1 UX=38.69, 38.69
```

```
      ADD=6 RD=0,1 UX=38.69, 38.69
      ADD=7 RD=0,1 UX=38.69, 38.69
      ADD=8 RD=0,1 UX=38.69, 38.69
      ADD=9 RD=0,1 UX=38.69, 38.69
      ADD=10 RD=0,1 UX=38.69, 38.69
      ADD=11 RD=0,1 UX=38.69, 38.69
      ADD=12 RD=0,1 UX=38.69, 38.69
      ADD=13 RD=0,1 UX=38.69, 38.69
      ADD=14 RD=0,1 UX=38.69, 38.69
      ADD=15 RD=0,1 UX=38.69, 38.69
      ADD=16 RD=0,1 UX=38.69, 38.69
      ADD=17 RD=0,1 UX=38.69, 38.69
      ADD=18 RD=0,1 UX=38.69, 38.69
      ADD=19 RD=0,1 UX=38.69, 38.69
      ADD=20 RD=0,1 UX=38.69, 38.69
      ADD=21 RD=0,1 UX=38.69, 38.69
      ADD=22 RD=0,1 UX=38.69, 38.69
      ADD=23 RD=0,1 UX=38.69, 38.69
      ADD=24 RD=0,1 UX=38.69, 38.69
      ADD=25 RD=0,1 UX=38.69, 38.69
      ADD=26 RD=0,1 UX=38.69, 38.69
      ADD=27 RD=0,1 UX=38.69, 38.69
      ADD=28 RD=0,1 UX=38.69, 38.69
      ADD=29 RD=0,1 UX=38.69, 38.69
      ADD=30 RD=0,1 UX=38.69, 38.69
NAME=FUNINER2  ; 구체 관성력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-1.935, -1.935
      ADD=40 RD=0,1 UX=-1.935, -1.935
      ADD=41 RD=0,1 UX=-1.935, -1.935
      ADD=42 RD=0,1 UX=-1.935, -1.935
      ADD=43 RD=0,1 UX=-1.935, -1.935
      ADD=44 RD=0,1 UX=-1.935, -1.935
      ADD=45 RD=0,1 UX=-1.935, -1.935
      ADD=46 RD=0,1 UX=-1.935, -1.935
      ADD=47 RD=0,1 UX=-1.935, -1.935
      ADD=48 RD=0,1 UX=-1.935, -1.935
      ADD=49 RD=0,1 UX=-1.935, -1.935
      ADD=50 RD=0,1 UX=-1.935, -1.935
      ADD=51 RD=0,1 UX=-1.935, -1.935
      ADD=52 RD=0,1 UX=-1.935, -1.935
      ADD=53 RD=0,1 UX=-1.935, -1.935
      ADD=54 RD=0,1 UX=-1.935, -1.935
      ADD=55 RD=0,1 UX=-1.935, -1.935
      ADD=56 RD=0,1 UX=-1.935, -1.935
      ADD=57 RD=0,1 UX=-1.935, -1.935
      ADD=58 RD=0,1 UX=-1.935, -1.935
      ADD=59 RD=0,1 UX=-1.935, -1.935
      ADD=60 RD=0,1 UX=-1.935, -1.935
      ADD=61 RD=0,1 UX=-1.935, -1.935
      ADD=62 RD=0,1 UX=-1.935, -1.935
      ADD=63 RD=0,1 UX=-1.935, -1.935
      ADD=64 RD=0,1 UX=-1.935, -1.935
      ADD=65 RD=0,1 UX=-1.935, -1.922
      ADD=66 RD=0,1 UX=-1.922, -1.906
      ADD=67 RD=0,1 UX=-1.906, -1.899
      ADD=68 RD=0,1 UX=-1.899, -1.862
      ADD=69 RD=0,1 UX=-1.862, -1.825
      ADD=70 RD=0,1 UX=-1.825, -1.789
      ADD=71 RD=0,1 UX=-1.789, -1.772
      ADD=72 RD=0,1 UX=-1.772, -1.752
      ADD=73 RD=0,1 UX=-1.075, -0.973
      ADD=31 RD=0,1 UX=-1.752, -1.772
      ADD=32 RD=0,1 UX=-1.772, -1.789
      ADD=33 RD=0,1 UX=-1.789, -1.825
      ADD=34 RD=0,1 UX=-1.825, -1.862
      ADD=35 RD=0,1 UX=-1.862, -1.899
      ADD=36 RD=0,1 UX=-1.899, -1.906
      ADD=37 RD=0,1 UX=-1.906, -1.922
      ADD=38 RD=0,1 UX=-1.922, -1.935
      ADD=1 RD=0,1 UX=-2.531, -2.531
      ADD=2 RD=0,1 UX=-2.531, -2.531
      ADD=3 RD=0,1 UX=-2.531, -2.531
      ADD=4 RD=0,1 UX=-2.531, -2.531
      ADD=5 RD=0,1 UX=-2.531, -2.531
      ADD=6 RD=0,1 UX=-2.531, -2.531
      ADD=7 RD=0,1 UX=-2.531, -2.531
      ADD=8 RD=0,1 UX=-2.531, -2.531
      ADD=9 RD=0,1 UX=-2.531, -2.531
      ADD=10 RD=0,1 UX=-2.531, -2.531
      ADD=11 RD=0,1 UX=-2.531, -2.531
      ADD=12 RD=0,1 UX=-2.531, -2.531
      ADD=13 RD=0,1 UX=-2.531, -2.531
      ADD=14 RD=0,1 UX=-2.531, -2.531
      ADD=15 RD=0,1 UX=-2.531, -2.531
      ADD=16 RD=0,1 UX=-2.531, -2.531
      ADD=17 RD=0,1 UX=-2.531, -2.531
      ADD=18 RD=0,1 UX=-2.531, -2.531
      ADD=19 RD=0,1 UX=-2.531, -2.531
      ADD=20 RD=0,1 UX=-2.531, -2.531
      ADD=21 RD=0,1 UX=-2.531, -2.531
      ADD=22 RD=0,1 UX=-2.531, -2.531
      ADD=23 RD=0,1 UX=-2.531, -2.531
      ADD=24 RD=0,1 UX=-2.531, -2.531
      ADD=25 RD=0,1 UX=-2.531, -2.531
      ADD=26 RD=0,1 UX=-2.531, -2.531
      ADD=27 RD=0,1 UX=-2.531, -2.531
      ADD=28 RD=0,1 UX=-2.531, -2.531
      ADD=29 RD=0,1 UX=-2.531, -2.531
      ADD=30 RD=0,1 UX=-2.531, -2.531
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=WATERV
      LOAD=WATERH
      LOAD=BUOYANCY
      LOAD=FUNSLAB
      LOAD=FUNWALL
      LOAD=FUNMS
      LOAD=FUNINER
      LOAD=FUNSLAB2
      LOAD=FUNWALL2
      LOAD=FUNMS2
      LOAD=FUNINER2
      NLLINK=*
HISTORY
   NAME=UE01   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
   NAME=UE02   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= FUNSLAB2      SF=1.000   AT=1
      LOAD= FUNWALL2      SF=1.000   AT=1
      LOAD= FUNMS2        SF=1.000   AT=1
      LOAD= FUNINER2      SF=1.000   AT=1
   NAME=UE03   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVELEE       SF=1.000   AT=1
      LOAD= LIVELEHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
   NAME=UE04   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVELEE       SF=1.000   AT=1
      LOAD= LIVELEHE      SF=1.000   AT=1
      LOAD= FUNSLAB2      SF=1.000   AT=1
      LOAD= FUNWALL2      SF=1.000   AT=1
      LOAD= FUNMS2        SF=1.000   AT=1
      LOAD= FUNINER2      SF=1.000   AT=1
   NAME=UE05   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVERIE       SF=1.000   AT=1
      LOAD= LIVERIHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
   NAME=UE06   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVERIE       SF=1.000   AT=1
      LOAD= LIVERIHE      SF=1.000   AT=1
      LOAD= FUNSLAB2      SF=1.000   AT=1
      LOAD= FUNWALL2      SF=1.000   AT=1
      LOAD= FUNMS2        SF=1.000   AT=1
      LOAD= FUNINER2      SF=1.000   AT=1
   NAME=UE07   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=0.500   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
```

```
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVEFUE        SF=1.000   AT=1
   LOAD= LIVEFUHE       SF=0.500   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVELEE        SF=1.000   AT=1
   LOAD= LIVELEHE       SF=0.500   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVELEE        SF=1.000   AT=1
   LOAD= LIVELEHE       SF=0.500   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVERIE        SF=1.000   AT=1
   LOAD= LIVERIHE       SF=0.500   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVERIE        SF=1.000   AT=1
   LOAD= LIVERIHE       SF=0.500   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=0.900   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=0.900   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=0.900   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=0.900   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVEFUE        SF=1.000   AT=1
   LOAD= LIVEFUHE       SF=1.000   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=1.000   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVEFUE        SF=1.000   AT=1
   LOAD= LIVEFUHE       SF=1.000   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=1.000   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVELEE        SF=1.000   AT=1
   LOAD= LIVELEHE       SF=1.000   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=1.000   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVELEE        SF=1.000   AT=1
   LOAD= LIVELEHE       SF=1.000   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=1.000   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVERIE        SF=1.000   AT=1
   LOAD= LIVERIHE       SF=1.000   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=1.000   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVERIE        SF=1.000   AT=1
   LOAD= LIVERIHE       SF=1.000   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=1.000   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVEFUE        SF=1.000   AT=1
   LOAD= LIVEFUHE       SF=0.500   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=0.500   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVEFUE        SF=1.000   AT=1
   LOAD= LIVEFUHE       SF=0.500   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=0.500   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVELEE        SF=1.000   AT=1
   LOAD= LIVELEHE       SF=0.500   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=0.500   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVELEE        SF=1.000   AT=1
   LOAD= LIVELEHE       SF=0.500   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=0.500   AT=1
   LOAD= FUNSLAB2       SF=1.000   AT=1
   LOAD= FUNWALL2       SF=1.000   AT=1
   LOAD= FUNMS2         SF=1.000   AT=1
   LOAD= FUNINER2       SF=1.000   AT=1
NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVERIE        SF=1.000   AT=1
   LOAD= LIVERIHE       SF=0.500   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=0.500   AT=1
   LOAD= FUNSLAB        SF=1.000   AT=1
   LOAD= FUNWALL        SF=1.000   AT=1
   LOAD= FUNMS          SF=1.000   AT=1
   LOAD= FUNINER        SF=1.000   AT=1
NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW             SF=1.200   AT=1
   LOAD= LIVERIE        SF=1.000   AT=1
   LOAD= LIVERIHE       SF=0.500   AT=1
   LOAD= WATERV         SF=1.200   AT=1
   LOAD= WATERH         SF=0.500   AT=1
```

```
        LOAD= FUNSLAB2        SF=1.000    AT=1
        LOAD= FUNWALL2        SF=1.000    AT=1
        LOAD= FUNMS2          SF=1.000    AT=1
        LOAD= FUNINER2        SF=1.000    AT=1
    NAME=UE29     TYPE=NON     NSTEP=100     DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
        LOAD= SW              SF=0.900    AT=1
        LOAD= WATERV          SF=0.900    AT=1
        LOAD= WATERH          SF=1.000    AT=1
        LOAD= FUNSLAB         SF=1.000    AT=1
        LOAD= FUNWALL         SF=1.000    AT=1
        LOAD= FUNMS           SF=1.000    AT=1
        LOAD= FUNINER         SF=1.000    AT=1
    NAME=UE30     TYPE=NON     NSTEP=100     DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
        LOAD= SW              SF=0.900    AT=1
        LOAD= WATERV          SF=0.900    AT=1
        LOAD= WATERH          SF=1.000    AT=1
        LOAD= FUNSLAB2        SF=1.000    AT=1
        LOAD= FUNWALL2        SF=1.000    AT=1
        LOAD= FUNMS2          SF=1.000    AT=1
        LOAD= FUNINER2        SF=1.000    AT=1
    NAME=UE31     TYPE=NON     NSTEP=100     DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
        LOAD= SW              SF=0.900    AT=1
        LOAD= WATERV          SF=0.900    AT=1
        LOAD= WATERH          SF=0.500    AT=1
        LOAD= FUNSLAB         SF=1.000    AT=1
        LOAD= FUNWALL         SF=1.000    AT=1
        LOAD= FUNMS           SF=1.000    AT=1
        LOAD= FUNINER         SF=1.000    AT=1
    NAME=UE32     TYPE=NON     NSTEP=100     DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
        LOAD= SW              SF=0.900    AT=1
        LOAD= WATERV          SF=0.900    AT=1
        LOAD= WATERH          SF=0.500    AT=1
        LOAD= FUNSLAB2        SF=1.000    AT=1
        LOAD= FUNWALL2        SF=1.000    AT=1
        LOAD= FUNMS2          SF=1.000    AT=1
        LOAD= FUNINER2        SF=1.000    AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
      HIST=UE06 SF=1
      HIST=UE07 SF=1
      HIST=UE08 SF=1
      HIST=UE09 SF=1
      HIST=UE10 SF=1
      HIST=UE11 SF=1
      HIST=UE12 SF=1
      HIST=UE13 SF=1
      HIST=UE14 SF=1
      HIST=UE15 SF=1
      HIST=UE16 SF=1
      HIST=UE17 SF=1
      HIST=UE18 SF=1
      HIST=UE19 SF=1
      HIST=UE20 SF=1
      HIST=UE21 SF=1
      HIST=UE22 SF=1
      HIST=UE23 SF=1
      HIST=UE24 SF=1
      HIST=UE25 SF=1
      HIST=UE26 SF=1
      HIST=UE27 SF=1
      HIST=UE28 SF=1
      HIST=UE29 SF=1
      HIST=UE30 SF=1
      HIST=UE31 SF=1
      HIST=UE32 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

17. INPUT DATA (붕괴방지)

```
; ACulvert SAP2000 데이터파일 : 내진(붕괴)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     0.950 Y=     0.000 Z=     0.500
  3    X=     1.567 Y=     0.000 Z=     0.500
  4    X=     2.050 Y=     0.000 Z=     0.500
  5    X=     2.350 Y=     0.000 Z=     0.500
  6    X=     2.633 Y=     0.000 Z=     0.500
  7    X=     3.700 Y=     0.000 Z=     0.500
  8    X=     4.767 Y=     0.000 Z=     0.500
  9    X=     5.833 Y=     0.000 Z=     0.500
  10   X=     6.900 Y=     0.000 Z=     0.500
  11   X=     7.967 Y=     0.000 Z=     0.500
  12   X=     9.033 Y=     0.000 Z=     0.500
  13   X=     9.200 Y=     0.000 Z=     0.500
  14   X=     9.500 Y=     0.000 Z=     0.500
  15   X=     9.850 Y=     0.000 Z=     0.500
  16   X=    10.100 Y=     0.000 Z=     0.500
  17   X=    10.350 Y=     0.000 Z=     0.500
  18   X=    10.700 Y=     0.000 Z=     0.500
  19   X=    11.000 Y=     0.000 Z=     0.500
  20   X=    11.167 Y=     0.000 Z=     0.500
  21   X=    12.233 Y=     0.000 Z=     0.500
  22   X=    13.300 Y=     0.000 Z=     0.500
  23   X=    14.367 Y=     0.000 Z=     0.500
  24   X=    15.433 Y=     0.000 Z=     0.500
  25   X=    16.500 Y=     0.000 Z=     0.500
  26   X=    17.567 Y=     0.000 Z=     0.500
  27   X=    17.850 Y=     0.000 Z=     0.500
  28   X=    18.150 Y=     0.000 Z=     0.500
  29   X=    18.633 Y=     0.000 Z=     0.500
  30   X=    19.250 Y=     0.000 Z=     0.500
  31   X=    19.700 Y=     0.000 Z=     0.500
  32   X=    19.700 Y=     0.000 Z=     1.150
  33   X=    19.700 Y=     0.000 Z=     1.695
  34   X=    19.700 Y=     0.000 Z=     2.890
  35   X=    19.700 Y=     0.000 Z=     4.085
  36   X=    19.700 Y=     0.000 Z=     5.280
  37   X=    19.700 Y=     0.000 Z=     5.525
  38   X=    19.700 Y=     0.000 Z=     6.025
  39   X=    19.700 Y=     0.000 Z=     6.475
  40   X=    19.250 Y=     0.000 Z=     6.475
  41   X=    18.750 Y=     0.000 Z=     6.475
  42   X=    18.633 Y=     0.000 Z=     6.475
  43   X=    17.567 Y=     0.000 Z=     6.475
  44   X=    16.500 Y=     0.000 Z=     6.475
  45   X=    15.433 Y=     0.000 Z=     6.475
  46   X=    14.367 Y=     0.000 Z=     6.475
  47   X=    13.300 Y=     0.000 Z=     6.475
  48   X=    12.233 Y=     0.000 Z=     6.475
  49   X=    11.167 Y=     0.000 Z=     6.475
  50   X=    10.850 Y=     0.000 Z=     6.475
  51   X=    10.350 Y=     0.000 Z=     6.475
  52   X=    10.100 Y=     0.000 Z=     6.475
  53   X=     9.850 Y=     0.000 Z=     6.475
  54   X=     9.350 Y=     0.000 Z=     6.475
  55   X=     9.033 Y=     0.000 Z=     6.475
  56   X=     7.967 Y=     0.000 Z=     6.475
  57   X=     6.900 Y=     0.000 Z=     6.475
  58   X=     5.833 Y=     0.000 Z=     6.475
  59   X=     4.767 Y=     0.000 Z=     6.475
  60   X=     3.700 Y=     0.000 Z=     6.475
  61   X=     2.633 Y=     0.000 Z=     6.475
  62   X=     1.567 Y=     0.000 Z=     6.475
  63   X=     1.450 Y=     0.000 Z=     6.475
  64   X=     0.950 Y=     0.000 Z=     6.475
  65   X=     0.500 Y=     0.000 Z=     6.475
  66   X=     0.500 Y=     0.000 Z=     6.025
  67   X=     0.500 Y=     0.000 Z=     5.525
  68   X=     0.500 Y=     0.000 Z=     5.280
  69   X=     0.500 Y=     0.000 Z=     4.085
  70   X=     0.500 Y=     0.000 Z=     2.890
  71   X=     0.500 Y=     0.000 Z=     1.695
  72   X=     0.500 Y=     0.000 Z=     1.150
  73   X=     0.500 Y=     0.000 Z=     0.000
  74   X=     1.567 Y=     0.000 Z=     0.000
  75   X=     2.633 Y=     0.000 Z=     0.000
  76   X=     3.700 Y=     0.000 Z=     0.000
  77   X=     4.767 Y=     0.000 Z=     0.000
  78   X=     5.833 Y=     0.000 Z=     0.000
  79   X=     6.900 Y=     0.000 Z=     0.000
  80   X=     7.967 Y=     0.000 Z=     0.000
  81   X=     9.033 Y=     0.000 Z=     0.000
  82   X=    10.100 Y=     0.000 Z=     0.000
  83   X=    11.167 Y=     0.000 Z=     0.000
  84   X=    12.233 Y=     0.000 Z=     0.000
  85   X=    13.300 Y=     0.000 Z=     0.000
  86   X=    14.367 Y=     0.000 Z=     0.000
  87   X=    15.433 Y=     0.000 Z=     0.000
  88   X=    16.500 Y=     0.000 Z=     0.000
  89   X=    17.567 Y=     0.000 Z=     0.000
  90   X=    18.633 Y=     0.000 Z=     0.000
  91   X=    19.700 Y=     0.000 Z=     0.000
  92   X=    20.200 Y=     0.000 Z=     0.500
  93   X=    20.200 Y=     0.000 Z=     1.695
  94   X=    20.200 Y=     0.000 Z=     2.890
  95   X=    20.200 Y=     0.000 Z=     4.085
  96   X=    20.200 Y=     0.000 Z=     5.280
  97   X=    20.200 Y=     0.000 Z=     6.475
  98   X=    19.700 Y=     0.000 Z=     6.975
  99   X=    18.633 Y=     0.000 Z=     6.975
  100  X=    17.567 Y=     0.000 Z=     6.975
  101  X=    16.500 Y=     0.000 Z=     6.975
  102  X=    15.433 Y=     0.000 Z=     6.975
  103  X=    14.367 Y=     0.000 Z=     6.975
  104  X=    13.300 Y=     0.000 Z=     6.975
  105  X=    12.233 Y=     0.000 Z=     6.975
  106  X=    11.167 Y=     0.000 Z=     6.975
  107  X=    10.100 Y=     0.000 Z=     6.975
  108  X=     9.033 Y=     0.000 Z=     6.975
  109  X=     7.967 Y=     0.000 Z=     6.975
  110  X=     6.900 Y=     0.000 Z=     6.975
  111  X=     5.833 Y=     0.000 Z=     6.975
  112  X=     4.767 Y=     0.000 Z=     6.975
  113  X=     3.700 Y=     0.000 Z=     6.975
  114  X=     2.633 Y=     0.000 Z=     6.975
  115  X=     1.567 Y=     0.000 Z=     6.975
  116  X=     0.500 Y=     0.000 Z=     6.975
  117  X=     0.000 Y=     0.000 Z=     6.475
  118  X=     0.000 Y=     0.000 Z=     5.280
  119  X=     0.000 Y=     0.000 Z=     4.085
  120  X=     0.000 Y=     0.000 Z=     2.890
  121  X=     0.000 Y=     0.000 Z=     1.695
  122  X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=89 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=90 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=91 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=92 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=93 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=94 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=95 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=96 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=97 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=98 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=99 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=100 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=101 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=102 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=103 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=104 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=105 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=106 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=107 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=108 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=109 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=110 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=111 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=112 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=113 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=114 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=115 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=116 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=117 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=118 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=119 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=120 DOF=UX,UY,UZ,RX,RY,RZ
```

```
  ADD=121 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=122 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=6247.74
  ADD=6 UX=6247.74
  ADD=7 UX=6247.74
  ADD=8 UX=6247.74
  ADD=9 UX=6247.74
  ADD=10 UX=6247.74
  ADD=11 UX=6247.74
  ADD=12 UX=6247.74
  ADD=16 UX=6247.74
  ADD=20 UX=6247.74
  ADD=21 UX=6247.74
  ADD=22 UX=6247.74
  ADD=23 UX=6247.74
  ADD=24 UX=6247.74
  ADD=25 UX=6247.74
  ADD=26 UX=6247.74
  ADD=29 UX=6247.74
  ADD=33 UZ=15522.8
  ADD=34 UZ=15522.8
  ADD=35 UZ=4523.11
  ADD=36 UZ=4523.11
  ADD=42 UX=1820.51
  ADD=43 UX=1820.51
  ADD=44 UX=1820.51
  ADD=45 UX=1820.51
  ADD=46 UX=1820.51
  ADD=47 UX=1820.51
  ADD=48 UX=1820.51
  ADD=49 UX=1820.51
  ADD=52 UX=1820.51
  ADD=55 UX=1820.51
  ADD=56 UX=1820.51
  ADD=57 UX=1820.51
  ADD=58 UX=1820.51
  ADD=59 UX=1820.51
  ADD=60 UX=1820.51
  ADD=61 UX=1820.51
  ADD=62 UX=1820.51
  ADD=68 UZ=4523.11
  ADD=69 UZ=4523.11
  ADD=70 UZ=15522.8
  ADD=71 UZ=15522.8
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=17278.9 CE=0.99999 K=17278.9 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=18743.2 CE=0.99999 K=18743.2 OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=48614.2 CE=0.99999 K=48614.2 OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=46568.3 CE=0.99999 K=46568.3 OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=13569.3 CE=0.99999 K=13569.3 OPEN=0
  NAME=6 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=11894.5 CE=0.99999 K=11894.5 OPEN=0
  NAME=7 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=5034.82 CE=0.99999 K=5034.82 OPEN=0
  NAME=8 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=5461.51 CE=0.99999 K=5461.51 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.3,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.05,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=0.9,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=1.4,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=0.5,1
  Name=6  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=7  TYPE=NONPR SEC=4,3 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.125 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 2 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 NSEG= 4 ANG=180
    15 J= 15,  16 SEC= 1 NSEG= 4 ANG=180
    16 J= 16,  17 SEC= 1 NSEG= 4 ANG=180
    17 J= 17,  18 SEC= 1 NSEG= 4 ANG=180
    18 J= 18,  19 SEC= 1 NSEG= 4 ANG=180
    19 J= 19,  20 SEC= 1 NSEG= 4 ANG=180
    20 J= 20,  21 SEC= 1 NSEG= 4 ANG=180
    21 J= 21,  22 SEC= 1 NSEG= 4 ANG=180
    22 J= 22,  23 SEC= 1 NSEG= 4 ANG=180
    23 J= 23,  24 SEC= 1 NSEG= 4 ANG=180
    24 J= 24,  25 SEC= 1 NSEG= 4 ANG=180
    25 J= 25,  26 SEC= 1 NSEG= 4 ANG=180
    26 J= 26,  27 SEC= 1 NSEG= 4 ANG=180
    27 J= 27,  28 SEC= 2 NSEG= 4 ANG=180
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=180
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=180
    30 J= 30,  31 SEC= 1 IOFF=0 JOFF=0.125 RIGID=1 NSEG=4 ANG=180
    31 J= 31,  32 SEC= 3 IOFF=0.425 JOFF=0 RIGID=1 NSEG=4 ANG=0
    32 J= 32,  33 SEC= 3 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 3 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 3 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 3 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 3 NSEG= 4 ANG=0
    37 J= 37,  38 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    38 J= 38,  39 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    39 J= 39,  40 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    41 J= 41,  42 SEC= 3 NSEG= 4 ANG=0
    42 J= 42,  43 SEC= 3 NSEG= 4 ANG=0
    43 J= 43,  44 SEC= 3 NSEG= 4 ANG=0
    44 J= 44,  45 SEC= 3 NSEG= 4 ANG=0
    45 J= 45,  46 SEC= 3 NSEG= 4 ANG=0
    46 J= 46,  47 SEC= 3 NSEG= 4 ANG=0
    47 J= 47,  48 SEC= 3 NSEG= 4 ANG=0
    48 J= 48,  49 SEC= 3 NSEG= 4 ANG=0
    49 J= 49,  50 SEC= 3 NSEG= 4 ANG=0
    50 J= 50,  51 SEC= 3 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    51 J= 51,  52 SEC= 3 IOFF=0 JOFF=0.245 RIGID=1 NSEG=4 ANG=0
    52 J= 52,  53 SEC= 3 IOFF=0.245 JOFF=0 RIGID=1 NSEG=4 ANG=0
    53 J= 53,  54 SEC= 3 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=0
    54 J= 54,  55 SEC= 3 NSEG= 4 ANG=0
    55 J= 55,  56 SEC= 3 NSEG= 4 ANG=0
    56 J= 56,  57 SEC= 3 NSEG= 4 ANG=0
    57 J= 57,  58 SEC= 3 NSEG= 4 ANG=0
    58 J= 58,  59 SEC= 3 NSEG= 4 ANG=0
    59 J= 59,  60 SEC= 3 NSEG= 4 ANG=0
    60 J= 60,  61 SEC= 3 NSEG= 4 ANG=0
    61 J= 61,  62 SEC= 3 NSEG= 4 ANG=0
    62 J= 62,  63 SEC= 3 NSEG= 4 ANG=0
    63 J= 63,  64 SEC= 6 IOFF=0 JOFF=0.05 RIGID=1 NSEG=4 ANG=0
    64 J= 64,  65 SEC= 4 IOFF=0 JOFF=0.441 RIGID=1 NSEG=4 ANG=0
    65 J= 65,  66 SEC= 4 IOFF=0.441 JOFF=0 RIGID=1 NSEG=4 ANG=180
    66 J= 66,  67 SEC= 7 IOFF=0.05 JOFF=0 RIGID=1 NSEG=4 ANG=180
    67 J= 67,  68 SEC= 3 NSEG= 4 ANG=180
    68 J= 68,  69 SEC= 3 NSEG= 4 ANG=180
    69 J= 69,  70 SEC= 3 NSEG= 4 ANG=180
    70 J= 70,  71 SEC= 3 NSEG= 4 ANG=180
    71 J= 71,  72 SEC= 3 NSEG= 4 ANG=180
    72 J= 72,   1 SEC= 3 IOFF=0 JOFF=0.425 RIGID=1 NSEG=4 ANG=180
    73 J= 52,  16 SEC= 5 IOFF=0.7 JOFF=0.525 RIGID=1 NSEG=4 ANG=0
NLLINK
     1 J= 1,73 NLP=1 ANG=0
     2 J= 3,74 NLP=2 ANG=0
     3 J= 6,75 NLP=2 ANG=0
     4 J= 7,76 NLP=2 ANG=0
     5 J= 8,77 NLP=2 ANG=0
     6 J= 9,78 NLP=2 ANG=0
     7 J=10,79 NLP=2 ANG=0
     8 J=11,80 NLP=2 ANG=0
     9 J=12,81 NLP=2 ANG=0
    10 J=16,82 NLP=2 ANG=0
    11 J=20,83 NLP=2 ANG=0
    12 J=21,84 NLP=2 ANG=0
    13 J=22,85 NLP=2 ANG=0
    14 J=23,86 NLP=2 ANG=0
    15 J=24,87 NLP=2 ANG=0
    16 J=25,88 NLP=2 ANG=0
    17 J=26,89 NLP=2 ANG=0
    18 J=29,90 NLP=2 ANG=0
    19 J=31,91 NLP=1 ANG=0
    20 J=31,92 NLP=3 ANG=0
    21 J=33,93 NLP=4 ANG=0
    22 J=34,94 NLP=4 ANG=0
    23 J=35,95 NLP=5 ANG=0
    24 J=36,96 NLP=5 ANG=0
    25 J=39,97 NLP=6 ANG=0
    26 J=39,98 NLP=7 ANG=0
    27 J=42,99 NLP=8 ANG=0
    28 J=43,100 NLP=8 ANG=0
    29 J=44,101 NLP=8 ANG=0
    30 J=45,102 NLP=8 ANG=0
    31 J=46,103 NLP=8 ANG=0
    32 J=47,104 NLP=8 ANG=0
```

```
    33 J=48,105 NLP=8 ANG=0
    34 J=49,106 NLP=8 ANG=0
    35 J=52,107 NLP=8 ANG=0
    36 J=55,108 NLP=8 ANG=0
    37 J=56,109 NLP=8 ANG=0
    38 J=57,110 NLP=8 ANG=0
    39 J=58,111 NLP=8 ANG=0
    40 J=59,112 NLP=8 ANG=0
    41 J=60,113 NLP=8 ANG=0
    42 J=61,114 NLP=8 ANG=0
    43 J=62,115 NLP=8 ANG=0
    44 J=65,116 NLP=7 ANG=0
    45 J=65,117 NLP=6 ANG=0
    46 J=68,118 NLP=5 ANG=0
    47 J=69,119 NLP=5 ANG=0
    48 J=70,120 NLP=4 ANG=0
    49 J=71,121 NLP=4 ANG=0
    50 J= 1,122 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-72.925, -72.925
      ADD=40 RD=0,1 UZ=-72.925, -72.925
      ADD=41 RD=0,1 UZ=-72.925, -72.925
      ADD=42 RD=0,1 UZ=-72.925, -72.925
      ADD=43 RD=0,1 UZ=-72.925, -72.925
      ADD=44 RD=0,1 UZ=-72.925, -72.925
      ADD=45 RD=0,1 UZ=-72.925, -72.925
      ADD=46 RD=0,1 UZ=-72.925, -72.925
      ADD=47 RD=0,1 UZ=-72.925, -72.925
      ADD=48 RD=0,1 UZ=-72.925, -72.925
      ADD=49 RD=0,1 UZ=-72.925, -72.925
      ADD=50 RD=0,1 UZ=-72.925, -72.925
      ADD=51 RD=0,1 UZ=-72.925, -72.925
      ADD=52 RD=0,1 UZ=-72.925, -72.925
      ADD=53 RD=0,1 UZ=-72.925, -72.925
      ADD=54 RD=0,1 UZ=-72.925, -72.925
      ADD=55 RD=0,1 UZ=-72.925, -72.925
      ADD=56 RD=0,1 UZ=-72.925, -72.925
      ADD=57 RD=0,1 UZ=-72.925, -72.925
      ADD=58 RD=0,1 UZ=-72.925, -72.925
      ADD=59 RD=0,1 UZ=-72.925, -72.925
      ADD=60 RD=0,1 UZ=-72.925, -72.925
      ADD=61 RD=0,1 UZ=-72.925, -72.925
      ADD=62 RD=0,1 UZ=-72.925, -72.925
      ADD=63 RD=0,1 UZ=-72.925, -72.925
      ADD=64 RD=0,1 UZ=-72.925, -72.925
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-53.575, -53.575
      ADD=40 RD=0,1 UZ=-53.575, -53.575
      ADD=41 RD=0,1 UZ=-53.575, -53.575
      ADD=42 RD=0,1 UZ=-53.575, -53.575
      ADD=43 RD=0,1 UZ=-53.575, -53.575
      ADD=44 RD=0,1 UZ=-53.575, -53.575
      ADD=45 RD=0,1 UZ=-53.575, -53.575
      ADD=46 RD=0,1 UZ=-53.575, -53.575
      ADD=47 RD=0,1 UZ=-53.575, -53.575
      ADD=48 RD=0,1 UZ=-53.575, -53.575
      ADD=49 RD=0,1 UZ=-53.575, -53.575
      ADD=50 RD=0,1 UZ=-53.575, -53.575
      ADD=51 RD=0,1 UZ=-53.575, -53.575
      ADD=52 RD=0,1 UZ=-53.575, -53.575
      ADD=53 RD=0,1 UZ=-53.575, -53.575
      ADD=54 RD=0,1 UZ=-53.575, -53.575
      ADD=55 RD=0,1 UZ=-53.575, -53.575
      ADD=56 RD=0,1 UZ=-53.575, -53.575
      ADD=57 RD=0,1 UZ=-53.575, -53.575
      ADD=58 RD=0,1 UZ=-53.575, -53.575
      ADD=59 RD=0,1 UZ=-53.575, -53.575
      ADD=60 RD=0,1 UZ=-53.575, -53.575
      ADD=61 RD=0,1 UZ=-53.575, -53.575
      ADD=62 RD=0,1 UZ=-53.575, -53.575
      ADD=63 RD=0,1 UZ=-53.575, -53.575
      ADD=64 RD=0,1 UZ=-53.575, -53.575
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11.25, -11.25
      ADD=40 RD=0,1 UZ=-11.25, -11.25
      ADD=41 RD=0,1 UZ=-11.25, -11.25
      ADD=42 RD=0,1 UZ=-11.25, -11.25
      ADD=43 RD=0,1 UZ=-11.25, -11.25
      ADD=44 RD=0,1 UZ=-11.25, -11.25
      ADD=45 RD=0,1 UZ=-11.25, -11.25
      ADD=46 RD=0,1 UZ=-11.25, -11.25
      ADD=47 RD=0,1 UZ=-11.25, -11.25
      ADD=48 RD=0,1 UZ=-11.25, -11.25
      ADD=49 RD=0,1 UZ=-11.25, -11.25
      ADD=50 RD=0,1 UZ=-11.25, -11.25
      ADD=51 RD=0,1 UZ=-11.25, -11.25
      ADD=52 RD=0,1 UZ=-11.25, -11.25
      ADD=53 RD=0,1 UZ=-11.25, -11.25
      ADD=54 RD=0,1 UZ=-11.25, -11.25
      ADD=55 RD=0,1 UZ=-11.25, -11.25
      ADD=56 RD=0,1 UZ=-11.25, -11.25
      ADD=57 RD=0,1 UZ=-11.25, -11.25
      ADD=58 RD=0,1 UZ=-11.25, -11.25
      ADD=59 RD=0,1 UZ=-11.25, -11.25
      ADD=60 RD=0,1 UZ=-11.25, -11.25
      ADD=61 RD=0,1 UZ=-11.25, -11.25
      ADD=62 RD=0,1 UZ=-11.25, -11.25
      ADD=63 RD=0,1 UZ=-11.25, -11.25
      ADD=64 RD=0,1 UZ=-11.25, -11.25
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=52 RD=0,1 UZ=-11.25, -11.25
      ADD=53 RD=0,1 UZ=-11.25, -11.25
      ADD=54 RD=0,1 UZ=-11.25, -11.25
      ADD=55 RD=0,1 UZ=-11.25, -11.25
      ADD=56 RD=0,1 UZ=-11.25, -11.25
      ADD=57 RD=0,1 UZ=-11.25, -11.25
      ADD=58 RD=0,1 UZ=-11.25, -11.25
      ADD=59 RD=0,1 UZ=-11.25, -11.25
      ADD=60 RD=0,1 UZ=-11.25, -11.25
      ADD=61 RD=0,1 UZ=-11.25, -11.25
      ADD=62 RD=0,1 UZ=-11.25, -11.25
      ADD=63 RD=0,1 UZ=-11.25, -11.25
      ADD=64 RD=0,1 UZ=-11.25, -11.25
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-11.25, -11.25
      ADD=40 RD=0,1 UZ=-11.25, -11.25
      ADD=41 RD=0,1 UZ=-11.25, -11.25
      ADD=42 RD=0,1 UZ=-11.25, -11.25
      ADD=43 RD=0,1 UZ=-11.25, -11.25
      ADD=44 RD=0,1 UZ=-11.25, -11.25
      ADD=45 RD=0,1 UZ=-11.25, -11.25
      ADD=46 RD=0,1 UZ=-11.25, -11.25
      ADD=47 RD=0,1 UZ=-11.25, -11.25
      ADD=48 RD=0,1 UZ=-11.25, -11.25
      ADD=49 RD=0,1 UZ=-11.25, -11.25
      ADD=50 RD=0,1 UZ=-11.25, -11.25
      ADD=51 RD=0,1 UZ=-11.25, -11.25
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.625, 5.625
      ADD=66 RD=0,1 UX=5.625, 5.625
      ADD=67 RD=0,1 UX=5.625, 5.625
      ADD=68 RD=0,1 UX=5.625, 5.625
      ADD=69 RD=0,1 UX=5.625, 5.625
      ADD=70 RD=0,1 UX=5.625, 5.625
      ADD=71 RD=0,1 UX=5.625, 5.625
      ADD=72 RD=0,1 UX=5.625, 5.625
      ADD=31 RD=0,1 UX=-5.625, -5.625
      ADD=32 RD=0,1 UX=-5.625, -5.625
      ADD=33 RD=0,1 UX=-5.625, -5.625
      ADD=34 RD=0,1 UX=-5.625, -5.625
      ADD=35 RD=0,1 UX=-5.625, -5.625
      ADD=36 RD=0,1 UX=-5.625, -5.625
      ADD=37 RD=0,1 UX=-5.625, -5.625
      ADD=38 RD=0,1 UX=-5.625, -5.625
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=5.625, 5.625
      ADD=66 RD=0,1 UX=5.625, 5.625
      ADD=67 RD=0,1 UX=5.625, 5.625
      ADD=68 RD=0,1 UX=5.625, 5.625
      ADD=69 RD=0,1 UX=5.625, 5.625
      ADD=70 RD=0,1 UX=5.625, 5.625
      ADD=71 RD=0,1 UX=5.625, 5.625
      ADD=72 RD=0,1 UX=5.625, 5.625
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=31 RD=0,1 UX=-5.625, -5.625
      ADD=32 RD=0,1 UX=-5.625, -5.625
      ADD=33 RD=0,1 UX=-5.625, -5.625
      ADD=34 RD=0,1 UX=-5.625, -5.625
      ADD=35 RD=0,1 UX=-5.625, -5.625
      ADD=36 RD=0,1 UX=-5.625, -5.625
      ADD=37 RD=0,1 UX=-5.625, -5.625
      ADD=38 RD=0,1 UX=-5.625, -5.625
NAME=WATERV  ; 연직수압
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UZ=-21.5, -21.5
      ADD=40 RD=0,1 UZ=-21.5, -21.5
      ADD=41 RD=0,1 UZ=-21.5, -21.5
      ADD=42 RD=0,1 UZ=-21.5, -21.5
      ADD=43 RD=0,1 UZ=-21.5, -21.5
      ADD=44 RD=0,1 UZ=-21.5, -21.5
```

```
      ADD=45 RD=0,1 UZ=-21.5, -21.5
      ADD=46 RD=0,1 UZ=-21.5, -21.5
      ADD=47 RD=0,1 UZ=-21.5, -21.5
      ADD=48 RD=0,1 UZ=-21.5, -21.5
      ADD=49 RD=0,1 UZ=-21.5, -21.5
      ADD=50 RD=0,1 UZ=-21.5, -21.5
      ADD=51 RD=0,1 UZ=-21.5, -21.5
      ADD=52 RD=0,1 UZ=-21.5, -21.5
      ADD=53 RD=0,1 UZ=-21.5, -21.5
      ADD=54 RD=0,1 UZ=-21.5, -21.5
      ADD=55 RD=0,1 UZ=-21.5, -21.5
      ADD=56 RD=0,1 UZ=-21.5, -21.5
      ADD=57 RD=0,1 UZ=-21.5, -21.5
      ADD=58 RD=0,1 UZ=-21.5, -21.5
      ADD=59 RD=0,1 UZ=-21.5, -21.5
      ADD=60 RD=0,1 UZ=-21.5, -21.5
      ADD=61 RD=0,1 UZ=-21.5, -21.5
      ADD=62 RD=0,1 UZ=-21.5, -21.5
      ADD=63 RD=0,1 UZ=-21.5, -21.5
      ADD=64 RD=0,1 UZ=-21.5, -21.5
NAME=WATERH  ; 수평수압
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=26.5, 31
      ADD=66 RD=0,1 UX=31, 36
      ADD=67 RD=0,1 UX=36, 38.45
      ADD=68 RD=0,1 UX=38.45, 50.4
      ADD=69 RD=0,1 UX=50.4, 62.35
      ADD=70 RD=0,1 UX=62.35, 74.3
      ADD=71 RD=0,1 UX=74.3, 79.75
      ADD=72 RD=0,1 UX=79.75, 86.25
      ADD=31 RD=0,1 UX=-86.25, -79.75
      ADD=32 RD=0,1 UX=-79.75, -74.3
      ADD=33 RD=0,1 UX=-74.3, -62.35
      ADD=34 RD=0,1 UX=-62.35, -50.4
      ADD=35 RD=0,1 UX=-50.4, -38.45
      ADD=36 RD=0,1 UX=-38.45, -36
      ADD=37 RD=0,1 UX=-36, -31
      ADD=38 RD=0,1 UX=-31, -26.5
NAME=BUOYANCY  ; 부력
   TYPE=DISTRIBUTED SPAN
      ADD=1 RD=0,1 UZ=91.5, 91.5
      ADD=2 RD=0,1 UZ=91.5, 91.5
      ADD=3 RD=0,1 UZ=91.5, 91.5
      ADD=4 RD=0,1 UZ=91.5, 91.5
      ADD=5 RD=0,1 UZ=91.5, 91.5
      ADD=6 RD=0,1 UZ=91.5, 91.5
      ADD=7 RD=0,1 UZ=91.5, 91.5
      ADD=8 RD=0,1 UZ=91.5, 91.5
      ADD=9 RD=0,1 UZ=91.5, 91.5
      ADD=10 RD=0,1 UZ=91.5, 91.5
      ADD=11 RD=0,1 UZ=91.5, 91.5
      ADD=12 RD=0,1 UZ=91.5, 91.5
      ADD=13 RD=0,1 UZ=91.5, 91.5
      ADD=14 RD=0,1 UZ=91.5, 91.5
      ADD=15 RD=0,1 UZ=91.5, 91.5
      ADD=16 RD=0,1 UZ=91.5, 91.5
      ADD=17 RD=0,1 UZ=91.5, 91.5
      ADD=18 RD=0,1 UZ=91.5, 91.5
      ADD=19 RD=0,1 UZ=91.5, 91.5
      ADD=20 RD=0,1 UZ=91.5, 91.5
      ADD=21 RD=0,1 UZ=91.5, 91.5
      ADD=22 RD=0,1 UZ=91.5, 91.5
      ADD=23 RD=0,1 UZ=91.5, 91.5
      ADD=24 RD=0,1 UZ=91.5, 91.5
      ADD=25 RD=0,1 UZ=91.5, 91.5
      ADD=26 RD=0,1 UZ=91.5, 91.5
      ADD=27 RD=0,1 UZ=91.5, 91.5
      ADD=28 RD=0,1 UZ=91.5, 91.5
      ADD=29 RD=0,1 UZ=91.5, 91.5
      ADD=30 RD=0,1 UZ=91.5, 91.5
NAME=COLSLAB  ; 슬래브 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=10.02, 10.02
      ADD=40 RD=0,1 UX=10.02, 10.02
      ADD=41 RD=0,1 UX=10.02, 10.02
      ADD=42 RD=0,1 UX=10.02, 10.02
      ADD=43 RD=0,1 UX=10.02, 10.02
      ADD=44 RD=0,1 UX=10.02, 10.02
      ADD=45 RD=0,1 UX=10.02, 10.02
      ADD=46 RD=0,1 UX=10.02, 10.02
      ADD=47 RD=0,1 UX=10.02, 10.02
      ADD=48 RD=0,1 UX=10.02, 10.02
      ADD=49 RD=0,1 UX=10.02, 10.02
      ADD=50 RD=0,1 UX=10.02, 10.02
      ADD=51 RD=0,1 UX=10.02, 10.02
      ADD=52 RD=0,1 UX=10.02, 10.02
      ADD=53 RD=0,1 UX=10.02, 10.02
      ADD=54 RD=0,1 UX=10.02, 10.02
      ADD=55 RD=0,1 UX=10.02, 10.02
      ADD=56 RD=0,1 UX=10.02, 10.02
      ADD=57 RD=0,1 UX=10.02, 10.02
      ADD=58 RD=0,1 UX=10.02, 10.02
      ADD=59 RD=0,1 UX=10.02, 10.02
      ADD=60 RD=0,1 UX=10.02, 10.02
      ADD=61 RD=0,1 UX=10.02, 10.02
      ADD=62 RD=0,1 UX=10.02, 10.02
      ADD=63 RD=0,1 UX=10.02, 10.02
      ADD=64 RD=0,1 UX=10.02, 10.02
NAME=COLWALL  ; 벽체 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=66.666, 63.679
      ADD=66 RD=0,1 UX=63.679, 59.966
      ADD=67 RD=0,1 UX=59.966, 58.002
      ADD=68 RD=0,1 UX=58.002, 46.953
      ADD=69 RD=0,1 UX=46.953, 33.566
      ADD=70 RD=0,1 UX=33.566, 61.416
      ADD=71 RD=0,1 UX=61.416, 34.332
      ADD=72 RD=0,1 UX=34.332, 0
      ADD=31 RD=0,1 UX=0, 34.332
      ADD=32 RD=0,1 UX=34.332, 61.416
      ADD=33 RD=0,1 UX=61.416, 33.566
      ADD=34 RD=0,1 UX=33.566, 46.953
      ADD=35 RD=0,1 UX=46.953, 58.002
      ADD=36 RD=0,1 UX=58.002, 59.966
      ADD=37 RD=0,1 UX=59.966, 63.679
      ADD=38 RD=0,1 UX=63.679, 66.666
NAME=COLMS  ; 주면전단력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=5.85, 5.85
      ADD=40 RD=0,1 UX=5.85, 5.85
      ADD=41 RD=0,1 UX=5.85, 5.85
      ADD=42 RD=0,1 UX=5.85, 5.85
      ADD=43 RD=0,1 UX=5.85, 5.85
      ADD=44 RD=0,1 UX=5.85, 5.85
      ADD=45 RD=0,1 UX=5.85, 5.85
      ADD=46 RD=0,1 UX=5.85, 5.85
      ADD=47 RD=0,1 UX=5.85, 5.85
      ADD=48 RD=0,1 UX=5.85, 5.85
      ADD=49 RD=0,1 UX=5.85, 5.85
      ADD=50 RD=0,1 UX=5.85, 5.85
      ADD=51 RD=0,1 UX=5.85, 5.85
      ADD=52 RD=0,1 UX=5.85, 5.85
      ADD=53 RD=0,1 UX=5.85, 5.85
      ADD=54 RD=0,1 UX=5.85, 5.85
      ADD=55 RD=0,1 UX=5.85, 5.85
      ADD=56 RD=0,1 UX=5.85, 5.85
      ADD=57 RD=0,1 UX=5.85, 5.85
      ADD=58 RD=0,1 UX=5.85, 5.85
      ADD=59 RD=0,1 UX=5.85, 5.85
      ADD=60 RD=0,1 UX=5.85, 5.85
      ADD=61 RD=0,1 UX=5.85, 5.85
      ADD=62 RD=0,1 UX=5.85, 5.85
      ADD=63 RD=0,1 UX=5.85, 5.85
      ADD=64 RD=0,1 UX=5.85, 5.85
      ADD=65 RD=0,1 UZ=-30.85, -30.85
      ADD=66 RD=0,1 UZ=-30.85, -30.85
      ADD=67 RD=0,1 UZ=-30.85, -30.85
      ADD=68 RD=0,1 UZ=-30.85, -30.85
      ADD=69 RD=0,1 UZ=-30.85, -30.85
      ADD=70 RD=0,1 UZ=-30.85, -30.85
      ADD=71 RD=0,1 UZ=-30.85, -30.85
      ADD=72 RD=0,1 UZ=-30.85, -30.85
      ADD=31 RD=0,1 UZ=30.85, 30.85
      ADD=32 RD=0,1 UZ=30.85, 30.85
      ADD=33 RD=0,1 UZ=30.85, 30.85
      ADD=34 RD=0,1 UZ=30.85, 30.85
      ADD=35 RD=0,1 UZ=30.85, 30.85
      ADD=36 RD=0,1 UZ=30.85, 30.85
      ADD=37 RD=0,1 UZ=30.85, 30.85
      ADD=38 RD=0,1 UZ=30.85, 30.85
      ADD=1 RD=0,1 UX=-55.85, -55.85
      ADD=2 RD=0,1 UX=-55.85, -55.85
      ADD=3 RD=0,1 UX=-55.85, -55.85
      ADD=4 RD=0,1 UX=-55.85, -55.85
      ADD=5 RD=0,1 UX=-55.85, -55.85
      ADD=6 RD=0,1 UX=-55.85, -55.85
      ADD=7 RD=0,1 UX=-55.85, -55.85
      ADD=8 RD=0,1 UX=-55.85, -55.85
      ADD=9 RD=0,1 UX=-55.85, -55.85
      ADD=10 RD=0,1 UX=-55.85, -55.85
      ADD=11 RD=0,1 UX=-55.85, -55.85
      ADD=12 RD=0,1 UX=-55.85, -55.85
      ADD=13 RD=0,1 UX=-55.85, -55.85
      ADD=14 RD=0,1 UX=-55.85, -55.85
      ADD=15 RD=0,1 UX=-55.85, -55.85
      ADD=16 RD=0,1 UX=-55.85, -55.85
      ADD=17 RD=0,1 UX=-55.85, -55.85
      ADD=18 RD=0,1 UX=-55.85, -55.85
      ADD=19 RD=0,1 UX=-55.85, -55.85
      ADD=20 RD=0,1 UX=-55.85, -55.85
```

```
      ADD=21 RD=0,1 UX=-55.85, -55.85
      ADD=22 RD=0,1 UX=-55.85, -55.85
      ADD=23 RD=0,1 UX=-55.85, -55.85
      ADD=24 RD=0,1 UX=-55.85, -55.85
      ADD=25 RD=0,1 UX=-55.85, -55.85
      ADD=26 RD=0,1 UX=-55.85, -55.85
      ADD=27 RD=0,1 UX=-55.85, -55.85
      ADD=28 RD=0,1 UX=-55.85, -55.85
      ADD=29 RD=0,1 UX=-55.85, -55.85
      ADD=30 RD=0,1 UX=-55.85, -55.85
NAME=COLINER  ; 구체 관성력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=4.764, 4.764
      ADD=40 RD=0,1 UX=4.764, 4.764
      ADD=41 RD=0,1 UX=4.764, 4.764
      ADD=42 RD=0,1 UX=4.764, 4.764
      ADD=43 RD=0,1 UX=4.764, 4.764
      ADD=44 RD=0,1 UX=4.764, 4.764
      ADD=45 RD=0,1 UX=4.764, 4.764
      ADD=46 RD=0,1 UX=4.764, 4.764
      ADD=47 RD=0,1 UX=4.764, 4.764
      ADD=48 RD=0,1 UX=4.764, 4.764
      ADD=49 RD=0,1 UX=4.764, 4.764
      ADD=50 RD=0,1 UX=4.764, 4.764
      ADD=51 RD=0,1 UX=4.764, 4.764
      ADD=52 RD=0,1 UX=4.764, 4.764
      ADD=53 RD=0,1 UX=4.764, 4.764
      ADD=54 RD=0,1 UX=4.764, 4.764
      ADD=55 RD=0,1 UX=4.764, 4.764
      ADD=56 RD=0,1 UX=4.764, 4.764
      ADD=57 RD=0,1 UX=4.764, 4.764
      ADD=58 RD=0,1 UX=4.764, 4.764
      ADD=59 RD=0,1 UX=4.764, 4.764
      ADD=60 RD=0,1 UX=4.764, 4.764
      ADD=61 RD=0,1 UX=4.764, 4.764
      ADD=62 RD=0,1 UX=4.764, 4.764
      ADD=63 RD=0,1 UX=4.764, 4.764
      ADD=64 RD=0,1 UX=4.764, 4.764
      ADD=65 RD=0,1 UX=4.764, 4.73
      ADD=66 RD=0,1 UX=4.73, 4.692
      ADD=67 RD=0,1 UX=4.692, 4.674
      ADD=68 RD=0,1 UX=4.674, 4.583
      ADD=69 RD=0,1 UX=4.583, 4.493
      ADD=70 RD=0,1 UX=4.493, 4.403
      ADD=71 RD=0,1 UX=4.403, 4.361
      ADD=72 RD=0,1 UX=4.361, 4.312
      ADD=73 RD=0,1 UX=2.647, 2.396
      ADD=31 RD=0,1 UX=4.312, 4.361
      ADD=32 RD=0,1 UX=4.361, 4.403
      ADD=33 RD=0,1 UX=4.403, 4.493
      ADD=34 RD=0,1 UX=4.493, 4.583
      ADD=35 RD=0,1 UX=4.583, 4.674
      ADD=36 RD=0,1 UX=4.674, 4.692
      ADD=37 RD=0,1 UX=4.692, 4.73
      ADD=38 RD=0,1 UX=4.73, 4.764
      ADD=1 RD=0,1 UX=6.229, 6.229
      ADD=2 RD=0,1 UX=6.229, 6.229
      ADD=3 RD=0,1 UX=6.229, 6.229
      ADD=4 RD=0,1 UX=6.229, 6.229
      ADD=5 RD=0,1 UX=6.229, 6.229
      ADD=6 RD=0,1 UX=6.229, 6.229
      ADD=7 RD=0,1 UX=6.229, 6.229
      ADD=8 RD=0,1 UX=6.229, 6.229
      ADD=9 RD=0,1 UX=6.229, 6.229
      ADD=10 RD=0,1 UX=6.229, 6.229
      ADD=11 RD=0,1 UX=6.229, 6.229
      ADD=12 RD=0,1 UX=6.229, 6.229
      ADD=13 RD=0,1 UX=6.229, 6.229
      ADD=14 RD=0,1 UX=6.229, 6.229
      ADD=15 RD=0,1 UX=6.229, 6.229
      ADD=16 RD=0,1 UX=6.229, 6.229
      ADD=17 RD=0,1 UX=6.229, 6.229
      ADD=18 RD=0,1 UX=6.229, 6.229
      ADD=19 RD=0,1 UX=6.229, 6.229
      ADD=20 RD=0,1 UX=6.229, 6.229
      ADD=21 RD=0,1 UX=6.229, 6.229
      ADD=22 RD=0,1 UX=6.229, 6.229
      ADD=23 RD=0,1 UX=6.229, 6.229
      ADD=24 RD=0,1 UX=6.229, 6.229
      ADD=25 RD=0,1 UX=6.229, 6.229
      ADD=26 RD=0,1 UX=6.229, 6.229
      ADD=27 RD=0,1 UX=6.229, 6.229
      ADD=28 RD=0,1 UX=6.229, 6.229
      ADD=29 RD=0,1 UX=6.229, 6.229
      ADD=30 RD=0,1 UX=6.229, 6.229
NAME=COLSLAB2  ; 슬래브 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-10.02, -10.02
      ADD=40 RD=0,1 UX=-10.02, -10.02
      ADD=41 RD=0,1 UX=-10.02, -10.02
      ADD=42 RD=0,1 UX=-10.02, -10.02
      ADD=43 RD=0,1 UX=-10.02, -10.02
      ADD=44 RD=0,1 UX=-10.02, -10.02
      ADD=45 RD=0,1 UX=-10.02, -10.02
      ADD=46 RD=0,1 UX=-10.02, -10.02
      ADD=47 RD=0,1 UX=-10.02, -10.02
      ADD=48 RD=0,1 UX=-10.02, -10.02
      ADD=49 RD=0,1 UX=-10.02, -10.02
      ADD=50 RD=0,1 UX=-10.02, -10.02
      ADD=51 RD=0,1 UX=-10.02, -10.02
      ADD=52 RD=0,1 UX=-10.02, -10.02
      ADD=53 RD=0,1 UX=-10.02, -10.02
      ADD=54 RD=0,1 UX=-10.02, -10.02
      ADD=55 RD=0,1 UX=-10.02, -10.02
      ADD=56 RD=0,1 UX=-10.02, -10.02
      ADD=57 RD=0,1 UX=-10.02, -10.02
      ADD=58 RD=0,1 UX=-10.02, -10.02
      ADD=59 RD=0,1 UX=-10.02, -10.02
      ADD=60 RD=0,1 UX=-10.02, -10.02
      ADD=61 RD=0,1 UX=-10.02, -10.02
      ADD=62 RD=0,1 UX=-10.02, -10.02
      ADD=63 RD=0,1 UX=-10.02, -10.02
      ADD=64 RD=0,1 UX=-10.02, -10.02
NAME=COLWALL2  ; 벽체 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=65 RD=0,1 UX=-66.666, -63.679
      ADD=66 RD=0,1 UX=-63.679, -59.966
      ADD=67 RD=0,1 UX=-59.966, -58.002
      ADD=68 RD=0,1 UX=-58.002, -46.953
      ADD=69 RD=0,1 UX=-46.953, -33.566
      ADD=70 RD=0,1 UX=-33.566, -61.416
      ADD=71 RD=0,1 UX=-61.416, -34.332
      ADD=72 RD=0,1 UX=-34.332, -0
      ADD=31 RD=0,1 UX=-0, -34.332
      ADD=32 RD=0,1 UX=-34.332, -61.416
      ADD=33 RD=0,1 UX=-61.416, -33.566
      ADD=34 RD=0,1 UX=-33.566, -46.953
      ADD=35 RD=0,1 UX=-46.953, -58.002
      ADD=36 RD=0,1 UX=-58.002, -59.966
      ADD=37 RD=0,1 UX=-59.966, -63.679
      ADD=38 RD=0,1 UX=-63.679, -66.666
NAME=COLMS2  ; 주면전단력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-5.85, -5.85
      ADD=40 RD=0,1 UX=-5.85, -5.85
      ADD=41 RD=0,1 UX=-5.85, -5.85
      ADD=42 RD=0,1 UX=-5.85, -5.85
      ADD=43 RD=0,1 UX=-5.85, -5.85
      ADD=44 RD=0,1 UX=-5.85, -5.85
      ADD=45 RD=0,1 UX=-5.85, -5.85
      ADD=46 RD=0,1 UX=-5.85, -5.85
      ADD=47 RD=0,1 UX=-5.85, -5.85
      ADD=48 RD=0,1 UX=-5.85, -5.85
      ADD=49 RD=0,1 UX=-5.85, -5.85
      ADD=50 RD=0,1 UX=-5.85, -5.85
      ADD=51 RD=0,1 UX=-5.85, -5.85
      ADD=52 RD=0,1 UX=-5.85, -5.85
      ADD=53 RD=0,1 UX=-5.85, -5.85
      ADD=54 RD=0,1 UX=-5.85, -5.85
      ADD=55 RD=0,1 UX=-5.85, -5.85
      ADD=56 RD=0,1 UX=-5.85, -5.85
      ADD=57 RD=0,1 UX=-5.85, -5.85
      ADD=58 RD=0,1 UX=-5.85, -5.85
      ADD=59 RD=0,1 UX=-5.85, -5.85
      ADD=60 RD=0,1 UX=-5.85, -5.85
      ADD=61 RD=0,1 UX=-5.85, -5.85
      ADD=62 RD=0,1 UX=-5.85, -5.85
      ADD=63 RD=0,1 UX=-5.85, -5.85
      ADD=64 RD=0,1 UX=-5.85, -5.85
      ADD=65 RD=0,1 UZ=30.85, 30.85
      ADD=66 RD=0,1 UZ=30.85, 30.85
      ADD=67 RD=0,1 UZ=30.85, 30.85
      ADD=68 RD=0,1 UZ=30.85, 30.85
      ADD=69 RD=0,1 UZ=30.85, 30.85
      ADD=70 RD=0,1 UZ=30.85, 30.85
      ADD=71 RD=0,1 UZ=30.85, 30.85
      ADD=72 RD=0,1 UZ=30.85, 30.85
      ADD=31 RD=0,1 UZ=-30.85, -30.85
      ADD=32 RD=0,1 UZ=-30.85, -30.85
      ADD=33 RD=0,1 UZ=-30.85, -30.85
      ADD=34 RD=0,1 UZ=-30.85, -30.85
      ADD=35 RD=0,1 UZ=-30.85, -30.85
      ADD=36 RD=0,1 UZ=-30.85, -30.85
      ADD=37 RD=0,1 UZ=-30.85, -30.85
      ADD=38 RD=0,1 UZ=-30.85, -30.85
      ADD=1 RD=0,1 UX=55.85, 55.85
      ADD=2 RD=0,1 UX=55.85, 55.85
      ADD=3 RD=0,1 UX=55.85, 55.85
      ADD=4 RD=0,1 UX=55.85, 55.85
      ADD=5 RD=0,1 UX=55.85, 55.85
```

```
      ADD=6 RD=0,1 UX=55.85, 55.85
      ADD=7 RD=0,1 UX=55.85, 55.85
      ADD=8 RD=0,1 UX=55.85, 55.85
      ADD=9 RD=0,1 UX=55.85, 55.85
      ADD=10 RD=0,1 UX=55.85, 55.85
      ADD=11 RD=0,1 UX=55.85, 55.85
      ADD=12 RD=0,1 UX=55.85, 55.85
      ADD=13 RD=0,1 UX=55.85, 55.85
      ADD=14 RD=0,1 UX=55.85, 55.85
      ADD=15 RD=0,1 UX=55.85, 55.85
      ADD=16 RD=0,1 UX=55.85, 55.85
      ADD=17 RD=0,1 UX=55.85, 55.85
      ADD=18 RD=0,1 UX=55.85, 55.85
      ADD=19 RD=0,1 UX=55.85, 55.85
      ADD=20 RD=0,1 UX=55.85, 55.85
      ADD=21 RD=0,1 UX=55.85, 55.85
      ADD=22 RD=0,1 UX=55.85, 55.85
      ADD=23 RD=0,1 UX=55.85, 55.85
      ADD=24 RD=0,1 UX=55.85, 55.85
      ADD=25 RD=0,1 UX=55.85, 55.85
      ADD=26 RD=0,1 UX=55.85, 55.85
      ADD=27 RD=0,1 UX=55.85, 55.85
      ADD=28 RD=0,1 UX=55.85, 55.85
      ADD=29 RD=0,1 UX=55.85, 55.85
      ADD=30 RD=0,1 UX=55.85, 55.85
NAME=COLINER2  ; 구체 관성력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=39 RD=0,1 UX=-4.764, -4.764
      ADD=40 RD=0,1 UX=-4.764, -4.764
      ADD=41 RD=0,1 UX=-4.764, -4.764
      ADD=42 RD=0,1 UX=-4.764, -4.764
      ADD=43 RD=0,1 UX=-4.764, -4.764
      ADD=44 RD=0,1 UX=-4.764, -4.764
      ADD=45 RD=0,1 UX=-4.764, -4.764
      ADD=46 RD=0,1 UX=-4.764, -4.764
      ADD=47 RD=0,1 UX=-4.764, -4.764
      ADD=48 RD=0,1 UX=-4.764, -4.764
      ADD=49 RD=0,1 UX=-4.764, -4.764
      ADD=50 RD=0,1 UX=-4.764, -4.764
      ADD=51 RD=0,1 UX=-4.764, -4.764
      ADD=52 RD=0,1 UX=-4.764, -4.764
      ADD=53 RD=0,1 UX=-4.764, -4.764
      ADD=54 RD=0,1 UX=-4.764, -4.764
      ADD=55 RD=0,1 UX=-4.764, -4.764
      ADD=56 RD=0,1 UX=-4.764, -4.764
      ADD=57 RD=0,1 UX=-4.764, -4.764
      ADD=58 RD=0,1 UX=-4.764, -4.764
      ADD=59 RD=0,1 UX=-4.764, -4.764
      ADD=60 RD=0,1 UX=-4.764, -4.764
      ADD=61 RD=0,1 UX=-4.764, -4.764
      ADD=62 RD=0,1 UX=-4.764, -4.764
      ADD=63 RD=0,1 UX=-4.764, -4.764
      ADD=64 RD=0,1 UX=-4.764, -4.764
      ADD=65 RD=0,1 UX=-4.764, -4.73
      ADD=66 RD=0,1 UX=-4.73, -4.692
      ADD=67 RD=0,1 UX=-4.692, -4.674
      ADD=68 RD=0,1 UX=-4.674, -4.583
      ADD=69 RD=0,1 UX=-4.583, -4.493
      ADD=70 RD=0,1 UX=-4.493, -4.403
      ADD=71 RD=0,1 UX=-4.403, -4.361
      ADD=72 RD=0,1 UX=-4.361, -4.312
      ADD=73 RD=0,1 UX=-2.647, -2.396
      ADD=31 RD=0,1 UX=-4.312, -4.361
      ADD=32 RD=0,1 UX=-4.361, -4.403
      ADD=33 RD=0,1 UX=-4.403, -4.493
      ADD=34 RD=0,1 UX=-4.493, -4.583
      ADD=35 RD=0,1 UX=-4.583, -4.674
      ADD=36 RD=0,1 UX=-4.674, -4.692
      ADD=37 RD=0,1 UX=-4.692, -4.73
      ADD=38 RD=0,1 UX=-4.73, -4.764
      ADD=1 RD=0,1 UX=-6.229, -6.229
      ADD=2 RD=0,1 UX=-6.229, -6.229
      ADD=3 RD=0,1 UX=-6.229, -6.229
      ADD=4 RD=0,1 UX=-6.229, -6.229
      ADD=5 RD=0,1 UX=-6.229, -6.229
      ADD=6 RD=0,1 UX=-6.229, -6.229
      ADD=7 RD=0,1 UX=-6.229, -6.229
      ADD=8 RD=0,1 UX=-6.229, -6.229
      ADD=9 RD=0,1 UX=-6.229, -6.229
      ADD=10 RD=0,1 UX=-6.229, -6.229
      ADD=11 RD=0,1 UX=-6.229, -6.229
      ADD=12 RD=0,1 UX=-6.229, -6.229
      ADD=13 RD=0,1 UX=-6.229, -6.229
      ADD=14 RD=0,1 UX=-6.229, -6.229
      ADD=15 RD=0,1 UX=-6.229, -6.229
      ADD=16 RD=0,1 UX=-6.229, -6.229
      ADD=17 RD=0,1 UX=-6.229, -6.229
      ADD=18 RD=0,1 UX=-6.229, -6.229
      ADD=19 RD=0,1 UX=-6.229, -6.229
      ADD=20 RD=0,1 UX=-6.229, -6.229
      ADD=21 RD=0,1 UX=-6.229, -6.229
      ADD=22 RD=0,1 UX=-6.229, -6.229
      ADD=23 RD=0,1 UX=-6.229, -6.229
      ADD=24 RD=0,1 UX=-6.229, -6.229
      ADD=25 RD=0,1 UX=-6.229, -6.229
      ADD=26 RD=0,1 UX=-6.229, -6.229
      ADD=27 RD=0,1 UX=-6.229, -6.229
      ADD=28 RD=0,1 UX=-6.229, -6.229
      ADD=29 RD=0,1 UX=-6.229, -6.229
      ADD=30 RD=0,1 UX=-6.229, -6.229
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=WATERV
      LOAD=WATERH
      LOAD=BUOYANCY
      LOAD=COLSLAB
      LOAD=COLWALL
      LOAD=COLMS
      LOAD=COLINER
      LOAD=COLSLAB2
      LOAD=COLWALL2
      LOAD=COLMS2
      LOAD=COLINER2
      NLLINK=*
HISTORY
   NAME=UE01   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
   NAME=UE02   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= COLSLAB2      SF=1.000   AT=1
      LOAD= COLWALL2      SF=1.000   AT=1
      LOAD= COLMS2        SF=1.000   AT=1
      LOAD= COLINER2      SF=1.000   AT=1
   NAME=UE03   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVELEE       SF=1.000   AT=1
      LOAD= LIVELEHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
   NAME=UE04   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVELEE       SF=1.000   AT=1
      LOAD= LIVELEHE      SF=1.000   AT=1
      LOAD= COLSLAB2      SF=1.000   AT=1
      LOAD= COLWALL2      SF=1.000   AT=1
      LOAD= COLMS2        SF=1.000   AT=1
      LOAD= COLINER2      SF=1.000   AT=1
   NAME=UE05   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVERIE       SF=1.000   AT=1
      LOAD= LIVERIHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
   NAME=UE06   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVERIE       SF=1.000   AT=1
      LOAD= LIVERIHE      SF=1.000   AT=1
      LOAD= COLSLAB2      SF=1.000   AT=1
      LOAD= COLWALL2      SF=1.000   AT=1
      LOAD= COLMS2        SF=1.000   AT=1
      LOAD= COLINER2      SF=1.000   AT=1
   NAME=UE07   TYPE=NON   NSTEP=100   DT=1   DAMP=0.99   DTMAX=1   ENVE
      LOAD= SW            SF=1.200   AT=1
```

```
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= WATERV        SF=1.200   AT=1
   LOAD= WATERH        SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE
```

```
      LOAD= SW              SF=1.200   AT=1
      LOAD= PAVEW           SF=1.200   AT=1
      LOAD= LIVELEE         SF=1.000   AT=1
      LOAD= LIVELEHE        SF=0.500   AT=1
      LOAD= WATERV          SF=1.200   AT=1
      LOAD= WATERH          SF=0.500   AT=1
      LOAD= COLSLAB2        SF=1.000   AT=1
      LOAD= COLWALL2        SF=1.000   AT=1
      LOAD= COLMS2          SF=1.000   AT=1
      LOAD= COLINER2        SF=1.000   AT=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
      LOAD= SW              SF=1.200   AT=1
      LOAD= PAVEW           SF=1.200   AT=1
      LOAD= LIVERIE         SF=1.000   AT=1
      LOAD= LIVERIHE        SF=0.500   AT=1
      LOAD= WATERV          SF=1.200   AT=1
      LOAD= WATERH          SF=0.500   AT=1
      LOAD= COLSLAB         SF=1.000   AT=1
      LOAD= COLWALL         SF=1.000   AT=1
      LOAD= COLMS           SF=1.000   AT=1
      LOAD= COLINER         SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW              SF=1.200   AT=1
      LOAD= PAVEW           SF=1.200   AT=1
      LOAD= LIVERIE         SF=1.000   AT=1
      LOAD= LIVERIHE        SF=0.500   AT=1
      LOAD= WATERV          SF=1.200   AT=1
      LOAD= WATERH          SF=0.500   AT=1
      LOAD= COLSLAB2        SF=1.000   AT=1
      LOAD= COLWALL2        SF=1.000   AT=1
      LOAD= COLMS2          SF=1.000   AT=1
      LOAD= COLINER2        SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW              SF=0.900   AT=1
      LOAD= PAVEW           SF=0.900   AT=1
      LOAD= WATERV          SF=0.900   AT=1
      LOAD= WATERH          SF=1.000   AT=1
      LOAD= COLSLAB         SF=1.000   AT=1
      LOAD= COLWALL         SF=1.000   AT=1
      LOAD= COLMS           SF=1.000   AT=1
      LOAD= COLINER         SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW              SF=0.900   AT=1
      LOAD= PAVEW           SF=0.900   AT=1
      LOAD= WATERV          SF=0.900   AT=1
      LOAD= WATERH          SF=1.000   AT=1
      LOAD= COLSLAB2        SF=1.000   AT=1
      LOAD= COLWALL2        SF=1.000   AT=1
      LOAD= COLMS2          SF=1.000   AT=1
      LOAD= COLINER2        SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW              SF=0.900   AT=1
      LOAD= PAVEW           SF=0.900   AT=1
      LOAD= WATERV          SF=0.900   AT=1
      LOAD= WATERH          SF=0.500   AT=1
      LOAD= COLSLAB         SF=1.000   AT=1
      LOAD= COLWALL         SF=1.000   AT=1
      LOAD= COLMS           SF=1.000   AT=1
      LOAD= COLINER         SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW              SF=0.900   AT=1
      LOAD= PAVEW           SF=0.900   AT=1
      LOAD= WATERV          SF=0.900   AT=1
      LOAD= WATERH          SF=0.500   AT=1
      LOAD= COLSLAB2        SF=1.000   AT=1
      LOAD= COLWALL2        SF=1.000   AT=1
      LOAD= COLMS2          SF=1.000   AT=1
      LOAD= COLINER2        SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
      HIST=UE06 SF=1
      HIST=UE07 SF=1
      HIST=UE08 SF=1
      HIST=UE09 SF=1
      HIST=UE10 SF=1
      HIST=UE11 SF=1
      HIST=UE12 SF=1
      HIST=UE13 SF=1
      HIST=UE14 SF=1
      HIST=UE15 SF=1
      HIST=UE16 SF=1
      HIST=UE17 SF=1
      HIST=UE18 SF=1
      HIST=UE19 SF=1
      HIST=UE20 SF=1
      HIST=UE21 SF=1
      HIST=UE22 SF=1
      HIST=UE23 SF=1
      HIST=UE24 SF=1
      HIST=UE25 SF=1
      HIST=UE26 SF=1
      HIST=UE27 SF=1
      HIST=UE28 SF=1
      HIST=UE29 SF=1
      HIST=UE30 SF=1
      HIST=UE31 SF=1
      HIST=UE32 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

18. OUTPUT DATA (상시)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVULT MAX	0.27778	266.71428	0.00000	303.24452
1	ENVULT MAX	0.45833	266.71428	0.00000	320.89882
1	ENVULT MAX	0.63889	266.71428	0.00000	342.47167
1	ENVULT MAX	0.81944	266.71428	0.00000	372.39414
1	ENVULT MAX	1.00000	266.71428	0.00000	402.57406
1	ENVULT MIN	0.27778	-699.91781	-697.23085	-1114.60900
1	ENVULT MIN	0.45833	-699.91781	-691.47835	-1058.19300
1	ENVULT MIN	0.63889	-699.91781	-685.72585	-1002.24400
1	ENVULT MIN	0.81944	-699.91781	-679.97335	-946.76270
1	ENVULT MIN	1.00000	-699.91781	-674.22085	-891.74856
2	ENVULT MAX	0.00000	266.71428	0.00000	402.57406
2	ENVULT MAX	0.25000	266.71428	0.00000	460.57783
2	ENVULT MAX	0.50000	266.71428	0.00000	519.50954
2	ENVULT MAX	0.75000	266.71428	0.00000	579.36918
2	ENVULT MAX	1.00000	266.71428	0.00000	640.15674
2	ENVULT MIN	0.00000	-699.91781	-674.22086	-891.74857
2	ENVULT MIN	0.25000	-699.91781	-663.29996	-788.59228
2	ENVULT MIN	0.50000	-699.91781	-652.37906	-687.12054
2	ENVULT MIN	0.75000	-699.91781	-641.45816	-587.33334
2	ENVULT MIN	1.00000	-699.91781	-635.85065	-489.23069
3	ENVULT MAX	0.00000	266.71428	0.00000	640.15674
3	ENVULT MAX	0.25000	266.71428	0.00000	650.35630
3	ENVULT MAX	0.50000	266.71428	0.00000	661.12450
3	ENVULT MAX	0.75000	266.71428	0.00000	672.48258
3	ENVULT MAX	1.00000	266.71428	0.00000	687.88796
3	ENVULT MIN	0.00000	-699.91781	-478.78905	-489.23070
3	ENVULT MIN	0.25000	-699.91781	-470.23995	-437.13042
3	ENVULT MIN	0.50000	-699.91781	-461.69085	-388.42136
3	ENVULT MIN	0.75000	-699.91781	-453.14175	-339.14367
3	ENVULT MIN	1.00000	-699.91781	-444.59265	-289.29733
4	ENVULT MAX	0.00000	266.71428	0.00000	687.88796
4	ENVULT MAX	0.25000	266.71428	0.00000	697.72171
4	ENVULT MAX	0.50000	266.71428	0.00000	707.73264
4	ENVULT MAX	0.75000	266.71428	0.00000	717.92076
4	ENVULT MAX	1.00000	266.71428	0.00000	728.28607
4	ENVULT MIN	0.00000	-699.91781	-444.59265	-289.29733
4	ENVULT MIN	0.25000	-699.91781	-438.72015	-258.07168
4	ENVULT MIN	0.50000	-699.91781	-432.84765	-226.66884
4	ENVULT MIN	0.75000	-699.91781	-426.97515	-195.08882
4	ENVULT MIN	1.00000	-699.91781	-424.61074	-163.33161
5	ENVULT MAX	0.00000	266.71428	0.00000	728.28607
5	ENVULT MAX	0.25000	266.71428	0.00000	738.24520
5	ENVULT MAX	0.50000	266.71428	0.00000	748.39954
5	ENVULT MAX	0.75000	266.71428	0.00000	758.74910
5	ENVULT MAX	1.00000	266.71428	0.00000	769.29387
5	ENVULT MIN	0.00000	-699.91781	-424.61074	-163.33161
5	ENVULT MIN	0.25000	-699.91781	-427.36999	-133.19279
5	ENVULT MIN	0.50000	-699.91781	-430.12924	-102.85875
5	ENVULT MIN	0.75000	-699.91781	-432.88849	-72.73606
5	ENVULT MIN	1.00000	-699.91781	-435.64774	-42.64443
6	ENVULT MAX	0.00000	266.71428	67.94577	769.29387
6	ENVULT MAX	0.25000	266.71428	60.14333	759.49994
6	ENVULT MAX	0.50000	266.71428	52.34090	752.48107
6	ENVULT MAX	0.75000	266.71428	44.53846	748.23727
6	ENVULT MAX	1.00000	266.71428	36.73602	746.76853
6	ENVULT MIN	0.00000	-699.91781	-297.69999	-42.63553
6	ENVULT MIN	0.25000	-699.91781	-278.81409	0.00000
6	ENVULT MIN	0.50000	-699.91781	-259.92819	0.00000
6	ENVULT MIN	0.75000	-699.91781	-264.58725	0.00000
6	ENVULT MIN	1.00000	-699.91781	-274.99050	0.00000
7	ENVULT MAX	0.00000	266.71428	112.21973	746.76853
7	ENVULT MAX	0.25000	266.71428	101.81648	719.06888
7	ENVULT MAX	0.50000	266.71428	91.41323	694.14429
7	ENVULT MAX	0.75000	266.71428	81.00998	671.99477
7	ENVULT MAX	1.00000	266.71428	70.60673	652.62032
7	ENVULT MIN	0.00000	-699.91781	-167.00960	0.00000
7	ENVULT MIN	0.25000	-699.91781	-148.12370	0.00000
7	ENVULT MIN	0.50000	-699.91781	-133.41545	0.00000
7	ENVULT MIN	0.75000	-699.91781	-143.81870	0.00000
7	ENVULT MIN	1.00000	-699.91781	-154.22195	0.00000
8	ENVULT MAX	0.00000	266.71428	146.02473	652.62032
8	ENVULT MAX	0.25000	266.71428	135.63123	615.08967
8	ENVULT MAX	0.50000	266.71428	125.23773	584.18940
8	ENVULT MAX	0.75000	266.71428	115.58095	555.90126
8	ENVULT MAX	1.00000	266.71428	134.44915	522.58475
8	ENVULT MIN	0.00000	-699.91782	-64.15928	0.00000
8	ENVULT MIN	0.25000	-699.91782	-45.29108	0.00000
8	ENVULT MIN	0.50000	-699.91782	-34.90224	0.00000
8	ENVULT MIN	0.75000	-699.91782	-45.29574	0.00000
8	ENVULT MIN	1.00000	-699.91782	-55.68924	0.00000
9	ENVULT MAX	0.00000	266.71428	199.25966	522.58475
9	ENVULT MAX	0.25000	266.71428	188.85641	484.20153
9	ENVULT MAX	0.50000	266.71428	178.45316	440.78050
9	ENVULT MAX	0.75000	266.71428	191.10685	392.32165
9	ENVULT MAX	1.00000	266.71428	209.99275	343.98387
9	ENVULT MIN	0.00000	-699.91781	0.00000	0.00000
9	ENVULT MIN	0.25000	-699.91781	0.00000	0.00000
9	ENVULT MIN	0.50000	-699.91781	0.00000	0.00000
9	ENVULT MIN	0.75000	-699.91781	0.00000	0.00000
9	ENVULT MIN	1.00000	-699.91781	0.00000	0.00000
10	ENVULT MAX	0.00000	266.71428	305.83541	343.98387
10	ENVULT MAX	0.25000	266.71428	295.43216	289.40665
10	ENVULT MAX	0.50000	266.71428	285.02891	233.62504
10	ENVULT MAX	0.75000	266.71428	300.97938	173.13395
10	ENVULT MAX	1.00000	266.71428	319.86528	114.53639
10	ENVULT MIN	0.00000	-699.91781	0.00000	0.00000
10	ENVULT MIN	0.25000	-699.91781	0.00000	0.00000
10	ENVULT MIN	0.50000	-699.91781	0.00000	0.00000
10	ENVULT MIN	0.75000	-699.91781	0.00000	0.00000
10	ENVULT MIN	1.00000	-699.91781	0.00000	0.00000
11	ENVULT MAX	0.00000	266.71428	500.77662	114.53639
11	ENVULT MAX	0.25000	266.71428	490.38312	6.03631
11	ENVULT MAX	0.50000	266.71428	479.98962	0.00000
11	ENVULT MAX	0.75000	266.71428	494.76237	0.00000
11	ENVULT MAX	1.00000	266.71428	513.63057	0.00000
11	ENVULT MIN	0.00000	-699.91781	0.00000	0.00000
11	ENVULT MIN	0.25000	-699.91781	0.00000	-116.34667
11	ENVULT MIN	0.50000	-699.91781	0.00000	-237.73009
11	ENVULT MIN	0.75000	-699.91781	0.00000	-356.34364
11	ENVULT MIN	1.00000	-699.91781	0.00000	-475.83422
12	ENVULT MAX	0.00000	266.71428	785.38998	0.00000
12	ENVULT MAX	0.25000	266.71428	783.76173	0.00000
12	ENVULT MAX	0.50000	266.71428	782.13348	0.00000
12	ENVULT MAX	0.75000	266.71428	780.50523	0.00000
12	ENVULT MAX	1.00000	266.71428	778.87698	0.00000
12	ENVULT MIN	0.00000	-699.91781	0.00000	-475.83422
12	ENVULT MIN	0.25000	-699.91781	0.00000	-507.37848
12	ENVULT MIN	0.50000	-699.91781	0.00000	-539.67295
12	ENVULT MIN	0.75000	-699.91781	0.00000	-572.29303
12	ENVULT MIN	1.00000	-699.91781	0.00000	-604.84514
13	ENVULT MAX	0.00000	266.71428	778.87698	0.00000
13	ENVULT MAX	0.25000	266.71428	775.95198	0.00000
13	ENVULT MAX	0.50000	266.71428	773.02698	0.00000
13	ENVULT MAX	0.75000	266.71428	770.10198	0.00000
13	ENVULT MAX	1.00000	266.71428	767.17698	0.00000
13	ENVULT MIN	0.00000	-699.91781	0.00000	-604.84514
13	ENVULT MIN	0.25000	-699.91781	0.00000	-663.15122
13	ENVULT MIN	0.50000	-699.91781	0.00000	-721.23793
13	ENVULT MIN	0.75000	-699.91781	0.00000	-779.10527
13	ENVULT MIN	1.00000	-699.91781	0.00000	-836.75323
14	ENVULT MAX	0.00000	266.71428	767.17698	0.00000
14	ENVULT MAX	0.25000	266.71428	766.75635	0.00000
14	ENVULT MAX	0.50000	266.71428	772.95135	0.00000
14	ENVULT MAX	0.75000	266.71428	779.14635	0.00000
14	ENVULT MAX	1.00000	266.71428	785.34135	0.00000
14	ENVULT MIN	0.00000	-699.91781	0.00000	-836.75323
14	ENVULT MIN	0.25000	-699.91781	0.00000	-903.73192
14	ENVULT MIN	0.50000	-699.91781	0.00000	-970.41201
14	ENVULT MIN	0.75000	-699.91781	0.00000	-1036.79400
14	ENVULT MIN	1.00000	-699.91781	0.00000	-1102.87600
15	ENVULT MAX	0.00000	266.71428	785.34135	0.00000
15	ENVULT MAX	0.25000	266.71428	789.76635	0.00000
15	ENVULT MAX	0.50000	266.71428	794.19135	0.00000
15	ENVULT MAX	0.75000	266.71428	798.61635	0.00000
15	ENVULT MAX	1.00000	266.71428	803.04135	0.00000
15	ENVULT MIN	0.00000	-699.91781	0.00000	-1102.87600
15	ENVULT MIN	0.25000	-699.91781	0.00000	-1149.89600
15	ENVULT MIN	0.50000	-699.91781	0.00000	-1196.76300
15	ENVULT MIN	0.75000	-699.91781	0.00000	-1243.47700
15	ENVULT MIN	1.00000	-699.91781	0.00000	-1290.03900
16	ENVULT MAX	0.00000	191.21808	0.00000	0.00000
16	ENVULT MAX	0.25000	191.21808	0.00000	0.00000
16	ENVULT MAX	0.50000	191.21808	0.00000	0.00000
16	ENVULT MAX	0.75000	191.21808	0.00000	0.00000
16	ENVULT MAX	1.00000	191.21808	0.00000	0.00000
16	ENVULT MIN	0.00000	-645.43162	-803.69273	-1292.21600
16	ENVULT MIN	0.25000	-645.43162	-799.26773	-1245.51900
16	ENVULT MIN	0.50000	-645.43162	-794.84273	-1198.67000
16	ENVULT MIN	0.75000	-645.43162	-790.41773	-1151.66900
16	ENVULT MIN	1.00000	-645.43162	-785.99273	-1104.51500
17	ENVULT MAX	0.00000	191.21808	0.00000	0.00000
17	ENVULT MAX	0.25000	191.21808	0.00000	0.00000
17	ENVULT MAX	0.50000	191.21808	0.00000	0.00000
17	ENVULT MAX	0.75000	191.21808	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVULT MAX	1.00000	191.21808	0.00000	0.00000
17	ENVULT MIN	0.00000	-645.43162	-785.99273	-1104.51500
17	ENVULT MIN	0.25000	-645.43162	-779.79773	-1038.24400
17	ENVULT MIN	0.50000	-645.43162	-773.60273	-971.67428
17	ENVULT MIN	0.75000	-645.43162	-767.40773	-904.80593
17	ENVULT MIN	1.00000	-645.43162	-769.32850	-837.63899
18	ENVULT MAX	0.00000	191.21808	0.00000	0.00000
18	ENVULT MAX	0.25000	191.21808	0.00000	0.00000
18	ENVULT MAX	0.50000	191.21808	0.00000	0.00000
18	ENVULT MAX	0.75000	191.21808	0.00000	0.00000
18	ENVULT MAX	1.00000	191.21808	0.00000	0.00000
18	ENVULT MIN	0.00000	-645.43163	-769.32850	-837.63899
18	ENVULT MIN	0.25000	-645.43163	-772.25350	-779.82966
18	ENVULT MIN	0.50000	-645.43163	-775.17850	-721.80096
18	ENVULT MIN	0.75000	-645.43163	-778.10350	-663.55289
18	ENVULT MIN	1.00000	-645.43163	-781.02850	-605.08544
19	ENVULT MAX	0.00000	191.21808	0.00000	0.00000
19	ENVULT MAX	0.25000	191.21808	0.00000	0.00000
19	ENVULT MAX	0.50000	191.21808	0.00000	0.00000
19	ENVULT MAX	0.75000	191.21808	0.00000	0.00000
19	ENVULT MAX	1.00000	191.21808	0.00000	0.00000
19	ENVULT MIN	0.00000	-645.43163	-781.02850	-605.08544
19	ENVULT MIN	0.25000	-645.43163	-782.65675	-572.44351
19	ENVULT MIN	0.50000	-645.43163	-784.28500	-539.73360
19	ENVULT MIN	0.75000	-645.43163	-785.91325	-507.34930
19	ENVULT MIN	1.00000	-645.43163	-787.54150	-475.71522
20	ENVULT MAX	0.00000	191.21808	0.00000	0.00000
20	ENVULT MAX	0.25000	191.21808	0.00000	0.00000
20	ENVULT MAX	0.50000	191.21808	0.00000	0.00000
20	ENVULT MAX	0.75000	191.21808	0.00000	5.29169
20	ENVULT MAX	1.00000	191.21808	0.00000	113.49953
20	ENVULT MIN	0.00000	-645.43163	-513.84731	-475.71522
20	ENVULT MIN	0.25000	-645.43163	-494.97911	-355.98734
20	ENVULT MIN	0.50000	-645.43163	-480.77214	-237.14693
20	ENVULT MIN	0.75000	-645.43163	-491.16564	-115.53666
20	ENVULT MIN	1.00000	-645.43163	-501.55914	0.00000
21	ENVULT MAX	0.00000	191.21808	0.00000	113.49953
21	ENVULT MAX	0.25000	191.21808	0.00000	172.50057
21	ENVULT MAX	0.50000	191.21808	0.00000	233.09258
21	ENVULT MAX	0.75000	191.21808	0.00000	289.07620
21	ENVULT MAX	1.00000	191.21808	0.00000	343.73516
21	ENVULT MIN	0.00000	-645.43162	-319.47490	0.00000
21	ENVULT MIN	0.25000	-645.43162	-300.58900	0.00000
21	ENVULT MIN	0.50000	-645.43162	-284.52155	0.00000
21	ENVULT MIN	0.75000	-645.43162	-294.92480	0.00000
21	ENVULT MIN	1.00000	-645.43162	-305.32805	0.00000
22	ENVULT MAX	0.00000	191.21808	0.00000	343.73516
22	ENVULT MAX	0.25000	191.21808	0.00000	392.03863
22	ENVULT MAX	0.50000	191.21808	0.00000	440.24092
22	ENVULT MAX	0.75000	191.21808	0.00000	483.40540
22	ENVULT MAX	1.00000	191.21808	0.00000	521.53206
22	ENVULT MIN	0.00000	-645.43162	-209.03097	0.00000
22	ENVULT MIN	0.25000	-645.43162	-190.14507	0.00000
22	ENVULT MIN	0.50000	-645.43162	-176.65020	0.00000
22	ENVULT MIN	0.75000	-645.43162	-187.05345	0.00000
22	ENVULT MIN	1.00000	-645.43162	-197.45670	0.00000
23	ENVULT MAX	0.00000	191.21808	52.26160	521.53206
23	ENVULT MAX	0.25000	191.21808	41.86810	554.59226
23	ENVULT MAX	0.50000	191.21808	31.47460	582.62408
23	ENVULT MAX	0.75000	191.21808	43.03859	611.05853
23	ENVULT MAX	1.00000	191.21808	61.90679	647.74946
23	ENVULT MIN	0.00000	-645.43163	-133.48737	0.00000
23	ENVULT MIN	0.25000	-645.43163	-114.61917	0.00000
23	ENVULT MIN	0.50000	-645.43163	-122.08678	0.00000
23	ENVULT MIN	0.75000	-645.43163	-132.48028	0.00000
23	ENVULT MIN	1.00000	-645.43163	-142.87378	0.00000
24	ENVULT MAX	0.00000	191.21808	149.36719	647.74946
24	ENVULT MAX	0.25000	191.21808	138.96394	665.93344
24	ENVULT MAX	0.50000	191.21808	128.56069	686.89249
24	ENVULT MAX	0.75000	191.21808	145.03443	710.62661
24	ENVULT MAX	1.00000	191.21808	163.92033	737.13579
24	ENVULT MIN	0.00000	-645.43164	-65.75196	0.00000
24	ENVULT MIN	0.25000	-645.43164	-76.15521	0.00000
24	ENVULT MIN	0.50000	-645.43164	-86.55846	0.00000
24	ENVULT MIN	0.75000	-645.43164	-96.96171	0.00000
24	ENVULT MIN	1.00000	-645.43164	-107.36496	0.00000
25	ENVULT MAX	0.00000	191.21808	269.10312	737.13579
25	ENVULT MAX	0.25000	191.21808	258.69987	737.16084
25	ENVULT MAX	0.50000	191.21808	256.18758	739.96096
25	ENVULT MAX	0.75000	191.21808	275.07348	745.53615
25	ENVULT MAX	1.00000	191.21808	293.95938	753.88640
25	ENVULT MIN	0.00000	-645.43165	-31.32390	0.00000
25	ENVULT MIN	0.25000	-645.43165	-39.12634	0.00000
25	ENVULT MIN	0.50000	-645.43165	-46.92877	0.00000
25	ENVULT MIN	0.75000	-645.43165	-54.73121	0.00000
25	ENVULT MIN	1.00000	-645.43165	-62.53365	-25.79686
26	ENVULT MAX	0.00000	191.21808	429.84927	753.88640
26	ENVULT MAX	0.25000	191.21808	427.09002	742.96450
26	ENVULT MAX	0.75000	191.21808	421.57152	721.70635
26	ENVULT MAX	1.00000	191.21808	418.81227	711.37010
26	ENVULT MIN	0.00000	-645.43165	0.00000	-25.79591
26	ENVULT MIN	0.25000	-645.43165	0.00000	-55.47506
26	ENVULT MIN	0.50000	-645.43165	0.00000	-85.27781
26	ENVULT MIN	0.75000	-645.43165	0.00000	-115.20161
26	ENVULT MIN	1.00000	-645.43165	0.00000	-144.93018
27	ENVULT MAX	0.00000	191.21808	418.81227	711.37010
27	ENVULT MAX	0.25000	191.21808	423.29315	700.60501
27	ENVULT MAX	0.50000	191.21808	429.16565	690.01711
27	ENVULT MAX	0.75000	191.21808	435.03815	679.60639
27	ENVULT MAX	1.00000	191.21808	440.91065	669.37287
27	ENVULT MIN	0.00000	-645.43164	0.00000	-144.93018
27	ENVULT MIN	0.25000	-645.43164	0.00000	-176.25251
27	ENVULT MIN	0.50000	-645.43164	0.00000	-207.39765
27	ENVULT MIN	0.75000	-645.43164	0.00000	-238.36560
27	ENVULT MIN	1.00000	-645.43164	0.00000	-269.15637
28	ENVULT MAX	0.00000	191.21808	440.91065	669.37287
28	ENVULT MAX	0.25000	191.21808	449.45975	653.32384
28	ENVULT MAX	0.50000	191.21808	458.00885	639.58320
28	ENVULT MAX	0.75000	191.21808	466.55795	628.11484
28	ENVULT MAX	1.00000	191.21808	475.10705	617.21512
28	ENVULT MIN	0.00000	-645.43163	0.00000	-269.15637
28	ENVULT MIN	0.25000	-645.43163	0.00000	-318.30254
28	ENVULT MIN	0.50000	-645.43163	0.00000	-366.88007
28	ENVULT MIN	0.75000	-645.43163	0.00000	-417.81132
28	ENVULT MIN	1.00000	-645.43163	0.00000	-474.66435
29	ENVULT MAX	0.00000	191.21808	632.63941	617.21512
29	ENVULT MAX	0.25000	191.21808	639.41886	555.93222
29	ENVULT MAX	0.50000	191.21808	650.33976	495.57725
29	ENVULT MAX	0.75000	191.21808	661.26066	436.15021
29	ENVULT MAX	1.00000	191.21808	672.18156	377.65110
29	ENVULT MIN	0.00000	-645.43159	0.00000	-474.66435
29	ENVULT MIN	0.25000	-645.43159	0.00000	-572.45243
29	ENVULT MIN	0.50000	-645.43159	0.00000	-671.92507
29	ENVULT MIN	0.75000	-645.43159	0.00000	-773.08225
29	ENVULT MIN	1.00000	-645.43159	0.00000	-875.92398
30	ENVULT MAX	0.00000	191.21808	672.18157	377.65110
30	ENVULT MAX	0.18056	191.21808	677.93407	347.21027
30	ENVULT MAX	0.36111	191.21808	683.68657	317.02689
30	ENVULT MAX	0.54167	191.21808	689.43907	297.26820
30	ENVULT MAX	0.72222	191.21808	695.19157	279.37406
30	ENVULT MIN	0.00000	-645.43152	0.00000	-875.92398
30	ENVULT MIN	0.18056	-645.43152	0.00000	-930.77243
30	ENVULT MIN	0.36111	-645.43152	0.00000	-986.08826
30	ENVULT MIN	0.54167	-645.43152	0.00000	-1041.87100
30	ENVULT MIN	0.72222	-645.43152	0.00000	-1098.12200
31	ENVULT MAX	0.65385	0.00000	191.21808	185.61882
31	ENVULT MAX	0.74038	0.00000	191.21808	176.80374
31	ENVULT MAX	0.82692	0.00000	191.21808	167.98866
31	ENVULT MAX	0.91346	0.00000	191.21808	159.17358
31	ENVULT MAX	1.00000	0.00000	191.21808	150.35849
31	ENVULT MIN	0.65385	-917.85175	-548.65915	-931.98343
31	ENVULT MIN	0.74038	-916.33300	-536.17587	-901.47280
31	ENVULT MIN	0.82692	-914.81425	-523.76853	-874.22286
31	ENVULT MIN	0.91346	-913.29550	-511.43712	-851.53343
31	ENVULT MIN	1.00000	-911.77675	-499.18165	-829.31189
32	ENVULT MAX	0.00000	0.00000	191.21808	150.35849
32	ENVULT MAX	0.25000	0.00000	191.21808	129.00641
32	ENVULT MAX	0.50000	0.00000	191.21808	107.65433
32	ENVULT MAX	0.75000	0.00000	191.21808	86.30224
32	ENVULT MAX	1.00000	0.00000	191.21808	64.95016
32	ENVULT MIN	0.00000	-911.77673	-499.18160	-829.31189
32	ENVULT MIN	0.25000	-908.09798	-469.81087	-777.40911
32	ENVULT MIN	0.50000	-904.41923	-440.88568	-728.19719
32	ENVULT MIN	0.75000	-900.74048	-412.40602	-681.63766
32	ENVULT MIN	1.00000	-897.06173	-384.37190	-637.69210
33	ENVULT MAX	0.00000	0.00000	191.21808	64.95016
33	ENVULT MAX	0.25000	0.00000	191.21808	38.75283
33	ENVULT MAX	0.50000	0.00000	191.21808	42.29190
33	ENVULT MAX	0.75000	0.00000	191.21808	71.76104
33	ENVULT MAX	1.00000	0.00000	191.21808	85.73522
33	ENVULT MIN	0.00000	-897.06176	-384.37192	-637.69210
33	ENVULT MIN	0.25000	-888.99551	-324.46209	-550.29569
33	ENVULT MIN	0.50000	-880.92926	-266.69430	-475.83586
33	ENVULT MIN	0.75000	-872.86301	-211.06854	-445.37879
33	ENVULT MIN	1.00000	-864.79676	-158.10086	-440.62177
34	ENVULT MAX	0.00000	0.00000	191.21808	85.73569
34	ENVULT MAX	0.25000	0.00000	193.59991	85.14653
34	ENVULT MAX	0.50000	0.00000	195.98991	70.34227
34	ENVULT MAX	0.75000	0.00000	198.37991	43.34178
34	ENVULT MAX	1.00000	0.00000	217.77373	17.54889
34	ENVULT MIN	0.00000	-864.79674	-158.10086	-440.62177
34	ENVULT MIN	0.25000	-856.73049	-122.75807	-454.43792
34	ENVULT MIN	0.50000	-848.66424	-88.77198	-468.65571
34	ENVULT MIN	0.75000	-840.59799	-56.14256	-483.27513
34	ENVULT MIN	1.00000	-832.53174	-24.86983	-527.08465
35	ENVULT MAX	0.00000	0.00000	217.77370	17.54932

26	ENVULT MAX	0.50000	191.21808	424.33077	732.23781
FRAME	LOAD	DIST	P	V2	M3
35	ENVULT MAX	0.50000	0.00000	280.93554	0.00000
35	ENVULT MAX	0.75000	0.00000	319.12625	0.00000
35	ENVULT MAX	1.00000	0.00000	355.17491	0.00000
35	ENVULT MIN	0.00000	-832.53174	-24.86983	-527.08465
35	ENVULT MIN	0.25000	-824.46549	-2.15757	-584.32063
35	ENVULT MIN	0.50000	-816.39924	0.00000	-643.15609
35	ENVULT MIN	0.75000	-808.33299	0.00000	-704.92113
35	ENVULT MIN	1.00000	-800.26674	0.00000	-767.40019
36	ENVULT MAX	0.00000	0.00000	355.17504	0.00000
36	ENVULT MAX	0.25000	0.00000	362.30117	0.00000
36	ENVULT MAX	0.50000	0.00000	369.33727	0.00000
36	ENVULT MAX	0.75000	0.00000	376.28332	0.00000
36	ENVULT MAX	1.00000	0.00000	383.13934	0.00000
36	ENVULT MIN	0.00000	-800.26677	0.00000	-767.40019
36	ENVULT MIN	0.25000	-798.61302	0.00000	-780.29790
36	ENVULT MIN	0.50000	-796.95927	0.00000	-793.22563
36	ENVULT MIN	0.75000	-795.30552	0.00000	-806.18337
36	ENVULT MIN	1.00000	-793.65177	0.00000	-819.17112
37	ENVULT MAX	0.00000	0.00000	383.13920	0.00000
37	ENVULT MAX	0.22500	0.00000	395.49733	0.00000
37	ENVULT MAX	0.45000	0.00000	407.55170	0.00000
37	ENVULT MAX	0.67500	0.00000	419.30233	0.00000
37	ENVULT MAX	0.90000	0.00000	430.74920	0.00000
37	ENVULT MIN	0.00000	-793.65180	0.00000	-819.17112
37	ENVULT MIN	0.22500	-790.40336	0.00000	-843.10436
37	ENVULT MIN	0.45000	-786.73305	0.00000	-867.13885
37	ENVULT MIN	0.67500	-782.64086	0.00000	-891.27459
37	ENVULT MIN	0.90000	-778.12680	0.00000	-915.51158
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
38	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
39	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
40	ENVULT MAX	0.10000	0.00000	0.00000	0.00000
40	ENVULT MAX	0.32500	0.00000	0.00000	0.00000
40	ENVULT MAX	0.55000	0.00000	0.00000	0.00000
40	ENVULT MAX	0.77500	0.00000	0.00000	43.01281
40	ENVULT MAX	1.00000	0.00000	0.00000	89.92962
40	ENVULT MIN	0.10000	-477.94922	-668.56825	-739.87577
40	ENVULT MIN	0.32500	-477.94922	-648.85353	-666.13546
40	ENVULT MIN	0.55000	-477.94922	-629.56068	-594.58933
40	ENVULT MIN	0.77500	-477.94922	-610.68970	-525.18990
40	ENVULT MIN	1.00000	-477.94922	-592.24060	-457.88974
41	ENVULT MAX	0.00000	0.00000	0.00000	89.92962
41	ENVULT MAX	0.25000	0.00000	0.00000	102.02382
41	ENVULT MAX	0.50000	0.00000	0.00000	115.78401
41	ENVULT MAX	0.75000	0.00000	0.00000	129.65583
41	ENVULT MAX	1.00000	0.00000	0.00000	143.39181
41	ENVULT MIN	0.00000	-477.94922	-592.24057	-457.88974
41	ENVULT MIN	0.25000	-477.94922	-587.49865	-440.72984
41	ENVULT MIN	0.50000	-477.94922	-582.75673	-423.70864
41	ENVULT MIN	0.75000	-477.94922	-578.01481	-406.82614
41	ENVULT MIN	1.00000	-477.94922	-573.27288	-390.08234
42	ENVULT MAX	0.00000	0.00000	0.00000	143.39181
42	ENVULT MAX	0.25000	0.00000	0.00000	262.28524
42	ENVULT MAX	0.50000	0.00000	0.00000	369.90296
42	ENVULT MAX	0.75000	0.00000	0.00000	466.24498
42	ENVULT MAX	1.00000	0.00000	0.00000	551.31130
42	ENVULT MIN	0.00000	-477.94924	-573.27293	-390.08234
42	ENVULT MIN	0.25000	-477.94924	-530.06875	-263.79606
42	ENVULT MIN	0.50000	-477.94924	-486.86457	-183.78108
42	ENVULT MIN	0.75000	-477.94924	-443.66039	-110.00309
42	ENVULT MIN	1.00000	-477.94924	-400.45621	-42.46209
43	ENVULT MAX	0.00000	0.00000	0.00000	551.31130
43	ENVULT MAX	0.25000	0.00000	0.00000	625.16583
43	ENVULT MAX	0.50000	0.00000	0.00000	687.72350
43	ENVULT MAX	0.75000	0.00000	0.00000	738.98429
43	ENVULT MAX	1.00000	0.00000	0.00000	778.94822
43	ENVULT MIN	0.00000	-477.94925	-400.45620	-42.46209
43	ENVULT MIN	0.25000	-477.94925	-357.21149	0.00000
43	ENVULT MIN	0.50000	-477.94925	-313.96678	0.00000
43	ENVULT MIN	0.75000	-477.94925	-270.72207	0.00000

35	ENVULT MAX	0.25000	0.00000	243.54089	0.00000
FRAME	LOAD	DIST	P	V2	M3
44	ENVULT MAX	0.25000	0.00000	0.00000	807.61527
44	ENVULT MAX	0.50000	0.00000	0.00000	824.98545
44	ENVULT MAX	0.75000	0.00000	14.41595	831.05877
44	ENVULT MAX	1.00000	0.00000	51.96448	825.83521
44	ENVULT MIN	0.00000	-477.94925	-227.47736	0.00000
44	ENVULT MIN	0.25000	-477.94925	-184.23265	0.00000
44	ENVULT MIN	0.50000	-477.94925	-140.98794	0.00000
44	ENVULT MIN	0.75000	-477.94925	-97.74323	0.00000
44	ENVULT MIN	1.00000	-477.94925	-54.49852	0.00000
45	ENVULT MAX	0.00000	0.00000	51.37555	825.83521
45	ENVULT MAX	0.25000	0.00000	88.88889	809.33555
45	ENVULT MAX	0.50000	0.00000	128.59697	781.56019
45	ENVULT MAX	0.75000	0.00000	170.90731	742.50912
45	ENVULT MAX	1.00000	0.00000	213.21765	692.18235
45	ENVULT MIN	0.00000	-477.94924	-54.78095	0.00000
45	ENVULT MIN	0.25000	-477.94924	-30.92953	0.00000
45	ENVULT MIN	0.50000	-477.94924	-7.52616	0.00000
45	ENVULT MIN	0.75000	-477.94924	0.00000	0.00000
45	ENVULT MIN	1.00000	-477.94924	0.00000	0.00000
46	ENVULT MAX	0.00000	0.00000	213.21765	692.18235
46	ENVULT MAX	0.25000	0.00000	255.56768	630.51679
46	ENVULT MAX	0.50000	0.00000	297.91771	558.91162
46	ENVULT MAX	0.75000	0.00000	340.26774	478.06341
46	ENVULT MAX	1.00000	0.00000	382.61777	392.20927
46	ENVULT MIN	0.00000	-477.94923	0.00000	0.00000
46	ENVULT MIN	0.25000	-477.94923	0.00000	0.00000
46	ENVULT MIN	0.50000	-477.94923	0.00000	0.00000
46	ENVULT MIN	0.75000	-477.94923	0.00000	0.00000
46	ENVULT MIN	1.00000	-477.94923	0.00000	0.00000
47	ENVULT MAX	0.00000	0.00000	382.61777	392.20927
47	ENVULT MAX	0.25000	0.00000	424.96780	298.84092
47	ENVULT MAX	0.50000	0.00000	467.31783	203.83405
47	ENVULT MAX	0.75000	0.00000	509.66786	97.29165
47	ENVULT MAX	1.00000	0.00000	552.01789	0.00000
47	ENVULT MIN	0.00000	-477.94923	0.00000	0.00000
47	ENVULT MIN	0.25000	-477.94923	0.00000	0.00000
47	ENVULT MIN	0.50000	-477.94923	0.00000	-13.28141
47	ENVULT MIN	0.75000	-477.94923	0.00000	-62.36800
47	ENVULT MIN	1.00000	-477.94923	0.00000	-191.21969
48	ENVULT MAX	0.00000	0.00000	552.01789	0.00000
48	ENVULT MAX	0.25000	0.00000	594.32823	0.00000
48	ENVULT MAX	0.50000	0.00000	636.63857	0.00000
48	ENVULT MAX	0.75000	0.00000	678.94891	0.00000
48	ENVULT MAX	1.00000	0.00000	721.25925	0.00000
48	ENVULT MIN	0.00000	-477.94923	0.00000	-191.21969
48	ENVULT MIN	0.25000	-477.94923	0.00000	-329.95261
48	ENVULT MIN	0.50000	-477.94923	0.00000	-478.68283
48	ENVULT MIN	0.75000	-477.94923	0.00000	-650.56286
48	ENVULT MIN	1.00000	-477.94923	0.00000	-837.14059
49	ENVULT MAX	0.00000	0.00000	721.25925	0.00000
49	ENVULT MAX	0.25000	0.00000	733.84122	0.00000
49	ENVULT MAX	0.50000	0.00000	746.42319	0.00000
49	ENVULT MAX	0.75000	0.00000	759.00515	0.00000
49	ENVULT MAX	1.00000	0.00000	771.58712	0.00000
49	ENVULT MIN	0.00000	-477.94923	0.00000	-837.14059
49	ENVULT MIN	0.25000	-477.94923	0.00000	-894.79895
49	ENVULT MIN	0.50000	-477.94923	0.00000	-953.45443
49	ENVULT MIN	0.75000	-477.94923	0.00000	-1013.10700
49	ENVULT MIN	1.00000	-477.94923	0.00000	-1073.75700
50	ENVULT MAX	0.00000	0.00000	771.58712	0.00000
50	ENVULT MAX	0.22500	0.00000	789.59660	0.00000
50	ENVULT MAX	0.45000	0.00000	807.83476	0.00000
50	ENVULT MAX	0.67500	0.00000	826.07292	0.00000
50	ENVULT MAX	0.90000	0.00000	844.31109	0.00000
50	ENVULT MIN	0.00000	-477.94924	0.00000	-1073.75700
50	ENVULT MIN	0.22500	-477.94924	0.00000	-1161.56500
50	ENVULT MIN	0.45000	-477.94924	0.00000	-1251.38300
50	ENVULT MIN	0.67500	-477.94924	0.00000	-1343.20900
50	ENVULT MIN	0.90000	-477.94924	0.00000	-1437.04600
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
51	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000

43	ENVULT MIN	1.00000	-477.94925	-227.47736	0.00000
44	ENVULT MAX	0.00000	0.00000	0.00000	778.94822
FRAME	LOAD	DIST	P	V2	M3
53	ENVULT MAX	0.10000	0.00000	0.00000	0.00000
53	ENVULT MAX	0.32500	0.00000	0.00000	0.00000
53	ENVULT MAX	0.55000	0.00000	0.00000	0.00000
53	ENVULT MAX	0.77500	0.00000	0.00000	0.00000
53	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
53	ENVULT MIN	0.10000	-477.94925	-845.91956	-1444.68000
53	ENVULT MIN	0.32500	-477.94925	-828.05872	-1350.51900
53	ENVULT MIN	0.55000	-477.94925	-810.19789	-1258.36700
53	ENVULT MIN	0.77500	-477.94925	-792.33705	-1168.22400
53	ENVULT MIN	1.00000	-477.94925	-774.47621	-1080.09100
54	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
54	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
54	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
54	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
54	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
54	ENVULT MIN	0.00000	-477.94925	-774.47621	-1080.09100
54	ENVULT MIN	0.25000	-477.94925	-761.89424	-1019.21200
54	ENVULT MIN	0.50000	-477.94925	-749.31227	-959.33060
54	ENVULT MIN	0.75000	-477.94925	-736.73031	-900.44616
54	ENVULT MIN	1.00000	-477.94925	-724.14834	-842.55885
55	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
55	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
55	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
55	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
55	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
55	ENVULT MIN	0.00000	-477.94925	-724.14834	-842.55885
55	ENVULT MIN	0.25000	-477.94925	-681.83800	-655.21117
55	ENVULT MIN	0.50000	-477.94925	-639.52766	-482.22063
55	ENVULT MIN	0.75000	-477.94925	-597.21732	-332.78807
55	ENVULT MIN	1.00000	-477.94925	-554.90698	-193.35282
56	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
56	ENVULT MAX	0.25000	0.00000	0.00000	98.10484
56	ENVULT MAX	0.50000	0.00000	0.00000	204.25038
56	ENVULT MAX	0.75000	0.00000	0.00000	298.86039
56	ENVULT MAX	1.00000	0.00000	0.00000	391.96209
56	ENVULT MIN	0.00000	-477.94924	-554.90698	-193.35282
56	ENVULT MIN	0.25000	-477.94924	-512.55695	-63.79814
56	ENVULT MIN	0.50000	-477.94924	-470.20692	-13.28141
56	ENVULT MIN	0.75000	-477.94924	-427.85689	0.00000
56	ENVULT MIN	1.00000	-477.94924	-385.50686	0.00000
57	ENVULT MAX	0.00000	0.00000	0.00000	391.96209
57	ENVULT MAX	0.25000	0.00000	0.00000	479.11561
57	ENVULT MAX	0.50000	0.00000	0.00000	560.04055
57	ENVULT MAX	0.75000	0.00000	0.00000	633.84132
57	ENVULT MAX	1.00000	0.00000	0.00000	696.34522
57	ENVULT MIN	0.00000	-477.94923	-385.50686	0.00000
57	ENVULT MIN	0.25000	-477.94923	-343.15683	0.00000
57	ENVULT MIN	0.50000	-477.94923	-300.80680	0.00000
57	ENVULT MIN	0.75000	-477.94923	-258.45677	0.00000
57	ENVULT MIN	1.00000	-477.94923	-216.10674	0.00000
58	ENVULT MAX	0.00000	0.00000	0.00000	696.34522
58	ENVULT MAX	0.25000	0.00000	0.00000	747.50955
58	ENVULT MAX	0.50000	0.00000	9.27106	787.39817
58	ENVULT MAX	0.75000	0.00000	32.67442	816.01109
58	ENVULT MAX	1.00000	0.00000	56.09821	833.34830
58	ENVULT MIN	0.00000	-477.94923	-216.10674	0.00000
58	ENVULT MIN	0.25000	-477.94923	-173.79640	0.00000
58	ENVULT MIN	0.50000	-477.94923	-131.48606	0.00000
58	ENVULT MIN	0.75000	-477.94923	-91.52427	0.00000
58	ENVULT MIN	1.00000	-477.94923	-54.01093	0.00000
59	ENVULT MAX	0.00000	0.00000	56.07779	833.34830
59	ENVULT MAX	0.25000	0.00000	99.23077	839.41019
59	ENVULT MAX	0.50000	0.00000	142.47548	834.17522
59	ENVULT MAX	0.75000	0.00000	185.72019	817.64337
59	ENVULT MAX	1.00000	0.00000	228.96490	789.81466
59	ENVULT MIN	0.00000	-477.94923	-54.60304	0.00000
59	ENVULT MIN	0.25000	-477.94923	-17.05451	0.00000
59	ENVULT MIN	0.50000	-477.94923	0.00000	0.00000
59	ENVULT MIN	0.75000	-477.94923	0.00000	0.00000
59	ENVULT MIN	1.00000	-477.94923	0.00000	0.00000
60	ENVULT MAX	0.00000	0.00000	228.96489	789.81466
60	ENVULT MAX	0.25000	0.00000	272.20960	750.68907
60	ENVULT MAX	0.50000	0.00000	315.45431	700.26662
60	ENVULT MAX	0.75000	0.00000	358.69902	638.54729
60	ENVULT MAX	1.00000	0.00000	401.94373	565.53109
60	ENVULT MIN	0.00000	-477.94924	0.00000	0.00000
60	ENVULT MIN	0.25000	-477.94924	0.00000	0.00000
60	ENVULT MIN	0.50000	-477.94924	0.00000	0.00000
60	ENVULT MIN	0.75000	-477.94924	0.00000	0.00000
60	ENVULT MIN	1.00000	-477.94924	0.00000	-50.35700
61	ENVULT MAX	0.00000	0.00000	401.94374	565.53109
61	ENVULT MAX	0.25000	0.00000	445.14792	481.30233
61	ENVULT MAX	0.50000	0.00000	488.35210	385.79787
61	ENVULT MAX	0.75000	0.00000	531.55628	279.01770
61	ENVULT MAX	1.00000	0.00000	574.76047	160.96182
61	ENVULT MIN	0.00000	-477.94925	0.00000	-50.35700
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
52	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
61	ENVULT MIN	1.00000	-477.94925	0.00000	-399.80633
62	ENVULT MAX	0.00000	0.00000	574.76041	160.96182
62	ENVULT MAX	0.25000	0.00000	579.50233	147.31776
62	ENVULT MAX	0.50000	0.00000	584.24425	133.53787
62	ENVULT MAX	0.75000	0.00000	588.98617	119.62215
62	ENVULT MAX	1.00000	0.00000	593.72810	105.57060
62	ENVULT MIN	0.00000	-477.94925	0.00000	-399.80634
62	ENVULT MIN	0.25000	-477.94925	0.00000	-416.60105
62	ENVULT MIN	0.50000	-477.94925	0.00000	-433.53447
62	ENVULT MIN	0.75000	-477.94925	0.00000	-450.60658
62	ENVULT MIN	1.00000	-477.94925	0.00000	-467.81739
63	ENVULT MAX	0.00000	0.00000	593.72812	105.57060
63	ENVULT MAX	0.22500	0.00000	612.17722	58.38519
63	ENVULT MAX	0.45000	0.00000	631.04820	10.66442
63	ENVULT MAX	0.67500	0.00000	650.34105	0.00000
63	ENVULT MAX	0.90000	0.00000	670.05577	0.00000
63	ENVULT MIN	0.00000	-477.94925	0.00000	-467.81739
63	ENVULT MIN	0.22500	-477.94925	0.00000	-535.31338
63	ENVULT MIN	0.45000	-477.94925	0.00000	-604.90862
63	ENVULT MIN	0.67500	-477.94925	0.00000	-676.65057
63	ENVULT MIN	0.90000	-477.94925	0.00000	-750.58670
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
64	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
65	ENVULT MIN	0.00000	0.00000	0.00000	0.00000
66	ENVULT MAX	0.10000	0.00000	0.00000	0.00000
66	ENVULT MAX	0.32500	0.00000	0.00000	0.00000
66	ENVULT MAX	0.55000	0.00000	0.00000	0.00000
66	ENVULT MAX	0.77500	0.00000	0.00000	0.00000
66	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
66	ENVULT MIN	0.10000	-779.61434	-430.74919	-931.10794
66	ENVULT MIN	0.32500	-784.12841	-419.30231	-906.05240
66	ENVULT MIN	0.55000	-788.22059	-407.55169	-881.09812
66	ENVULT MIN	0.77500	-791.89091	-395.49731	-856.24508
66	ENVULT MIN	1.00000	-795.13934	-383.13919	-831.49330
67	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
67	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
67	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
67	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
67	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
67	ENVULT MIN	0.00000	-795.13931	-383.13932	-831.49330
67	ENVULT MIN	0.25000	-796.79306	-376.28330	-818.05990
67	ENVULT MIN	0.50000	-798.44681	-369.33724	-804.65651
67	ENVULT MIN	0.75000	-800.10056	-362.30115	-791.28313
67	ENVULT MIN	1.00000	-801.75431	-355.17502	-777.93976
68	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
68	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
68	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
68	ENVULT MAX	0.75000	0.00000	5.47970	0.00000
68	ENVULT MAX	1.00000	0.00000	32.78470	18.96709
68	ENVULT MIN	0.00000	-801.75428	-355.17492	-777.93976
68	ENVULT MIN	0.25000	-809.82053	-319.12626	-713.28702
68	ENVULT MIN	0.50000	-817.88678	-280.93555	-649.34829
68	ENVULT MIN	0.75000	-825.95303	-247.88821	-587.98626
68	ENVULT MIN	1.00000	-834.01928	-222.12103	-528.76747
69	ENVULT MAX	0.00000	0.00000	32.78470	18.96710
69	ENVULT MAX	0.25000	0.00000	64.05744	43.36721
69	ENVULT MAX	0.50000	0.00000	96.68685	70.41242
69	ENVULT MAX	0.75000	0.00000	130.67295	85.07180
69	ENVULT MAX	1.00000	0.00000	166.01573	85.51608
69	ENVULT MIN	0.00000	-834.01928	-222.12104	-528.76747
69	ENVULT MIN	0.25000	-842.08553	-205.65586	-483.12513
69	ENVULT MIN	0.50000	-850.15178	-203.26586	-467.51430
69	ENVULT MIN	0.75000	-858.21803	-200.87586	-452.30511
69	ENVULT MIN	1.00000	-866.28428	-199.13295	-437.49755
70	ENVULT MAX	0.00000	0.00000	166.01573	85.51598
70	ENVULT MAX	0.25000	0.00000	216.09253	71.34700
70	ENVULT MAX	0.50000	0.00000	271.71829	47.56292
70	ENVULT MAX	0.75000	0.00000	329.48608	46.82838
70	ENVULT MAX	1.00000	0.00000	389.39591	80.49486

61	ENVULT MIN	0.25000	-477.94925	0.00000	-118.36301
61	ENVULT MIN	0.50000	-477.94925	0.00000	-192.60601
61	ENVULT MIN	0.75000	-477.94925	0.00000	-273.08601
FRAME	LOAD	DIST	P	V2	M3
70	ENVULT MIN	0.75000	-890.48305	-199.13295	-564.84086
70	ENVULT MIN	1.00000	-898.54930	-199.13295	-654.60183
71	ENVULT MAX	0.00000	0.00000	389.39591	80.49486
71	ENVULT MAX	0.25000	0.00000	417.43003	102.83829
71	ENVULT MAX	0.50000	0.00000	445.90968	125.18173
71	ENVULT MAX	0.75000	0.00000	474.83488	147.52516
71	ENVULT MAX	1.00000	0.00000	504.20561	169.86859
71	ENVULT MIN	0.00000	-898.54926	-199.13295	-654.60183
71	ENVULT MIN	0.25000	-902.22801	-199.13295	-699.62580
71	ENVULT MIN	0.50000	-905.90676	-199.13295	-747.26373
71	ENVULT MIN	0.75000	-909.58551	-199.13295	-797.55405
71	ENVULT MIN	1.00000	-913.26426	-199.13295	-850.53524
72	ENVULT MAX	0.00000	0.00000	504.20564	169.86859
72	ENVULT MAX	0.08654	0.00000	516.46111	179.09294
72	ENVULT MAX	0.17308	0.00000	528.79252	188.31730
72	ENVULT MAX	0.25962	0.00000	541.19986	197.54165
72	ENVULT MAX	0.34615	0.00000	553.68314	206.76600
72	ENVULT MIN	0.00000	-913.26429	-199.13295	-850.53524
72	ENVULT MIN	0.08654	-914.78304	-199.13295	-873.20199
72	ENVULT MIN	0.17308	-916.30179	-199.13295	-896.33662
72	ENVULT MIN	0.25962	-917.82054	-199.13295	-919.94185
72	ENVULT MIN	0.34615	-919.33929	-199.13295	-946.59052
73	ENVULT MAX	0.11715	0.00000	75.49621	184.72551
73	ENVULT MAX	0.31590	0.00000	75.49621	95.07376
73	ENVULT MAX	0.51464	0.00000	75.49621	8.51403
73	ENVULT MAX	0.71339	0.00000	75.49621	84.22973
73	ENVULT MAX	0.91213	0.00000	75.49621	173.88147
73	ENVULT MIN	0.11715	-1782.28900	-75.49621	-184.72551
73	ENVULT MIN	0.31590	-1800.10200	-75.49621	-95.07376
73	ENVULT MIN	0.51464	-1817.91400	-75.49621	-8.51403
73	ENVULT MIN	0.71339	-1835.72700	-75.49621	-84.22973
73	ENVULT MIN	0.91213	-1853.53900	-75.49621	-173.88147

70	ENVULT MIN	0.00000	-866.28430	-199.13295	-437.49755
70	ENVULT MIN	0.25000	-874.35055	-199.13295	-450.28681
70	ENVULT MIN	0.50000	-882.41680	-199.13295	-487.05701

2) 사용하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVUSE MAX	0.27778	166.14226	0.00000	188.07012
1	ENVUSE MAX	0.45833	166.14226	0.00000	209.03799
1	ENVUSE MAX	0.63889	166.14226	0.00000	230.22041
1	ENVUSE MAX	0.81944	166.14226	0.00000	251.61738
1	ENVUSE MAX	1.00000	166.14226	0.00000	273.22891
1	ENVUSE MIN	0.27778	-461.34327	-493.67391	-794.16996
1	ENVUSE MIN	0.45833	-461.34327	-488.88016	-754.25370
1	ENVUSE MIN	0.63889	-461.34327	-484.08641	-714.72693
1	ENVUSE MIN	0.81944	-461.34327	-479.29266	-675.58966
1	ENVUSE MIN	1.00000	-461.34327	-474.49891	-636.84188
2	ENVUSE MAX	0.00000	166.14226	0.00000	273.22891
2	ENVUSE MAX	0.25000	166.14226	0.00000	314.84785
2	ENVUSE MAX	0.50000	166.14226	0.00000	357.24006
2	ENVUSE MAX	0.75000	166.14226	0.00000	400.40555
2	ENVUSE MAX	1.00000	166.14226	0.00000	444.34432
2	ENVUSE MIN	0.00000	-461.34327	-474.49892	-636.84188
2	ENVUSE MIN	0.25000	-461.34327	-465.39817	-564.35232
2	ENVUSE MIN	0.50000	-461.34327	-456.29742	-493.26655
2	ENVUSE MIN	0.75000	-461.34327	-447.19667	-423.58457
2	ENVUSE MIN	1.00000	-461.34327	-448.10971	-355.30637
3	ENVUSE MAX	0.00000	166.14226	0.00000	444.34432
3	ENVUSE MAX	0.25000	166.14226	0.00000	451.36115
3	ENVUSE MAX	0.50000	166.14226	0.00000	458.85186
3	ENVUSE MAX	0.75000	166.14226	0.00000	466.81643
3	ENVUSE MAX	1.00000	166.14226	0.00000	475.25487
3	ENVUSE MIN	0.00000	-461.34327	-343.11405	-355.30638
3	ENVUSE MIN	0.25000	-461.34327	-335.98980	-318.89158
3	ENVUSE MIN	0.50000	-461.34327	-328.86555	-284.71587
3	ENVUSE MIN	0.75000	-461.34327	-321.74130	-250.06630
3	ENVUSE MIN	1.00000	-461.34327	-314.61705	-214.94286
4	ENVUSE MAX	0.00000	166.14226	0.00000	475.25487
4	ENVUSE MAX	0.25000	166.14226	0.00000	480.71713
4	ENVUSE MAX	0.50000	166.14226	0.00000	486.32705
4	ENVUSE MAX	0.75000	166.14226	0.00000	492.08462
4	ENVUSE MAX	1.00000	166.14226	0.00000	497.98985
4	ENVUSE MIN	0.00000	-461.34327	-314.61705	-214.94286
4	ENVUSE MIN	0.25000	-461.34327	-309.72330	-192.90606
4	ENVUSE MIN	0.50000	-461.34327	-304.82955	-170.72161
4	ENVUSE MIN	0.75000	-461.34327	-299.93580	-148.38950
4	ENVUSE MIN	1.00000	-461.34327	-300.71457	-126.08822
5	ENVUSE MAX	0.00000	166.14226	0.00000	497.98985
5	ENVUSE MAX	0.25000	166.14226	0.00000	503.71143
5	ENVUSE MAX	0.50000	166.14226	0.00000	509.59570
5	ENVUSE MAX	0.75000	166.14226	0.00000	515.64264
5	ENVUSE MAX	1.00000	166.14226	0.00000	521.85227
5	ENVUSE MIN	0.00000	-461.34327	-300.71457	-126.08964
5	ENVUSE MIN	0.25000	-461.34327	-303.01394	-105.18034
5	ENVUSE MIN	0.50000	-461.34327	-305.31332	-84.10836
5	ENVUSE MIN	0.75000	-461.34327	-307.61269	-62.87370
5	ENVUSE MIN	1.00000	-461.34327	-309.91207	-41.47636
6	ENVUSE MAX	0.00000	166.14226	42.97512	521.85227
6	ENVUSE MAX	0.25000	166.14226	34.30574	511.54494
6	ENVUSE MAX	0.50000	166.14226	25.63637	503.55016
6	ENVUSE MAX	0.75000	166.14226	16.96699	501.82449
6	ENVUSE MAX	1.00000	166.14226	8.29762	503.52164
6	ENVUSE MIN	0.00000	-461.34327	-215.96474	-41.46896
6	ENVUSE MIN	0.25000	-461.34327	-200.22649	0.00000
6	ENVUSE MIN	0.50000	-461.34327	-184.48824	0.00000
6	ENVUSE MIN	0.75000	-461.34327	-189.29769	0.00000
6	ENVUSE MIN	1.00000	-461.34327	-197.96706	0.00000
7	ENVUSE MAX	0.00000	166.14226	84.09041	503.52164
7	ENVUSE MAX	0.25000	166.14226	75.42104	485.29833
7	ENVUSE MAX	0.50000	166.14226	66.75166	469.38758
7	ENVUSE MAX	0.75000	166.14226	58.08229	460.31889
7	ENVUSE MAX	1.00000	166.14226	49.41291	452.13202
7	ENVUSE MIN	0.00000	-461.34327	-123.84689	0.00000
7	ENVUSE MIN	0.25000	-461.34327	-108.10864	0.00000
7	ENVUSE MIN	0.50000	-461.34327	-95.76327	0.00000
7	ENVUSE MIN	0.75000	-461.34327	-104.43265	0.00000
7	ENVUSE MIN	1.00000	-461.34327	-113.10202	0.00000
8	ENVUSE MAX	0.00000	166.14226	104.41396	452.13202
8	ENVUSE MAX	0.25000	166.14226	95.75271	439.76055
8	ENVUSE MAX	0.50000	166.14226	87.09146	423.19877
8	ENVUSE MAX	0.75000	166.14226	85.73078	402.44667
8	ENVUSE MAX	1.00000	166.14226	101.45428	377.50426
8	ENVUSE MIN	0.00000	-461.34327	-51.24000	0.00000
8	ENVUSE MIN	0.25000	-461.34327	-35.51650	0.00000
8	ENVUSE MIN	0.50000	-461.34327	-26.19322	0.00000
8	ENVUSE MIN	0.75000	-461.34327	-34.85447	0.00000
8	ENVUSE MIN	1.00000	-461.34327	-43.51572	0.00000
9	ENVUSE MAX	0.75000	166.14226	148.66903	278.16197
9	ENVUSE MAX	1.00000	166.14226	164.40728	237.58180
9	ENVUSE MIN	0.00000	-461.34327	0.00000	0.00000
9	ENVUSE MIN	0.25000	-461.34327	0.00000	0.00000
9	ENVUSE MIN	0.50000	-461.34327	0.00000	0.00000
9	ENVUSE MIN	0.75000	-461.34327	0.00000	0.00000
9	ENVUSE MIN	1.00000	-461.34327	0.00000	0.00000
10	ENVUSE MAX	0.00000	166.14226	211.38612	237.58180
10	ENVUSE MAX	0.25000	166.14226	202.71675	200.85566
10	ENVUSE MAX	0.50000	166.14226	201.69862	161.90614
10	ENVUSE MAX	0.75000	166.14226	217.43687	119.34369
10	ENVUSE MAX	1.00000	166.14226	233.17512	79.56535
10	ENVUSE MIN	0.00000	-461.34327	0.00000	0.00000
10	ENVUSE MIN	0.25000	-461.34327	0.00000	0.00000
10	ENVUSE MIN	0.50000	-461.34327	0.00000	0.00000
10	ENVUSE MIN	0.75000	-461.34327	0.00000	0.00000
10	ENVUSE MIN	1.00000	-461.34327	0.00000	0.00000
11	ENVUSE MAX	0.00000	166.14226	346.41132	79.56535
11	ENVUSE MAX	0.25000	166.14226	337.75007	1.42729
11	ENVUSE MAX	0.50000	166.14226	329.08882	0.00000
11	ENVUSE MAX	0.75000	166.14226	344.01653	0.00000
11	ENVUSE MAX	1.00000	166.14226	359.74003	0.00000
11	ENVUSE MIN	0.00000	-461.34327	0.00000	0.00000
11	ENVUSE MIN	0.25000	-461.34327	0.00000	-75.44881
11	ENVUSE MIN	0.50000	-461.34327	0.00000	-158.76977
11	ENVUSE MIN	0.75000	-461.34327	0.00000	-239.78251
11	ENVUSE MIN	1.00000	-461.34327	0.00000	-325.48942
12	ENVUSE MAX	0.00000	166.14226	543.65915	0.00000
12	ENVUSE MAX	0.25000	166.14226	542.30227	0.00000
12	ENVUSE MAX	0.50000	166.14226	540.94540	0.00000
12	ENVUSE MAX	0.75000	166.14226	539.58852	0.00000
12	ENVUSE MAX	1.00000	166.14226	538.23165	0.00000
12	ENVUSE MIN	0.00000	-461.34327	0.00000	-325.48942
12	ENVUSE MIN	0.25000	-461.34327	0.00000	-345.30634
12	ENVUSE MIN	0.50000	-461.34327	0.00000	-365.22611
12	ENVUSE MIN	0.75000	-461.34327	0.00000	-387.26691
12	ENVUSE MIN	1.00000	-461.34327	0.00000	-409.76640
13	ENVUSE MAX	0.00000	166.14226	538.23165	0.00000
13	ENVUSE MAX	0.25000	166.14226	535.79415	0.00000
13	ENVUSE MAX	0.50000	166.14226	533.35665	0.00000
13	ENVUSE MAX	0.75000	166.14226	530.91915	0.00000
13	ENVUSE MAX	1.00000	166.14226	528.48165	0.00000
13	ENVUSE MIN	0.00000	-461.34327	0.00000	-409.76640
13	ENVUSE MIN	0.25000	-461.34327	0.00000	-450.04237
13	ENVUSE MIN	0.50000	-461.34327	0.00000	-490.13552
13	ENVUSE MIN	0.75000	-461.34327	0.00000	-530.04587
13	ENVUSE MIN	1.00000	-461.34327	0.00000	-569.77340
14	ENVUSE MAX	0.00000	166.14226	528.48165	0.00000
14	ENVUSE MAX	0.25000	166.14226	528.97634	0.00000
14	ENVUSE MAX	0.50000	166.14226	534.13884	0.00000
14	ENVUSE MAX	0.75000	166.14226	539.30134	0.00000
14	ENVUSE MAX	1.00000	166.14226	544.46384	0.00000
14	ENVUSE MIN	0.00000	-461.34327	0.00000	-569.77340
14	ENVUSE MIN	0.25000	-461.34327	0.00000	-615.89113
14	ENVUSE MIN	0.50000	-461.34327	0.00000	-661.76003
14	ENVUSE MIN	0.75000	-461.34327	0.00000	-707.38010
14	ENVUSE MIN	1.00000	-461.34327	0.00000	-752.75135
15	ENVUSE MAX	0.00000	166.14226	544.46384	0.00000
15	ENVUSE MAX	0.25000	166.14226	548.15134	0.00000
15	ENVUSE MAX	0.50000	166.14226	551.83884	0.00000
15	ENVUSE MAX	0.75000	166.14226	555.52634	0.00000
15	ENVUSE MAX	1.00000	166.14226	559.21384	0.00000
15	ENVUSE MIN	0.00000	-461.34327	0.00000	-752.75135
15	ENVUSE MIN	0.25000	-461.34327	0.00000	-785.00704
15	ENVUSE MIN	0.50000	-461.34327	0.00000	-817.13577
15	ENVUSE MIN	0.75000	-461.34327	0.00000	-849.13755
15	ENVUSE MIN	1.00000	-461.34327	0.00000	-881.01238
16	ENVUSE MAX	0.00000	131.39055	0.00000	0.00000
16	ENVUSE MAX	0.25000	131.39055	0.00000	0.00000
16	ENVUSE MAX	0.50000	131.39055	0.00000	0.00000
16	ENVUSE MAX	0.75000	131.39055	0.00000	0.00000
16	ENVUSE MAX	1.00000	131.39055	0.00000	0.00000
16	ENVUSE MIN	0.00000	-427.12339	-559.59656	-882.37280
16	ENVUSE MIN	0.25000	-427.12339	-555.90906	-850.41393
16	ENVUSE MIN	0.50000	-427.12339	-552.22156	-818.32810
16	ENVUSE MIN	0.75000	-427.12339	-548.53406	-786.11532
16	ENVUSE MIN	1.00000	-427.12339	-544.84656	-753.77559
17	ENVUSE MAX	0.00000	131.39055	0.00000	0.00000
17	ENVUSE MAX	0.25000	131.39055	0.00000	0.00000
17	ENVUSE MAX	0.50000	131.39055	0.00000	0.00000

9	ENVUSE MAX	0.00000	166.14226	137.84393	377.50426
9	ENVUSE MAX	0.25000	166.14226	129.17455	348.34224
9	ENVUSE MAX	0.50000	166.14226	132.93078	315.01809
FRAME	LOAD	DIST	P	V2	M3
17	ENVUSE MIN	0.25000	-427.12339	-539.68406	-708.28668
17	ENVUSE MIN	0.50000	-427.12339	-534.52156	-662.54895
17	ENVUSE MIN	0.75000	-427.12339	-529.35906	-616.56238
17	ENVUSE MIN	1.00000	-427.12339	-529.82634	-570.32699
18	ENVUSE MAX	0.00000	131.39055	0.00000	0.00000
18	ENVUSE MAX	0.25000	131.39055	0.00000	0.00000
18	ENVUSE MAX	0.50000	131.39055	0.00000	0.00000
18	ENVUSE MAX	0.75000	131.39055	0.00000	0.00000
18	ENVUSE MAX	1.00000	131.39055	0.00000	0.00000
18	ENVUSE MIN	0.00000	-427.12339	-529.82634	-570.32699
18	ENVUSE MIN	0.25000	-427.12339	-532.26384	-530.49861
18	ENVUSE MIN	0.50000	-427.12339	-534.70134	-490.48742
18	ENVUSE MIN	0.75000	-427.12339	-537.13884	-450.29341
18	ENVUSE MIN	1.00000	-427.12339	-539.57634	-409.91659
19	ENVUSE MAX	0.00000	131.39055	0.00000	0.00000
19	ENVUSE MAX	0.25000	131.39055	0.00000	0.00000
19	ENVUSE MAX	0.50000	131.39055	0.00000	0.00000
19	ENVUSE MAX	0.75000	131.39055	0.00000	0.00000
19	ENVUSE MAX	1.00000	131.39055	0.00000	0.00000
19	ENVUSE MIN	0.00000	-427.12339	-539.57634	-409.91659
19	ENVUSE MIN	0.25000	-427.12339	-540.93322	-387.36095
19	ENVUSE MIN	0.50000	-427.12339	-542.29009	-364.95962
19	ENVUSE MIN	0.75000	-427.12339	-543.64697	-345.02377
19	ENVUSE MIN	1.00000	-427.12339	-545.00384	-325.19077
20	ENVUSE MAX	0.00000	131.39055	0.00000	0.00000
20	ENVUSE MAX	0.25000	131.39055	0.00000	0.00000
20	ENVUSE MAX	0.50000	131.39055	0.00000	0.00000
20	ENVUSE MAX	0.75000	131.39055	0.00000	0.93333
20	ENVUSE MAX	1.00000	131.39055	0.00000	78.91731
20	ENVUSE MIN	0.00000	-427.12340	-359.81679	-325.19077
20	ENVUSE MIN	0.25000	-427.12340	-344.09329	-239.55982
20	ENVUSE MIN	0.50000	-427.12340	-329.57789	-158.40530
20	ENVUSE MIN	0.75000	-427.12340	-338.23914	-74.94255
20	ENVUSE MIN	1.00000	-427.12340	-346.90039	0.00000
21	ENVUSE MAX	0.00000	131.39055	0.00000	78.91731
21	ENVUSE MAX	0.25000	131.39055	0.00000	118.84539
21	ENVUSE MAX	0.50000	131.39055	0.00000	161.47980
21	ENVUSE MAX	0.75000	131.39055	0.00000	200.54690
21	ENVUSE MAX	1.00000	131.39055	0.00000	237.33578
21	ENVUSE MIN	0.00000	-427.12339	-232.87664	0.00000
21	ENVUSE MIN	0.25000	-427.12339	-217.13839	0.00000
21	ENVUSE MIN	0.50000	-427.12339	-201.40014	0.00000
21	ENVUSE MIN	0.75000	-427.12339	-202.39964	0.00000
21	ENVUSE MIN	1.00000	-427.12339	-211.06902	0.00000
22	ENVUSE MAX	0.00000	131.39055	0.00000	237.33578
22	ENVUSE MAX	0.25000	131.39055	0.00000	277.86366
22	ENVUSE MAX	0.50000	131.39055	0.00000	314.64405
22	ENVUSE MAX	0.75000	131.39055	0.00000	347.81541
22	ENVUSE MAX	1.00000	131.39055	0.00000	376.78859
22	ENVUSE MIN	0.00000	-427.12339	-163.69935	0.00000
22	ENVUSE MIN	0.25000	-427.12339	-147.96110	0.00000
22	ENVUSE MIN	0.50000	-427.12339	-132.22285	0.00000
22	ENVUSE MIN	0.75000	-427.12339	-128.04770	0.00000
22	ENVUSE MIN	1.00000	-427.12339	-136.71708	0.00000
23	ENVUSE MAX	0.00000	131.39055	41.37344	376.78859
23	ENVUSE MAX	0.25000	131.39055	32.71219	401.54234
23	ENVUSE MAX	0.50000	131.39055	24.05094	422.10577
23	ENVUSE MAX	0.75000	131.39055	34.03041	438.47889
23	ENVUSE MAX	1.00000	131.39055	49.75391	450.66170
23	ENVUSE MIN	0.00000	-427.12339	-100.74635	0.00000
23	ENVUSE MIN	0.25000	-427.12339	-85.02285	0.00000
23	ENVUSE MIN	0.50000	-427.12339	-85.12212	0.00000
23	ENVUSE MIN	0.75000	-427.12339	-93.78337	0.00000
23	ENVUSE MIN	1.00000	-427.12339	-102.44462	0.00000
24	ENVUSE MAX	0.00000	131.39055	110.06779	450.66170
24	ENVUSE MAX	0.25000	131.39055	101.39842	458.65973
24	ENVUSE MAX	0.50000	131.39055	92.72904	464.85520
24	ENVUSE MAX	0.75000	131.39055	106.16992	480.02191
24	ENVUSE MAX	1.00000	131.39055	121.90817	497.50117
24	ENVUSE MIN	0.00000	-427.12340	-46.62362	0.00000
24	ENVUSE MIN	0.25000	-427.12340	-55.29299	0.00000
24	ENVUSE MIN	0.50000	-427.12340	-63.96237	0.00000
24	ENVUSE MIN	0.75000	-427.12340	-72.63174	0.00000
24	ENVUSE MIN	1.00000	-427.12340	-81.30112	0.00000
25	ENVUSE MAX	0.00000	131.39055	194.28745	497.50117
25	ENVUSE MAX	0.25000	131.39055	185.61808	494.90172
25	ENVUSE MAX	0.50000	131.39055	182.14935	495.72509
25	ENVUSE MAX	0.75000	131.39055	197.88760	502.81757
25	ENVUSE MAX	1.00000	131.39055	213.62585	512.22260
25	ENVUSE MIN	0.00000	-427.12340	-4.91504	0.00000
25	ENVUSE MIN	0.25000	-427.12340	-13.58441	0.00000
25	ENVUSE MIN	0.50000	-427.12340	-22.25379	0.00000
25	ENVUSE MIN	0.75000	-427.12340	-30.92316	0.00000
25	ENVUSE MIN	1.00000	-427.12340	-39.59254	-30.90920
26	ENVUSE MAX	0.00000	131.39055	306.28803	512.22260
17	ENVUSE MAX	0.75000	131.39055	0.00000	0.00000
17	ENVUSE MAX	1.00000	131.39055	0.00000	0.00000
17	ENVUSE MIN	0.00000	-427.12339	-544.84656	-753.77559
FRAME	LOAD	DIST	P	V2	M3
26	ENVUSE MIN	0.00000	-427.12340	0.00000	-30.90847
26	ENVUSE MIN	0.25000	-427.12340	0.00000	-52.04786
26	ENVUSE MIN	0.50000	-427.12340	0.00000	-73.02457
26	ENVUSE MIN	0.75000	-427.12340	0.00000	-93.83860
26	ENVUSE MIN	1.00000	-427.12340	0.00000	-114.48995
27	ENVUSE MAX	0.00000	131.39055	297.09053	487.41736
27	ENVUSE MAX	0.25000	131.39055	297.63661	481.26227
27	ENVUSE MAX	0.50000	131.39055	302.53036	475.25484
27	ENVUSE MAX	0.75000	131.39055	307.42411	469.39506
27	ENVUSE MAX	1.00000	131.39055	312.31786	463.68294
27	ENVUSE MIN	0.00000	-427.12340	0.00000	-114.48854
27	ENVUSE MIN	0.25000	-427.12340	0.00000	-136.61681
27	ENVUSE MIN	0.50000	-427.12340	0.00000	-158.67711
27	ENVUSE MIN	0.75000	-427.12340	0.00000	-180.58976
27	ENVUSE MIN	1.00000	-427.12340	0.00000	-202.35475
28	ENVUSE MAX	0.00000	131.39055	312.31786	463.68294
28	ENVUSE MAX	0.25000	131.39055	319.44211	454.84222
28	ENVUSE MAX	0.50000	131.39055	326.56636	446.47537
28	ENVUSE MAX	0.75000	131.39055	333.69061	438.58239
28	ENVUSE MAX	1.00000	131.39055	340.81486	431.16327
28	ENVUSE MIN	0.00000	-427.12339	0.00000	-202.35475
28	ENVUSE MIN	0.25000	-427.12339	0.00000	-237.04059
28	ENVUSE MIN	0.50000	-427.12339	0.00000	-271.25257
28	ENVUSE MIN	0.75000	-427.12339	0.00000	-305.49926
28	ENVUSE MIN	1.00000	-427.12339	0.00000	-346.22253
29	ENVUSE MAX	0.00000	131.39055	446.10269	431.16327
29	ENVUSE MAX	0.25000	131.39055	445.92254	386.93992
29	ENVUSE MAX	0.50000	131.39055	455.02329	343.48983
29	ENVUSE MAX	0.75000	131.39055	464.12404	300.81303
29	ENVUSE MAX	1.00000	131.39055	473.22479	258.90949
29	ENVUSE MIN	0.00000	-427.12336	0.00000	-346.22253
29	ENVUSE MIN	0.25000	-427.12336	0.00000	-414.30419
29	ENVUSE MIN	0.50000	-427.12336	0.00000	-483.78964
29	ENVUSE MIN	0.75000	-427.12336	0.00000	-554.67887
29	ENVUSE MIN	1.00000	-427.12336	0.00000	-626.97190
30	ENVUSE MAX	0.00000	131.39055	473.22480	258.90949
30	ENVUSE MAX	0.18056	131.39055	478.01855	237.14806
30	ENVUSE MAX	0.36111	131.39055	482.81230	215.60118
30	ENVUSE MAX	0.54167	131.39055	487.60605	194.26886
30	ENVUSE MAX	0.72222	131.39055	492.39980	173.15108
30	ENVUSE MIN	0.00000	-427.12332	0.00000	-626.97190
30	ENVUSE MIN	0.18056	-427.12332	0.00000	-665.61616
30	ENVUSE MIN	0.36111	-427.12332	0.00000	-704.64992
30	ENVUSE MIN	0.54167	-427.12332	0.00000	-744.07316
30	ENVUSE MIN	0.72222	-427.12332	0.00000	-783.88590
31	ENVUSE MAX	0.65385	0.00000	131.39055	85.24015
31	ENVUSE MAX	0.74038	0.00000	131.39055	77.84943
31	ENVUSE MAX	0.82692	0.00000	131.39055	70.45871
31	ENVUSE MAX	0.91346	0.00000	131.39055	63.06799
31	ENVUSE MAX	1.00000	0.00000	131.39055	55.67728
31	ENVUSE MIN	0.65385	-638.10583	-366.64059	-677.31793
31	ENVUSE MIN	0.74038	-636.84021	-358.83854	-656.91405
31	ENVUSE MIN	0.82692	-635.57458	-351.08395	-636.94771
31	ENVUSE MIN	0.91346	-634.30896	-343.37682	-617.80950
31	ENVUSE MIN	1.00000	-633.04333	-335.71715	-602.67306
32	ENVUSE MAX	0.00000	0.00000	131.39055	55.67728
32	ENVUSE MAX	0.25000	0.00000	131.39055	37.77531
32	ENVUSE MAX	0.50000	0.00000	131.39055	19.87335
32	ENVUSE MAX	0.75000	0.00000	131.39055	1.97139
32	ENVUSE MAX	1.00000	0.00000	131.39055	0.00000
32	ENVUSE MIN	0.00000	-633.04334	-335.71712	-602.67306
32	ENVUSE MIN	0.25000	-629.97771	-317.36042	-567.21095
32	ENVUSE MIN	0.50000	-626.91209	-299.28217	-533.43061
32	ENVUSE MIN	0.75000	-623.84646	-281.48239	-501.30803
32	ENVUSE MIN	1.00000	-620.78084	-263.96106	-470.81917
33	ENVUSE MAX	0.00000	0.00000	131.39055	0.00000
33	ENVUSE MAX	0.25000	0.00000	131.39055	0.00000
33	ENVUSE MAX	0.50000	0.00000	131.39055	0.00000
33	ENVUSE MAX	0.75000	0.00000	131.39055	0.00000
33	ENVUSE MAX	1.00000	0.00000	131.39055	0.00000
33	ENVUSE MIN	0.00000	-620.78088	-263.96107	-470.81917
33	ENVUSE MIN	0.25000	-614.05900	-226.51743	-409.56827
33	ENVUSE MIN	0.50000	-607.33713	-190.41256	-356.40273
33	ENVUSE MIN	0.75000	-600.61525	-155.64646	-330.73892
33	ENVUSE MIN	1.00000	-593.89338	-122.21914	-321.13763
34	ENVUSE MAX	0.00000	0.00000	131.39055	0.00000
34	ENVUSE MAX	0.25000	0.00000	131.39055	0.00000
34	ENVUSE MAX	0.50000	0.00000	131.39055	0.00000
34	ENVUSE MAX	0.75000	0.00000	131.39055	0.00000
34	ENVUSE MAX	1.00000	0.00000	146.82623	0.00000
34	ENVUSE MIN	0.00000	-593.89340	-122.21914	-321.13763
34	ENVUSE MIN	0.25000	-587.17152	-98.91006	-323.14458
34	ENVUSE MIN	0.50000	-580.44965	-77.66875	-325.40255
34	ENVUSE MIN	0.75000	-573.72777	-57.27537	-327.91154
34	ENVUSE MIN	1.00000	-567.00590	-37.72991	-353.84919

26	ENVUSE MAX	0.25000	131.39055	303.98865	505.77727
26	ENVUSE MAX	0.50000	131.39055	301.68928	499.49462
26	ENVUSE MAX	0.75000	131.39055	299.38990	493.37465
26	ENVUSE MAX	1.00000	131.39055	297.09053	487.41736
FRAME	LOAD	DIST	P	V2	M3
35	ENVUSE MAX	1.00000	0.00000	226.33241	0.00000
35	ENVUSE MIN	0.00000	-567.00592	-37.77918	-353.84919
35	ENVUSE MIN	0.25000	-560.28405	-24.00428	-389.10267
35	ENVUSE MIN	0.50000	-553.56217	-15.91965	-425.35582
35	ENVUSE MIN	0.75000	-546.84030	-8.25896	-463.43997
35	ENVUSE MIN	1.00000	-540.11842	-1.02219	-501.97037
36	ENVUSE MAX	0.00000	0.00000	226.33249	0.00000
36	ENVUSE MAX	0.25000	0.00000	230.48007	0.00000
36	ENVUSE MAX	0.50000	0.00000	234.57138	0.00000
36	ENVUSE MAX	0.75000	0.00000	238.60641	0.00000
36	ENVUSE MAX	1.00000	0.00000	242.58518	0.00000
36	ENVUSE MIN	0.00000	-540.11846	-3.64144	-501.97037
36	ENVUSE MIN	0.25000	-538.74033	-2.21011	-509.92504
36	ENVUSE MIN	0.50000	-537.36221	-0.79662	-517.89846
36	ENVUSE MIN	0.75000	-535.98408	-0.60959	-525.89064
36	ENVUSE MIN	1.00000	-534.60596	-0.60959	-533.90158
37	ENVUSE MAX	0.00000	0.00000	242.58509	0.00000
37	ENVUSE MAX	0.22500	0.00000	249.74642	0.00000
37	ENVUSE MAX	0.45000	0.00000	256.71790	0.00000
37	ENVUSE MAX	0.67500	0.00000	263.49954	0.00000
37	ENVUSE MAX	0.90000	0.00000	270.09134	0.00000
37	ENVUSE MIN	0.00000	-534.60599	-2.30071	-533.90158
37	ENVUSE MIN	0.22500	-531.89896	-2.30071	-548.66441
37	ENVUSE MIN	0.45000	-528.84036	-2.30071	-563.49053
37	ENVUSE MIN	0.67500	-525.43021	-2.30071	-578.37992
37	ENVUSE MIN	0.90000	-521.66849	-2.30071	-593.33260
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
38	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
39	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.10000	14.17260	0.00000	0.00000
40	ENVUSE MAX	0.32500	14.17260	0.00000	13.37498
40	ENVUSE MAX	0.55000	14.17260	0.00000	46.16080
40	ENVUSE MAX	0.77500	14.17260	0.00000	77.65981
40	ENVUSE MAX	1.00000	14.17260	0.00000	107.91154
40	ENVUSE MIN	0.10000	-297.09135	-443.50601	-479.93582
40	ENVUSE MIN	0.32500	-297.09135	-430.03272	-434.85724
40	ENVUSE MIN	0.55000	-297.09135	-416.91101	-391.13225
40	ENVUSE MIN	0.77500	-297.09135	-404.14085	-348.72129
40	ENVUSE MIN	1.00000	-297.09135	-391.72226	-307.58482
41	ENVUSE MAX	0.00000	15.20215	0.00000	107.91032
41	ENVUSE MAX	0.25000	15.20215	0.00000	115.61774
41	ENVUSE MAX	0.50000	15.20215	0.00000	124.43304
41	ENVUSE MAX	0.75000	15.20215	0.00000	133.49546
41	ENVUSE MAX	1.00000	15.20215	0.00000	142.46661
41	ENVUSE MIN	0.00000	-297.09135	-391.72224	-307.58482
41	ENVUSE MIN	0.25000	-297.09135	-388.53911	-297.09333
41	ENVUSE MIN	0.50000	-297.09135	-385.35598	-286.68533
41	ENVUSE MIN	0.75000	-297.09135	-382.17285	-276.36080
41	ENVUSE MIN	1.00000	-297.09135	-378.98972	-266.11976
42	ENVUSE MAX	0.00000	17.31628	0.00000	142.46661
42	ENVUSE MAX	0.25000	17.31628	0.00000	219.99988
42	ENVUSE MAX	0.50000	17.31628	0.00000	289.95684
42	ENVUSE MAX	0.75000	17.31628	0.00000	352.33751
42	ENVUSE MAX	1.00000	17.31628	0.00000	407.14187
42	ENVUSE MIN	0.00000	-297.09136	-378.98975	-266.11976
42	ENVUSE MIN	0.25000	-297.09136	-349.98789	-176.65778
42	ENVUSE MIN	0.50000	-297.09136	-320.98603	-94.12580
42	ENVUSE MIN	0.75000	-297.09136	-291.98417	-18.52382
42	ENVUSE MIN	1.00000	-297.09136	-262.98230	0.00000
43	ENVUSE MAX	0.00000	20.25594	0.00000	407.14187
43	ENVUSE MAX	0.25000	20.25594	0.00000	454.41069
43	ENVUSE MAX	0.50000	20.25594	0.00000	494.08898
43	ENVUSE MAX	0.75000	20.25594	0.00000	526.17676
43	ENVUSE MAX	1.00000	20.25594	0.00000	550.67401
43	ENVUSE MIN	0.00000	-297.09137	-262.98231	0.00000
43	ENVUSE MIN	0.25000	-297.09137	-233.95324	0.00000
43	ENVUSE MIN	0.50000	-297.09137	-204.92417	0.00000
35	ENVUSE MAX	0.00000	0.00000	146.82623	0.00000
35	ENVUSE MAX	0.25000	0.00000	161.43697	0.00000
35	ENVUSE MAX	0.50000	0.00000	182.92030	0.00000
35	ENVUSE MAX	0.75000	0.00000	205.29574	0.00000
FRAME	LOAD	DIST	P	V2	M3
44	ENVUSE MAX	0.75000	22.55837	17.95989	578.62267
44	ENVUSE MAX	1.00000	22.55837	43.41451	572.75784
44	ENVUSE MIN	0.00000	-297.09137	-146.86604	0.00000
44	ENVUSE MIN	0.25000	-297.09137	-117.83697	0.00000
44	ENVUSE MIN	0.50000	-297.09137	-88.80791	0.00000
44	ENVUSE MIN	0.75000	-297.09137	-62.48222	0.00000
44	ENVUSE MIN	1.00000	-297.09137	-36.45408	0.00000
45	ENVUSE MAX	0.00000	24.34561	42.85043	572.75784
45	ENVUSE MAX	0.25000	24.34561	68.28120	559.31867
45	ENVUSE MAX	0.50000	24.34561	95.08368	538.30319
45	ENVUSE MAX	0.75000	24.34561	123.51256	509.71141
45	ENVUSE MAX	1.00000	24.34561	151.94145	473.54334
45	ENVUSE MIN	0.00000	-297.09136	-36.53635	0.00000
45	ENVUSE MIN	0.25000	-297.09136	-10.53261	0.00000
45	ENVUSE MIN	0.50000	-297.09136	0.00000	0.00000
45	ENVUSE MIN	0.75000	-297.09136	0.00000	0.00000
45	ENVUSE MIN	1.00000	-297.09136	0.00000	0.00000
46	ENVUSE MAX	0.00000	25.69771	151.94145	473.54334
46	ENVUSE MAX	0.25000	25.69771	180.39701	429.75438
46	ENVUSE MAX	0.50000	25.69771	208.85256	378.96167
46	ENVUSE MAX	0.75000	25.69771	237.30812	321.92292
46	ENVUSE MAX	1.00000	25.69771	265.76368	261.41248
46	ENVUSE MIN	0.00000	-297.09136	0.00000	0.00000
46	ENVUSE MIN	0.25000	-297.09136	0.00000	0.00000
46	ENVUSE MIN	0.50000	-297.09136	0.00000	0.00000
46	ENVUSE MIN	0.75000	-297.09136	0.00000	0.00000
46	ENVUSE MIN	1.00000	-297.09136	0.00000	0.00000
47	ENVUSE MAX	0.00000	26.65659	265.76368	261.41248
47	ENVUSE MAX	0.25000	26.65659	294.21923	195.52711
47	ENVUSE MAX	0.50000	26.65659	322.67479	130.19523
47	ENVUSE MAX	0.75000	26.65659	351.13034	57.11985
47	ENVUSE MAX	1.00000	26.65659	379.58590	0.00000
47	ENVUSE MIN	0.00000	-297.09136	0.00000	0.00000
47	ENVUSE MIN	0.25000	-297.09136	0.00000	0.00000
47	ENVUSE MIN	0.50000	-297.09136	0.00000	-15.40724
47	ENVUSE MIN	0.75000	-297.09136	0.00000	-45.91604
47	ENVUSE MIN	1.00000	-297.09136	0.00000	-135.40616
48	ENVUSE MAX	0.00000	27.23883	379.58590	0.00000
48	ENVUSE MAX	0.25000	27.23883	408.01479	0.00000
48	ENVUSE MAX	0.50000	27.23883	436.44368	0.00000
48	ENVUSE MAX	0.75000	27.23883	464.87256	0.00000
48	ENVUSE MAX	1.00000	27.23883	493.34444	0.00000
48	ENVUSE MIN	0.00000	-297.09136	0.00000	-135.40616
48	ENVUSE MIN	0.25000	-297.09136	0.00000	-231.59289
48	ENVUSE MIN	0.50000	-297.09136	0.00000	-334.55692
48	ENVUSE MIN	0.75000	-297.09136	0.00000	-452.51855
48	ENVUSE MIN	1.00000	-297.09136	0.00000	-580.19524
49	ENVUSE MAX	0.00000	27.38001	493.34443	0.00000
49	ENVUSE MAX	0.25000	27.38001	501.96881	0.00000
49	ENVUSE MAX	0.50000	27.38001	510.59320	0.00000
49	ENVUSE MAX	0.75000	27.38001	519.21758	0.00000
49	ENVUSE MAX	1.00000	27.38001	527.84196	0.00000
49	ENVUSE MIN	0.00000	-297.09136	0.00000	-580.19524
49	ENVUSE MIN	0.25000	-297.09136	0.00000	-619.62437
49	ENVUSE MIN	0.50000	-297.09136	0.00000	-659.72348
49	ENVUSE MIN	0.75000	-297.09136	0.00000	-700.49257
49	ENVUSE MIN	1.00000	-297.09136	0.00000	-741.93163
50	ENVUSE MAX	0.00000	27.42262	527.84198	0.00000
50	ENVUSE MAX	0.22500	27.42262	540.08479	0.00000
50	ENVUSE MAX	0.45000	27.42262	552.32760	0.00000
50	ENVUSE MAX	0.67500	27.42262	564.57041	0.00000
50	ENVUSE MAX	0.90000	27.42262	576.81323	0.00000
50	ENVUSE MIN	0.00000	-297.09136	0.00000	-741.93163
50	ENVUSE MIN	0.22500	-297.09136	0.00000	-801.90739
50	ENVUSE MIN	0.45000	-297.09136	0.00000	-863.23326
50	ENVUSE MIN	0.67500	-297.09136	0.00000	-925.90924
50	ENVUSE MIN	0.90000	-297.09136	0.00000	-989.93532
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
51	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000

43	ENVUSE MIN	0.75000	-297.09137	-175.89510	0.00000
43	ENVUSE MIN	1.00000	-297.09137	-146.86603	0.00000
44	ENVUSE MAX	0.00000	22.55837	0.00000	550.67401
44	ENVUSE MAX	0.25000	22.55837	0.00000	567.58075
44	ENVUSE MAX	0.50000	22.55837	0.00000	576.89697

FRAME	LOAD	DIST	P	V2	M3
53	ENVUSE MAX	0.55000	25.01229	0.00000	0.00000
53	ENVUSE MAX	0.77500	25.01229	0.00000	0.00000
53	ENVUSE MAX	1.00000	25.01229	0.00000	0.00000
53	ENVUSE MIN	0.10000	-297.09137	-577.35398	-994.70668
53	ENVUSE MIN	0.32500	-297.09137	-565.11117	-930.47746
53	ENVUSE MIN	0.55000	-297.09137	-552.92498	-867.59835
53	ENVUSE MIN	0.77500	-297.09137	-540.92404	-806.06934
53	ENVUSE MIN	1.00000	-297.09137	-528.92311	-745.89044
54	ENVUSE MAX	0.00000	24.97396	0.00000	0.00000
54	ENVUSE MAX	0.25000	24.97396	0.00000	0.00000
54	ENVUSE MAX	0.50000	24.97396	0.00000	0.00000
54	ENVUSE MAX	0.75000	24.97396	0.00000	0.00000
54	ENVUSE MAX	1.00000	24.97396	0.00000	0.00000
54	ENVUSE MIN	0.00000	-297.09137	-528.92311	-745.89044
54	ENVUSE MIN	0.25000	-297.09137	-520.46911	-704.30827
54	ENVUSE MIN	0.50000	-297.09137	-512.01512	-663.39609
54	ENVUSE MIN	0.75000	-297.09137	-503.56112	-623.15388
54	ENVUSE MIN	1.00000	-297.09137	-495.10713	-583.58165
55	ENVUSE MAX	0.00000	24.84967	0.00000	0.00000
55	ENVUSE MAX	0.25000	24.84967	0.00000	0.00000
55	ENVUSE MAX	0.50000	24.84967	0.00000	0.00000
55	ENVUSE MAX	0.75000	24.84967	0.00000	0.00000
55	ENVUSE MAX	1.00000	24.84967	0.00000	0.00000
55	ENVUSE MIN	0.00000	-297.09137	-495.10713	-583.58165
55	ENVUSE MIN	0.25000	-297.09137	-466.67824	-455.42375
55	ENVUSE MIN	0.50000	-297.09137	-438.24936	-336.76804
55	ENVUSE MIN	0.75000	-297.09137	-409.82047	-233.36506
55	ENVUSE MIN	1.00000	-297.09137	-381.39158	-136.73937
56	ENVUSE MAX	0.00000	24.26727	0.00000	0.00000
56	ENVUSE MAX	0.25000	24.26727	0.00000	57.61996
56	ENVUSE MAX	0.50000	24.26727	0.00000	130.44872
56	ENVUSE MAX	0.75000	24.26727	0.00000	195.53398
56	ENVUSE MAX	1.00000	24.26727	0.00000	261.20351
56	ENVUSE MIN	0.00000	-297.09136	-381.39158	-136.73937
56	ENVUSE MIN	0.25000	-297.09136	-352.93602	-46.80988
56	ENVUSE MIN	0.50000	-297.09136	-324.48047	-15.40724
56	ENVUSE MIN	0.75000	-297.09136	-296.02491	0.00000
56	ENVUSE MIN	1.00000	-297.09136	-267.56936	0.00000
57	ENVUSE MAX	0.00000	23.31408	0.00000	261.20351
57	ENVUSE MAX	0.25000	23.31408	0.00000	322.59098
57	ENVUSE MAX	0.50000	23.31408	0.00000	379.92876
57	ENVUSE MAX	0.75000	23.31408	0.00000	431.83221
57	ENVUSE MAX	1.00000	23.31408	0.00000	476.14514
57	ENVUSE MIN	0.00000	-297.09136	-267.56936	0.00000
57	ENVUSE MIN	0.25000	-297.09136	-239.11380	0.00000
57	ENVUSE MIN	0.50000	-297.09136	-210.65824	0.00000
57	ENVUSE MIN	0.75000	-297.09136	-182.20269	0.00000
57	ENVUSE MIN	1.00000	-297.09136	-153.74713	0.00000
58	ENVUSE MAX	0.00000	21.96509	0.00000	476.14514
58	ENVUSE MAX	0.25000	21.96509	0.00000	512.83668
58	ENVUSE MAX	0.50000	21.96509	0.00000	541.95193
58	ENVUSE MAX	0.75000	21.96509	11.54090	563.49087
58	ENVUSE MAX	1.00000	21.96509	37.54464	577.45352
58	ENVUSE MIN	0.00000	-297.09135	-153.74713	0.00000
58	ENVUSE MIN	0.25000	-297.09135	-125.31824	0.00000
58	ENVUSE MIN	0.50000	-297.09135	-96.88936	0.00000
58	ENVUSE MIN	0.75000	-297.09135	-69.92831	0.00000
58	ENVUSE MIN	1.00000	-297.09135	-44.49755	0.00000
59	ENVUSE MAX	0.00000	20.18440	37.54464	577.45352
59	ENVUSE MAX	0.25000	20.18440	63.57277	583.84231
59	ENVUSE MAX	0.50000	20.18440	89.73198	582.64057
59	ENVUSE MAX	0.75000	20.18440	118.76105	573.84832
59	ENVUSE MAX	1.00000	20.18440	147.79012	557.46554
59	ENVUSE MIN	0.00000	-297.09136	-45.06937	0.00000
59	ENVUSE MIN	0.25000	-297.09136	-19.61475	0.00000
59	ENVUSE MIN	0.50000	-297.09136	0.00000	0.00000
59	ENVUSE MIN	0.75000	-297.09136	0.00000	0.00000
59	ENVUSE MIN	1.00000	-297.09136	0.00000	0.00000
60	ENVUSE MAX	0.00000	17.89625	147.79011	557.46554
60	ENVUSE MAX	0.25000	17.89625	176.81918	533.49225
60	ENVUSE MAX	0.50000	17.89625	205.84825	501.92843
60	ENVUSE MAX	0.75000	17.89625	234.87732	462.77410
60	ENVUSE MAX	1.00000	17.89625	263.90639	416.02924
60	ENVUSE MIN	0.00000	-297.09136	0.00000	0.00000
60	ENVUSE MIN	0.25000	-297.09136	0.00000	0.00000
60	ENVUSE MIN	0.50000	-297.09136	0.00000	0.00000
60	ENVUSE MIN	0.75000	-297.09136	0.00000	0.00000
60	ENVUSE MIN	1.00000	-297.09136	0.00000	0.00000
61	ENVUSE MAX	0.00000	14.97082	263.90639	416.02924
61	ENVUSE MAX	0.25000	14.97082	292.90825	361.74835
61	ENVUSE MAX	0.50000	14.97082	321.91011	299.89115
61	ENVUSE MAX	0.75000	14.97082	350.91197	230.45766
61	ENVUSE MAX	1.00000	14.97082	379.91384	153.44787

52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
52	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
53	ENVUSE MAX	0.10000	25.01229	0.00000	0.00000
53	ENVUSE MAX	0.32500	25.01229	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
62	ENVUSE MAX	0.25000	12.85776	383.09693	144.53417
62	ENVUSE MAX	0.50000	12.85776	386.28006	135.52920
62	ENVUSE MAX	0.75000	12.85776	389.46319	126.43297
62	ENVUSE MAX	1.00000	12.85776	392.64632	117.36834
62	ENVUSE MIN	0.00000	-297.09137	0.00000	-272.21662
62	ENVUSE MIN	0.25000	-297.09137	0.00000	-282.48956
62	ENVUSE MIN	0.50000	-297.09137	0.00000	-292.84598
62	ENVUSE MIN	0.75000	-297.09137	0.00000	-303.28588
62	ENVUSE MIN	1.00000	-297.09137	0.00000	-313.80927
63	ENVUSE MAX	0.00000	11.82951	392.64633	117.36982
63	ENVUSE MAX	0.22500	11.82951	405.06493	87.30774
63	ENVUSE MAX	0.45000	11.82951	417.83508	55.99839
63	ENVUSE MAX	0.67500	11.82951	430.95680	23.40221
63	ENVUSE MAX	0.90000	11.82951	444.43008	0.00000
63	ENVUSE MIN	0.00000	-297.09137	0.00000	-313.80926
63	ENVUSE MIN	0.22500	-297.09137	0.00000	-355.06842
63	ENVUSE MIN	0.45000	-297.09137	0.00000	-397.60207
63	ENVUSE MIN	0.67500	-297.09137	0.00000	-441.44975
63	ENVUSE MIN	0.90000	-297.09137	0.00000	-486.65101
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
64	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
65	ENVUSE MIN	0.00000	0.00000	0.00000	0.00000
66	ENVUSE MAX	0.10000	0.00000	0.00000	0.00000
66	ENVUSE MAX	0.32500	0.00000	0.00000	0.00000
66	ENVUSE MAX	0.55000	0.00000	0.00000	0.00000
66	ENVUSE MAX	0.77500	0.00000	0.00000	0.00000
66	ENVUSE MAX	1.00000	0.00000	1.93381	0.00000
66	ENVUSE MIN	0.10000	-522.59259	-270.09133	-603.08032
66	ENVUSE MIN	0.32500	-526.35431	-263.49953	-587.61606
66	ENVUSE MIN	0.55000	-529.76446	-256.71789	-572.21507
66	ENVUSE MIN	0.77500	-532.82306	-249.74641	-556.87737
66	ENVUSE MIN	1.00000	-535.53009	-242.58508	-541.60294
67	ENVUSE MAX	0.00000	0.00000	0.12687	0.00000
67	ENVUSE MAX	0.25000	0.00000	1.50472	0.00000
67	ENVUSE MAX	0.50000	0.00000	2.90040	0.00000
67	ENVUSE MAX	0.75000	0.00000	4.31389	0.00000
67	ENVUSE MAX	1.00000	0.00000	5.74521	0.00000
67	ENVUSE MIN	0.00000	-535.53006	-242.58516	-541.60294
67	ENVUSE MIN	0.25000	-536.90818	-238.60640	-533.31347
67	ENVUSE MIN	0.50000	-538.28631	-234.57136	-525.04276
67	ENVUSE MIN	0.75000	-539.66443	-230.48006	-516.79081
67	ENVUSE MIN	1.00000	-541.04256	-226.33247	-508.55761
68	ENVUSE MAX	0.00000	0.00000	3.11805	0.00000
68	ENVUSE MAX	0.25000	0.00000	10.35482	0.00000
68	ENVUSE MAX	0.50000	0.00000	18.01552	0.00000
68	ENVUSE MAX	0.75000	0.00000	26.10014	0.00000
68	ENVUSE MAX	1.00000	0.00000	42.70454	0.00000
68	ENVUSE MIN	0.00000	-541.04252	-226.33241	-508.55761
68	ENVUSE MIN	0.25000	-547.76440	-205.29575	-468.66865
68	ENVUSE MIN	0.50000	-554.48627	-182.92031	-429.22595
68	ENVUSE MIN	0.75000	-561.20815	-164.18346	-391.39368
68	ENVUSE MIN	1.00000	-567.93002	-149.57272	-354.90095
69	ENVUSE MAX	0.00000	0.00000	42.67671	0.00000
69	ENVUSE MAX	0.25000	0.00000	62.22216	0.00000
69	ENVUSE MAX	0.50000	0.00000	82.61555	0.00000
69	ENVUSE MAX	0.75000	0.00000	103.85686	0.00000
69	ENVUSE MAX	1.00000	0.00000	125.94610	0.00000
69	ENVUSE MIN	0.00000	-567.93000	-149.57272	-354.90095
69	ENVUSE MIN	0.25000	-574.65188	-135.93802	-327.81779
69	ENVUSE MIN	0.50000	-581.37375	-135.93802	-324.68917
69	ENVUSE MIN	0.75000	-588.09563	-135.93802	-321.81157
69	ENVUSE MIN	1.00000	-594.81750	-135.93802	-319.18499
70	ENVUSE MAX	0.00000	0.00000	125.94610	0.00000
70	ENVUSE MAX	0.25000	0.00000	158.77764	0.00000
70	ENVUSE MAX	0.50000	0.00000	193.54374	0.00000
70	ENVUSE MAX	0.75000	0.00000	229.64861	0.00000

61	ENVUSE MIN	0.00000	-297.09137	0.00000	0.00000
61	ENVUSE MIN	0.25000	-297.09137	0.00000	-23.74877
61	ENVUSE MIN	0.50000	-297.09137	0.00000	-99.64139
61	ENVUSE MIN	0.75000	-297.09137	0.00000	-182.46400
61	ENVUSE MIN	1.00000	-297.09137	0.00000	-272.21661
62	ENVUSE MAX	0.00000	12.85776	379.91379	153.44787
FRAME	LOAD	DIST	P	V2	M3
71	ENVUSE MAX	0.00000	0.00000	267.09225	0.00000
71	ENVUSE MAX	0.25000	0.00000	284.61358	12.30642
71	ENVUSE MAX	0.50000	0.00000	302.41336	30.82798
71	ENVUSE MAX	0.75000	0.00000	320.49161	49.34953
71	ENVUSE MAX	1.00000	0.00000	338.84832	67.87109
71	ENVUSE MIN	0.00000	-621.70495	-135.93802	-481.38776
71	ENVUSE MIN	0.25000	-624.77058	-135.93802	-512.55062
71	ENVUSE MIN	0.50000	-627.83620	-135.93802	-545.34720
71	ENVUSE MIN	0.75000	-630.90183	-135.93802	-579.80153
71	ENVUSE MIN	1.00000	-633.96745	-135.93802	-615.93765
72	ENVUSE MAX	0.00000	0.00000	338.84834	67.87109
72	ENVUSE MAX	0.08654	0.00000	346.50800	75.51760
72	ENVUSE MAX	0.17308	0.00000	354.21513	83.16411
72	ENVUSE MAX	0.25962	0.00000	361.96972	90.81063
72	ENVUSE MAX	0.34615	0.00000	369.77177	98.45714
72	ENVUSE MIN	0.00000	-633.96746	-135.93802	-615.93765
72	ENVUSE MIN	0.08654	-635.23308	-135.93802	-631.35235
72	ENVUSE MIN	0.17308	-636.49871	-135.93802	-647.05947
72	ENVUSE MIN	0.25962	-637.76433	-135.93802	-665.85051
72	ENVUSE MIN	0.34615	-639.02996	-135.93802	-686.43052
73	ENVUSE MAX	0.11715	0.00000	47.18513	115.45344
73	ENVUSE MAX	0.31590	0.00000	47.18513	59.42110
73	ENVUSE MAX	0.51464	0.00000	47.18513	5.32127
73	ENVUSE MAX	0.71339	0.00000	47.18513	52.64358
73	ENVUSE MAX	0.91213	0.00000	47.18513	108.67592
73	ENVUSE MIN	0.11715	-1218.79500	-47.18513	-115.45344
73	ENVUSE MIN	0.31590	-1233.63900	-47.18513	-59.42110
73	ENVUSE MIN	0.51464	-1248.48300	-47.18513	-5.32127
73	ENVUSE MIN	0.71339	-1263.32700	-47.18513	-52.64358
73	ENVUSE MIN	0.91213	-1278.17000	-47.18513	-108.67592

70	ENVUSE MAX	1.00000	0.00000	267.09226	0.00000
70	ENVUSE MIN	0.00000	-594.81749	-135.93802	-319.18499
70	ENVUSE MIN	0.25000	-601.53937	-135.93802	-333.80643
70	ENVUSE MIN	0.50000	-608.26124	-135.93802	-363.41595
70	ENVUSE MIN	0.75000	-614.98312	-135.93802	-418.65900
70	ENVUSE MIN	1.00000	-621.70499	-135.93802	-481.38776

19. OUTPUT DATA (기능수행)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.27778	179.20730	35.22975	386.70506
1	ENVEQ MAX	0.45833	176.26938	32.85319	385.44324
1	ENVEQ MAX	0.63889	173.33147	30.47663	384.43887
1	ENVEQ MAX	0.81944	170.39355	28.10007	383.69197
1	ENVEQ MAX	1.00000	167.45563	25.72350	383.20253
1	ENVEQ MIN	0.27778	-446.99288	-266.29502	-583.09093
1	ENVEQ MIN	0.45833	-444.05496	-269.46377	-561.32638
1	ENVEQ MIN	0.63889	-441.11704	-272.63252	-539.30437
1	ENVEQ MIN	0.81944	-438.17912	-275.80127	-520.21456
1	ENVEQ MIN	1.00000	-435.24120	-278.97002	-502.28106
2	ENVEQ MAX	0.00000	167.45563	26.00940	383.20253
2	ENVEQ MAX	0.25000	161.87810	21.49759	382.99804
2	ENVEQ MAX	0.50000	156.30058	16.98577	386.55408
2	ENVEQ MAX	0.75000	150.72305	12.47396	391.84106
2	ENVEQ MAX	1.00000	145.14552	7.96215	406.56241
2	ENVEQ MIN	0.00000	-435.24120	-278.97002	-502.28106
2	ENVEQ MIN	0.25000	-429.66367	-284.98577	-467.70373
2	ENVEQ MIN	0.50000	-424.08615	-291.00152	-432.43045
2	ENVEQ MIN	0.75000	-418.50862	-297.01727	-396.46123
2	ENVEQ MIN	1.00000	-412.93110	-303.03302	-359.79606
3	ENVEQ MAX	0.00000	154.47934	53.44805	406.56241
3	ENVEQ MAX	0.25000	150.11315	49.91611	408.29620
3	ENVEQ MAX	0.50000	145.74695	46.38417	410.59863
3	ENVEQ MAX	0.75000	141.38075	42.85223	413.46970
3	ENVEQ MAX	1.00000	137.01455	39.32030	416.90941
3	ENVEQ MIN	0.00000	-421.55506	-193.72486	-359.79606
3	ENVEQ MIN	0.25000	-417.18886	-198.43411	-339.95871
3	ENVEQ MIN	0.50000	-412.82266	-203.14336	-319.69488
3	ENVEQ MIN	0.75000	-408.45646	-207.85261	-299.00456
3	ENVEQ MIN	1.00000	-404.09027	-212.56186	-277.88777
4	ENVEQ MAX	0.00000	137.01455	39.48670	416.90941
4	ENVEQ MAX	0.25000	134.30262	37.71483	419.31107
4	ENVEQ MAX	0.50000	131.59070	35.94295	421.88991
4	ENVEQ MAX	0.75000	128.87877	34.17108	424.64595
4	ENVEQ MAX	1.00000	126.16685	32.39920	427.57917
4	ENVEQ MIN	0.00000	-404.09026	-212.56186	-277.88777
4	ENVEQ MIN	0.25000	-401.37834	-214.92436	-264.57285
4	ENVEQ MIN	0.50000	-398.66641	-217.28686	-251.12505
4	ENVEQ MIN	0.75000	-395.95449	-219.64936	-237.54435
4	ENVEQ MIN	1.00000	-393.24256	-222.01186	-223.83076
5	ENVEQ MAX	0.00000	126.16685	32.51785	427.57917
5	ENVEQ MAX	0.25000	123.60860	30.44841	430.52735
5	ENVEQ MAX	0.50000	121.05035	28.37897	433.67076
5	ENVEQ MAX	0.75000	118.49210	26.30954	437.00938
5	ENVEQ MAX	1.00000	115.93385	24.24010	440.54321
5	ENVEQ MIN	0.00000	-393.24256	-222.01186	-223.83076
5	ENVEQ MIN	0.25000	-390.68431	-224.77111	-210.75839
5	ENVEQ MIN	0.50000	-388.12606	-227.53036	-197.53961
5	ENVEQ MIN	0.75000	-385.56781	-230.28961	-184.17441
5	ENVEQ MIN	1.00000	-383.00956	-233.04886	-170.66280
6	ENVEQ MAX	0.00000	125.66345	64.54491	440.54321
6	ENVEQ MAX	0.25000	116.01803	56.74247	433.16313
6	ENVEQ MAX	0.50000	106.37262	48.94003	428.55812
6	ENVEQ MAX	0.75000	96.72721	41.13759	426.72817
6	ENVEQ MAX	1.00000	87.08179	33.33516	427.67329
6	ENVEQ MIN	0.00000	-391.84424	-124.83035	-170.66280
6	ENVEQ MIN	0.25000	-382.19883	-135.23360	-139.52191
6	ENVEQ MIN	0.50000	-372.55341	-145.63685	-106.29971
6	ENVEQ MIN	0.75000	-362.90800	-156.04010	-76.12324
6	ENVEQ MIN	1.00000	-353.26259	-166.44335	-47.76401
7	ENVEQ MAX	0.00000	97.28576	79.94102	427.67329
7	ENVEQ MAX	0.25000	87.64035	69.53777	409.71576
7	ENVEQ MAX	0.50000	77.99493	59.13452	394.53331
7	ENVEQ MAX	0.75000	68.34952	48.88398	382.12592
7	ENVEQ MAX	1.00000	58.70411	41.08154	372.49360
7	ENVEQ MIN	0.00000	-362.28042	-65.34132	-47.76401
7	ENVEQ MIN	0.25000	-352.63501	-73.14376	-34.30792
7	ENVEQ MIN	0.50000	-342.98959	-81.23470	-19.04194
7	ENVEQ MIN	0.75000	-333.34418	-91.63795	-1.74772
7	ENVEQ MIN	1.00000	-323.69877	-102.04120	0.00000
8	ENVEQ MAX	0.00000	68.94642	114.06682	372.49360
8	ENVEQ MAX	0.25000	59.31005	103.67332	343.47972
8	ENVEQ MAX	0.50000	49.67367	93.27982	317.23572
8	ENVEQ MAX	0.75000	40.03730	82.88632	293.76158
8	ENVEQ MAX	1.00000	30.40092	72.49282	273.05731
8	ENVEQ MIN	0.00000	-332.88523	-18.60855	0.00000
8	ENVEQ MIN	0.25000	-323.24885	-26.40367	0.00000
8	ENVEQ MIN	0.50000	-313.61248	-34.19880	0.00000
8	ENVEQ MIN	0.75000	-303.97611	-41.99392	0.00000
8	ENVEQ MIN	1.00000	-294.33973	-49.78905	0.00000
9	ENVEQ MAX	0.00000	40.80558	161.74669	273.05731
9	ENVEQ MAX	0.25000	31.16017	151.34344	231.29892
9	ENVEQ MAX	0.50000	21.51476	140.94019	194.09965
9	ENVEQ MAX	0.75000	11.86934	130.53694	159.93991
9	ENVEQ MAX	1.00000	2.22393	120.13369	129.22686
9	ENVEQ MIN	0.00000	-303.68023	0.00000	0.00000
9	ENVEQ MIN	0.25000	-294.03482	0.00000	0.00000
9	ENVEQ MIN	0.50000	-284.38940	-0.83099	0.00000
9	ENVEQ MIN	0.75000	-274.74399	-8.63342	0.00000
9	ENVEQ MIN	1.00000	-265.09858	-16.43586	0.00000
10	ENVEQ MAX	0.00000	12.86334	218.59900	129.22686
10	ENVEQ MAX	0.25000	3.21793	208.19575	92.87289
10	ENVEQ MAX	0.50000	0.00000	197.79250	60.73269
10	ENVEQ MAX	0.75000	0.00000	187.38925	35.63707
10	ENVEQ MAX	1.00000	0.00000	176.98600	22.63649
10	ENVEQ MIN	0.00000	-275.09501	0.00000	0.00000
10	ENVEQ MIN	0.25000	-265.44959	0.00000	0.00000
10	ENVEQ MIN	0.50000	-255.80418	0.00000	-10.72848
10	ENVEQ MIN	0.75000	-246.15877	0.00000	-50.80523
10	ENVEQ MIN	1.00000	-236.51335	0.00000	-95.59732
11	ENVEQ MAX	0.00000	0.00000	286.11406	22.63649
11	ENVEQ MAX	0.25000	0.00000	275.72056	2.18773
11	ENVEQ MAX	0.50000	0.00000	265.32706	0.00000
11	ENVEQ MAX	0.75000	0.00000	254.93356	0.00000
11	ENVEQ MAX	1.00000	0.00000	244.54006	0.00000
11	ENVEQ MIN	0.00000	-246.85691	0.00000	-95.59732
11	ENVEQ MIN	0.25000	-237.22053	0.00000	-165.16328
11	ENVEQ MIN	0.50000	-227.58416	0.00000	-235.32952
11	ENVEQ MIN	0.75000	-218.73429	0.00000	-304.65425
11	ENVEQ MIN	1.00000	-228.37066	0.00000	-371.20911
12	ENVEQ MAX	0.00000	0.00000	363.43916	0.00000
12	ENVEQ MAX	0.25000	0.00000	361.81091	0.00000
12	ENVEQ MAX	0.50000	0.00000	360.18266	0.00000
12	ENVEQ MAX	0.75000	0.00000	358.55441	0.00000
12	ENVEQ MAX	1.00000	0.00000	356.92616	0.00000
12	ENVEQ MIN	0.00000	-218.76675	0.00000	-371.20911
12	ENVEQ MIN	0.25000	-219.94934	0.00000	-386.34870
12	ENVEQ MIN	0.50000	-221.45898	0.00000	-401.42032
12	ENVEQ MIN	0.75000	-222.96862	0.00000	-416.42396
12	ENVEQ MIN	1.00000	-224.47826	0.00000	-431.35961
13	ENVEQ MAX	0.00000	0.00000	356.92616	0.00000
13	ENVEQ MAX	0.25000	0.00000	354.00116	0.00000
13	ENVEQ MAX	0.50000	0.00000	351.07616	0.00000
13	ENVEQ MAX	0.75000	0.00000	348.15116	0.00000
13	ENVEQ MAX	1.00000	0.00000	345.22616	0.00000
13	ENVEQ MIN	0.00000	-224.47826	0.00000	-431.35961
13	ENVEQ MIN	0.25000	-227.19018	0.00000	-458.01939
13	ENVEQ MIN	0.50000	-229.90211	0.00000	-484.45979
13	ENVEQ MIN	0.75000	-232.61403	0.00000	-510.68081
13	ENVEQ MIN	1.00000	-235.32596	0.00000	-536.68246
14	ENVEQ MAX	0.00000	0.00000	345.22616	0.00000
14	ENVEQ MAX	0.25000	0.00000	341.81366	0.00000
14	ENVEQ MAX	0.50000	0.00000	338.40116	0.00000
14	ENVEQ MAX	0.75000	0.00000	334.98866	0.00000
14	ENVEQ MAX	1.00000	0.00000	331.57616	0.00000
14	ENVEQ MIN	0.00000	-235.32596	0.00000	-536.68246
14	ENVEQ MIN	0.25000	-238.48987	0.00000	-566.74045
14	ENVEQ MIN	0.50000	-241.65378	0.00000	-596.49985
14	ENVEQ MIN	0.75000	-244.81770	0.00000	-625.96066
14	ENVEQ MIN	1.00000	-247.98161	0.00000	-655.12287
15	ENVEQ MAX	0.00000	0.00000	331.57616	0.00000
15	ENVEQ MAX	0.25000	0.00000	329.13866	0.00000
15	ENVEQ MAX	0.50000	0.00000	326.70116	0.00000
15	ENVEQ MAX	0.75000	0.00000	324.26366	0.00000
15	ENVEQ MAX	1.00000	0.00000	321.82616	0.00000
15	ENVEQ MIN	0.00000	-247.98161	0.00000	-655.12287
15	ENVEQ MIN	0.25000	-250.24155	0.00000	-675.77020
15	ENVEQ MIN	0.50000	-252.50149	0.00000	-696.26520
15	ENVEQ MIN	0.75000	-254.76142	0.00000	-716.60785
15	ENVEQ MIN	1.00000	-257.02136	0.00000	-736.79816
16	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
16	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
16	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
16	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
16	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
16	ENVEQ MIN	0.00000	-257.02136	-321.82616	-736.79816
16	ENVEQ MIN	0.25000	-254.76142	-324.26366	-716.60785
16	ENVEQ MIN	0.50000	-252.50149	-326.70116	-696.26520
16	ENVEQ MIN	0.75000	-250.24155	-329.13866	-675.77020
16	ENVEQ MIN	1.00000	-247.98161	-331.57616	-655.12287
17	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
17	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
17	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
17	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
17	ENVEQ MIN	0.00000	-247.98161	-331.57616	-655.12287
17	ENVEQ MIN	0.25000	-244.81770	-334.98866	-625.96066
17	ENVEQ MIN	0.50000	-241.65378	-338.40116	-596.49985
17	ENVEQ MIN	0.75000	-238.48987	-341.81366	-566.74045
17	ENVEQ MIN	1.00000	-235.32596	-345.22616	-536.68246
18	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
18	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
18	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
18	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
18	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
18	ENVEQ MIN	0.00000	-235.32596	-345.22616	-536.68246
18	ENVEQ MIN	0.25000	-232.61403	-348.15116	-510.68081
18	ENVEQ MIN	0.50000	-229.90211	-351.07616	-484.45979
18	ENVEQ MIN	0.75000	-227.19018	-354.00116	-458.01939
18	ENVEQ MIN	1.00000	-224.47826	-356.92616	-431.35961
19	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
19	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
19	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
19	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
19	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
19	ENVEQ MIN	0.00000	-224.47826	-356.92616	-431.35961
19	ENVEQ MIN	0.25000	-222.96862	-358.55441	-416.42396
19	ENVEQ MIN	0.50000	-221.45898	-360.18266	-401.42032
19	ENVEQ MIN	0.75000	-219.94934	-361.81091	-386.34870
19	ENVEQ MIN	1.00000	-218.76675	-363.43916	-371.20911
20	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
20	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
20	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
20	ENVEQ MAX	0.75000	0.00000	0.00000	2.18771
20	ENVEQ MAX	1.00000	0.00000	0.00000	22.63648
20	ENVEQ MIN	0.00000	-228.37066	-244.54006	-371.20911
20	ENVEQ MIN	0.25000	-218.73429	-254.93356	-304.65425
20	ENVEQ MIN	0.50000	-227.58416	-265.32706	-235.32952
20	ENVEQ MIN	0.75000	-237.22053	-275.72056	-165.16328
20	ENVEQ MIN	1.00000	-246.85691	-286.11406	-95.59732
21	ENVEQ MAX	0.00000	0.00000	0.00000	22.63649
21	ENVEQ MAX	0.25000	0.00000	0.00000	35.63707
21	ENVEQ MAX	0.50000	0.00000	0.00000	60.73269
21	ENVEQ MAX	0.75000	3.21794	0.00000	92.87289
21	ENVEQ MAX	1.00000	12.86335	0.00000	129.22686
21	ENVEQ MIN	0.00000	-236.51335	-176.98600	-95.59732
21	ENVEQ MIN	0.25000	-246.15877	-187.38925	-50.80523
21	ENVEQ MIN	0.50000	-255.80418	-197.79250	-10.72848
21	ENVEQ MIN	0.75000	-265.44959	-208.19575	0.00000
21	ENVEQ MIN	1.00000	-275.09501	-218.59900	0.00000
22	ENVEQ MAX	0.00000	2.22394	16.43586	129.22686
22	ENVEQ MAX	0.25000	11.86935	8.63342	159.93991
22	ENVEQ MAX	0.50000	21.51476	0.83099	194.09965
22	ENVEQ MAX	0.75000	31.16018	0.00000	231.29892
22	ENVEQ MAX	1.00000	40.80559	0.00000	273.05731
22	ENVEQ MIN	0.00000	-265.09858	-120.13369	0.00000
22	ENVEQ MIN	0.25000	-274.74399	-130.53694	0.00000
22	ENVEQ MIN	0.50000	-284.38940	-140.94019	0.00000
22	ENVEQ MIN	0.75000	-294.03482	-151.34344	0.00000
22	ENVEQ MIN	1.00000	-303.68023	-161.74669	0.00000
23	ENVEQ MAX	0.00000	30.40092	49.78905	273.05731
23	ENVEQ MAX	0.25000	40.03730	41.99392	293.76158
23	ENVEQ MAX	0.50000	49.67367	34.19880	317.23572
23	ENVEQ MAX	0.75000	59.31005	26.40367	343.47972
23	ENVEQ MAX	1.00000	68.94642	18.60855	372.49360
23	ENVEQ MIN	0.00000	-294.33973	-72.49282	0.00000
23	ENVEQ MIN	0.25000	-303.97611	-82.88632	0.00000
23	ENVEQ MIN	0.50000	-313.61248	-93.27982	0.00000
23	ENVEQ MIN	0.75000	-323.24885	-103.67332	0.00000
23	ENVEQ MIN	1.00000	-332.88523	-114.06682	0.00000
24	ENVEQ MAX	0.00000	58.70411	102.04120	372.49360
24	ENVEQ MAX	0.25000	68.34952	91.63795	382.12592
24	ENVEQ MAX	0.50000	77.99493	81.23470	394.53331
24	ENVEQ MAX	0.75000	87.64035	73.14376	409.71576
24	ENVEQ MAX	1.00000	97.28576	65.34132	427.67329
24	ENVEQ MIN	0.00000	-323.69877	-41.08154	0.00000
24	ENVEQ MIN	0.25000	-333.34418	-48.88398	-1.74771
24	ENVEQ MIN	0.50000	-342.98959	-59.13452	-19.04194
24	ENVEQ MIN	0.75000	-352.63501	-69.53777	-34.30792
24	ENVEQ MIN	1.00000	-362.28042	-79.94102	-47.76401
25	ENVEQ MAX	0.00000	87.08179	166.44335	427.67329
25	ENVEQ MAX	0.25000	96.72721	156.04010	426.72817
25	ENVEQ MAX	0.50000	106.37262	145.63685	428.55812
25	ENVEQ MAX	0.75000	116.01803	135.23360	433.16313
25	ENVEQ MAX	1.00000	125.66345	124.83035	440.54321
25	ENVEQ MIN	0.00000	-353.26259	-33.33516	-47.76401
25	ENVEQ MIN	0.25000	-362.90800	-41.13759	-76.12324
25	ENVEQ MIN	0.50000	-372.55341	-48.94003	-106.29971
25	ENVEQ MIN	0.75000	-382.19883	-56.74247	-139.52191
25	ENVEQ MIN	1.00000	-391.84424	-64.54491	-170.66280
26	ENVEQ MAX	0.00000	115.93385	233.04886	440.54321
26	ENVEQ MAX	0.25000	118.49210	230.28961	437.00938
26	ENVEQ MAX	0.75000	123.60860	224.77111	430.52735
26	ENVEQ MAX	1.00000	126.16685	222.01186	427.57917
26	ENVEQ MIN	0.00000	-383.00956	-24.24008	-170.66280
26	ENVEQ MIN	0.25000	-385.56781	-26.30952	-184.17441
26	ENVEQ MIN	0.50000	-388.12606	-28.37896	-197.53961
26	ENVEQ MIN	0.75000	-390.68431	-30.44840	-210.75839
26	ENVEQ MIN	1.00000	-393.24256	-32.51783	-223.83076
27	ENVEQ MAX	0.00000	126.16685	222.01186	427.57917
27	ENVEQ MAX	0.25000	128.87877	219.64936	424.64595
27	ENVEQ MAX	0.50000	131.59070	217.28686	421.88991
27	ENVEQ MAX	0.75000	134.30262	214.92436	419.31107
27	ENVEQ MAX	1.00000	137.01455	212.56186	416.90941
27	ENVEQ MIN	0.00000	-393.24256	-32.39921	-223.83076
27	ENVEQ MIN	0.25000	-395.95449	-34.17108	-237.54435
27	ENVEQ MIN	0.50000	-398.66641	-35.94296	-251.12505
27	ENVEQ MIN	0.75000	-401.37834	-37.71483	-264.57285
27	ENVEQ MIN	1.00000	-404.09026	-39.48671	-277.88777
28	ENVEQ MAX	0.00000	137.01455	212.56186	416.90941
28	ENVEQ MAX	0.25000	141.38075	207.85261	413.46970
28	ENVEQ MAX	0.50000	145.74695	203.14336	410.59863
28	ENVEQ MAX	0.75000	150.11315	198.43411	408.29620
28	ENVEQ MAX	1.00000	154.47934	193.72486	406.56241
28	ENVEQ MIN	0.00000	-404.09027	-39.32032	-277.88777
28	ENVEQ MIN	0.25000	-408.45646	-42.85226	-299.00456
28	ENVEQ MIN	0.50000	-412.82266	-46.38420	-319.69488
28	ENVEQ MIN	0.75000	-417.18886	-49.91614	-339.95871
28	ENVEQ MIN	1.00000	-421.55506	-53.44807	-359.79606
29	ENVEQ MAX	0.00000	145.14552	303.03302	406.56241
29	ENVEQ MAX	0.25000	150.72305	297.01727	391.84106
29	ENVEQ MAX	0.50000	156.30058	291.00152	386.55408
29	ENVEQ MAX	0.75000	161.87810	284.98577	382.99804
29	ENVEQ MAX	1.00000	167.45563	278.97002	383.20253
29	ENVEQ MIN	0.00000	-412.93110	-7.96212	-359.79606
29	ENVEQ MIN	0.25000	-418.50862	-12.47394	-396.46123
29	ENVEQ MIN	0.50000	-424.08615	-16.98575	-432.43045
29	ENVEQ MIN	0.75000	-429.66367	-21.49756	-467.70373
29	ENVEQ MIN	1.00000	-435.24120	-26.00937	-502.28106
30	ENVEQ MAX	0.00000	167.45563	278.97002	383.20253
30	ENVEQ MAX	0.18056	170.39355	275.80127	383.69197
30	ENVEQ MAX	0.36111	173.33147	272.63252	384.43887
30	ENVEQ MAX	0.54167	176.26938	269.46377	385.44324
30	ENVEQ MAX	0.72222	179.20730	266.29502	386.70506
30	ENVEQ MIN	0.00000	-435.24120	-25.72335	-502.28106
30	ENVEQ MIN	0.18056	-438.17912	-28.09991	-520.21456
30	ENVEQ MIN	0.36111	-441.11704	-30.47648	-539.30437
30	ENVEQ MIN	0.54167	-444.05496	-32.85304	-561.32638
30	ENVEQ MIN	0.72222	-446.99288	-35.22960	-583.09093
31	ENVEQ MAX	0.65385	0.00000	180.39831	312.05714
31	ENVEQ MAX	0.74038	0.00000	179.52223	302.04467
31	ENVEQ MAX	0.82692	0.00000	178.52999	292.09365
31	ENVEQ MAX	0.91346	0.00000	177.42159	282.21060
31	ENVEQ MAX	1.00000	0.00000	176.19703	272.40207
31	ENVEQ MIN	0.65385	-339.15782	-346.24906	-462.19204
31	ENVEQ MIN	0.74038	-336.43645	-340.61809	-443.20210
31	ENVEQ MIN	0.82692	-333.71507	-334.90261	-424.54907
31	ENVEQ MIN	0.91346	-330.99370	-329.10261	-406.23771
31	ENVEQ MIN	1.00000	-328.27232	-323.21809	-388.27278
32	ENVEQ MAX	0.00000	0.00000	176.19703	272.40207
32	ENVEQ MAX	0.25000	0.00000	172.77047	248.99142
32	ENVEQ MAX	0.50000	0.00000	168.70450	226.14341
32	ENVEQ MAX	0.75000	0.00000	163.99911	211.81756
32	ENVEQ MAX	1.00000	0.00000	158.65429	201.05805
32	ENVEQ MIN	0.00000	-328.27232	-323.21810	-388.27278
32	ENVEQ MIN	0.25000	-321.68055	-308.63522	-346.22164
32	ENVEQ MIN	0.50000	-315.08877	-293.59857	-306.29278
32	ENVEQ MIN	0.75000	-308.49700	-278.10814	-268.54808
32	ENVEQ MIN	1.00000	-301.90522	-262.16393	-241.49548
33	ENVEQ MAX	0.00000	0.00000	158.65457	201.05805
33	ENVEQ MAX	0.25000	0.00000	146.95414	176.83544
33	ENVEQ MAX	0.50000	0.00000	136.69360	149.77966
33	ENVEQ MAX	0.75000	0.00000	133.12935	119.72718
33	ENVEQ MAX	1.00000	0.00000	135.28528	86.51469
33	ENVEQ MIN	0.00000	-390.86764	-235.89832	-241.49548
33	ENVEQ MIN	0.25000	-376.41411	-201.60679	-202.77189
33	ENVEQ MIN	0.50000	-361.96059	-169.64767	-169.46478
33	ENVEQ MIN	0.75000	-347.50706	-140.02097	-139.74113
33	ENVEQ MIN	1.00000	-333.05354	-112.72669	-112.93960
34	ENVEQ MAX	0.00000	0.00000	172.54014	86.51469
34	ENVEQ MAX	0.25000	0.00000	174.62209	46.39589
34	ENVEQ MAX	0.50000	0.00000	175.92981	50.86907
34	ENVEQ MAX	0.75000	0.00000	184.76669	64.82618
34	ENVEQ MAX	1.00000	0.00000	192.01571	71.15425
34	ENVEQ MIN	0.00000	-422.73119	-112.72333	-112.93960
34	ENVEQ MIN	0.25000	-408.27767	-94.07489	-88.73633
34	ENVEQ MIN	0.50000	-393.82414	-85.53087	-105.21197
34	ENVEQ MIN	0.75000	-379.37062	-76.29150	-156.90199
34	ENVEQ MIN	1.00000	-364.91709	-66.35680	-208.36136
35	ENVEQ MAX	0.00000	0.00000	217.90002	71.15422

26	ENVEQ MAX	0.50000	121.05035	227.53036	433.67076
FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	227.87334	62.19129
35	ENVEQ MAX	0.75000	0.00000	230.65736	73.42589
35	ENVEQ MAX	1.00000	0.00000	231.97294	81.07245
35	ENVEQ MIN	0.00000	-391.27350	-66.35630	-208.36136
35	ENVEQ MIN	0.25000	-376.81997	-55.78597	-267.88060
35	ENVEQ MIN	0.50000	-362.36645	-44.63972	-326.52276
35	ENVEQ MIN	0.75000	-350.76813	-32.91755	-383.98247
35	ENVEQ MIN	1.00000	-349.08915	-20.61947	-439.95436
36	ENVEQ MAX	0.00000	0.00000	272.40212	81.07238
36	ENVEQ MAX	0.25000	0.00000	272.49204	82.20376
36	ENVEQ MAX	0.50000	0.00000	272.52343	83.22473
36	ENVEQ MAX	0.75000	0.00000	272.49627	84.08849
36	ENVEQ MAX	1.00000	0.00000	272.41057	84.79034
36	ENVEQ MIN	0.00000	-375.20349	-20.61985	-439.95436
36	ENVEQ MIN	0.25000	-374.85927	-18.02894	-453.73164
36	ENVEQ MIN	0.50000	-374.51504	-15.41700	-467.43110
36	ENVEQ MIN	0.75000	-374.17082	-12.78404	-481.05031
36	ENVEQ MIN	1.00000	-373.82659	-10.13005	-494.58684
37	ENVEQ MAX	0.00000	0.00000	272.41057	84.79034
37	ENVEQ MAX	0.22500	0.00000	272.10355	85.65347
37	ENVEQ MAX	0.45000	0.00000	271.60482	85.95869
37	ENVEQ MAX	0.67500	0.00000	270.91436	85.69868
37	ENVEQ MAX	0.90000	0.00000	270.03219	84.86611
37	ENVEQ MIN	0.00000	-373.82659	-10.13006	-494.58684
37	ENVEQ MIN	0.22500	-372.98340	-5.20351	-521.23649
37	ENVEQ MIN	0.45000	-371.71834	-0.21180	-551.39288
37	ENVEQ MIN	0.67500	-370.03140	0.00000	-581.91138
37	ENVEQ MIN	0.90000	-367.92259	0.00000	-612.34142
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.10000	0.00000	0.00000	104.86644
40	ENVEQ MAX	0.32500	0.00000	0.00000	110.71965
40	ENVEQ MAX	0.55000	0.00000	0.00000	116.20978
40	ENVEQ MAX	0.77500	0.00000	0.00000	121.37243
40	ENVEQ MAX	1.00000	0.00000	0.00000	126.24319
40	ENVEQ MIN	0.10000	-296.80691	-318.08759	-578.28187
40	ENVEQ MIN	0.32500	-295.35048	-309.40540	-543.26937
40	ENVEQ MIN	0.55000	-293.89406	-301.14509	-509.20990
40	ENVEQ MIN	0.77500	-292.43763	-293.30665	-476.05597
40	ENVEQ MIN	1.00000	-290.98121	-285.89009	-443.76015
41	ENVEQ MAX	0.00000	0.00000	0.00000	126.24319
41	ENVEQ MAX	0.25000	0.00000	0.00000	127.46607
41	ENVEQ MAX	0.50000	0.00000	0.00000	128.67162
41	ENVEQ MAX	0.75000	0.00000	0.00000	129.85985
41	ENVEQ MAX	1.00000	0.00000	0.00000	131.03075
41	ENVEQ MIN	0.00000	-290.98121	-285.89009	-443.76015
41	ENVEQ MIN	0.25000	-290.60254	-284.01663	-435.49807
41	ENVEQ MIN	0.50000	-290.22387	-282.14317	-427.29079
41	ENVEQ MIN	0.75000	-289.84519	-280.26970	-419.13831
41	ENVEQ MIN	1.00000	-289.46652	-278.39624	-411.04063
42	ENVEQ MAX	0.00000	0.00000	0.00000	131.03075
42	ENVEQ MAX	0.25000	0.00000	0.00000	140.90141
42	ENVEQ MAX	0.50000	0.00000	0.00000	149.33426
42	ENVEQ MAX	0.75000	0.00000	0.00000	169.21072
42	ENVEQ MAX	1.00000	0.00000	0.00000	188.06105
42	ENVEQ MIN	0.00000	-295.54877	-278.39624	-411.04063
42	ENVEQ MIN	0.25000	-292.09866	-261.32692	-339.78589
42	ENVEQ MIN	0.50000	-288.64855	-244.25759	-273.08016
42	ENVEQ MIN	0.75000	-285.19844	-227.18827	-218.47624
42	ENVEQ MIN	1.00000	-281.74833	-210.11894	-174.48007
43	ENVEQ MAX	0.00000	0.00000	0.00000	188.06105
43	ENVEQ MAX	0.25000	0.00000	0.00000	219.17276
43	ENVEQ MAX	0.50000	0.00000	0.00000	248.69466
43	ENVEQ MAX	0.75000	0.00000	0.00000	273.65905
43	ENVEQ MAX	1.00000	0.00000	4.31984	294.06592
43	ENVEQ MIN	0.00000	-287.89024	-210.11894	-174.48007
43	ENVEQ MIN	0.25000	-284.43690	-193.03361	-136.72642
43	ENVEQ MIN	0.50000	-280.98355	-175.94827	-101.79103
43	ENVEQ MIN	0.75000	-277.53020	-158.86293	-72.62581

35	ENVEQ MAX	0.25000	0.00000	223.62090	70.15506
FRAME	LOAD	DIST	P	V2	M3
44	ENVEQ MAX	0.25000	0.00000	8.85327	309.91528
44	ENVEQ MAX	0.50000	0.00000	14.25495	321.20713
44	ENVEQ MAX	0.75000	0.00000	19.65664	327.94146
44	ENVEQ MAX	1.00000	0.00000	26.52382	330.11828
44	ENVEQ MIN	0.00000	-280.27691	-141.77759	-55.23329
44	ENVEQ MIN	0.25000	-276.82357	-124.69226	-39.28142
44	ENVEQ MIN	0.50000	-273.37022	-107.60692	-24.77045
44	ENVEQ MIN	0.75000	-269.91688	-90.52158	-11.70038
44	ENVEQ MIN	1.00000	-266.46353	-73.43624	-0.07121
45	ENVEQ MAX	0.00000	0.00000	26.43162	330.11828
45	ENVEQ MAX	0.25000	0.00000	33.62712	327.74195
45	ENVEQ MAX	0.50000	0.00000	40.82262	320.81665
45	ENVEQ MAX	0.75000	0.00000	54.54728	309.34236
45	ENVEQ MAX	1.00000	0.00000	71.61661	293.31911
45	ENVEQ MIN	0.00000	-272.72015	-73.43689	-0.07121
45	ENVEQ MIN	0.25000	-269.27004	-56.36757	0.00000
45	ENVEQ MIN	0.50000	-265.81993	-41.20228	0.00000
45	ENVEQ MIN	0.75000	-266.08635	-30.64888	0.00000
45	ENVEQ MIN	1.00000	-269.53646	-20.09548	0.00000
46	ENVEQ MAX	0.00000	0.00000	71.61661	293.31911
46	ENVEQ MAX	0.25000	0.00000	88.70194	272.72544
46	ENVEQ MAX	0.50000	0.00000	105.78728	247.57427
46	ENVEQ MAX	0.75000	0.00000	122.87262	217.86557
46	ENVEQ MAX	1.00000	0.00000	139.95796	184.91905
46	ENVEQ MIN	0.00000	-265.23129	-20.11387	0.00000
46	ENVEQ MIN	0.25000	-266.24163	-13.90887	0.00000
46	ENVEQ MIN	0.50000	-269.69498	-8.50718	0.00000
46	ENVEQ MIN	0.75000	-273.14832	-3.10550	0.00000
46	ENVEQ MIN	1.00000	-276.60167	0.00000	0.00000
47	ENVEQ MAX	0.00000	0.00000	139.95796	184.91905
47	ENVEQ MAX	0.25000	0.00000	157.04329	151.91227
47	ENVEQ MAX	0.50000	0.00000	174.12863	128.22212
47	ENVEQ MAX	0.75000	0.00000	191.21397	99.97468
47	ENVEQ MAX	1.00000	0.00000	208.29931	67.17137
47	ENVEQ MIN	0.00000	-269.90930	0.00000	0.00000
47	ENVEQ MIN	0.25000	-273.36264	0.00000	0.00000
47	ENVEQ MIN	0.50000	-276.81599	0.00000	-0.36792
47	ENVEQ MIN	0.75000	-280.26934	0.00000	-26.66002
47	ENVEQ MIN	1.00000	-283.72268	0.00000	-55.64424
48	ENVEQ MAX	0.00000	0.00000	208.29931	67.17137
48	ENVEQ MAX	0.25000	0.00000	225.36863	29.94120
48	ENVEQ MAX	0.50000	0.00000	242.43796	11.79296
48	ENVEQ MAX	0.75000	0.00000	259.50728	2.13753
48	ENVEQ MAX	1.00000	0.00000	276.57661	0.00000
48	ENVEQ MIN	0.00000	-277.08759	0.00000	-55.64424
48	ENVEQ MIN	0.25000	-280.53770	0.00000	-98.54816
48	ENVEQ MIN	0.50000	-283.98781	0.00000	-152.10010
48	ENVEQ MIN	0.75000	-287.43792	0.00000	-210.86374
48	ENVEQ MIN	1.00000	-290.88803	0.00000	-282.29691
49	ENVEQ MAX	0.00000	0.00000	276.57661	0.00000
49	ENVEQ MAX	0.25000	0.00000	281.65257	0.00000
49	ENVEQ MAX	0.50000	0.00000	286.72853	0.00000
49	ENVEQ MAX	0.75000	0.00000	291.80449	0.00000
49	ENVEQ MAX	1.00000	0.00000	296.88046	0.00000
49	ENVEQ MIN	0.00000	-284.31164	0.00000	-282.29691
49	ENVEQ MIN	0.25000	-285.33761	0.00000	-304.41674
49	ENVEQ MIN	0.50000	-286.36358	0.00000	-326.93885
49	ENVEQ MIN	0.75000	-287.38955	0.00000	-349.86322
49	ENVEQ MIN	1.00000	-288.41552	0.00000	-373.18986
50	ENVEQ MAX	0.00000	0.00000	296.88046	0.00000
50	ENVEQ MAX	0.22500	0.00000	304.08608	0.00000
50	ENVEQ MAX	0.45000	0.00000	311.29171	0.00000
50	ENVEQ MAX	0.67500	0.00000	318.49733	0.00000
50	ENVEQ MAX	0.90000	0.00000	325.70296	0.00000
50	ENVEQ MIN	0.00000	-288.41552	0.00000	-373.18986
50	ENVEQ MIN	0.22500	-289.87195	0.00000	-406.99423
50	ENVEQ MIN	0.45000	-291.32837	0.00000	-441.60923
50	ENVEQ MIN	0.67500	-292.78480	0.00000	-477.03486
50	ENVEQ MIN	0.90000	-294.24122	0.00000	-513.27113
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000

43	ENVEQ MIN	1.00000	-274.07686	-141.77759	-55.23329
44	ENVEQ MAX	0.00000	0.00000	3.45158	294.06592
FRAME	LOAD	DIST	P	V2	M3
53	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
53	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
53	ENVEQ MIN	0.10000	-294.24122	-325.70296	-513.27113
53	ENVEQ MIN	0.32500	-292.78480	-318.49733	-477.03486
53	ENVEQ MIN	0.55000	-291.32837	-311.29171	-441.60923
53	ENVEQ MIN	0.77500	-289.87195	-304.08608	-406.99423
53	ENVEQ MIN	1.00000	-288.41552	-296.88046	-373.18986
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
54	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	-288.41552	-296.88046	-373.18986
54	ENVEQ MIN	0.25000	-287.38955	-291.80449	-349.86322
54	ENVEQ MIN	0.50000	-286.36358	-286.72853	-326.93885
54	ENVEQ MIN	0.75000	-285.33761	-281.65257	-304.41674
54	ENVEQ MIN	1.00000	-284.31164	-276.57661	-282.29691
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.25000	0.00000	0.00000	2.13746
55	ENVEQ MAX	0.50000	0.00000	0.00000	11.79291
55	ENVEQ MAX	0.75000	0.00000	0.00000	29.94118
55	ENVEQ MAX	1.00000	0.00000	0.00000	67.17137
55	ENVEQ MIN	0.00000	-290.88803	-276.57661	-282.29691
55	ENVEQ MIN	0.25000	-287.43792	-259.50728	-210.86374
55	ENVEQ MIN	0.50000	-283.98781	-242.43796	-152.10010
55	ENVEQ MIN	0.75000	-280.53770	-225.36863	-98.54816
55	ENVEQ MIN	1.00000	-277.08759	-208.29931	-55.64424
56	ENVEQ MAX	0.00000	0.00000	0.00000	67.17137
56	ENVEQ MAX	0.25000	0.00000	0.00000	99.97468
56	ENVEQ MAX	0.50000	0.00000	0.00000	128.22212
56	ENVEQ MAX	0.75000	0.00000	0.00000	151.91227
56	ENVEQ MAX	1.00000	0.00000	0.00000	184.91905
56	ENVEQ MIN	0.00000	-283.72268	-208.29931	-55.64424
56	ENVEQ MIN	0.25000	-280.26934	-191.21397	-26.66002
56	ENVEQ MIN	0.50000	-276.81599	-174.12863	-0.36792
56	ENVEQ MIN	0.75000	-273.36264	-157.04329	0.00000
56	ENVEQ MIN	1.00000	-269.90930	-139.95796	0.00000
57	ENVEQ MAX	0.00000	0.00000	0.00000	184.91905
57	ENVEQ MAX	0.25000	0.00000	3.10550	217.86557
57	ENVEQ MAX	0.50000	0.00000	8.50718	247.57427
57	ENVEQ MAX	0.75000	0.00000	13.90887	272.72544
57	ENVEQ MAX	1.00000	0.00000	20.11388	293.31911
57	ENVEQ MIN	0.00000	-276.60167	-139.95796	0.00000
57	ENVEQ MIN	0.25000	-273.14832	-122.87262	0.00000
57	ENVEQ MIN	0.50000	-269.69498	-105.78728	0.00000
57	ENVEQ MIN	0.75000	-266.24163	-88.70194	0.00000
57	ENVEQ MIN	1.00000	-265.23129	-71.61661	0.00000
58	ENVEQ MAX	0.00000	0.00000	20.09548	293.31911
58	ENVEQ MAX	0.25000	0.00000	30.64888	309.34236
58	ENVEQ MAX	0.50000	0.00000	41.20228	320.81665
58	ENVEQ MAX	0.75000	0.00000	56.36757	327.74195
58	ENVEQ MAX	1.00000	0.00000	73.43689	330.11828
58	ENVEQ MIN	0.00000	-269.53646	-71.61661	0.00000
58	ENVEQ MIN	0.25000	-266.08635	-54.54728	0.00000
58	ENVEQ MIN	0.50000	-265.81993	-40.82262	0.00000
58	ENVEQ MIN	0.75000	-269.27004	-33.62712	0.00000
58	ENVEQ MIN	1.00000	-272.72015	-26.43162	-0.07121
59	ENVEQ MAX	0.00000	0.00000	73.43624	330.11828
59	ENVEQ MAX	0.25000	0.00000	90.52158	327.94146
59	ENVEQ MAX	0.50000	0.00000	107.60692	321.20713
59	ENVEQ MAX	0.75000	0.00000	124.69226	309.91528
59	ENVEQ MAX	1.00000	0.00000	141.77759	294.06592
59	ENVEQ MIN	0.00000	-266.46353	-26.52382	-0.07121
59	ENVEQ MIN	0.25000	-269.91688	-19.65664	-11.70038
59	ENVEQ MIN	0.50000	-273.37022	-14.25495	-24.77045
59	ENVEQ MIN	0.75000	-276.82357	-8.85327	-39.28142
59	ENVEQ MIN	1.00000	-280.27691	-3.45158	-55.23329
60	ENVEQ MAX	0.00000	0.00000	141.77759	294.06592
60	ENVEQ MAX	0.25000	0.00000	158.86293	273.65905
60	ENVEQ MAX	0.50000	0.00000	175.94827	248.69466
60	ENVEQ MAX	0.75000	0.00000	193.03361	219.17276
60	ENVEQ MAX	1.00000	0.00000	210.11894	188.06105
60	ENVEQ MIN	0.00000	-274.07686	-4.31984	-55.23329
60	ENVEQ MIN	0.25000	-277.53020	0.00000	-72.62581
60	ENVEQ MIN	0.50000	-280.98355	0.00000	-101.79103
60	ENVEQ MIN	0.75000	-284.43690	0.00000	-136.72642
60	ENVEQ MIN	1.00000	-287.89024	0.00000	-174.48007
61	ENVEQ MAX	0.00000	0.00000	210.11894	188.06105
61	ENVEQ MAX	0.25000	0.00000	227.18827	169.21072
61	ENVEQ MAX	0.50000	0.00000	244.25759	149.33426
61	ENVEQ MAX	0.75000	0.00000	261.32692	140.90141
61	ENVEQ MAX	1.00000	0.00000	278.39624	131.03075
61	ENVEQ MIN	0.00000	-281.74833	0.00000	-174.48007
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
61	ENVEQ MIN	1.00000	-295.54877	0.00000	-411.04063
62	ENVEQ MAX	0.00000	0.00000	278.39624	131.03075
62	ENVEQ MAX	0.25000	0.00000	280.26970	129.85985
62	ENVEQ MAX	0.50000	0.00000	282.14317	128.67162
62	ENVEQ MAX	0.75000	0.00000	284.01663	127.46607
62	ENVEQ MAX	1.00000	0.00000	285.89009	126.24319
62	ENVEQ MIN	0.00000	-289.46652	0.00000	-411.04063
62	ENVEQ MIN	0.25000	-289.84519	0.00000	-419.13831
62	ENVEQ MIN	0.50000	-290.22387	0.00000	-427.29079
62	ENVEQ MIN	0.75000	-290.60254	0.00000	-435.49807
62	ENVEQ MIN	1.00000	-290.98121	0.00000	-443.76015
63	ENVEQ MAX	0.00000	0.00000	285.89009	126.24319
63	ENVEQ MAX	0.22500	0.00000	293.30665	121.37243
63	ENVEQ MAX	0.45000	0.00000	301.14509	116.20978
63	ENVEQ MAX	0.67500	0.00000	309.40540	110.71965
63	ENVEQ MAX	0.90000	0.00000	318.08759	104.86644
63	ENVEQ MIN	0.00000	-290.98121	0.00000	-443.76015
63	ENVEQ MIN	0.22500	-292.43763	0.00000	-476.05597
63	ENVEQ MIN	0.45000	-293.89406	0.00000	-509.20990
63	ENVEQ MIN	0.67500	-295.35048	0.00000	-543.26937
63	ENVEQ MIN	0.90000	-296.80691	0.00000	-578.28187
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.10000	0.00000	0.00000	84.86611
66	ENVEQ MAX	0.32500	0.00000	0.00000	85.69868
66	ENVEQ MAX	0.55000	0.00000	0.21180	85.95869
66	ENVEQ MAX	0.77500	0.00000	5.20351	85.65347
66	ENVEQ MAX	1.00000	0.00000	10.13006	84.79034
66	ENVEQ MIN	0.10000	-367.92259	-270.03219	-612.34142
66	ENVEQ MIN	0.32500	-370.03140	-270.91436	-581.91138
66	ENVEQ MIN	0.55000	-371.71834	-271.60482	-551.39288
66	ENVEQ MIN	0.77500	-372.98340	-272.10355	-521.23649
66	ENVEQ MIN	1.00000	-373.82659	-272.41057	-494.58684
67	ENVEQ MAX	0.00000	0.00000	10.13005	84.79034
67	ENVEQ MAX	0.25000	0.00000	12.78404	84.08849
67	ENVEQ MAX	0.50000	0.00000	15.41700	83.22473
67	ENVEQ MAX	0.75000	0.00000	18.02894	82.20430
67	ENVEQ MAX	1.00000	0.00000	20.61985	81.07297
67	ENVEQ MIN	0.00000	-373.82659	-272.41057	-494.58684
67	ENVEQ MIN	0.25000	-374.17082	-272.49627	-481.05031
67	ENVEQ MIN	0.50000	-374.51504	-272.52343	-467.43110
67	ENVEQ MIN	0.75000	-374.85927	-272.49204	-453.73164
67	ENVEQ MIN	1.00000	-375.20349	-272.40212	-439.95436
68	ENVEQ MAX	0.00000	0.00000	20.61947	81.07216
68	ENVEQ MAX	0.25000	0.00000	32.91755	73.42564
68	ENVEQ MAX	0.50000	0.00000	44.63972	62.19109
68	ENVEQ MAX	0.75000	0.00000	55.78597	70.15478
68	ENVEQ MAX	1.00000	0.00000	66.35630	71.15398
68	ENVEQ MIN	0.00000	-349.08915	-231.97294	-439.95436
68	ENVEQ MIN	0.25000	-350.76813	-230.65736	-383.98247
68	ENVEQ MIN	0.50000	-362.36645	-227.87334	-326.52276
68	ENVEQ MIN	0.75000	-376.81997	-223.62090	-267.88060
68	ENVEQ MIN	1.00000	-391.27350	-217.90002	-208.36136
69	ENVEQ MAX	0.00000	0.00000	66.35680	71.15453
69	ENVEQ MAX	0.25000	0.00000	76.29150	64.82636
69	ENVEQ MAX	0.50000	0.00000	85.53087	50.86915
69	ENVEQ MAX	0.75000	0.00000	94.07489	46.39589
69	ENVEQ MAX	1.00000	0.00000	112.72333	86.51469
69	ENVEQ MIN	0.00000	-364.91709	-192.01571	-208.36136
69	ENVEQ MIN	0.25000	-379.37062	-184.76669	-156.90199
69	ENVEQ MIN	0.50000	-393.82414	-175.92981	-105.21197
69	ENVEQ MIN	0.75000	-408.27767	-174.62209	-88.73633
69	ENVEQ MIN	1.00000	-422.73119	-172.54014	-112.93960
70	ENVEQ MAX	0.00000	0.00000	112.72669	86.51469
70	ENVEQ MAX	0.25000	0.00000	140.02097	119.72718
70	ENVEQ MAX	0.50000	0.00000	169.64767	149.77966
70	ENVEQ MAX	0.75000	0.00000	201.60679	176.83544
70	ENVEQ MAX	1.00000	0.00000	235.89832	201.05805

61	ENVEQ MIN	0.25000	-285.19844	0.00000	-218.47624
61	ENVEQ MIN	0.50000	-288.64855	0.00000	-273.08016
61	ENVEQ MIN	0.75000	-292.09866	0.00000	-339.78589
FRAME	LOAD	DIST	P	V2	M3
70	ENVEQ MIN	0.75000	-376.41411	-146.95414	-202.77189
70	ENVEQ MIN	1.00000	-390.86764	-158.65457	-241.49548
71	ENVEQ MAX	0.00000	0.00000	262.16393	201.05805
71	ENVEQ MAX	0.25000	0.00000	278.10814	211.81756
71	ENVEQ MAX	0.50000	0.00000	293.59857	226.14341
71	ENVEQ MAX	0.75000	0.00000	308.63522	248.99142
71	ENVEQ MAX	1.00000	0.00000	323.21810	272.40207
71	ENVEQ MIN	0.00000	-301.90522	-158.65429	-241.49548
71	ENVEQ MIN	0.25000	-308.49700	-163.99911	-268.54808
71	ENVEQ MIN	0.50000	-315.08877	-168.70450	-306.29278
71	ENVEQ MIN	0.75000	-321.68055	-172.77047	-346.22164
71	ENVEQ MIN	1.00000	-328.27232	-176.19703	-388.27278
72	ENVEQ MAX	0.00000	0.00000	323.21809	272.40207
72	ENVEQ MAX	0.08654	0.00000	329.10261	282.21060
72	ENVEQ MAX	0.17308	0.00000	334.90261	292.09365
72	ENVEQ MAX	0.25962	0.00000	340.61809	302.04467
72	ENVEQ MAX	0.34615	0.00000	346.24906	312.05714
72	ENVEQ MIN	0.00000	-328.27232	-176.19703	-388.27278
72	ENVEQ MIN	0.08654	-330.99370	-177.42159	-406.23771
72	ENVEQ MIN	0.17308	-333.71507	-178.52999	-424.54907
72	ENVEQ MIN	0.25962	-336.43645	-179.52223	-443.20210
72	ENVEQ MIN	0.34615	-339.15782	-180.39831	-462.19204
73	ENVEQ MAX	0.11715	0.00000	72.00655	180.24508
73	ENVEQ MAX	0.31590	0.00000	73.25689	93.99253
73	ENVEQ MAX	0.51464	0.00000	74.48315	6.45310
73	ENVEQ MAX	0.71339	0.00000	75.68534	82.89542
73	ENVEQ MAX	0.91213	0.00000	76.86346	173.47365
73	ENVEQ MIN	0.11715	-634.43542	-72.00655	-180.24508
73	ENVEQ MIN	0.31590	-652.24792	-73.25689	-93.99253
73	ENVEQ MIN	0.51464	-670.06042	-74.48315	-6.45310
73	ENVEQ MIN	0.71339	-687.87292	-75.68534	-82.89542
73	ENVEQ MIN	0.91213	-705.68542	-76.86346	-173.47365

70	ENVEQ MIN	0.00000	-333.05354	-135.28528	-112.93960
70	ENVEQ MIN	0.25000	-347.50706	-133.12935	-139.74113
70	ENVEQ MIN	0.50000	-361.96059	-136.69360	-169.46478

20. OUTPUT DATA (붕괴방지)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.27778	411.38914	0.00000	827.24762
1	ENVEQ MAX	0.45833	407.35743	0.00000	837.90910
1	ENVEQ MAX	0.63889	403.32573	0.00000	848.82803
1	ENVEQ MAX	0.81944	399.29402	0.00000	860.00442
1	ENVEQ MAX	1.00000	395.26232	0.00000	871.43828
1	ENVEQ MIN	0.27778	-500.44602	-437.33235	-849.71309
1	ENVEQ MIN	0.45833	-496.41431	-440.50110	-821.44785
1	ENVEQ MIN	0.63889	-492.38261	-443.66985	-792.98951
1	ENVEQ MIN	0.81944	-488.35090	-446.83860	-764.33808
1	ENVEQ MIN	1.00000	-484.31920	-450.00735	-735.49355
2	ENVEQ MAX	0.00000	395.26232	0.00000	871.43828
2	ENVEQ MAX	0.25000	387.60828	0.00000	893.85337
2	ENVEQ MAX	0.50000	379.95424	0.00000	918.11917
2	ENVEQ MAX	0.75000	372.30020	0.00000	946.29467
2	ENVEQ MAX	1.00000	364.64616	0.00000	975.39810
2	ENVEQ MIN	0.00000	-484.31921	-450.00735	-735.49355
2	ENVEQ MIN	0.25000	-476.66517	-456.02310	-680.20205
2	ENVEQ MIN	0.50000	-469.01113	-462.03885	-624.21460
2	ENVEQ MIN	0.75000	-461.35709	-468.05460	-567.53120
2	ENVEQ MIN	1.00000	-453.70305	-474.07035	-510.15186
3	ENVEQ MAX	0.00000	370.79910	11.47229	975.39810
3	ENVEQ MAX	0.25000	364.80737	7.94036	980.89298
3	ENVEQ MAX	0.50000	358.81563	4.40842	986.95650
3	ENVEQ MAX	0.75000	352.82389	0.87648	993.58866
3	ENVEQ MAX	1.00000	346.83216	0.00000	1000.78900
3	ENVEQ MIN	0.00000	-459.58566	-317.46342	-510.15186
3	ENVEQ MIN	0.25000	-453.59392	-322.17267	-478.23914
3	ENVEQ MIN	0.50000	-447.60219	-326.88192	-445.89995
3	ENVEQ MIN	0.75000	-441.61045	-331.59117	-413.13427
3	ENVEQ MIN	1.00000	-435.61872	-336.30042	-379.94211
4	ENVEQ MAX	0.00000	346.83216	0.00000	1000.78900
4	ENVEQ MAX	0.25000	343.11058	0.00000	1005.52700
4	ENVEQ MAX	0.50000	339.38901	0.00000	1010.44200
4	ENVEQ MAX	0.75000	335.66743	0.00000	1015.53400
4	ENVEQ MAX	1.00000	331.94586	0.00000	1020.80400
4	ENVEQ MIN	0.00000	-435.61872	-336.30042	-379.94211
4	ENVEQ MIN	0.25000	-431.89715	-338.66292	-359.12697
4	ENVEQ MIN	0.50000	-428.17557	-341.02542	-338.17894
4	ENVEQ MIN	0.75000	-424.45400	-343.38792	-317.09801
4	ENVEQ MIN	1.00000	-420.73242	-345.75042	-295.88420
5	ENVEQ MAX	0.00000	331.94586	0.00000	1020.80400
5	ENVEQ MAX	0.25000	328.43517	0.00000	1025.95500
5	ENVEQ MAX	0.50000	324.92449	0.00000	1031.30300
5	ENVEQ MAX	0.75000	321.41380	0.00000	1036.84500
5	ENVEQ MAX	1.00000	317.90312	0.00000	1042.58200
5	ENVEQ MIN	0.00000	-420.73243	-345.75042	-295.88420
5	ENVEQ MIN	0.25000	-417.22174	-348.50967	-275.73661
5	ENVEQ MIN	0.50000	-413.71106	-351.26892	-255.44261
5	ENVEQ MIN	0.75000	-410.20037	-354.02817	-235.00220
5	ENVEQ MIN	1.00000	-406.68969	-356.78742	-214.41538
6	ENVEQ MAX	0.00000	324.12649	76.38021	1042.58200
6	ENVEQ MAX	0.25000	310.89009	68.57777	1028.59600
6	ENVEQ MAX	0.50000	297.65369	60.77533	1017.38500
6	ENVEQ MAX	0.75000	284.41728	52.97290	1008.94900
6	ENVEQ MAX	1.00000	271.18088	45.17046	1003.28800
6	ENVEQ MIN	0.00000	-412.66091	-200.24851	-214.41538
6	ENVEQ MIN	0.25000	-399.42450	-210.65176	-165.78482
6	ENVEQ MIN	0.50000	-386.18810	-221.05501	-115.43677
6	ENVEQ MIN	0.75000	-372.95170	-231.45826	-63.75707
6	ENVEQ MIN	1.00000	-359.71530	-241.86151	-9.99608
7	ENVEQ MAX	0.00000	277.46142	155.30306	1003.28800
7	ENVEQ MAX	0.25000	264.22502	144.89981	963.86777
7	ENVEQ MAX	0.50000	250.98862	134.49656	927.22228
7	ENVEQ MAX	0.75000	237.75221	124.09331	893.35186
7	ENVEQ MAX	1.00000	224.51581	113.69006	862.25651
7	ENVEQ MIN	0.00000	-365.76069	-95.18727	-9.99608
7	ENVEQ MIN	0.25000	-352.52429	-102.98971	0.00000
7	ENVEQ MIN	0.50000	-339.28789	-110.79215	0.00000
7	ENVEQ MIN	0.75000	-326.05149	-118.59458	0.00000
7	ENVEQ MIN	1.00000	-312.81508	-127.26008	0.00000
8	ENVEQ MAX	0.00000	230.84455	249.62836	862.25651
8	ENVEQ MAX	0.25000	217.62055	239.23486	797.11549
8	ENVEQ MAX	0.50000	204.39656	228.84136	734.74433
8	ENVEQ MAX	0.75000	191.17256	218.44786	675.14305
8	ENVEQ MAX	1.00000	177.94856	208.05436	618.31163
8	ENVEQ MIN	0.00000	-318.92563	-11.48990	0.00000
8	ENVEQ MIN	0.25000	-305.70164	-19.28503	0.00000
8	ENVEQ MIN	0.50000	-292.47764	-27.08015	0.00000
8	ENVEQ MIN	0.75000	-279.25364	-34.87528	0.00000
8	ENVEQ MIN	1.00000	-266.02965	-42.67040	0.00000
9	ENVEQ MAX	0.00000	184.31652	351.43200	618.31163
9	ENVEQ MAX	0.25000	171.08012	341.02875	527.89984
9	ENVEQ MAX	0.50000	157.84371	330.62550	440.86224
9	ENVEQ MAX	0.75000	144.60731	320.22225	356.59972
9	ENVEQ MAX	1.00000	131.37091	309.81900	275.11226
9	ENVEQ MIN	0.00000	-272.19631	0.00000	0.00000
9	ENVEQ MIN	0.25000	-258.95991	0.00000	0.00000
9	ENVEQ MIN	0.50000	-245.72351	0.00000	0.00000
9	ENVEQ MIN	0.75000	-232.48711	0.00000	0.00000
9	ENVEQ MIN	1.00000	-219.25071	0.00000	0.00000
10	ENVEQ MAX	0.00000	137.94971	461.08667	275.11226
10	ENVEQ MAX	0.25000	124.71331	450.68342	157.03852
10	ENVEQ MAX	0.50000	111.47691	440.28017	41.73985
10	ENVEQ MAX	0.75000	98.24050	429.87692	0.00000
10	ENVEQ MAX	1.00000	85.00410	419.47367	0.00000
10	ENVEQ MIN	0.00000	-226.02787	0.00000	0.00000
10	ENVEQ MIN	0.25000	-212.79147	0.00000	0.00000
10	ENVEQ MIN	0.50000	-199.55507	0.00000	-17.74424
10	ENVEQ MIN	0.75000	-186.31867	0.00000	-102.87181
10	ENVEQ MIN	1.00000	-173.08226	0.00000	-211.91465
11	ENVEQ MAX	0.00000	91.86546	580.89525	0.00000
11	ENVEQ MAX	0.25000	78.64146	570.50175	0.00000
11	ENVEQ MAX	0.50000	73.29978	560.10825	0.00000
11	ENVEQ MAX	0.75000	86.52378	549.71475	0.00000
11	ENVEQ MAX	1.00000	99.74778	539.32125	0.00000
11	ENVEQ MIN	0.00000	-180.03671	0.00000	-211.91465
11	ENVEQ MIN	0.25000	-166.81271	0.00000	-359.31748
11	ENVEQ MIN	0.50000	-157.54999	0.00000	-507.77361
11	ENVEQ MIN	0.75000	-170.77399	0.00000	-655.47107
11	ENVEQ MIN	1.00000	-183.99799	0.00000	-800.58512
12	ENVEQ MAX	0.00000	93.71963	710.61728	0.00000
12	ENVEQ MAX	0.25000	95.79130	708.98903	0.00000
12	ENVEQ MAX	0.50000	97.86298	707.36078	0.00000
12	ENVEQ MAX	0.75000	99.93466	705.73253	0.00000
12	ENVEQ MAX	1.00000	102.00633	704.10428	0.00000
12	ENVEQ MIN	0.00000	-177.65720	0.00000	-800.58512
12	ENVEQ MIN	0.25000	-179.72888	0.00000	-830.21940
12	ENVEQ MIN	0.50000	-181.80055	0.00000	-859.78570
12	ENVEQ MIN	0.75000	-183.87223	0.00000	-889.28403
12	ENVEQ MIN	1.00000	-185.94391	0.00000	-918.71437
13	ENVEQ MAX	0.00000	102.00633	704.10428	0.00000
13	ENVEQ MAX	0.25000	105.72791	701.17928	0.00000
13	ENVEQ MAX	0.50000	109.44948	698.25428	0.00000
13	ENVEQ MAX	0.75000	113.17106	695.32928	0.00000
13	ENVEQ MAX	1.00000	116.89263	692.40428	0.00000
13	ENVEQ MIN	0.00000	-185.94390	0.00000	-918.71437
13	ENVEQ MIN	0.25000	-189.66548	0.00000	-971.41250
13	ENVEQ MIN	0.50000	-193.38705	0.00000	-1023.89100
13	ENVEQ MIN	0.75000	-197.10863	0.00000	-1076.15100
13	ENVEQ MIN	1.00000	-200.83020	0.00000	-1128.19100
14	ENVEQ MAX	0.00000	116.89263	692.40428	0.00000
14	ENVEQ MAX	0.25000	121.23447	688.99178	0.00000
14	ENVEQ MAX	0.50000	125.57631	685.57928	0.00000
14	ENVEQ MAX	0.75000	129.91815	682.16678	0.00000
14	ENVEQ MAX	1.00000	134.25998	678.75428	0.00000
14	ENVEQ MIN	0.00000	-200.83020	0.00000	-1128.19100
14	ENVEQ MIN	0.25000	-205.17203	0.00000	-1188.62700
14	ENVEQ MIN	0.50000	-209.51387	0.00000	-1248.76400
14	ENVEQ MIN	0.75000	-213.85571	0.00000	-1308.60300
14	ENVEQ MIN	1.00000	-218.19755	0.00000	-1368.14300
15	ENVEQ MAX	0.00000	134.25998	678.75428	0.00000
15	ENVEQ MAX	0.25000	137.36130	676.31678	0.00000
15	ENVEQ MAX	0.50000	140.46261	673.87928	0.00000
15	ENVEQ MAX	0.75000	143.56392	671.44178	0.00000
15	ENVEQ MAX	1.00000	146.66523	669.00428	0.00000
15	ENVEQ MIN	0.00000	-218.19754	0.00000	-1368.14300
15	ENVEQ MIN	0.25000	-221.29885	0.00000	-1410.48900
15	ENVEQ MIN	0.50000	-224.40016	0.00000	-1452.68300
15	ENVEQ MIN	0.75000	-227.50148	0.00000	-1494.72400
15	ENVEQ MIN	1.00000	-230.60279	0.00000	-1536.61300
16	ENVEQ MAX	0.00000	146.66523	0.00000	0.00000
16	ENVEQ MAX	0.25000	143.56392	0.00000	0.00000
16	ENVEQ MAX	0.50000	140.46261	0.00000	0.00000
16	ENVEQ MAX	0.75000	137.36130	0.00000	0.00000
16	ENVEQ MAX	1.00000	134.25998	0.00000	0.00000
16	ENVEQ MIN	0.00000	-230.60279	-669.00428	-1536.61300
16	ENVEQ MIN	0.25000	-227.50148	-671.44178	-1494.72400
16	ENVEQ MIN	0.50000	-224.40016	-673.87928	-1452.68300
16	ENVEQ MIN	0.75000	-221.29885	-676.31678	-1410.48900
16	ENVEQ MIN	1.00000	-218.19754	-678.75428	-1368.14300
17	ENVEQ MAX	0.00000	134.25998	0.00000	0.00000
17	ENVEQ MAX	0.25000	129.91815	0.00000	0.00000
17	ENVEQ MAX	0.50000	125.57631	0.00000	0.00000
17	ENVEQ MAX	0.75000	121.23447	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	116.89263	0.00000	0.00000
17	ENVEQ MIN	0.00000	-218.19755	-678.75428	-1368.14300
17	ENVEQ MIN	0.25000	-213.85571	-682.16678	-1308.60300
17	ENVEQ MIN	0.50000	-209.51387	-685.57928	-1248.76400
17	ENVEQ MIN	0.75000	-205.17203	-688.99178	-1188.62700
17	ENVEQ MIN	1.00000	-200.83020	-692.40428	-1128.19100
18	ENVEQ MAX	0.00000	116.89263	0.00000	0.00000
18	ENVEQ MAX	0.25000	113.17106	0.00000	0.00000
18	ENVEQ MAX	0.50000	109.44948	0.00000	0.00000
18	ENVEQ MAX	0.75000	105.72791	0.00000	0.00000
18	ENVEQ MAX	1.00000	102.00633	0.00000	0.00000
18	ENVEQ MIN	0.00000	-200.83020	-692.40428	-1128.19100
18	ENVEQ MIN	0.25000	-197.10863	-695.32928	-1076.15100
18	ENVEQ MIN	0.50000	-193.38705	-698.25428	-1023.89100
18	ENVEQ MIN	0.75000	-189.66548	-701.17928	-971.41250
18	ENVEQ MIN	1.00000	-185.94390	-704.10428	-918.71437
19	ENVEQ MAX	0.00000	102.00633	0.00000	0.00000
19	ENVEQ MAX	0.25000	99.93466	0.00000	0.00000
19	ENVEQ MAX	0.50000	97.86298	0.00000	0.00000
19	ENVEQ MAX	0.75000	95.79130	0.00000	0.00000
19	ENVEQ MAX	1.00000	93.71963	0.00000	0.00000
19	ENVEQ MIN	0.00000	-185.94391	-704.10428	-918.71437
19	ENVEQ MIN	0.25000	-183.87223	-705.73253	-889.28403
19	ENVEQ MIN	0.50000	-181.80055	-707.36078	-859.78570
19	ENVEQ MIN	0.75000	-179.72888	-708.98903	-830.21940
19	ENVEQ MIN	1.00000	-177.65720	-710.61728	-800.58512
20	ENVEQ MAX	0.00000	99.74778	0.00000	0.00000
20	ENVEQ MAX	0.25000	86.52378	0.00000	0.00000
20	ENVEQ MAX	0.50000	73.29978	0.00000	0.00000
20	ENVEQ MAX	0.75000	78.64146	0.00000	0.00000
20	ENVEQ MAX	1.00000	91.86546	0.00000	0.00000
20	ENVEQ MIN	0.00000	-183.99799	-539.32125	-800.58512
20	ENVEQ MIN	0.25000	-170.77399	-549.71475	-655.47107
20	ENVEQ MIN	0.50000	-157.54999	-560.10825	-507.77361
20	ENVEQ MIN	0.75000	-166.81268	-570.50175	-359.31748
20	ENVEQ MIN	1.00000	-180.03668	-580.89525	-211.91465
21	ENVEQ MAX	0.00000	85.00410	0.00000	0.00000
21	ENVEQ MAX	0.25000	98.24050	0.00000	0.00000
21	ENVEQ MAX	0.50000	111.47691	0.00000	41.73985
21	ENVEQ MAX	0.75000	124.71331	0.00000	157.03852
21	ENVEQ MAX	1.00000	137.94971	0.00000	275.11226
21	ENVEQ MIN	0.00000	-173.08223	-419.47367	-211.91465
21	ENVEQ MIN	0.25000	-186.31864	-429.87692	-102.87181
21	ENVEQ MIN	0.50000	-199.55504	-440.28017	-17.74424
21	ENVEQ MIN	0.75000	-212.79144	-450.68342	0.00000
21	ENVEQ MIN	1.00000	-226.02784	-461.08667	0.00000
22	ENVEQ MAX	0.00000	131.37091	0.00000	275.11226
22	ENVEQ MAX	0.25000	144.60731	0.00000	356.59972
22	ENVEQ MAX	0.50000	157.84371	0.00000	440.86224
22	ENVEQ MAX	0.75000	171.08012	0.00000	527.89984
22	ENVEQ MAX	1.00000	184.31652	0.00000	618.31163
22	ENVEQ MIN	0.00000	-219.25071	-309.81900	0.00000
22	ENVEQ MIN	0.25000	-232.48711	-320.22225	0.00000
22	ENVEQ MIN	0.50000	-245.72351	-330.62550	0.00000
22	ENVEQ MIN	0.75000	-258.95991	-341.02875	0.00000
22	ENVEQ MIN	1.00000	-272.19631	-351.43200	0.00000
23	ENVEQ MAX	0.00000	177.94856	42.67040	618.31163
23	ENVEQ MAX	0.25000	191.17256	34.87527	675.14305
23	ENVEQ MAX	0.50000	204.39656	27.08015	734.74433
23	ENVEQ MAX	0.75000	217.62055	19.28502	797.11549
23	ENVEQ MAX	1.00000	230.84455	11.48990	862.25651
23	ENVEQ MIN	0.00000	-266.02965	-208.05436	0.00000
23	ENVEQ MIN	0.25000	-279.25364	-218.44786	0.00000
23	ENVEQ MIN	0.50000	-292.47764	-228.84136	0.00000
23	ENVEQ MIN	0.75000	-305.70164	-239.23486	0.00000
23	ENVEQ MIN	1.00000	-318.92563	-249.62836	0.00000
24	ENVEQ MAX	0.00000	224.51581	127.26008	862.25651
24	ENVEQ MAX	0.25000	237.75221	118.59458	893.35186
24	ENVEQ MAX	0.50000	250.98862	110.79215	927.22228
24	ENVEQ MAX	0.75000	264.22502	102.98971	963.86777
24	ENVEQ MAX	1.00000	277.46142	95.18727	1003.28800
24	ENVEQ MIN	0.00000	-312.81508	-113.69006	0.00000
24	ENVEQ MIN	0.25000	-326.05149	-124.09331	0.00000
24	ENVEQ MIN	0.50000	-339.28789	-134.49656	0.00000
24	ENVEQ MIN	0.75000	-352.52429	-144.89981	0.00000
24	ENVEQ MIN	1.00000	-365.76069	-155.30306	-9.99608
25	ENVEQ MAX	0.00000	271.18088	241.86151	1003.28800
25	ENVEQ MAX	0.25000	284.41728	231.45826	1008.94900
25	ENVEQ MAX	0.50000	297.65369	221.05501	1017.38500
25	ENVEQ MAX	0.75000	310.89009	210.65176	1028.59600
25	ENVEQ MAX	1.00000	324.12649	200.24851	1042.58200
25	ENVEQ MIN	0.00000	-359.71530	-45.17046	-9.99609
25	ENVEQ MIN	0.25000	-372.95170	-52.97290	-63.75708
25	ENVEQ MIN	0.50000	-386.18810	-60.77533	-115.43678
25	ENVEQ MIN	0.75000	-399.42450	-68.57777	-165.78482
25	ENVEQ MIN	1.00000	-412.66091	-76.38021	-214.41538
26	ENVEQ MAX	0.00000	317.90312	356.78742	1042.58200
26	ENVEQ MAX	0.25000	321.41380	354.02817	1036.84500
26	ENVEQ MAX	0.75000	328.43517	348.50967	1025.95500
26	ENVEQ MAX	1.00000	331.94586	345.75042	1020.80400
26	ENVEQ MIN	0.00000	-406.68969	0.00000	-214.41538
26	ENVEQ MIN	0.25000	-410.20037	0.00000	-235.00220
26	ENVEQ MIN	0.50000	-413.71106	0.00000	-255.44261
26	ENVEQ MIN	0.75000	-417.22174	0.00000	-275.73661
26	ENVEQ MIN	1.00000	-420.73243	0.00000	-295.88420
27	ENVEQ MAX	0.00000	331.94586	345.75042	1020.80400
27	ENVEQ MAX	0.25000	335.66743	343.38792	1015.53400
27	ENVEQ MAX	0.50000	339.38901	341.02542	1010.44200
27	ENVEQ MAX	0.75000	343.11058	338.66292	1005.52700
27	ENVEQ MAX	1.00000	346.83216	336.30042	1000.78900
27	ENVEQ MIN	0.00000	-420.73242	0.00000	-295.88420
27	ENVEQ MIN	0.25000	-424.45400	0.00000	-317.09801
27	ENVEQ MIN	0.50000	-428.17557	0.00000	-338.17894
27	ENVEQ MIN	0.75000	-431.89715	0.00000	-359.12697
27	ENVEQ MIN	1.00000	-435.61872	0.00000	-379.94211
28	ENVEQ MAX	0.00000	346.83216	336.30042	1000.78900
28	ENVEQ MAX	0.25000	352.82389	331.59117	993.58866
28	ENVEQ MAX	0.50000	358.81563	326.88192	986.95650
28	ENVEQ MAX	0.75000	364.80737	322.17267	980.89298
28	ENVEQ MAX	1.00000	370.79910	317.46342	975.39810
28	ENVEQ MIN	0.00000	-435.61872	0.00000	-379.94211
28	ENVEQ MIN	0.25000	-441.61045	-0.87653	-413.13427
28	ENVEQ MIN	0.50000	-447.60219	-4.40846	-445.89995
28	ENVEQ MIN	0.75000	-453.59392	-7.94040	-478.23914
28	ENVEQ MIN	1.00000	-459.58566	-11.47234	-510.15186
29	ENVEQ MAX	0.00000	364.64616	474.07035	975.39810
29	ENVEQ MAX	0.25000	372.30020	468.05460	946.29467
29	ENVEQ MAX	0.50000	379.95424	462.03885	918.11917
29	ENVEQ MAX	0.75000	387.60828	456.02310	893.85337
29	ENVEQ MAX	1.00000	395.26232	450.00735	871.43828
29	ENVEQ MIN	0.00000	-453.70305	0.00000	-510.15186
29	ENVEQ MIN	0.25000	-461.35709	0.00000	-567.53120
29	ENVEQ MIN	0.50000	-469.01113	0.00000	-624.21460
29	ENVEQ MIN	0.75000	-476.66517	0.00000	-680.20205
29	ENVEQ MIN	1.00000	-484.31921	0.00000	-735.49355
30	ENVEQ MAX	0.00000	395.26232	450.00735	871.43828
30	ENVEQ MAX	0.18056	399.29402	446.83860	860.00442
30	ENVEQ MAX	0.36111	403.32573	443.66985	848.82803
30	ENVEQ MAX	0.54167	407.35743	440.50110	837.90910
30	ENVEQ MAX	0.72222	411.38914	437.33235	827.24762
30	ENVEQ MIN	0.00000	-484.31920	0.00000	-735.49355
30	ENVEQ MIN	0.18056	-488.35090	0.00000	-764.33808
30	ENVEQ MIN	0.36111	-492.38261	0.00000	-792.98951
30	ENVEQ MIN	0.54167	-496.41431	0.00000	-821.44785
30	ENVEQ MIN	0.72222	-500.44602	0.00000	-849.71309
31	ENVEQ MAX	0.65385	0.00000	412.17750	636.06208
31	ENVEQ MAX	0.74038	0.00000	410.74498	613.13709
31	ENVEQ MAX	0.82692	0.00000	409.14510	590.30630
31	ENVEQ MAX	0.91346	0.00000	407.37786	567.57913
31	ENVEQ MAX	1.00000	0.00000	405.44327	544.96496
31	ENVEQ MIN	0.65385	-550.53737	-419.23048	-722.02428
31	ENVEQ MIN	0.74038	-547.28331	-413.04308	-700.10691
31	ENVEQ MIN	0.82692	-544.02925	-406.71996	-678.55919
31	ENVEQ MIN	0.91346	-540.77518	-400.26112	-657.38877
31	ENVEQ MIN	1.00000	-537.52112	-393.66656	-636.60327
32	ENVEQ MAX	0.00000	0.00000	405.44327	544.96496
32	ENVEQ MAX	0.25000	0.00000	400.09256	490.71335
32	ENVEQ MAX	0.50000	0.00000	393.81787	441.79432
32	ENVEQ MAX	0.75000	0.00000	386.61920	404.36383
32	ENVEQ MAX	1.00000	0.00000	378.49656	370.58207
32	ENVEQ MIN	0.00000	-537.52112	-393.66655	-636.60327
32	ENVEQ MIN	0.25000	-529.63906	-377.15952	-587.89689
32	ENVEQ MIN	0.50000	-521.75700	-359.91415	-541.59431
32	ENVEQ MIN	0.75000	-513.87493	-341.93045	-509.39713
32	ENVEQ MIN	1.00000	-505.99287	-323.20840	-482.44911
33	ENVEQ MAX	0.00000	0.00000	379.22025	370.58207
33	ENVEQ MAX	0.25000	0.00000	361.43372	296.00307
33	ENVEQ MAX	0.50000	0.00000	345.72051	220.31437
33	ENVEQ MAX	0.75000	0.00000	332.08063	143.16318
33	ENVEQ MAX	1.00000	0.00000	320.51408	64.19676
33	ENVEQ MIN	0.00000	-634.57684	-303.57786	-482.44911
33	ENVEQ MIN	0.25000	-617.29416	-263.20023	-437.09914
33	ENVEQ MIN	0.50000	-600.01147	-225.78844	-398.05439
33	ENVEQ MIN	0.75000	-582.72878	-191.34249	-364.48796
33	ENVEQ MIN	1.00000	-565.44609	-159.86238	-335.18879
34	ENVEQ MAX	0.00000	0.00000	379.07233	64.19676
34	ENVEQ MAX	0.25000	0.00000	368.03916	0.00000
34	ENVEQ MAX	0.50000	0.00000	364.82590	0.00000
34	ENVEQ MAX	0.75000	0.00000	369.01561	0.00000
34	ENVEQ MAX	1.00000	0.00000	371.30624	0.00000
34	ENVEQ MIN	0.00000	-694.49320	-159.86625	-335.18879
34	ENVEQ MIN	0.25000	-677.21052	-129.81204	-310.75224
34	ENVEQ MIN	0.50000	-659.92783	-106.56637	-334.01571
34	ENVEQ MIN	0.75000	-642.64514	-92.67983	-436.98361
34	ENVEQ MIN	1.00000	-625.36245	-77.78674	-535.90357
35	ENVEQ MAX	0.00000	0.00000	400.70985	0.00000

26	ENVEQ MAX	0.50000	324.92449	351.26892	1031.30300
FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	399.94296	0.00000
35	ENVEQ MAX	0.75000	0.00000	396.97272	0.00000
35	ENVEQ MAX	1.00000	0.00000	392.27793	0.00000
35	ENVEQ MIN	0.00000	-663.11326	-77.78813	-535.90357
35	ENVEQ MIN	0.25000	-653.27018	-61.97574	-640.07213
35	ENVEQ MIN	0.50000	-654.42037	-45.33133	-739.64347
35	ENVEQ MIN	0.75000	-655.57056	-27.85490	-834.36904
35	ENVEQ MIN	1.00000	-656.72075	-9.54646	-924.73700
36	ENVEQ MAX	0.00000	0.00000	432.22006	0.00000
36	ENVEQ MAX	0.25000	0.00000	431.04682	0.00000
36	ENVEQ MAX	0.50000	0.00000	429.80571	0.00000
36	ENVEQ MAX	0.75000	0.00000	428.49673	0.00000
36	ENVEQ MAX	1.00000	0.00000	427.11990	0.00000
36	ENVEQ MIN	0.00000	-696.34667	-9.54834	-924.73700
36	ENVEQ MIN	0.25000	-696.58248	-5.69426	-947.96568
36	ENVEQ MIN	0.50000	-696.81829	-1.80983	-971.28151
36	ENVEQ MIN	0.75000	-697.05410	0.00000	-994.43886
36	ENVEQ MIN	1.00000	-697.28992	0.00000	-1017.43500
37	ENVEQ MAX	0.00000	0.00000	427.11990	0.00000
37	ENVEQ MAX	0.22500	0.00000	424.41793	0.00000
37	ENVEQ MAX	0.45000	0.00000	421.49445	0.00000
37	ENVEQ MAX	0.67500	0.00000	418.34946	0.00000
37	ENVEQ MAX	0.90000	0.00000	414.98297	0.00000
37	ENVEQ MIN	0.00000	-697.28992	0.00000	-1017.43500
37	ENVEQ MIN	0.22500	-697.51210	0.00000	-1064.22400
37	ENVEQ MIN	0.45000	-697.31242	0.00000	-1111.80800
37	ENVEQ MIN	0.67500	-696.69085	0.00000	-1159.05200
37	ENVEQ MIN	0.90000	-695.64742	0.00000	-1205.92900
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
38	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
39	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.10000	0.00000	0.00000	46.30972
40	ENVEQ MAX	0.32500	0.00000	0.00000	77.87514
40	ENVEQ MAX	0.55000	0.00000	0.00000	108.24683
40	ENVEQ MAX	0.77500	0.00000	0.00000	137.46038
40	ENVEQ MAX	1.00000	0.00000	0.00000	165.55138
40	ENVEQ MIN	0.10000	-423.92165	-618.40242	-1082.88700
40	ENVEQ MIN	0.32500	-421.60033	-602.48760	-1014.39700
40	ENVEQ MIN	0.55000	-419.27900	-586.99467	-947.67282
40	ENVEQ MIN	0.77500	-416.95768	-571.92360	-882.66809
40	ENVEQ MIN	1.00000	-414.63635	-557.27442	-819.33512
41	ENVEQ MAX	0.00000	0.00000	0.00000	165.55138
41	ENVEQ MAX	0.25000	0.00000	0.00000	172.67546
41	ENVEQ MAX	0.50000	0.00000	0.00000	179.72606
41	ENVEQ MAX	0.75000	0.00000	0.00000	186.70318
41	ENVEQ MAX	1.00000	0.00000	0.00000	193.60682
41	ENVEQ MIN	0.00000	-414.63635	-557.27442	-819.33512
41	ENVEQ MIN	0.25000	-414.03281	-553.52047	-803.13667
41	ENVEQ MIN	0.50000	-413.42926	-549.76653	-787.04802
41	ENVEQ MIN	0.75000	-412.82572	-546.01258	-771.06917
41	ENVEQ MIN	1.00000	-412.22217	-542.25864	-755.20013
42	ENVEQ MAX	0.00000	0.00000	0.00000	193.60682
42	ENVEQ MAX	0.25000	0.00000	0.00000	253.12289
42	ENVEQ MAX	0.50000	0.00000	0.00000	306.53939
42	ENVEQ MAX	0.75000	0.00000	0.00000	377.50234
42	ENVEQ MAX	1.00000	0.00000	0.00000	447.02337
42	ENVEQ MIN	0.00000	-417.88282	-542.25864	-755.20013
42	ENVEQ MIN	0.25000	-412.38386	-508.05603	-615.67321
42	ENVEQ MIN	0.50000	-406.88490	-473.85342	-486.94245
42	ENVEQ MIN	0.75000	-401.38594	-439.65081	-375.09716
42	ENVEQ MIN	1.00000	-395.88698	-405.44820	-290.77615
43	ENVEQ MAX	0.00000	0.00000	0.00000	447.02337
43	ENVEQ MAX	0.25000	0.00000	0.00000	507.66527
43	ENVEQ MAX	0.50000	0.00000	0.00000	559.35866
43	ENVEQ MAX	0.75000	0.00000	0.00000	602.10352
43	ENVEQ MAX	1.00000	0.00000	0.00000	635.89986
43	ENVEQ MIN	0.00000	-401.58048	-405.44820	-290.77615
43	ENVEQ MIN	0.25000	-396.07636	-371.21350	-212.97215
43	ENVEQ MIN	0.50000	-390.57224	-336.97881	-141.41686
43	ENVEQ MIN	0.75000	-385.06812	-302.74411	-76.11027

35	ENVEQ MAX	0.25000	0.00000	401.18868	0.00000
FRAME	LOAD	DIST	P	V2	M3
44	ENVEQ MAX	0.25000	0.00000	0.00000	660.74768
44	ENVEQ MAX	0.50000	0.00000	0.00000	676.64697
44	ENVEQ MAX	0.75000	0.00000	17.55752	683.59774
44	ENVEQ MAX	1.00000	0.00000	40.46667	681.59998
44	ENVEQ MIN	0.00000	-385.28908	-268.50942	-17.05239
44	ENVEQ MIN	0.25000	-379.78496	-234.27472	0.00000
44	ENVEQ MIN	0.50000	-374.28084	-200.04003	0.00000
44	ENVEQ MIN	0.75000	-368.77672	-165.80533	0.00000
44	ENVEQ MIN	1.00000	-363.27260	-131.57064	0.00000
45	ENVEQ MAX	0.00000	0.00000	40.04526	681.59998
45	ENVEQ MAX	0.25000	0.00000	63.94647	670.66815
45	ENVEQ MAX	0.50000	0.00000	94.46339	650.80456
45	ENVEQ MAX	0.75000	0.00000	127.05696	623.91832
45	ENVEQ MAX	1.00000	0.00000	160.57200	587.95121
45	ENVEQ MIN	0.00000	-369.02792	-131.57155	0.00000
45	ENVEQ MIN	0.25000	-363.52896	-97.36894	0.00000
45	ENVEQ MIN	0.50000	-358.03000	-69.18497	0.00000
45	ENVEQ MIN	0.75000	-352.53104	-45.78161	0.00000
45	ENVEQ MIN	1.00000	-353.36750	-22.37824	0.00000
46	ENVEQ MAX	0.00000	0.00000	160.57200	587.95121
46	ENVEQ MAX	0.25000	0.00000	194.11848	542.82253
46	ENVEQ MAX	0.50000	0.00000	227.66496	488.56175
46	ENVEQ MAX	0.75000	0.00000	261.21144	425.32060
46	ENVEQ MAX	1.00000	0.00000	294.75792	355.09474
46	ENVEQ MIN	0.00000	-352.81632	-22.91363	0.00000
46	ENVEQ MIN	0.25000	-352.86112	0.00000	0.00000
46	ENVEQ MIN	0.50000	-358.36524	0.00000	0.00000
46	ENVEQ MIN	0.75000	-363.86936	0.00000	0.00000
46	ENVEQ MIN	1.00000	-369.37348	0.00000	0.00000
47	ENVEQ MAX	0.00000	0.00000	294.75792	355.09474
47	ENVEQ MAX	0.25000	0.00000	328.30440	282.09987
47	ENVEQ MAX	0.50000	0.00000	361.85088	230.47558
47	ENVEQ MAX	0.75000	0.00000	395.39736	169.71918
47	ENVEQ MAX	1.00000	0.00000	428.94384	99.83067
47	ENVEQ MIN	0.00000	-363.39194	0.00000	0.00000
47	ENVEQ MIN	0.25000	-368.89606	0.00000	0.00000
47	ENVEQ MIN	0.50000	-374.40018	0.00000	0.00000
47	ENVEQ MIN	0.75000	-379.90430	0.00000	0.00000
47	ENVEQ MIN	1.00000	-385.40842	0.00000	-89.24353
48	ENVEQ MAX	0.00000	0.00000	428.94384	99.83067
48	ENVEQ MAX	0.25000	0.00000	462.46943	31.16210
48	ENVEQ MAX	0.50000	0.00000	496.67204	0.00000
48	ENVEQ MAX	0.75000	0.00000	530.87465	0.00000
48	ENVEQ MAX	1.00000	0.00000	565.07726	0.00000
48	ENVEQ MIN	0.00000	-379.45715	0.00000	-89.24353
48	ENVEQ MIN	0.25000	-384.95611	0.00000	-199.87301
48	ENVEQ MIN	0.50000	-390.45507	0.00000	-318.63525
48	ENVEQ MIN	0.75000	-395.95403	0.00000	-447.31759
48	ENVEQ MIN	1.00000	-401.45299	0.00000	-592.89228
49	ENVEQ MAX	0.00000	0.00000	565.07726	0.00000
49	ENVEQ MAX	0.25000	0.00000	575.24820	0.00000
49	ENVEQ MAX	0.50000	0.00000	585.41915	0.00000
49	ENVEQ MAX	0.75000	0.00000	595.59009	0.00000
49	ENVEQ MAX	1.00000	0.00000	605.76104	0.00000
49	ENVEQ MIN	0.00000	-395.53325	0.00000	-592.89228
49	ENVEQ MIN	0.25000	-397.16850	0.00000	-637.90527
49	ENVEQ MIN	0.50000	-398.80374	0.00000	-683.70810
49	ENVEQ MIN	0.75000	-400.43899	0.00000	-730.30078
49	ENVEQ MIN	1.00000	-402.07423	0.00000	-777.68330
50	ENVEQ MAX	0.00000	0.00000	605.76104	0.00000
50	ENVEQ MAX	0.22500	0.00000	620.19929	0.00000
50	ENVEQ MAX	0.45000	0.00000	634.63754	0.00000
50	ENVEQ MAX	0.67500	0.00000	649.07579	0.00000
50	ENVEQ MAX	0.90000	0.00000	663.51404	0.00000
50	ENVEQ MIN	0.00000	-402.07423	0.00000	-777.68330
50	ENVEQ MIN	0.22500	-404.39556	0.00000	-846.30199
50	ENVEQ MIN	0.45000	-406.71688	0.00000	-916.51233
50	ENVEQ MIN	0.67500	-409.03821	0.00000	-988.31432
50	ENVEQ MIN	0.90000	-411.35953	0.00000	-1061.70800
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
51	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000

43	ENVEQ MIN	1.00000	-379.56400	-268.50942	-17.05239
44	ENVEQ MAX	0.00000	0.00000	0.00000	635.89986
FRAME	LOAD	DIST	P	V2	M3
53	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
53	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
53	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
53	ENVEQ MIN	0.10000	-411.35953	-663.51404	-1061.70800
53	ENVEQ MIN	0.32500	-409.03821	-649.07579	-988.31432
53	ENVEQ MIN	0.55000	-406.71688	-634.63754	-916.51233
53	ENVEQ MIN	0.77500	-404.39556	-620.19929	-846.30199
53	ENVEQ MIN	1.00000	-402.07423	-605.76104	-777.68330
54	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
54	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
54	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
54	ENVEQ MIN	0.00000	-402.07423	-605.76104	-777.68330
54	ENVEQ MIN	0.25000	-400.43899	-595.59009	-730.30078
54	ENVEQ MIN	0.50000	-398.80374	-585.41915	-683.70810
54	ENVEQ MIN	0.75000	-397.16850	-575.24820	-637.90527
54	ENVEQ MIN	1.00000	-395.53325	-565.07726	-592.89228
55	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
55	ENVEQ MAX	0.75000	0.00000	0.00000	31.16210
55	ENVEQ MAX	1.00000	0.00000	0.00000	99.83067
55	ENVEQ MIN	0.00000	-401.45299	-565.07726	-592.89228
55	ENVEQ MIN	0.25000	-395.95403	-530.87465	-447.31759
55	ENVEQ MIN	0.50000	-390.45507	-496.67204	-318.63525
55	ENVEQ MIN	0.75000	-384.95611	-462.46943	-199.87301
55	ENVEQ MIN	1.00000	-379.45715	-428.94384	-89.24353
56	ENVEQ MAX	0.00000	0.00000	0.00000	99.83067
56	ENVEQ MAX	0.25000	0.00000	0.00000	169.71918
56	ENVEQ MAX	0.50000	0.00000	0.00000	230.47558
56	ENVEQ MAX	0.75000	0.00000	0.00000	282.09987
56	ENVEQ MAX	1.00000	0.00000	0.00000	355.09474
56	ENVEQ MIN	0.00000	-385.40842	-428.94384	-89.24353
56	ENVEQ MIN	0.25000	-379.90430	-395.39736	0.00000
56	ENVEQ MIN	0.50000	-374.40018	-361.85088	0.00000
56	ENVEQ MIN	0.75000	-368.89606	-328.30440	0.00000
56	ENVEQ MIN	1.00000	-363.39194	-294.75792	0.00000
57	ENVEQ MAX	0.00000	0.00000	0.00000	355.09474
57	ENVEQ MAX	0.25000	0.00000	0.00000	425.32060
57	ENVEQ MAX	0.50000	0.00000	0.00000	488.56175
57	ENVEQ MAX	0.75000	0.00000	0.00000	542.82253
57	ENVEQ MAX	1.00000	0.00000	22.91363	587.95121
57	ENVEQ MIN	0.00000	-369.37348	-294.75792	0.00000
57	ENVEQ MIN	0.25000	-363.86936	-261.21144	0.00000
57	ENVEQ MIN	0.50000	-358.36524	-227.66496	0.00000
57	ENVEQ MIN	0.75000	-352.86112	-194.11848	0.00000
57	ENVEQ MIN	1.00000	-352.81632	-160.57200	0.00000
58	ENVEQ MAX	0.00000	0.00000	22.37824	587.95121
58	ENVEQ MAX	0.25000	0.00000	45.78161	623.91832
58	ENVEQ MAX	0.50000	0.00000	69.18497	650.80456
58	ENVEQ MAX	0.75000	0.00000	97.36894	670.66815
58	ENVEQ MAX	1.00000	0.00000	131.57155	681.59998
58	ENVEQ MIN	0.00000	-353.36750	-160.57200	0.00000
58	ENVEQ MIN	0.25000	-352.53104	-127.05696	0.00000
58	ENVEQ MIN	0.50000	-358.03000	-94.46339	0.00000
58	ENVEQ MIN	0.75000	-363.52896	-63.94647	0.00000
58	ENVEQ MIN	1.00000	-369.02792	-40.04526	0.00000
59	ENVEQ MAX	0.00000	0.00000	131.57064	681.59998
59	ENVEQ MAX	0.25000	0.00000	165.80533	683.59774
59	ENVEQ MAX	0.50000	0.00000	200.04003	676.64697
59	ENVEQ MAX	0.75000	0.00000	234.27472	660.74768
59	ENVEQ MAX	1.00000	0.00000	268.50942	635.89986
59	ENVEQ MIN	0.00000	-363.27260	-40.46667	0.00000
59	ENVEQ MIN	0.25000	-368.77672	-17.55752	0.00000
59	ENVEQ MIN	0.50000	-374.28084	0.00000	0.00000
59	ENVEQ MIN	0.75000	-379.78496	0.00000	0.00000
59	ENVEQ MIN	1.00000	-385.28908	0.00000	-17.05239
60	ENVEQ MAX	0.00000	0.00000	268.50942	635.89986
60	ENVEQ MAX	0.25000	0.00000	302.74411	602.10352
60	ENVEQ MAX	0.50000	0.00000	336.97881	559.35866
60	ENVEQ MAX	0.75000	0.00000	371.21350	507.66527
60	ENVEQ MAX	1.00000	0.00000	405.44820	447.02337
60	ENVEQ MIN	0.00000	-379.56400	0.00000	-17.05239
60	ENVEQ MIN	0.25000	-385.06812	0.00000	-76.11027
60	ENVEQ MIN	0.50000	-390.57224	0.00000	-141.41686
60	ENVEQ MIN	0.75000	-396.07636	0.00000	-212.97215
60	ENVEQ MIN	1.00000	-401.58048	0.00000	-290.77615
61	ENVEQ MAX	0.00000	0.00000	405.44820	447.02337
61	ENVEQ MAX	0.25000	0.00000	439.65081	377.50234
61	ENVEQ MAX	0.50000	0.00000	473.85342	306.53939
61	ENVEQ MAX	0.75000	0.00000	508.05603	253.12289
61	ENVEQ MAX	1.00000	0.00000	542.25864	193.60682
61	ENVEQ MIN	0.00000	-395.88698	0.00000	-290.77615
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
52	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
FRAME	LOAD	DIST	P	V2	M3
61	ENVEQ MIN	1.00000	-417.88282	0.00000	-755.20013
62	ENVEQ MAX	0.00000	0.00000	542.25864	193.60682
62	ENVEQ MAX	0.25000	0.00000	546.01258	186.70318
62	ENVEQ MAX	0.50000	0.00000	549.76653	179.72606
62	ENVEQ MAX	0.75000	0.00000	553.52047	172.67546
62	ENVEQ MAX	1.00000	0.00000	557.27442	165.55138
62	ENVEQ MIN	0.00000	-412.22217	0.00000	-755.20013
62	ENVEQ MIN	0.25000	-412.82572	0.00000	-771.06917
62	ENVEQ MIN	0.50000	-413.42926	0.00000	-787.04802
62	ENVEQ MIN	0.75000	-414.03281	0.00000	-803.13667
62	ENVEQ MIN	1.00000	-414.63635	0.00000	-819.33512
63	ENVEQ MAX	0.00000	0.00000	557.27442	165.55138
63	ENVEQ MAX	0.22500	0.00000	571.92360	137.46038
63	ENVEQ MAX	0.45000	0.00000	586.99467	108.24683
63	ENVEQ MAX	0.67500	0.00000	602.48760	77.87514
63	ENVEQ MAX	0.90000	0.00000	618.40242	46.30972
63	ENVEQ MIN	0.00000	-414.63635	0.00000	-819.33512
63	ENVEQ MIN	0.22500	-416.95768	0.00000	-882.66809
63	ENVEQ MIN	0.45000	-419.27900	0.00000	-947.67282
63	ENVEQ MIN	0.67500	-421.60033	0.00000	-1014.39700
63	ENVEQ MIN	0.90000	-423.92165	0.00000	-1082.88700
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
64	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
65	ENVEQ MIN	0.00000	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.10000	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.32500	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.55000	0.00000	0.00000	0.00000
66	ENVEQ MAX	0.77500	0.00000	0.00000	0.00000
66	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
66	ENVEQ MIN	0.10000	-695.64742	-414.98297	-1205.92900
66	ENVEQ MIN	0.32500	-696.69085	-418.34946	-1159.05200
66	ENVEQ MIN	0.55000	-697.31242	-421.49445	-1111.80800
66	ENVEQ MIN	0.77500	-697.51210	-424.41793	-1064.22400
66	ENVEQ MIN	1.00000	-697.28992	-427.11990	-1017.43500
67	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
67	ENVEQ MAX	0.50000	0.00000	1.80983	0.00000
67	ENVEQ MAX	0.75000	0.00000	5.69426	0.00000
67	ENVEQ MAX	1.00000	0.00000	9.54834	0.00000
67	ENVEQ MIN	0.00000	-697.28992	-427.11990	-1017.43500
67	ENVEQ MIN	0.25000	-697.05410	-428.49673	-994.43886
67	ENVEQ MIN	0.50000	-696.81829	-429.80571	-971.28151
67	ENVEQ MIN	0.75000	-696.58248	-431.04682	-947.96568
67	ENVEQ MIN	1.00000	-696.34667	-432.22006	-924.73700
68	ENVEQ MAX	0.00000	0.00000	9.54646	0.00000
68	ENVEQ MAX	0.25000	0.00000	27.85490	0.00000
68	ENVEQ MAX	0.50000	0.00000	45.33133	0.00000
68	ENVEQ MAX	0.75000	0.00000	61.97574	0.00000
68	ENVEQ MAX	1.00000	0.00000	77.78813	0.00000
68	ENVEQ MIN	0.00000	-656.72075	-392.27793	-924.73700
68	ENVEQ MIN	0.25000	-655.57056	-396.97272	-834.36904
68	ENVEQ MIN	0.50000	-654.42037	-399.94296	-739.64347
68	ENVEQ MIN	0.75000	-653.27018	-401.18868	-640.07213
68	ENVEQ MIN	1.00000	-663.11326	-400.70985	-535.90357
69	ENVEQ MAX	0.00000	0.00000	77.78674	0.00000
69	ENVEQ MAX	0.25000	0.00000	92.67983	0.00000
69	ENVEQ MAX	0.50000	0.00000	106.56637	0.00000
69	ENVEQ MAX	0.75000	0.00000	129.81204	0.00000
69	ENVEQ MAX	1.00000	0.00000	159.86625	64.19676
69	ENVEQ MIN	0.00000	-625.36245	-371.30624	-535.90357
69	ENVEQ MIN	0.25000	-642.64514	-369.01561	-436.98361
69	ENVEQ MIN	0.50000	-659.92783	-364.82590	-334.01571
69	ENVEQ MIN	0.75000	-677.21052	-368.03916	-310.75224
69	ENVEQ MIN	1.00000	-694.49320	-379.07233	-335.18879
70	ENVEQ MAX	0.00000	0.00000	159.86238	64.19676
70	ENVEQ MAX	0.25000	0.00000	191.34249	143.16318
70	ENVEQ MAX	0.50000	0.00000	225.78844	220.31437
70	ENVEQ MAX	0.75000	0.00000	263.20023	296.00307
70	ENVEQ MAX	1.00000	0.00000	303.57786	370.58207

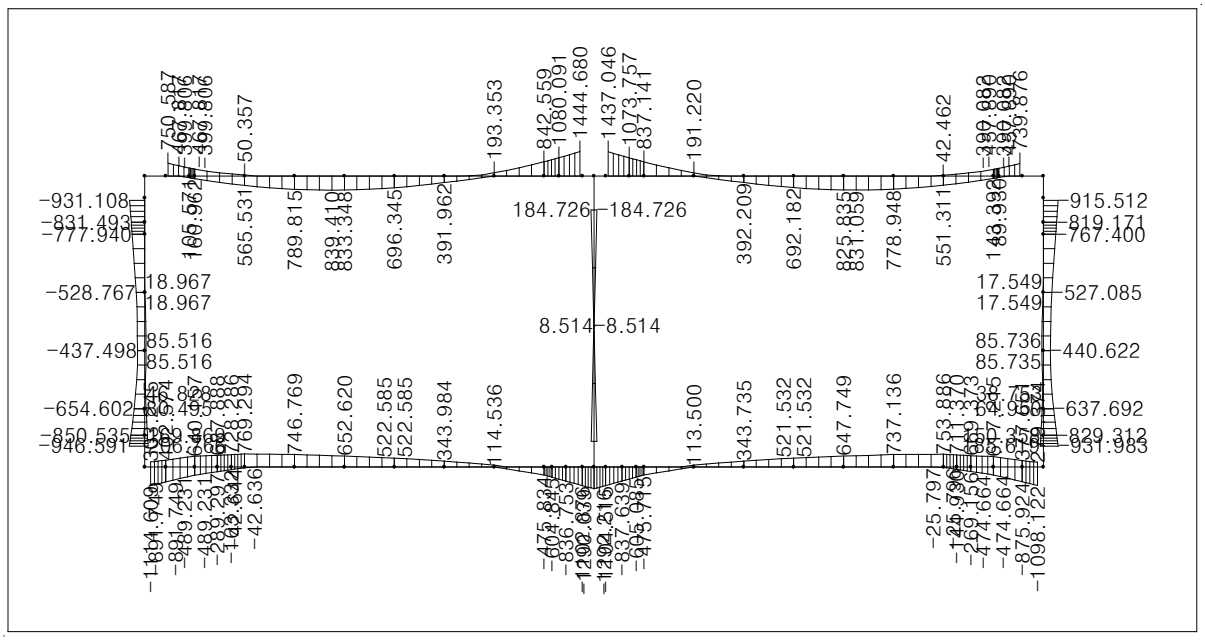
61	ENVEQ MIN	0.25000	-401.38594	0.00000	-375.09716
61	ENVEQ MIN	0.50000	-406.88490	0.00000	-486.94245
61	ENVEQ MIN	0.75000	-412.38386	0.00000	-615.67321
FRAME	LOAD	DIST	P	V2	M3
70	ENVEQ MIN	0.75000	-617.29416	-361.43372	-437.09914
70	ENVEQ MIN	1.00000	-634.57684	-379.22025	-482.44911
71	ENVEQ MAX	0.00000	0.00000	323.20840	370.58207
71	ENVEQ MAX	0.25000	0.00000	341.93045	404.36383
71	ENVEQ MAX	0.50000	0.00000	359.91415	441.79432
71	ENVEQ MAX	0.75000	0.00000	377.15952	490.71335
71	ENVEQ MAX	1.00000	0.00000	393.66655	544.96496
71	ENVEQ MIN	0.00000	-505.99287	-378.49656	-482.44911
71	ENVEQ MIN	0.25000	-513.87493	-386.61920	-509.39713
71	ENVEQ MIN	0.50000	-521.75700	-393.81787	-541.59431
71	ENVEQ MIN	0.75000	-529.63906	-400.09256	-587.89689
71	ENVEQ MIN	1.00000	-537.52112	-405.44327	-636.60327
72	ENVEQ MAX	0.00000	0.00000	393.66656	544.96496
72	ENVEQ MAX	0.08654	0.00000	400.26112	567.57913
72	ENVEQ MAX	0.17308	0.00000	406.71996	590.30630
72	ENVEQ MAX	0.25962	0.00000	413.04308	613.13709
72	ENVEQ MAX	0.34615	0.00000	419.23048	636.06208
72	ENVEQ MIN	0.00000	-537.52112	-405.44327	-636.60327
72	ENVEQ MIN	0.08654	-540.77518	-407.37786	-657.38877
72	ENVEQ MIN	0.17308	-544.02925	-409.14510	-678.55919
72	ENVEQ MIN	0.25962	-547.28331	-410.74498	-700.10691
72	ENVEQ MIN	0.34615	-550.53737	-412.17750	-722.02428
73	ENVEQ MAX	0.11715	0.00000	141.24216	349.48501
73	ENVEQ MAX	0.31590	0.00000	144.32093	179.92607
73	ENVEQ MAX	0.51464	0.00000	147.34047	6.94107
73	ENVEQ MAX	0.71339	0.00000	150.30077	169.98410
73	ENVEQ MAX	0.91213	0.00000	153.20182	350.19462
73	ENVEQ MIN	0.11715	-1276.52900	-141.24216	-349.48501
73	ENVEQ MIN	0.31590	-1294.34100	-144.32093	-179.92607
73	ENVEQ MIN	0.51464	-1312.15400	-147.34047	-6.94107
73	ENVEQ MIN	0.71339	-1329.96600	-150.30077	-169.98410
73	ENVEQ MIN	0.91213	-1347.77900	-153.20182	-350.19462

70	ENVEQ MIN	0.00000	-565.44609	-320.51408	-335.18879
70	ENVEQ MIN	0.25000	-582.72878	-332.08063	-364.48796
70	ENVEQ MIN	0.50000	-600.01147	-345.72051	-398.05439

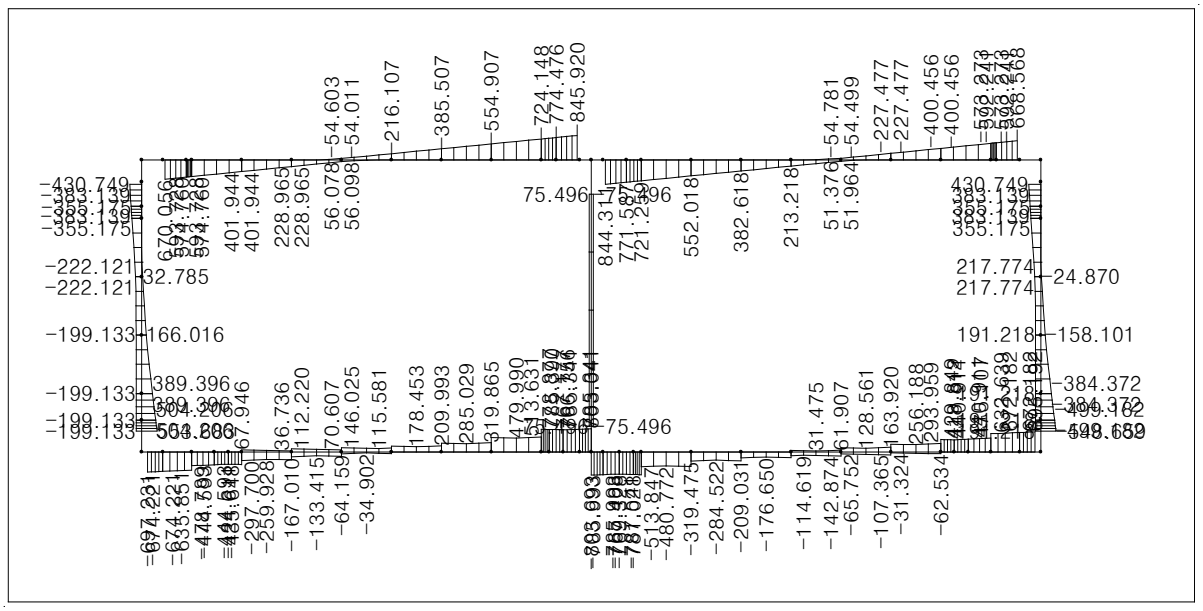
21. 단면력정리

21.1 상시

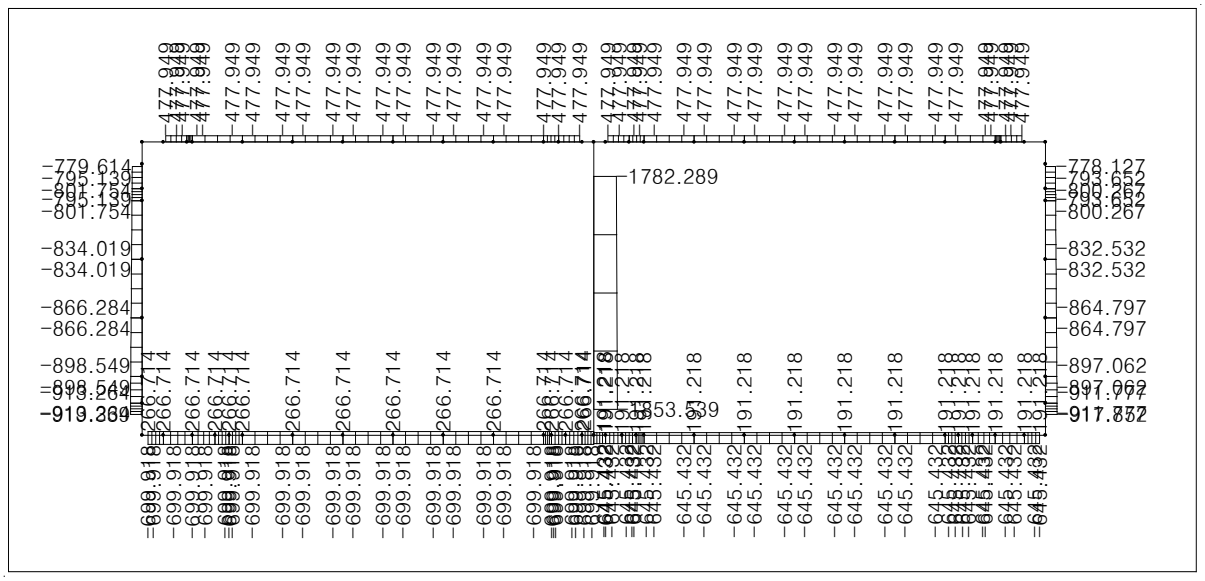
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



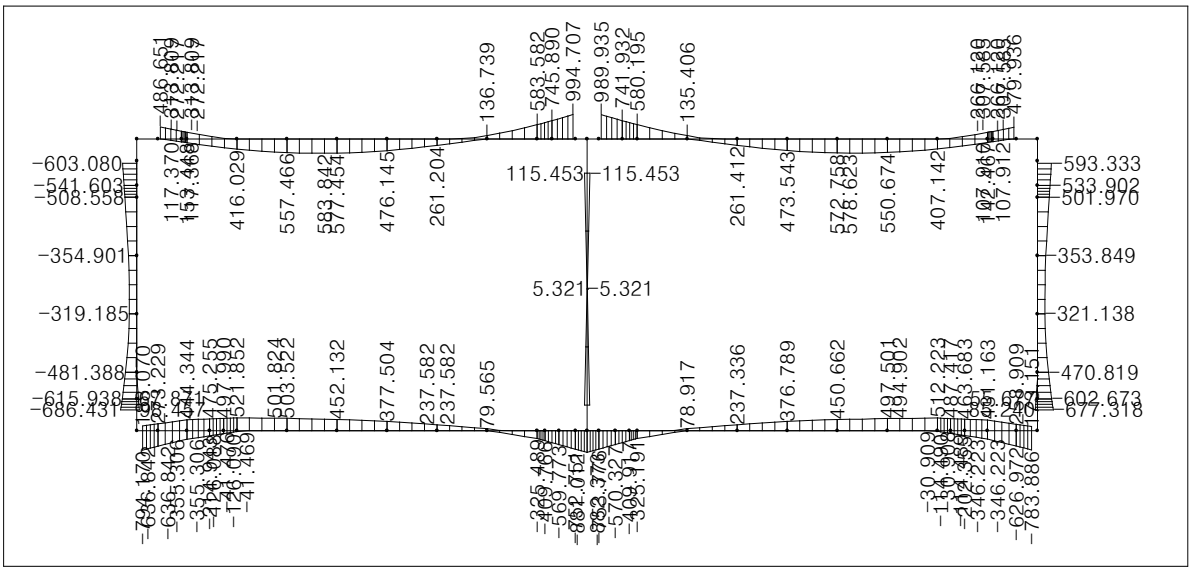
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

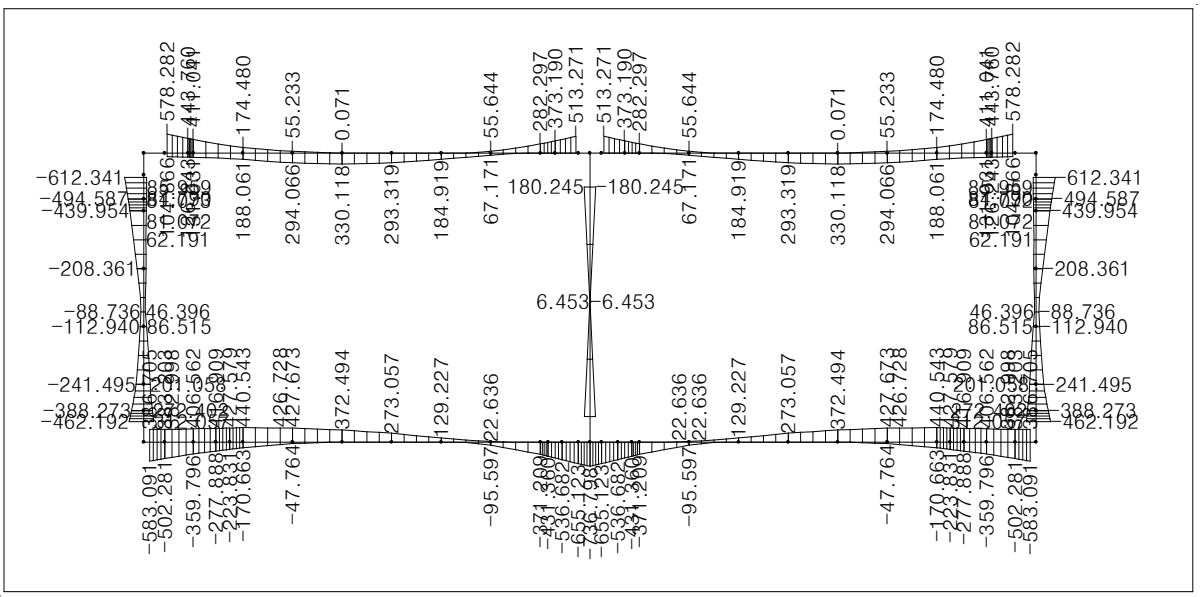


5) 단면력 정리

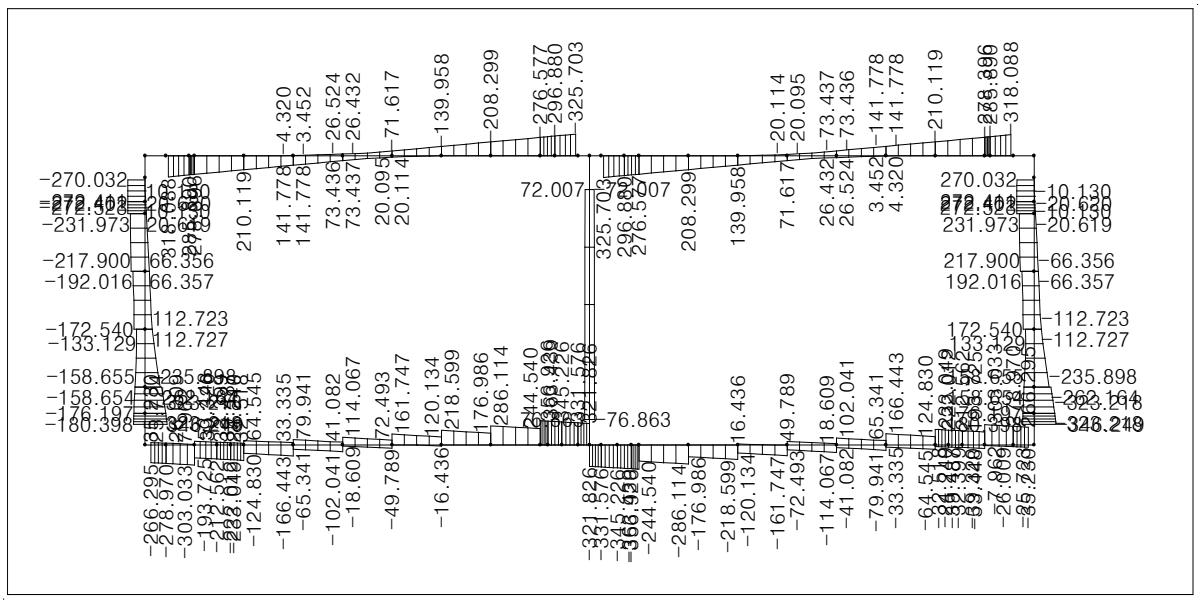
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	750.59	545.06	477.95	486.65	1000.00	1050.00	
		중앙부	2	839.41	99.23	477.95	583.84	1000.00	900.00	
		우측	3	1444.68	726.80	477.95	994.71	1000.00	1050.00	
	2 경간	좌측	4	1437.05	723.91	477.95	989.94	1000.00	1050.00	
		중앙부	5	831.06	97.74	477.95	578.62	1000.00	900.00	
		우측	6	739.88	543.57	477.95	479.94	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	891.75	436.76	699.92	636.84	1000.00	1300.00	
		측구부	8	289.30	436.76	699.92	214.94	1000.00	1300.00	
		중앙부	9	769.29	435.65	699.92	521.85	1000.00	1300.00	
		우측	10	1102.88	488.30	699.92	752.75	1000.00	1300.00	
	2 경간	좌측	11	1104.52	488.76	645.43	753.78	1000.00	1300.00	
		중앙부	12	753.89	429.85	645.43	512.22	1000.00	1300.00	
		측구부	13	144.93	433.08	645.43	114.49	1000.00	1300.00	
		우측	14	875.92	433.08	645.43	626.97	1000.00	1300.00	
좌측 벽체	1 층	상부	15	931.11	376.31	779.61	603.08	1000.00	1050.00	
		중앙부	16	80.50	389.40	898.55	0.00	1000.00	900.00	
		하부	17	850.54	267.72	913.26	615.94	1000.00	900.00	
우측 벽체	1 층	상부	18	915.51	376.31	778.13	593.33	1000.00	1050.00	
		중앙부	19	64.95	384.37	897.06	0.00	1000.00	900.00	
		하부	20	829.31	262.69	911.78	602.67	1000.00	900.00	
중간 벽체	1 련	상부	21	184.73	75.50	1782.29	115.45	1000.00	500.00	
		중앙부	22	95.07	75.50	1800.10	59.42	1000.00	500.00	
		하부	23	173.88	75.50	1853.54	108.68	1000.00	500.00	

21.2 지진시(기능수행)

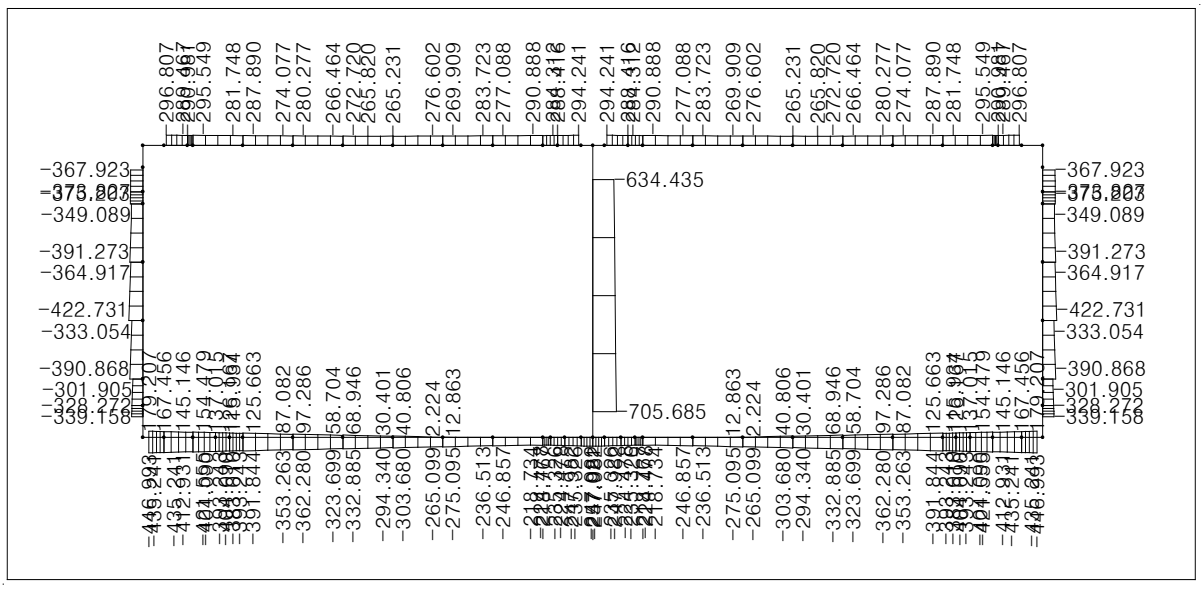
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

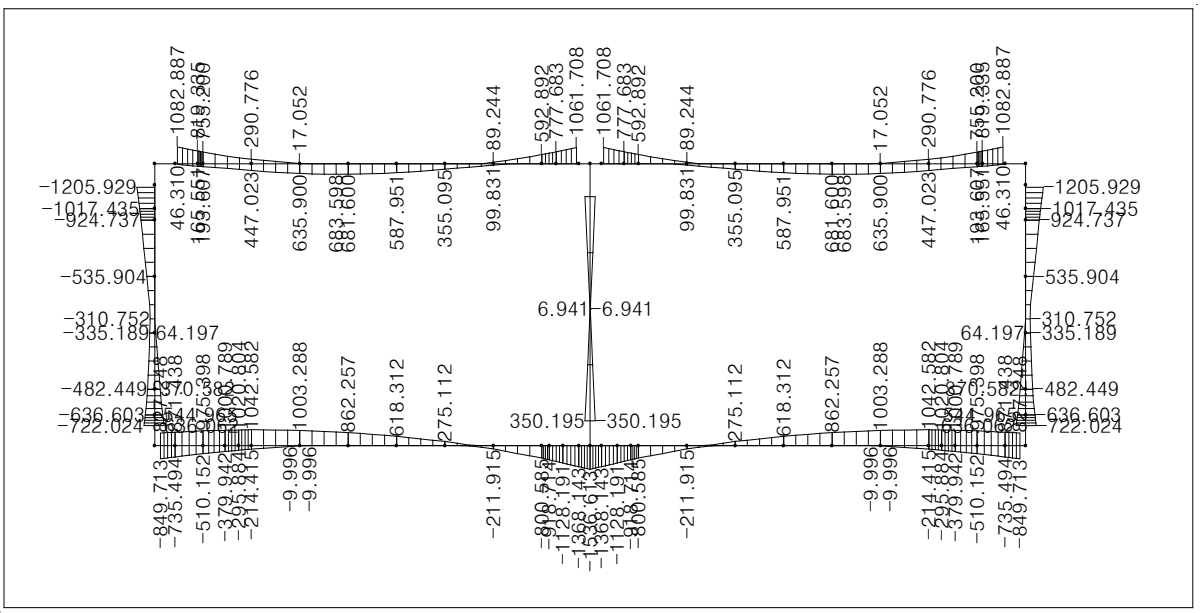


4) 단면력 정리

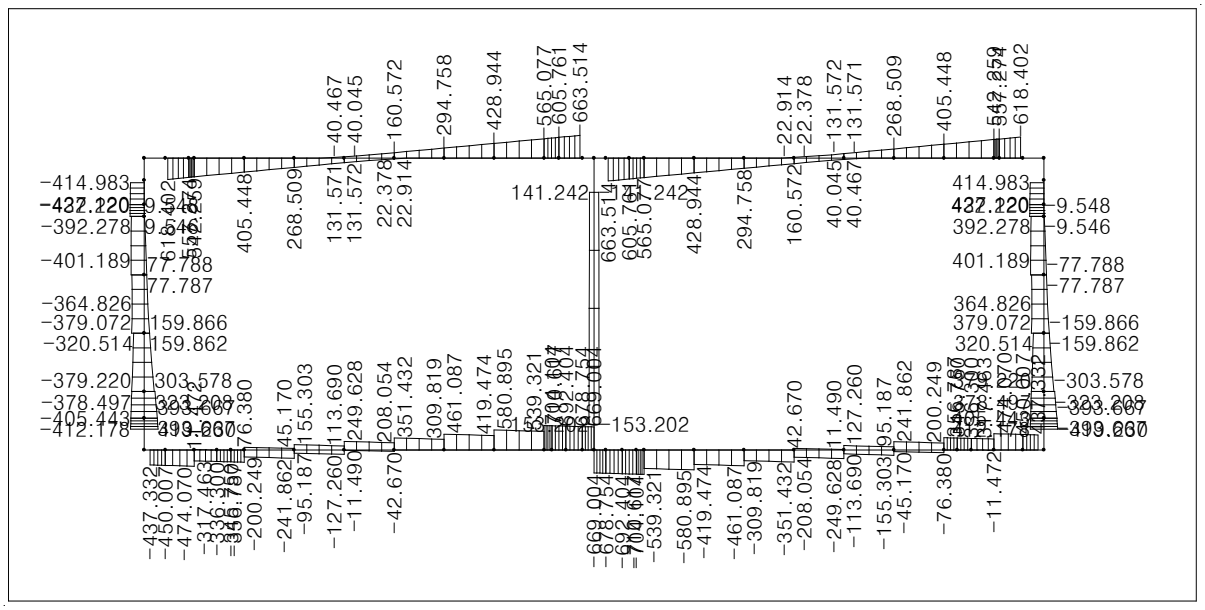
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	578.28	266.66	296.81	1000.00	1050.00	
		중앙부	2	327.94	90.52	269.92	1000.00	900.00	
		우측	3	513.27	277.65	294.24	1000.00	1050.00	
	2 경간	좌측	4	513.27	277.65	294.24	1000.00	1050.00	
		중앙부	5	327.94	90.52	269.92	1000.00	900.00	
		우측	6	578.28	266.66	296.81	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	502.28	215.71	435.24	1000.00	1300.00	
		측구부	8	277.89	215.71	446.99	1000.00	1300.00	
		중앙부	9	440.54	233.05	383.01	1000.00	1300.00	
		우측	10	655.12	259.48	247.98	1000.00	1300.00	
	2 경간	좌측	11	655.12	259.48	247.98	1000.00	1300.00	
		중앙부	12	440.54	233.05	391.84	1000.00	1300.00	
		측구부	13	223.83	215.71	393.24	1000.00	1300.00	
		우측	14	502.28	215.71	435.24	1000.00	1300.00	
좌측 벽체	1 층	상부	15	612.34	272.50	367.92	1000.00	1050.00	
		중앙부	16	201.06	262.16	390.87	1000.00	900.00	
		하부	17	388.27	167.52	328.27	1000.00	900.00	
우측 벽체	1 층	상부	18	612.34	272.50	367.92	1000.00	1050.00	
		중앙부	19	201.06	262.16	301.91	1000.00	900.00	
		하부	20	388.27	167.52	328.27	1000.00	900.00	
중간 벽체	1 련	상부	21	180.25	72.36	634.44	1000.00	500.00	
		중앙부	22	93.99	73.26	652.25	1000.00	500.00	
		하부	23	173.47	75.56	705.69	1000.00	500.00	

21.3 지진시(붕괴방지)

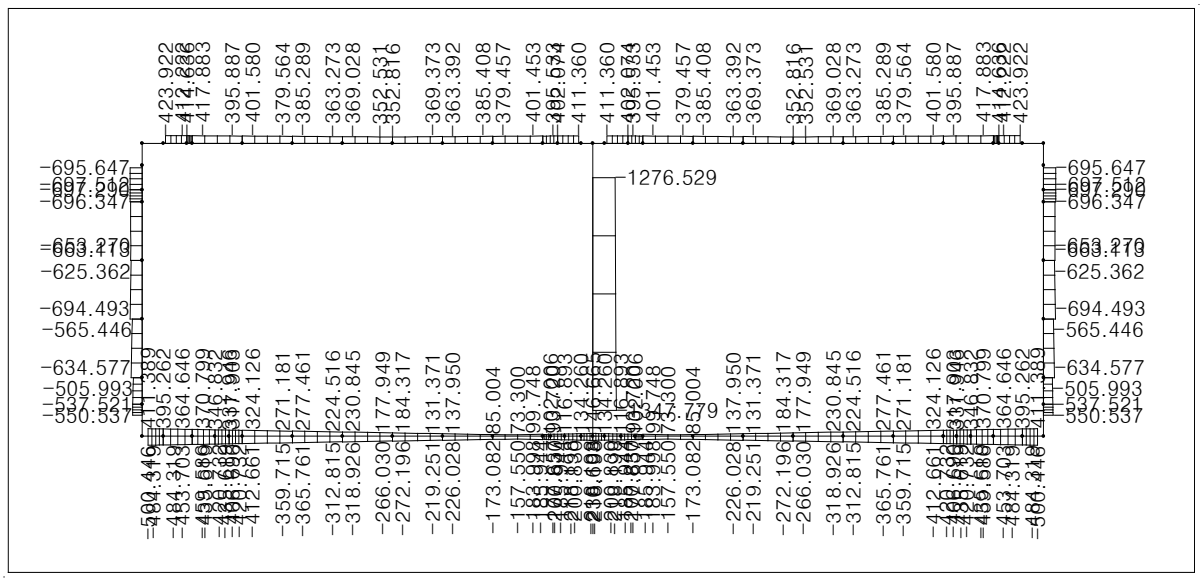
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	1082.89	518.75	423.92	1000.00	1050.00	
		중앙부	2	683.60	165.81	368.78	1000.00	900.00	
		우측	3	1061.71	567.22	411.36	1000.00	1050.00	
	2 경간	좌측	4	1061.71	567.22	411.36	1000.00	1050.00	
		중앙부	5	683.60	165.81	368.78	1000.00	900.00	
		우측	6	1082.89	518.75	423.92	1000.00	1050.00	
하부 슬래브	1 경간	좌측	7	735.49	339.45	484.32	1000.00	1300.00	
		측구부	8	379.94	339.45	500.45	1000.00	1300.00	
		중앙부	9	1042.58	356.79	406.69	1000.00	1300.00	
		우측	10	1368.14	554.26	218.20	1000.00	1300.00	
	2 경간	좌측	11	1368.14	554.26	218.20	1000.00	1300.00	
		중앙부	12	1042.58	356.79	412.66	1000.00	1300.00	
		측구부	13	295.88	339.45	420.73	1000.00	1300.00	
		우측	14	735.49	339.45	484.32	1000.00	1300.00	
좌측 벽체	1 층	상부	15	1205.93	428.49	695.65	1000.00	1050.00	
		중앙부	16	370.58	379.22	634.58	1000.00	900.00	
		하부	17	636.60	344.74	537.52	1000.00	900.00	
우측 벽체	1 층	상부	18	1205.93	428.49	695.65	1000.00	1050.00	
		중앙부	19	370.58	379.22	505.99	1000.00	900.00	
		하부	20	636.60	344.74	537.52	1000.00	900.00	
중간 벽체	1 련	상부	21	349.49	142.10	1276.53	1000.00	500.00	
		중앙부	22	179.93	144.32	1294.34	1000.00	500.00	
		하부	23	350.20	150.00	1347.78	1000.00	500.00	

21.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-750.59	-	-1082.89	-578.28	-1082.89	
		중앙부	2	839.41	-	683.60	327.94	839.41	
		우측	3	-1444.68	-	-1061.71	-513.27	-1444.68	
	2 경간	좌측	4	-1437.05	-	-1061.71	-513.27	-1437.05	
		중앙부	5	831.06	-	683.60	327.94	831.06	
		우측	6	-739.88	-	-1082.89	-578.28	-1082.89	
하부 슬래브	1 경간	좌측	7	-891.75	-	-735.49	-502.28	-891.75	
		측구부	8	-289.30	-	-379.94	-277.89	-379.94	
		중앙부	9	769.29	-	1042.58	440.54	1042.58	
		우측	10	-1102.88	-	-1368.14	-655.12	-1368.14	
	2 경간	좌측	11	-1104.52	-	-1368.14	-655.12	-1368.14	
		중앙부	12	753.89	-	1042.58	440.54	1042.58	
		측구부	13	-144.93	-	-295.88	-223.83	-295.88	
		우측	14	-875.92	-	-735.49	-502.28	-875.92	
좌측 벽체	1 층	상부	15	-931.11	-	-1205.93	-612.34	-1205.93	
		중앙부	16	80.50	-	370.58	201.06	370.58	
		하부	17	-850.54	-	-636.60	-388.27	-850.54	
우측 벽체	1 층	상부	18	-915.51	-	-1205.93	-612.34	-1205.93	
		중앙부	19	64.95	-	370.58	201.06	370.58	
		하부	20	-829.31	-	-636.60	-388.27	-829.31	
중간 벽체	1 련	상부	21	-184.73	-	-349.49	-180.25	-349.49	
		중앙부	22	95.07	-	179.93	93.99	179.93	
		하부	23	-173.88	-	-350.20	-173.47	-350.20	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	545.06	-	518.75	266.66	545.06	
		중앙부	2	99.23	-	165.81	90.52	165.81	
		우측	3	-726.80	-	-567.22	-277.65	-726.80	
	2 경간	좌측	4	723.91	-	567.22	277.65	723.91	
		중앙부	5	-97.74	-	-165.81	-90.52	-165.81	
		우측	6	-543.57	-	-518.75	-266.66	-543.57	
하부 슬래브	1 경간	좌측	7	-436.76	-	-339.45	-215.71	-436.76	
		측구부	8	-436.76	-	-339.45	-215.71	-436.76	
		중앙부	9	-435.65	-	-356.79	-233.05	-435.65	
		우측	10	488.30	-	554.26	259.48	554.26	
	2 경간	좌측	11	-488.76	-	-554.26	-259.48	-554.26	
		중앙부	12	429.85	-	356.79	233.05	429.85	
		측구부	13	433.08	-	339.45	215.71	433.08	
		우측	14	433.08	-	339.45	215.71	433.08	
좌측 벽체	1 층	상부	15	-376.31	-	-428.49	-272.50	-428.49	
		중앙부	16	389.40	-	-379.22	262.16	389.40	
		하부	17	267.72	-	-344.74	167.52	-344.74	
우측 벽체	1 층	상부	18	376.31	-	428.49	272.50	428.49	
		중앙부	19	-384.37	-	379.22	-262.16	-384.37	
		하부	20	-262.69	-	344.74	-167.52	344.74	
중간 벽체	1 련	상부	21	-75.50	-	-142.10	-72.36	-142.10	
		중앙부	22	-75.50	-	-144.32	-73.26	-144.32	
		하부	23	-75.50	-	-150.00	-75.56	-150.00	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-477.95	-	-423.92	-296.81	-477.95	
		중앙부	2	-477.95	-	-368.78	-269.92	-477.95	
		우측	3	-477.95	-	-411.36	-294.24	-477.95	
	2 경간	좌측	4	-477.95	-	-411.36	-294.24	-477.95	
		중앙부	5	-477.95	-	-368.78	-269.92	-477.95	
		우측	6	-477.95	-	-423.92	-296.81	-477.95	
하부 슬래브	1 경간	좌측	7	-699.92	-	-484.32	-435.24	-699.92	
		측구부	8	-699.92	-	-500.45	-446.99	-699.92	
		중앙부	9	-699.92	-	-406.69	-383.01	-699.92	
		우측	10	-699.92	-	-218.20	-247.98	-699.92	
	2 경간	좌측	11	-645.43	-	-218.20	-247.98	-645.43	
		중앙부	12	-645.43	-	-412.66	-391.84	-645.43	
		측구부	13	-645.43	-	-420.73	-393.24	-645.43	
		우측	14	-645.43	-	-484.32	-435.24	-645.43	
좌측 벽체	1 층	상부	15	-779.61	-	-695.65	-367.92	-779.61	
		중앙부	16	-898.55	-	-634.58	-390.87	-898.55	
		하부	17	-913.26	-	-537.52	-328.27	-913.26	
우측 벽체	1 층	상부	18	-778.13	-	-695.65	-367.92	-778.13	
		중앙부	19	-897.06	-	-505.99	-301.91	-897.06	
		하부	20	-911.78	-	-537.52	-328.27	-911.78	
중간 벽체	1 련	상부	21	-1782.29	-	-1276.53	-634.44	-1782.29	
		중앙부	22	-1800.10	-	-1294.34	-652.25	-1800.10	
		하부	23	-1853.54	-	-1347.78	-705.69	-1853.54	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-486.65	-	-	-	-486.65	
		중앙부	2	583.84	-	-	-	583.84	
		우측	3	-994.71	-	-	-	-994.71	
	2 경간	좌측	4	-989.94	-	-	-	-989.94	
		중앙부	5	578.62	-	-	-	578.62	
		우측	6	-479.94	-	-	-	-479.94	
하부 슬래브	1 경간	좌측	7	-636.84	-	-	-	-636.84	
		측구부	8	-214.94	-	-	-	-214.94	
		중앙부	9	521.85	-	-	-	521.85	
		우측	10	-752.75	-	-	-	-752.75	
	2 경간	좌측	11	-753.78	-	-	-	-753.78	
		중앙부	12	512.22	-	-	-	512.22	
		측구부	13	-114.49	-	-	-	-114.49	
		우측	14	-626.97	-	-	-	-626.97	
좌측 벽체	1 층	상부	15	-603.08	-	-	-	-603.08	
		중앙부	16	-	-	-	-	-	
		하부	17	-615.94	-	-	-	-615.94	
우측 벽체	1 층	상부	18	-593.33	-	-	-	-593.33	
		중앙부	19	-	-	-	-	-	
		하부	20	-602.67	-	-	-	-602.67	
중간 벽체	1 련	상부	21	-115.45	-	-	-	-115.45	
		중앙부	22	59.42	-	-	-	59.42	
		하부	23	-108.68	-	-	-	-108.68	

22. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	950	1082.89	1260.63	3462.57	H25 - 8.0EA	4053.60	1.16
		중앙부	2	1000	820	839.41	1081.46	3113.84	H25 - 8.0EA	4053.60	1.29
		우측	3	1000	950	1444.68	1581.71	4673.01	H29 - 8.0EA	5139.20	1.09
	2경간	좌측	4	1000	950	1437.05	1581.71	4647.17	H29 - 8.0EA	5139.20	1.10
		중앙부	5	1000	820	831.06	1081.46	3081.78	H25 - 8.0EA	4053.60	1.30
		우측	6	1000	950	1082.89	1260.63	3462.57	H25 - 8.0EA	4053.60	1.16
하부슬래브	1경간	좌측	7	1000	1200	891.75	1605.18	2221.50	H25 - 8.0EA	4053.60	1.80
		측구부	8	1000	950	379.94	1260.63	1189.27	H25 - 8.0EA	4053.60	3.32
		중앙부	9	1000	1220	1042.58	1632.75	2560.28	H25 - 8.0EA	4053.60	1.57
		우측	10	1000	1200	1368.14	2018.54	3439.19	H29 - 8.0EA	5139.20	1.48
	2경간	좌측	11	1000	1200	1368.14	2018.54	3439.19	H29 - 8.0EA	5139.20	1.48
		중앙부	12	1000	1220	1042.58	1632.75	2560.28	H25 - 8.0EA	4053.60	1.57
		측구부	13	1000	950	295.88	1260.63	923.88	H25 - 8.0EA	4053.60	4.26
		우측	14	1000	1200	875.92	1605.18	2181.43	H25 - 8.0EA	4053.60	1.83
좌측벽체	1층	상부	15	1000	950	1205.93	1260.63	3870.98	H25 - 8.0EA	4053.60	1.05
		중앙부	16	1000	820	370.58	623.44	1348.53	H19 - 8.0EA	2292.00	1.68
		하부	17	1000	800	850.54	1053.89	3241.42	H25 - 8.0EA	4053.60	1.24
우측벽체	1층	상부	18	1000	950	1205.93	1260.63	3870.98	H25 - 8.0EA	4053.60	1.05
		중앙부	19	1000	820	370.58	623.44	1348.53	H19 - 8.0EA	2292.00	1.68
		하부	20	1000	800	829.31	1053.89	3157.55	H25 - 8.0EA	4053.60	1.27

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	519.6	545.1	925.06	2.00	15.90	H13	150	253.40	O.K
		중앙부	2	532.6	165.8	740.39	2.00	-	H13	300	253.40	O.K
		우측	3	519.6	726.8	925.06	2.00	129.49	H13	150	253.40	O.K
	2경간	좌측	4	519.6	723.9	925.06	2.00	127.68	H13	150	253.40	O.K
		중앙부	5	532.6	165.8	740.39	2.00	-	H13	300	253.40	O.K
		우측	6	519.6	543.6	925.06	2.00	14.97	H13	150	253.40	O.K
하부슬래브	1경간	좌측	7	779.4	436.8	1387.58	2.00	131.25	H13	150	253.40	O.K
		측구부	8	617.0	436.8	1098.50	2.00	131.25	H13	150	253.40	O.K
		중앙부	9	792.4	435.6	1410.71	2.00	131.25	H13	150	253.40	O.K
		우측	10	779.4	554.3	1387.58	2.00	131.25	H13	150	253.40	O.K
	2경간	좌측	11	779.4	554.3	1387.58	2.00	131.25	H13	150	253.40	O.K
		중앙부	12	792.4	429.8	1410.71	2.00	131.25	H13	150	253.40	O.K
		측구부	13	617.0	433.1	1098.50	2.00	131.25	H13	150	253.40	O.K
		우측	14	779.4	433.1	1387.58	2.00	131.25	H13	150	253.40	O.K
좌측벽체	1층	상부	15	519.6	428.5	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	16	532.6	389.4	948.18	2.00	-	H13	150	253.40	O.K
		하부	17	519.6	344.7	925.06	2.00	-	H13	150	253.40	O.K
우측벽체	1층	상부	18	519.6	428.5	925.06	2.00	-	H13	150	253.40	O.K
		중앙부	19	532.6	384.4	948.18	2.00	-	H13	150	253.40	O.K
		하부	20	519.6	344.7	925.06	2.00	-	H13	150	253.40	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1082.89	545.06

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 83.119) / 83.119 = 0.03129

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3462.573 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.171]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00427

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (950.00 - a/2) = 1260.626 kN.m

≥ Mu (= 1082.887 kN.m) ∴ O.K [안전률 1.164]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 545.058 kN) , 전단보강 필요.

Av_req = (545.058-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 15.902 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 545.058 kN ∴ O.K

▣ TITLE : 상부슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	839.41	165.81

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 83.119) / 83.119 = 0.02660

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3113.842 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.302]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00494

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (820.00 - a/2) = 1081.457 kN.m

≥ Mu (= 839.410 kN.m) ∴ O.K [안전률 1.288]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

ΦVc/2 ≥ Vu (= 165.805 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1444.68	726.80

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4673.010 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.100]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1444.680 kN.m) ∴ O.K [안전률 1.095]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 726.798 kN) , 전단보강 필요.

Av_req = (726.798-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 129.489 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 726.798 kN ∴ O.K

▣ TITLE : 상부슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1437.05	723.91

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 105.379) / 105.379 = 0.02405

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4647.166 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.106]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00541

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (950.00 - a/2) = 1581.706 kN.m

≥ Mu (= 1437.046 kN.m) ∴ O.K [안전률 1.101]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 723.909 kN) , 전단보강 필요.

Av_req = (723.909-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 127.683 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 723.909 kN ∴ O.K

▣ TITLE : 상부슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	831.06	165.81

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 83.119) / 83.119 = 0.02660

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3081.776 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.315]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00494

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (820.00 - a/2) = 1081.457 kN.m

≥ Mu (= 831.059 kN.m) ∴ O.K [안전률 1.301]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

ΦVc/2 ≥ Vu (= 165.805 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1082.89	543.57

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 83.119) / 83.119 = 0.03129

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3462.573 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm), [사용률 = 1.171]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00427

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (950.00 - a/2) = 1260.626 kN.m

≥ Mu (= 1082.887 kN.m) ∴ O.K [안전률 1.164]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

< Vu (= 543.570 kN) , 전단보강 필요.

Av_req = (543.570-519.615) x 150.00 / (400x800.00xΦ) x 1000 = 14.972 mm²

Av_min1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_min2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_min = 131.250 mm² (Av_min1,Av_min2중 큰 값을 사용)

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm) → 최소 전단철근 만족

Vs = 253.400 x 400.0 x 800.00 / 150.00 x 1000 = 540.587 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 800.00 / 1000 = 2771.281 kN ≥ 540.587 kN ∴ O.K

s = 150.000 ≤ 400.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (692.820 + 540.587) = 925.055 kN ≥ 543.570 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1200.00	100.00	891.75	436.76

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1200.00 - 83.119) / 83.119 = 0.04031

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2221.497 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.825]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00338

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1200.00 - a/2) = 1605.182 kN.m

≥ Mu (= 891.749 kN.m) ∴ O.K [안전률 1.800]

* 전단에 대한 검토 (d = 1200.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1200.00 = 779.423 kN

ΦVc/2 < Vu (= 436.763 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 1경간(측구)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	379.94	436.76

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 83.119) / 83.119 = 0.03129

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1189.266 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 3.408]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00427

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (950.00 - a/2) = 1260.626 kN.m

≥ Mu (= 379.942 kN.m) ∴ O.K [안전률 3.318]

* 전단에 대한 검토 (d = 950.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 950.00 = 617.043 kN

ΦVc/2 < Vu (= 436.763 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1220.00	80.00	1042.58	435.65

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1220.00 - 83.119) / 83.119 = 0.04103

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2560.280 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.583]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00332

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1220.00 - a/2) = 1632.747 kN.m

≥ Mu (= 1042.582 kN.m) ∴ O.K [안전률 1.566]

* 전단에 대한 검토 (d = 1220.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1220.00 = 792.413 kN

ΦVc/2 < Vu (= 435.648 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1200.00	100.00	1368.14	554.26

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1200.00 - 105.379) / 105.379 = 0.03116

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3439.189 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.494]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00428

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1200.00 - a/2) = 2018.538 kN.m

≥ Mu (= 1368.143 kN.m) ∴ O.K [안전률 1.475]

* 전단에 대한 검토 (d = 1200.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1200.00 = 779.423 kN

ΦVc/2 < Vu (= 554.262 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1200.00	100.00	1368.14	554.26

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1200.00 - 105.379) / 105.379 = 0.03116

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3439.189 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm) , [사용률 = 1.494]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00428

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1200.00 - a/2) = 2018.538 kN.m

≥ Mu (= 1368.143 kN.m) ∴ O.K [안전률 1.475]

* 전단에 대한 검토 (d = 1200.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1200.00 = 779.423 kN

ΦVc/2 < Vu (= 554.262 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1220.00	80.00	1042.58	429.85

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1220.00 - 83.119) / 83.119 = 0.04103

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2560.280 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm), [사용률 = 1.583]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00332

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1220.00 - a/2) = 1632.747 kN.m

≥ Mu (= 1042.582 kN.m) ∴ O.K [안전률 1.566]

* 전단에 대한 검토 (d = 1220.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1220.00 = 792.413 kN

ΦVc/2 < Vu (= 429.849 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(측구)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	295.88	433.08

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 83.119) / 83.119 = 0.03129

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 923.880 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm), [사용률 = 4.388]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00427

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (950.00 - a/2) = 1260.626 kN.m

≥ Mu (= 295.884 kN.m) ∴ O.K [안전률 4.261]

* 전단에 대한 검토 (d = 950.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 950.00 = 617.043 kN

ΦVc/2 < Vu (= 433.081 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 하부슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1300.00	1200.00	100.00	875.92	433.08

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1200.00 - 83.119) / 83.119 = 0.04031

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2181.431 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.858]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00338

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1200.00 - a/2) = 1605.182 kN.m

≥ Mu (= 875.924 kN.m) ∴ O.K [안전률 1.833]

* 전단에 대한 검토 (d = 1200.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1200.00 = 779.423 kN

ΦVc/2 < Vu (= 433.081 kN) , 최소 전단철근 보강.

Av_req1 = 0.0625 x √27.0 x 1000.0 x 150.0 / 400.0 = 121.785 mm²

Av_req2 = 0.35 x 1000.0 x 150.0 / 400.0 = 131.250 mm²

Av_req = 131.250 mm² (Av_req1,Av_req2중 큰 값을 사용)

Av_use = H13 - 2.0 EA = 253.400 mm² ∴ O.K

▣ TITLE : 좌측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1205.93	428.49

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 83.119) / 83.119 = 0.03129

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3870.983 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm), [사용률 = 1.047]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00427

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (950.00 - a/2) = 1260.626 kN.m

≥ Mu (= 1205.929 kN.m) ∴ O.K [안전률 1.045]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 428.491 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	370.58	389.40

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 46.997) / 46.997 = 0.04934

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1348.531 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm), [사용률 = 1.700]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00280

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (820.00 - a/2) = 623.444 kN.m

≥ Mu (= 370.582 kN.m) ∴ O.K [안전률 1.682]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

≥ Vu (= 389.396 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	800.00	100.00	850.54	344.74

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (800.00 - 83.119) / 83.119 = 0.02587

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3241.421 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.251]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00507

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (800.00 - a/2) = 1053.893 kN.m

≥ Mu (= 850.535 kN.m) ∴ O.K [안전률 1.239]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 344.739 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1050.00	950.00	100.00	1205.93	428.49

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (950.00 - 83.119) / 83.119 = 0.03129

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3870.983 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm), [사용률 = 1.047]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00427

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (950.00 - a/2) = 1260.626 kN.m

≥ Mu (= 1205.929 kN.m) ∴ O.K [안전률 1.045]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 428.491 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	820.00	80.00	370.58	384.37

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (820.00 - 46.997) / 46.997 = 0.04934

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1348.531 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm), [사용률 = 1.700]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00280

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (820.00 - a/2) = 623.444 kN.m

≥ Mu (= 370.582 kN.m) ∴ O.K [안전률 1.682]

* 전단에 대한 검토 (d = 820.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 820.00 = 532.606 kN

≥ Vu (= 384.372 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	900.00	800.00	100.00	829.31	344.74

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (800.00 - 83.119) / 83.119 = 0.02587

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3157.548 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm) , [사용률 = 1.284]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00507

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (800.00 - a/2) = 1053.893 kN.m

≥ Mu (= 829.312 kN.m) ∴ O.K [안전률 1.271]

* 전단에 대한 검토 (d = 800.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 800.00 = 519.615 kN

≥ Vu (= 344.739 kN) , 전단보강 불필요.

23. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

2) 상부슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

4) 상부슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

5) 상부슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

6) 상부슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

7) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

8) 하부슬래브 : 1경간(측구)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

9) 하부슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 3.3EA = 1323.338 ㎟ ≥ 810.720 ∴ O.K
H16 - 3.3EA

10) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

11) 하부슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 5139.200 × 0.20 = 1027.84 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1027.840 ∴ O.K

12) 하부슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 3.3EA = 1323.338 ㎟ ≥ 810.720 ∴ O.K
H16 - 3.3EA

13) 하부슬래브 : 2경간(측구)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 2648.000 ㎟ ≥ 1800.000 ∴ O.K
H16 - 3.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

14) 하부슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1300 × 0.0020 = 2600.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

15) 좌측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

16) 좌측벽체 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 2292.000 × 0.20 = 458.40 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 458.400 ∴ O.K

17) 좌측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

18) 우측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

19) 우측벽체 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 2292.000 × 0.20 = 458.40 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 458.400 ∴ O.K

20) 우측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 900 × 0.0020 = 1800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 4053.600 × 0.20 = 810.72 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 810.720 ∴ O.K

24. 거더,기둥검토,내측벽체 검토

24.1 내측벽체 검토

(단위 : kN,m)

부재	폭	두께	높이	CTC	축력	모멘트	축력×CTC	모멘트×CTC	해석모델	조합
W1	1.00	0.50	4.25	-	1853.54	41.53	1853.54	41.53	상시	68
					1203.00	350.19	1203.00	350.19	지진(붕괴)	19

* 벽체와 기둥의 판별 (W1)

$0.4Agfck = 0.4 \times 1000 \times 500 \times 27$

$= 5400000\ N = 5400.00\ kN \quad \geq 1853.54\ kN$

∴ 벽체로 검토한다

(1) 벽체 1

1) 축력최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	80	420	1853.539	41.531	22.4

* 철근비 검토

As = 2292.000 mm² (인장중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0092) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 252.00 mm, ab = k1 x cb = 214.20 mm

Cc = 0.85 x 27.0 x 214200.000 = 4915.890 kN, ∑Csi = 864.199 kN, ∑Tsi = 916.800 kN

Pb = 4915.890 + 864.199 - 916.800 = 4863.289 kN

Mb = Cc x 142.900 + ∑(Csi*di) + ∑(Tsi*di) = 1005.250 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 206.702 mm, e = Mu/Pu = 22.407 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 551.79 mm, a = k1 x c = 469.02 mm 를 사용.

Cc = 0.85 x 27.0 x 469020.081 = 10764.011 kN

∑Csi = 1140.048 kN, ∑Tsi = 0.000 kN

Pn = 10764.011 + 1140.048 - 0.000 = 11904.059 kN

Mn = Cc x 15.490 + ∑(Csi*di) + ∑(Tsi*di) = 266.753 kN.m

- 편심오차 : |e - Mn/Pn(=22.409)| = 0.0021 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 500.00 - 80.00 = 420.000 mm

c = 551.788 mm, a = k1 x c = 469.020 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (420.00-551.79) / 551.79 = -0.00072

εt ≤ εy 이므로 압축지배단면이며, Φ = 0.65 를 적용한다.

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10562.718 kN < Pn = 11904.059 kN

ΦPn = 0.65 x 10562.718 = 6865.767 kN ≥ Pu = 1853.539 kN ∴ O.K

ΦMn = ΦPn x 0.022 = 153.838 kN.m ≥ Mu = 41.531 kN.m ∴ O.K

* 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 420.00 = 345.033 kN

≥ Vu (= 153.202 kN) , 전단보강 불필요.

2) 모멘트최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	80	420	1203.002	350.195	291.1

* 철근비 검토

As = 2292.000 mm² (인장중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0092) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 252.00 mm, ab = k1 x cb = 214.20 mm

Cc = 0.85 x 27.0 x 214200.000 = 4915.890 kN, ∑Csi = 864.199 kN, ∑Tsi = 916.800 kN

Pb = 4915.890 + 864.199 - 916.800 = 4863.289 kN

Mb = Cc x 142.900 + ∑(Csi*di) + ∑(Tsi*di) = 1005.250 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 206.702 mm, e = Mu/Pu = 291.101 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 161.34 mm, a = k1 x c = 137.14 mm 를 사용.

Cc = 0.85 x 27.0 x 137137.985 = 3147.317 kN

∑Csi = 640.704 kN, ∑Tsi = 916.800 kN

Pn = 3147.317 + 640.704 - 916.800 = 2871.221 kN

Mn = Cc x 181.431 + ∑(Csi*di) + ∑(Tsi*di) = 835.797 kN.m

- 편심오차 : |e - Mn/Pn(=291.094)| = 0.0061 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 500.00 - 80.00 = 420.000 mm

c = 161.339 mm, a = k1 x c = 137.138 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (420.00-161.34) / 161.34 = 0.00481

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.84 를 적용한다.

Φ = 0.650 + (0.0048-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.837

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10562.718 kN ≥ Pn = 2871.221 kN

ΦPn = 0.84 x 2871.221 = 2404.103 kN ≥ Pu = 1203.002 kN ∴ O.K

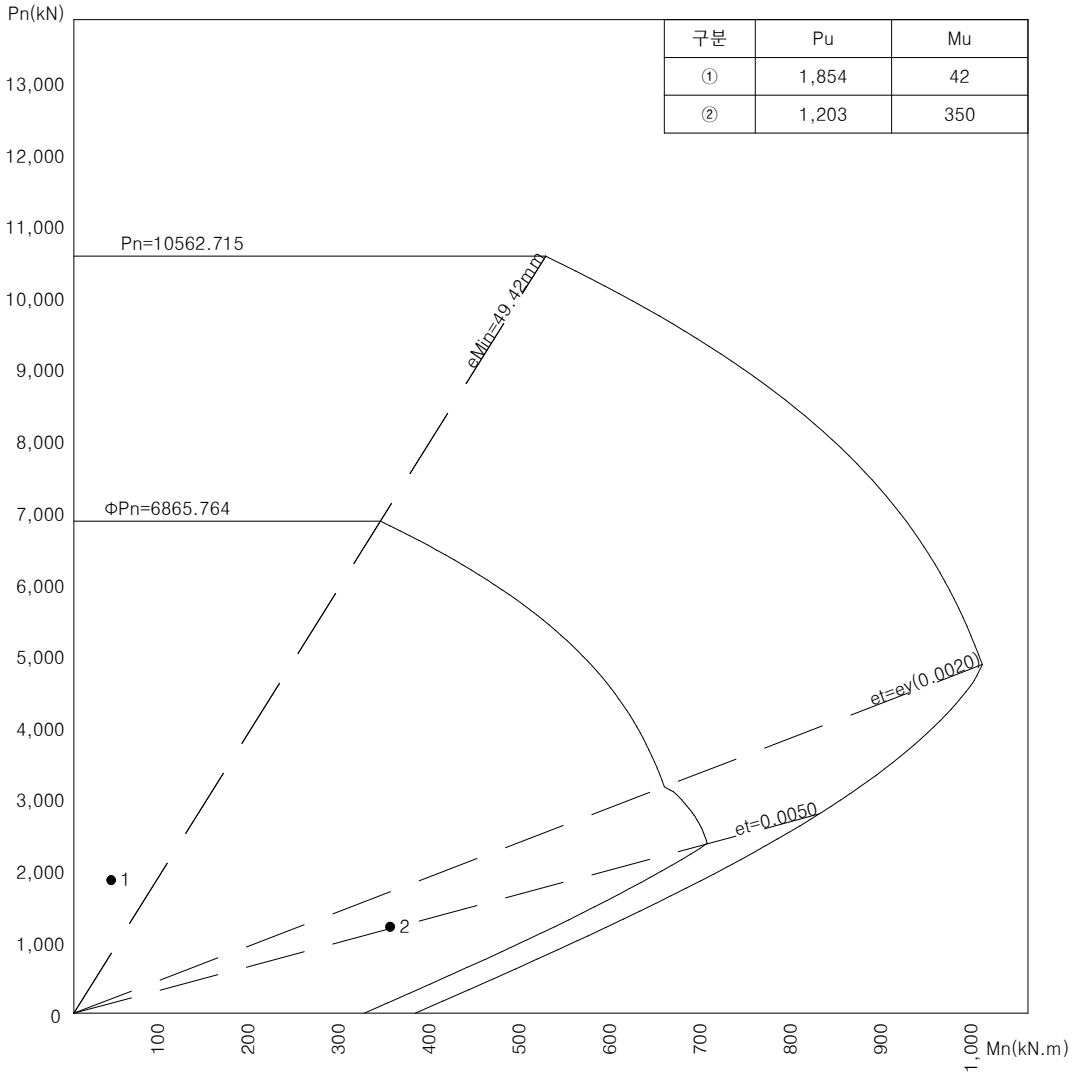
ΦMn = ΦPn x 0.291 = 699.836 kN.m ≥ Mu = 350.195 kN.m ∴ O.K

* 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 420.00 = 319.680 kN

≥ Vu (= 153.202 kN) , 전단보강 불필요.

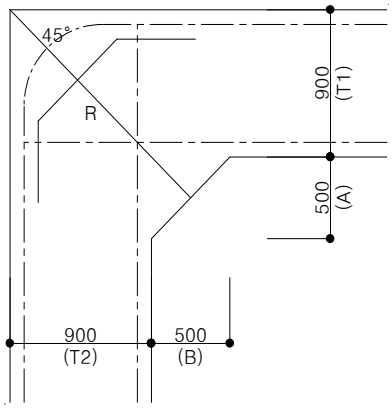
4) PM 상관도



구분	Pu	Mu
①	1,854	42
②	1,203	350

25. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 603.080 kN.m
- 절점부 휨모멘트 : Mo = 603.080 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 1626.346 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H25 @250 - 4EA = 2026.800 mm²

∴ Total Asb = 2026.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 603.08 \times 10^6}{1626.346^2 \times 1000} = 1.140 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 603.08 \times 10^6}{1626.346 \times 180} = 4120.214 \text{ mm}^2$$

Asb = 2026.800 mm²

Req'd As = As - Asb

= 4120.214 mm² - 2026.800 mm²

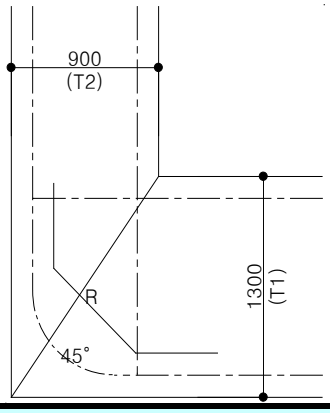
= 2093.414 mm²

- 사용보강철근

Use'd As = H29 - 4EA

∴ Total As = 2569.600 mm² > Req'd As (= 2093.414 mm²) ----------> O.K !!!

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 794.170 kN.m
- 절점부 휨모멘트 : Mo = 794.170 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 1581.139$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H25 @250 - 4EA = 2026.800 mm²

∴ Total Asb = 2026.800 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 794.17 \times 10^6}{1581.139^2 \times 1000} = 1.588 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 794.17 \times 10^6}{1581.139 \times 180} = 5580.858 \text{ mm}^2$$

Asb = 2026.800 mm²

Req'd As = As - Asb

= 5580.858 mm² - 2026.800 mm²

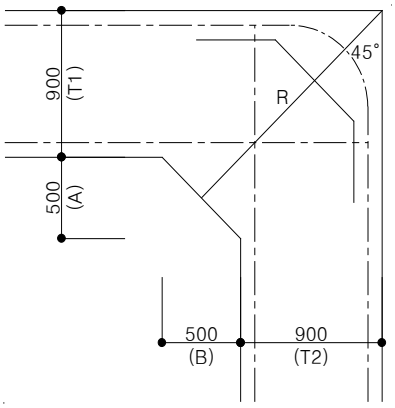
= 3554.058 mm²

- 사용보강철근

Use'd As = H25 - 4EA , H25 - 4EA

∴ Total As = 4053.600 mm² > Req'd As (= 3554.058 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 593.333 kN.m
- 절점부 휨모멘트 : Mo = 593.333 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

= 1626.346 mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H25 @250 - 4EA = 2026.800 mm²

∴ Total Asb = 2026.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 593.33 \times 10^6}{1626.346^2 \times 1000} = 1.122 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 593.33 \times 10^6}{1626.346 \times 180} = 4053.618 \text{ mm}^2$$

Asb = 2026.800 mm²

Req'd As = As - Asb

= 4053.618 mm² - 2026.800 mm²

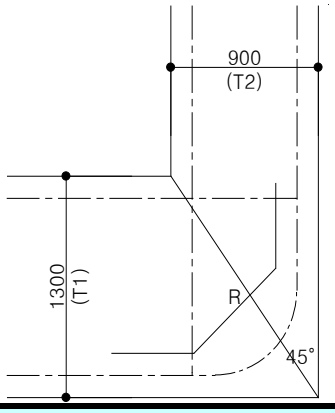
= 2026.818 mm²

- 사용보강철근

Use'd As = H29 - 4EA

∴ Total As = 2569.600 mm² > Req'd As (= 2026.818 mm²) ----------> O.K !!!

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 783.886 kN.m
- 절점부 휨모멘트 : Mo = 783.886 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 1581.139$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H25 @250 - 4EA = 2026.800 mm²

∴ Total Asb = 2026.800 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 783.89 \times 10^6}{1581.139^2 \times 1000} = 1.568 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 783.89 \times 10^6}{1581.139 \times 180} = 5508.589 \text{ mm}^2$$

Asb = 2026.800 mm²

Req'd As = As - Asb
= 5508.589 mm² - 2026.800 mm²
= 3481.789 mm²

- 사용보강철근

Use'd As = H25 - 4EA , H25 - 4EA

∴ Total As = 4053.600 mm² > Req'd As (= 3481.789 mm²) ----------> O.K !!!

26. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	950	H25 - 8.0EA	125	359.464	O.K	2.876
		중앙부	2	820	H25 - 8.0EA	125	245.109	O.K	1.961
		우측	3	950	H29 - 8.0EA	125	141.860	O.K	1.135
	2경간	좌측	4	950	H29 - 8.0EA	125	143.574	O.K	1.149
		중앙부	5	820	H25 - 8.0EA	125	248.843	O.K	1.991
		우측	6	950	H25 - 8.0EA	125	367.555	O.K	2.940
하부슬래브	1경간	좌측	7	1200	H25 - 8.0EA	125	343.639	O.K	2.749
		측구부	8	950	H25 - 8.0EA	125	1047.306	O.K	8.378
		중앙부	9	1220	H25 - 8.0EA	125	529.356	O.K	4.235
		우측	10	1200	H29 - 8.0EA	125	384.817	O.K	3.079
	2경간	좌측	11	1200	H29 - 8.0EA	125	384.004	O.K	3.072
		중앙부	12	1220	H25 - 8.0EA	125	542.480	O.K	4.340
		측구부	13	950	H25 - 8.0EA	125	1966.231	O.K	15.730
		우측	14	1200	H25 - 8.0EA	125	352.492	O.K	2.820
좌측벽체	1층	상부	15	950	H25 - 8.0EA	125	247.836	O.K	1.983
		중앙부	16	820	H19 - 8.0EA	-	-	-	-
		하부	17	800	H25 - 8.0EA	125	163.632	O.K	1.309
우측벽체	1층	상부	18	950	H25 - 8.0EA	125	255.501	O.K	2.044
		중앙부	19	820	H19 - 8.0EA	-	-	-	-
		하부	20	800	H25 - 8.0EA	125	172.048	O.K	1.376

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 486.651 x 1000000 / [4053.600 x (950.000 - 205.544/3)]
= 136.195 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x950.0/(7x4053.600)]
= 205.544 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 136.20) - 2.5 x 87.50 = 359.46 mm
300 x (Kcr / fs) = 300 x (210 / 136.20) = 462.57 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 359.46 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 359.46 mm) ∴ O.K

2) 상부슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 583.842 x 1000000 / [4053.600 x (820.000 - 189.203/3)]
= 190.282 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x820.0/(7x4053.600)]
= 189.203 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 190.28) - 2.5 x 67.50 = 245.11 mm
300 x (Kcr / fs) = 300 x (210 / 190.28) = 331.09 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 245.11 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 245.11 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 994.707 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 221.450 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 221.45) - 2.5 x 85.50 = 141.86 mm
300 x (Kcr / fs) = 300 x (210 / 221.45) = 284.49 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 141.86 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 141.86 mm) ∴ O.K

4) 상부슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 989.935 x 1000000 / [5139.200 x (950.000 - 227.930/3)]
= 220.388 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x950.0/(7x5139.200)]
= 227.930 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 220.39) - 2.5 x 85.50 = 143.57 mm
300 x (Kcr / fs) = 300 x (210 / 220.39) = 285.86 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 143.57 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 143.57 mm) ∴ O.K

5) 상부슬래브 2경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 578.623 x 1000000 / [4053.600 x (820.000 - 189.203/3)]
= 188.581 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x820.0/(7x4053.600)]
= 189.203 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 188.58) - 2.5 x 67.50 = 248.84 mm
300 x (Kcr / fs) = 300 x (210 / 188.58) = 334.07 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 248.84 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 248.84 mm) ∴ O.K

6) 상부슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 479.936 x 1000000 / [4053.600 x (950.000 - 205.544/3)]
= 134.316 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x950.0/(7x4053.600)]
= 205.544 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 134.32) - 2.5 x 87.50 = 367.55 mm
300 x (Kcr / fs) = 300 x (210 / 134.32) = 469.04 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 367.55 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 367.55 mm) ∴ O.K

7) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 636.842 x 1000000 / [4053.600 x (1200.000 - 234.124/3)]
= 140.028 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1200.0/(7x4053.600)]
= 234.124 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 140.03) - 2.5 x 87.50 = 343.64 mm
300 x (Kcr / fs) = 300 x (210 / 140.03) = 449.91 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 343.64 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 343.64 mm) ∴ O.K

8) 하부슬래브 1경간(측구)

① 응력 산정

fs = M / [As x (d - χ/3)] = 214.943 x 1000000 / [4053.600 x (950.000 - 205.544/3)]
= 60.154 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x950.0/(7x4053.600)]
= 205.544 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 60.15) - 2.5 x 87.50 = 1090.38 mm
300 x (Kcr / fs) = 300 x (210 / 60.15) = 1047.31 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1047.31 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1047.31 mm) ∴ O.K

9) 하부슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 521.852 x 1000000 / [4053.600 x (1220.000 - 236.277/3)]
= 112.805 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1220.0/(7x4053.600)]
= 236.277 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 112.81) - 2.5 x 67.50 = 529.36 mm
300 x (Kcr / fs) = 300 x (210 / 112.81) = 558.48 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 529.36 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 529.36 mm) ∴ O.K

10) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 752.751 x 1000000 / [5139.200 x (1200.000 - 260.054/3)]
= 131.564 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1200.0/(7x5139.200)]
= 260.054 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 131.56) - 2.5 x 85.50 = 384.82 mm
300 x (Kcr / fs) = 300 x (210 / 131.56) = 478.85 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 384.82 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 384.82 mm) ∴ O.K

11) 하부슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 753.776 x 1000000 / [5139.200 x (1200.000 - 260.054/3)]
= 131.743 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1200.0/(7x5139.200)]
= 260.054 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 131.74) - 2.5 x 85.50 = 384.00 mm
300 x (Kcr / fs) = 300 x (210 / 131.74) = 478.20 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 384.00 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 384.00 mm) ∴ O.K

12) 하부슬래브 2경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 512.223 x 1000000 / [4053.600 x (1220.000 - 236.277/3)]
= 110.724 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1220.0/(7x4053.600)]
= 236.277 mm

사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 110.72) - 2.5 x 67.50 = 542.48 mm
300 x (Kcr / fs) = 300 x (210 / 110.72) = 568.98 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 542.48 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 542.48 mm) ∴ O.K

13) 하부슬래브 2경간(측구)

① 응력 산정

fs = M / [As x (d - χ/3)] = 114.489 x 1000000 / [4053.600 x (950.000 - 205.544/3)]
= 32.041 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x950.0/(7x4053.600)]
= 205.544 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 32.04) - 2.5 x 87.50 = 2239.04 mm
300 x (Kcr / fs) = 300 x (210 / 32.04) = 1966.23 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1966.23 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1966.23 mm) ∴ O.K

14) 하부슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 626.972 x 1000000 / [4053.600 x (1200.000 - 234.124/3)]
= 137.857 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1200.0/(7x4053.600)]
= 234.124 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 137.86) - 2.5 x 87.50 = 352.49 mm
300 x (Kcr / fs) = 300 x (210 / 137.86) = 456.99 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 352.49 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 352.49 mm) ∴ O.K

15) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 603.080 x 1000000 / [4053.600 x (950.000 - 205.544/3)]
= 168.779 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x950.0/(7x4053.600)]
= 205.544 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 168.78) - 2.5 x 87.50 = 247.84 mm
300 x (Kcr / fs) = 300 x (210 / 168.78) = 373.27 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 247.84 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 247.84 mm) ∴ O.K

16) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 615.938 x 1000000 / [4053.600 x (800.000 - 186.579/3)]
= 205.946 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x800.0/(7x4053.600)]
= 186.579 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 205.95) - 2.5 x 87.50 = 163.63 mm
300 x (Kcr / fs) = 300 x (210 / 205.95) = 305.91 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 163.63 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 163.63 mm) ∴ O.K

17) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 593.333 x 1000000 / [4053.600 x (950.000 - 205.544/3)]
= 166.051 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x950.0/(7x4053.600)]
= 205.544 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 166.05) - 2.5 x 87.50 = 255.50 mm
300 x (Kcr / fs) = 300 x (210 / 166.05) = 379.40 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 255.50 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 255.50 mm) ∴ O.K

18) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 602.673 x 1000000 / [4053.600 x (800.000 - 186.579/3)]
= 201.511 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x800.0/(7x4053.600)]
= 186.579 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 201.51) - 2.5 x 87.50 = 172.05 mm
300 x (Kcr / fs) = 300 x (210 / 201.51) = 312.64 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 172.05 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 172.05 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 9.600 m
- fy = 400 MPa
- 부재두께(T) = 0.90 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28

T = 9.600 / 28

T = 0.343 m < 0.900 m ----------> O.K

27. 기초 지지력 검토

(1) 하중산정

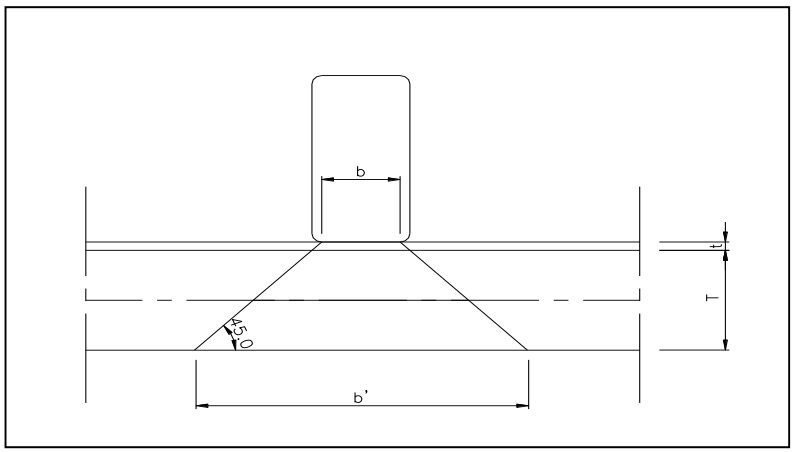
1) 고정하중

- 구체자중 = 1391.125 / 20.100 = 69.210 kN/m²
- 상부연직하중 = 62.925 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.08 × 23.00 = 1.840 kN/m²

2) 활하중

- 도로 노면 활하중 = 11.250 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중

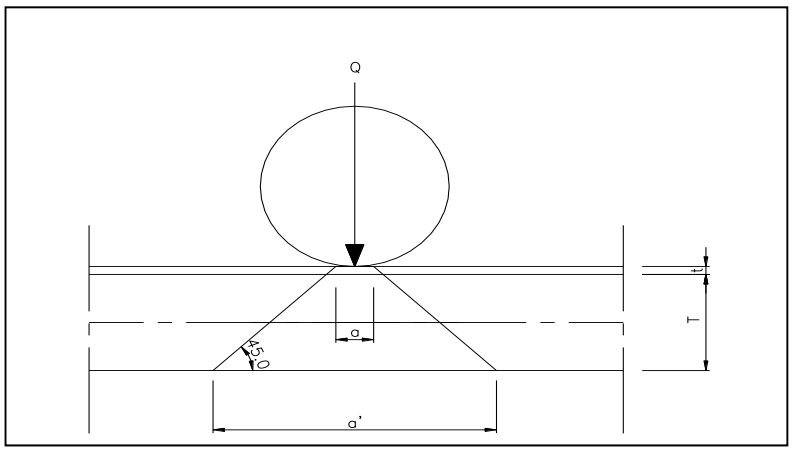


t = 80 mm (암거내부 포장두께)

T = 1300 mm (하부 슬래브 두께)

b' = 0.500 + 2 × (1.300 + 0.080) × cot 45°

= 3.260 m



a' = 0.200 + 2 × (1.300 + 0.080) × cot 45°

= 2.960 m

Qz = 96.0 / (3.260 × 2.960)= 9.949 kN/m²

3) 내부 고정하중

- 암거내부 고정하중 = 10.000 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 69.21 + 62.93 + 11.25 + 1.84 + 9.95 + 10.00

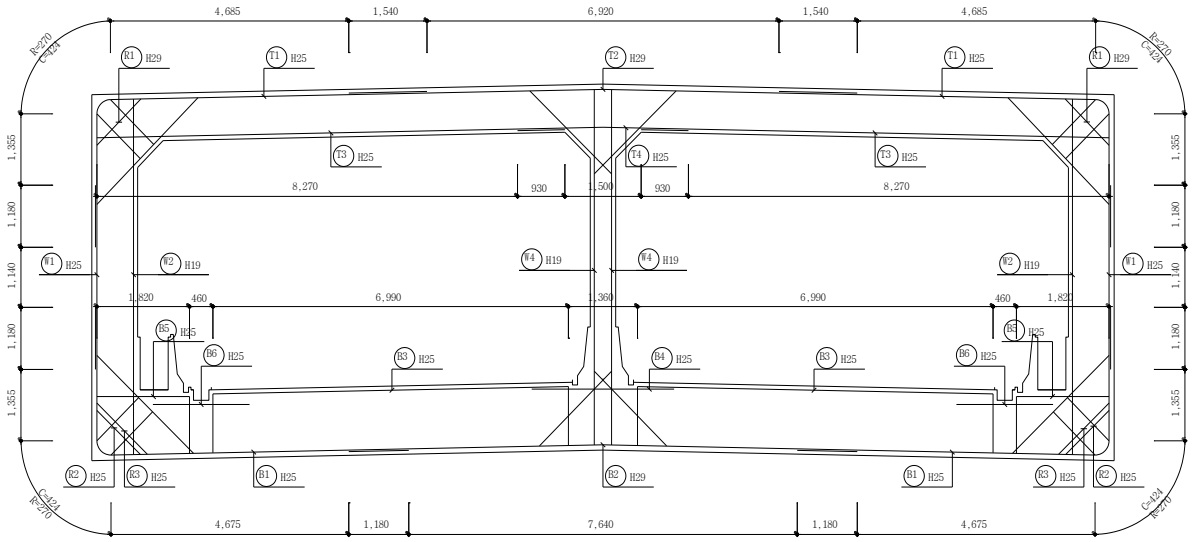
= 165.174 kN/m²

2) 지반의 허용연직지지력

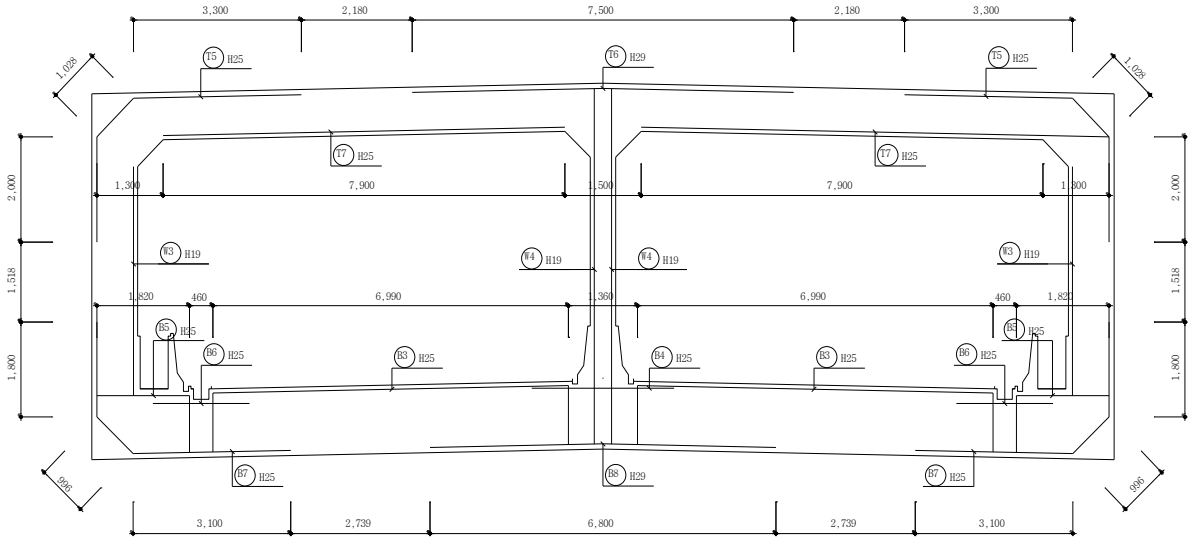
Qa = 700.000 kN/m² ≥ Qmax = 165.174 kN/m² ..... O.K

28. 주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



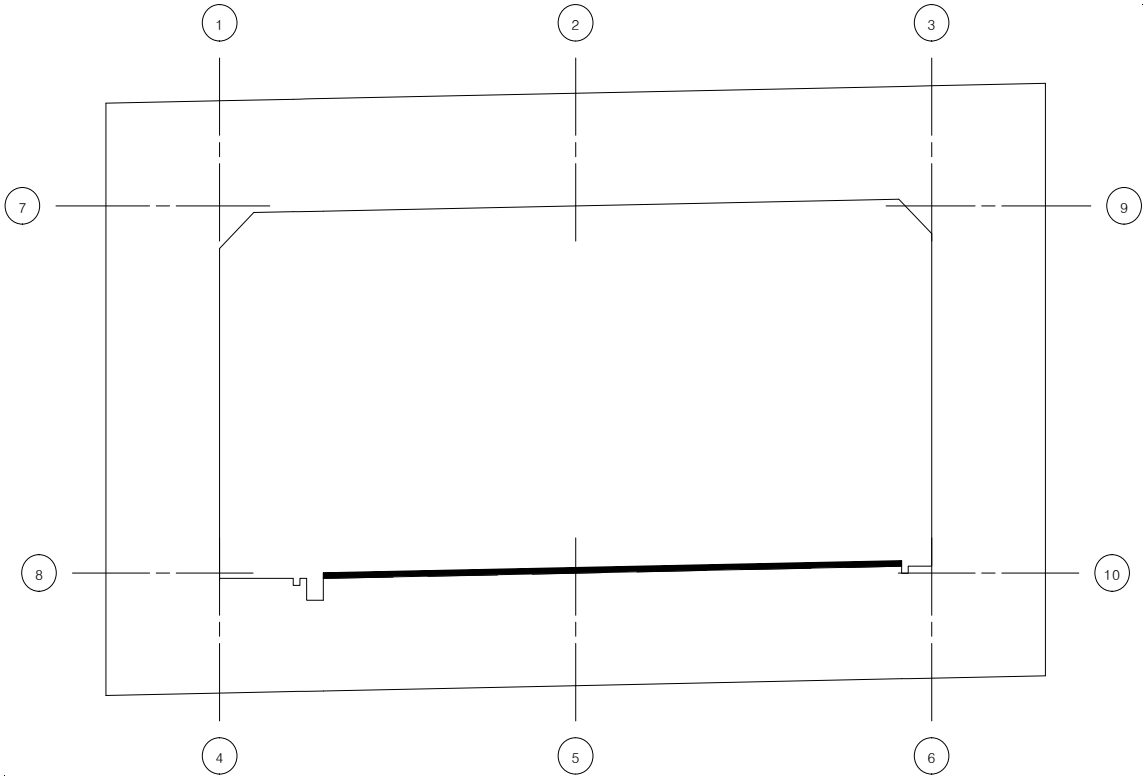
지하차도 구조계산서

▣ STA. 0K+780.000 (BLOCK3 : 단면 C-C)
▣ 토 피(FH) = 15.65 m ▣ 선 형 = ∞
▣ 지반 조건 : 토사
▣ 구조형식 : 지중 1 련
(내공 : 10.65M × 5.22M, 사각 : 90°)

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. INPUT DATA(상시)
16. INPUT DATA(기능수행)
17. INPUT DATA(붕괴방지)
18. OUTPUT DATA(상시)
19. OUTPUT DATA(기능수행)
20. OUTPUT DATA(붕괴방지)
21. 단면력정리
22. 단면검토 및 철근량 산정
23. 수평철근 검토
24. 절점부 검토
25. 사용성 검토
26. STM-우각부
27. 기초 지지력 검토
28. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qa(kN)	비 고
직접기초	430.26	700.00	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	3240.843	6480.859	2	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1617	3260.08	5336.67	6133.83	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.64
		중앙부	2	1000	1475	4930.86	5373.38	10478.99	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.09
		우측	3	1000	1617	3260.08	5336.67	6133.82	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.64
하부슬래브	1경간	좌측	4	1000	1455	2978.95	5295.23	6254.83	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.78
		측구부	5	1000	1182	924.97	2727.03	2342.62	H29 - 8.0EA + H25 - 4.0EA	7166.00	2.95
		중앙부	6	1000	1475	4550.19	5373.38	9617.83	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.18
		우측	7	1000	1455	2978.98	5295.23	6254.91	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.78
좌측벽체	1층	상부	8	1000	1717	5239.51	5686.14	9428.13	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.09
		하부	9	1000	1555	4828.59	5685.99	9653.44	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.18
우측벽체	1층	상부	10	1000	1705	5239.51	5646.53	9497.49	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.08
		하부	11	1000	1555	4828.58	5685.99	9653.43	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.18

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부슬래브	1경간	좌측	1	1800.0	3972.0	O.K	2055.7	2647.3	O.K
		중앙부	2	1800.0	3310.7	O.K	2298.6	2647.3	O.K
		우측	3	1800.0	3972.0	O.K	2055.7	2647.3	O.K
하부슬래브	1경간	좌측	4	1800.0	3972.0	O.K	2298.6	2647.3	O.K
		중앙부	6	1800.0	3308.7	O.K	2298.6	2647.3	O.K
		우측	7	1800.0	5296.7	O.K	2298.6	2647.3	O.K
좌측벽체	1층	상부	8	1800.0	3972.0	O.K	2055.7	2647.3	O.K
		하부	9	1800.0	3972.0	O.K	2298.6	2647.3	O.K
우측벽체	1층	상부	10	1800.0	3972.0	O.K	2055.7	2647.3	O.K
		하부	11	1800.0	3972.0	O.K	2298.6	2647.3	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부 슬래브	1 경간	좌측	1	941.8	2063.6	2093.68	2.00	386.84	H16	150	397.20	O.K
		중앙부	2	958.2	94.6	1544.21	2.00	-	H16	300	397.20	O.K
		우측	3	941.8	2063.5	2093.68	2.00	386.79	H16	150	397.20	O.K
하부 슬래브	1 경간	좌측	4	945.2	1766.4	2101.31	2.00	282.14	H16	150	397.20	O.K
		중앙부	6	958.2	274.7	1544.21	2.00	-	H16	300	397.20	O.K
		우측	7	945.2	1766.3	2101.31	2.00	282.11	H16	150	397.20	O.K
좌측 벽체	1 층	상부	8	1006.8	864.4	1622.41	2.00	-	H16	300	397.20	O.K
		중앙부	8	1052.2	950.9	1695.68	2.00	-	H16	300	397.20	O.K
		하부	9	1010.2	641.0	1627.94	2.00	-	H16	300	397.20	O.K
우측 벽체	1 층	상부	10	1006.8	864.4	1622.41	2.00	-	H16	300	397.20	O.K
		중앙부	10	1052.2	950.9	1695.68	2.00	-	H16	300	397.20	O.K
		하부	11	1010.2	641.0	1627.94	2.00	-	H16	300	397.20	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1 경간	좌측	1	1617	H29 - 8.0EA + H29 - 8.0EA	125	360.615	O.K	2.885
		중앙부	2	1475	H32 - 8.0EA + H29 - 8.0EA	125	208.392	O.K	1.667
		우측	3	1617	H29 - 8.0EA + H29 - 8.0EA	125	360.615	O.K	2.885
하부슬래브	1 경간	좌측	4	1455	H32 - 8.0EA + H29 - 8.0EA	125	374.770	O.K	2.998
		측구부	5	1182	H29 - 8.0EA + H25 - 4.0EA	125	771.843	O.K	6.175
		중앙부	6	1475	H32 - 8.0EA + H29 - 8.0EA	125	241.949	O.K	1.936
		우측	7	1455	H32 - 8.0EA + H29 - 8.0EA	125	374.762	O.K	2.998
좌측벽체	1 층	상부	8	1717	H29 - 8.0EA + H29 - 8.0EA	125	162.137	O.K	1.297
		하부	9	1555	H32 - 8.0EA + H29 - 8.0EA	125	181.570	O.K	1.453
우측벽체	1 층	상부	10	1705	H29 - 8.0EA + H29 - 8.0EA	125	159.559	O.K	1.276
		하부	11	1555	H32 - 8.0EA + H29 - 8.0EA	125	181.570	O.K	1.453

2. 설 계 조 건

1) 구조형식

- 지중 1 련 지하차도 (내공 : 10.65M × 5.22M, 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (ω_c) = 25.00 kN/m³
- Mortar (γ_{mot}) = 21.50 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sd
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 10.000 kN/m² (∵ 토피 : 15.647 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

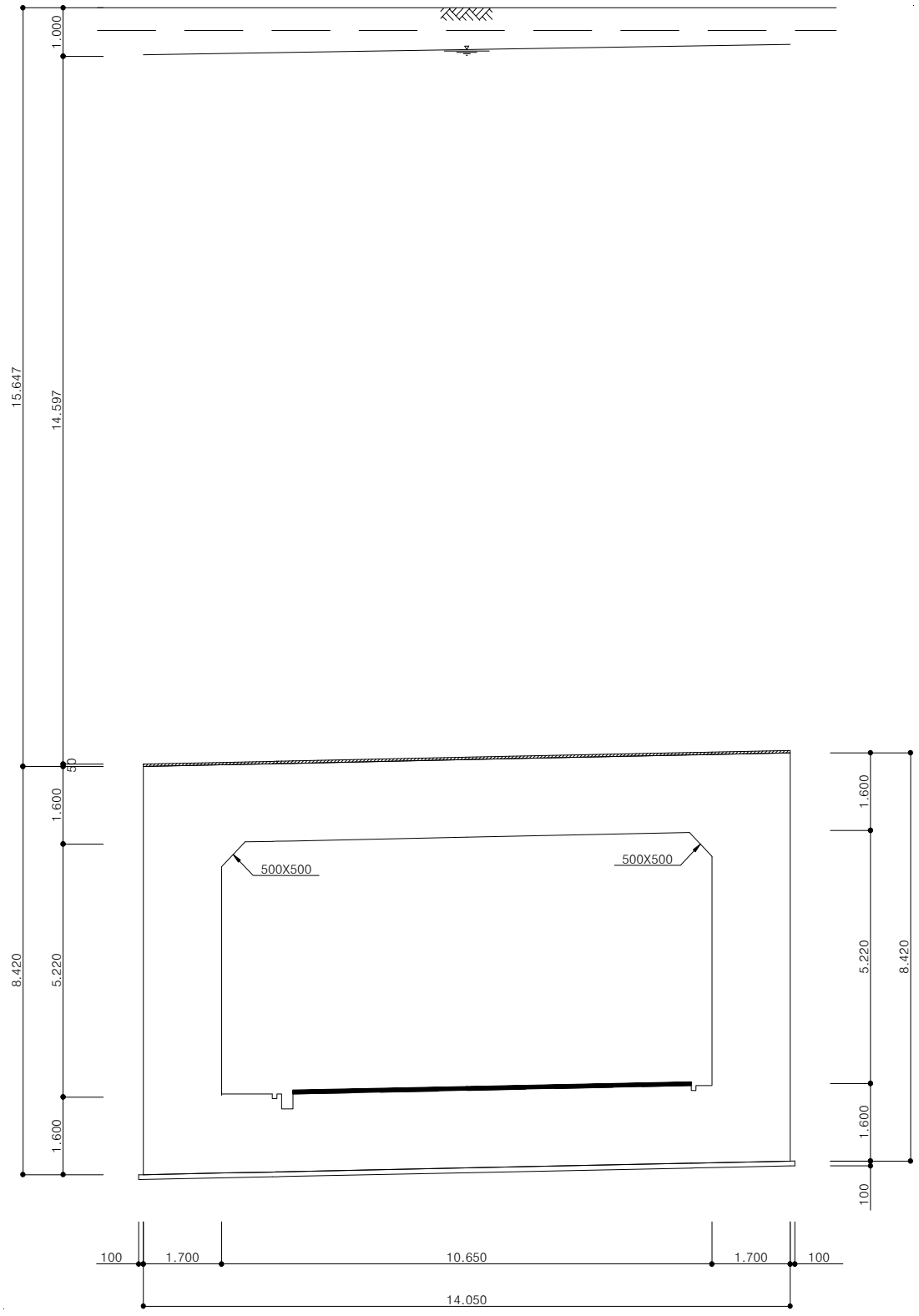
10) 사용프로그램 : SAP2000

11) 참고문헌

- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정

1) 단 면 가 정


1.000
15.647
14.597
50
1.600
8.420
5.220
1.600
500X500
500X500
1.600
5.220
8.420
1.600
100
100
1.700
10.650
1.700
100
14.050

4. 부 력 검 토

4.1 시공중 부력검토 (지하수위:G.L -9.6m) -상부슬래브 폐합전

: 부력에 대한 안전률 Fs = 1.10 (R/B)

1) 구체자중

- 하부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
		∴ Σ	=	1573.950	kN/m

2) 상재 하중

∴ Σ	=	0.000	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 0.000^2 \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$

$= 0.500 \times (2 \times 0.000 \times 0.000 \times 19.000 + 0.000^2 \times 10.000) \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

∴ Σ = 0.000 + 0.000 = 0.000 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반편,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 14.050 \times 14.466 \times 10.000$

$= 2032.473$ kN/m

6) 안정검토

$R = 1573.950 + 429.081 + 700.080 = 1573.950$ kN/m

$Fs = R / U$

$= 1573.950 / 2032.473$

$\geq 1.100 \Rightarrow H \leq 0.704$ m

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 0.704m이하로 유지.

4.2 완공후 부력검토 (지하수위:G.L -9.6m)

: 부력에 대한 안전률 Fs = 1.20 (R/B)

부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려

(최소토피 H = 15.647 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 하부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 2EA × 25.0	=	6.250	kN/m
		∴ Σ	=	1573.950	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 14.050 × 23.0	=	161.575	kN/m
- 흙의 자중(지하수위 이상	:	9.100 × 14.050 × 19.0	=	2429.245	kN/m
- 흙의 자중(지하수위 이하	:	5.997 × 14.050 × 10.0	=	842.579	kN/m
- 지하수 자중	:	5.997 × 14.050 × 10.0	=	842.579	kN/m
- 방수 Mortal	:	0.050 × 14.050 × 21.5	=	15.104	kN/m
		∴ Σ	=	4291.081	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 9.600^2 \times \tan(30.0 \times 2/3)$

$= 318.663$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$

$= 0.500 \times (2 \times 9.600 \times 5.047 \times 19.000 + 5.047^2 \times 10.000) \times \tan(30.0 \times 2/3)$

$= 381.417$ kN/m

∴ ∑ = 318.663 + 381.417 = 700.080 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 14.050 \times 14.466 \times 10.000$

$= 2032.473$ kN/m

6) 안정검토

$R = 1573.950 + 429.081 + 700.080 = 6565.111$ kN/m

$Fs = R / U$

$= 6565.111 / 2032.473$

$= 3.230 > 1.200$ ∴O.K

4.3 완공후 부력검토 (극한수위:G.L -1.0m)

: 부력에 대한 안전률 Fs = 1.05 (R/B)
부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려
(최소토피 H = 15.647 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 하부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 2EA × 25.0	=	6.250	kN/m
		∴ Σ	=	1573.950	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 14.050 × 23.0	=	161.575	kN/m
- 흙의 자중(지하수위 이상	:	0.500 × 14.050 × 19.0	=	133.475	kN/m
- 흙의 자중(지하수위 이하	:	14.597 × 14.050 × 10.0	=	2050.808	kN/m
- 지하수 자중	:	14.597 × 14.050 × 10.0	=	2050.808	kN/m
- 방수 Mortal	:	0.050 × 14.050 × 21.5	=	15.104	kN/m
		∴ Σ	=	4411.770	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$
$= 0.500 \times 19.000 \times 1.000^2 \times \tan(30.0 \times 2/3)$
$= 3.458$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$
$= 0.500 \times (2 \times 1.000 \times 14.647 \times 19.000 + 14.647^2 \times 10.000) \times \tan(30.0 \times 2/3)$
$= 491.681$ kN/m

∴ Σ = 3.458 + 491.681 = 495.139 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)
$= 14.050 \times 23.066 \times 10.000$
$= 3240.843$ kN/m

6) 안정검토

$R = 1573.950 + 4411.770 + 495.139 = 6480.859$ kN/m
$Fs = R / U$
$= 6480.859 / 3240.843$
$= 2.000 > 1.050$ ∴O.K

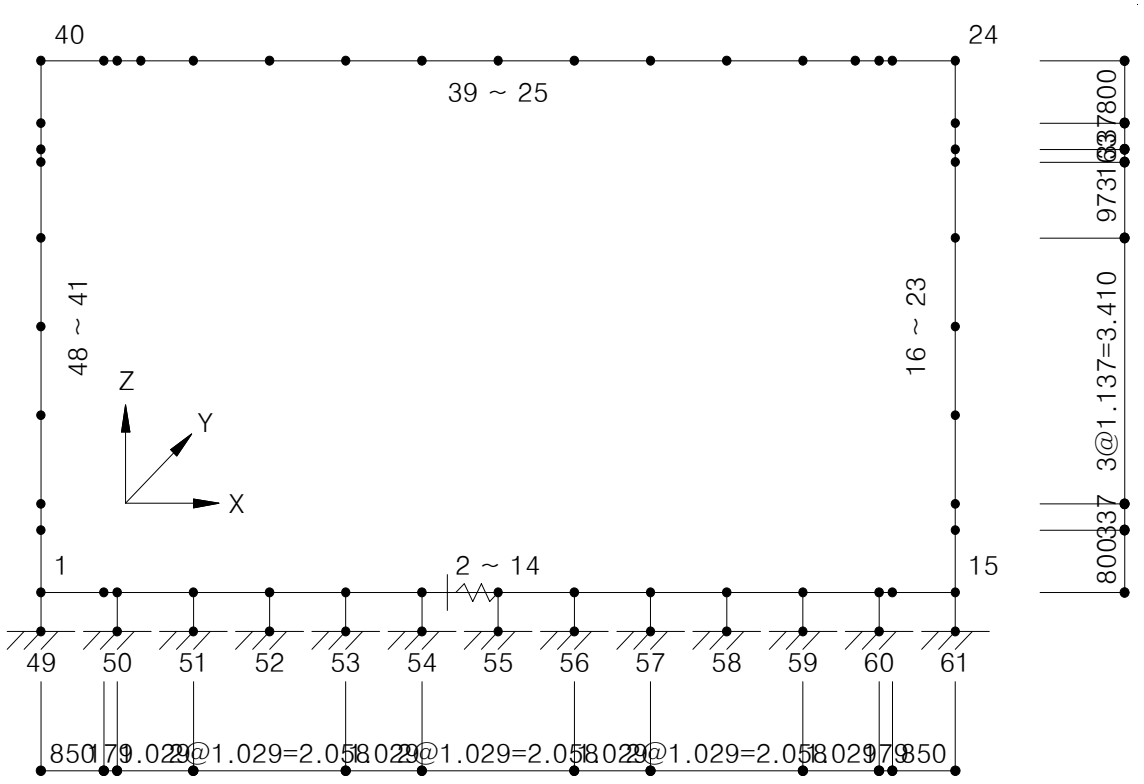
5. 해석모델 및 단면제원 (상시)

1) Modeling

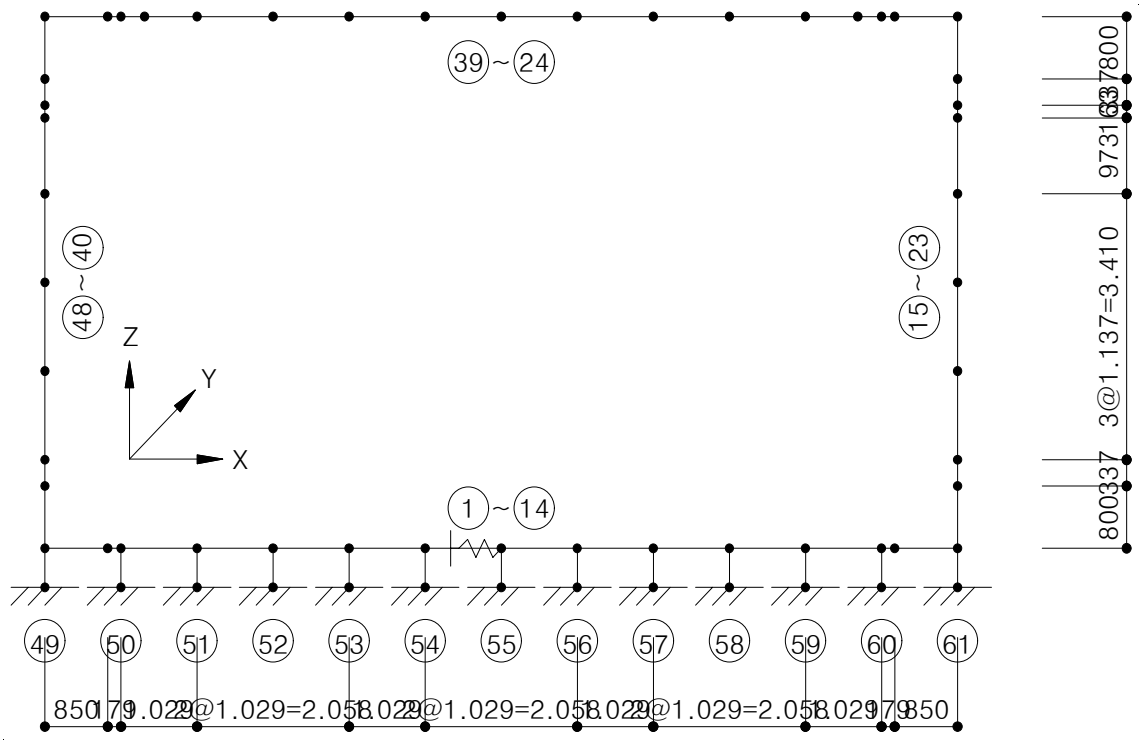
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.600 × 1.000	= 1.600	0.34133	1~14,27~36
2	1.700 × 1.000	= 1.700	0.40942	15~20,43~48
4	2.200 × 1.000	= 2.200	0.88733	23,40
5	2.100 × 1.000	= 2.100	0.77175	24,39

NO	A (m²)		I (m⁴)	절 점
3	1.863 × 1.000	= 1.863	0.53913	22,42
6	1.921 × 1.000	= 1.921	0.59059	26,38

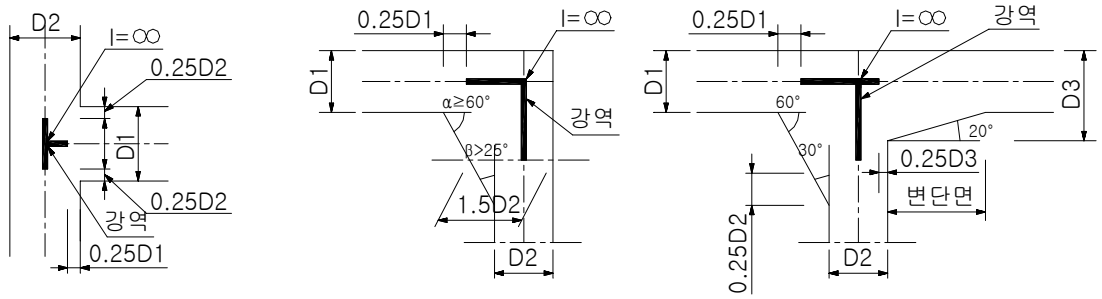
NO	Section(Tapper)	부 재
7	SEC 2 ~ 3	21
8	SEC 3 ~ 4	22
9	SEC 5 ~ 6	25
10	SEC 6 ~ 1	26
11	SEC 1 ~ 6	37
12	SEC 6 ~ 5	38
13	SEC 4 ~ 3	41
14	SEC 3 ~ 2	42

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	32	6.175	7.320
2	0.850	0.500	33	5.146	7.320
3	1.029	0.500	34	4.117	7.320
4	2.058	0.500	35	3.087	7.320
5	3.087	0.500	36	2.058	7.320
6	4.117	0.500	37	1.350	7.320
7	5.146	0.500	38	1.029	7.320
8	6.175	0.500	39	0.850	7.320
9	7.204	0.500	40	0.000	7.320
10	8.233	0.500	41	0.000	6.520
11	9.262	0.500	42	0.000	6.183
12	10.292	0.500	43	0.000	6.020
13	11.321	0.500	44	0.000	5.047
14	11.500	0.500	45	0.000	3.910
15	12.350	0.500	46	0.000	2.773
16	12.350	1.300	47	0.000	1.637
17	12.350	1.637	48	0.000	1.300
18	12.350	2.773	49	0.000	0.000
19	12.350	3.910	50	1.029	0.000
20	12.350	5.047	51	2.058	0.000
21	12.350	6.020	52	3.087	0.000
22	12.350	6.183	53	4.117	0.000
23	12.350	6.520	54	5.146	0.000
24	12.350	7.320	55	6.175	0.000
25	11.500	7.320	56	7.204	0.000
26	11.321	7.320	57	8.233	0.000
27	11.000	7.320	58	9.262	0.000
28	10.292	7.320	59	10.292	0.000
29	9.262	7.320	60	11.321	0.000
30	8.233	7.320	61	12.350	0.000
31	7.204	7.320			

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 40 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(2) 40 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(3) 24 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(4) 24 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

(7) 15 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(8) 15 지점 - 슬래브 벽체 연결부

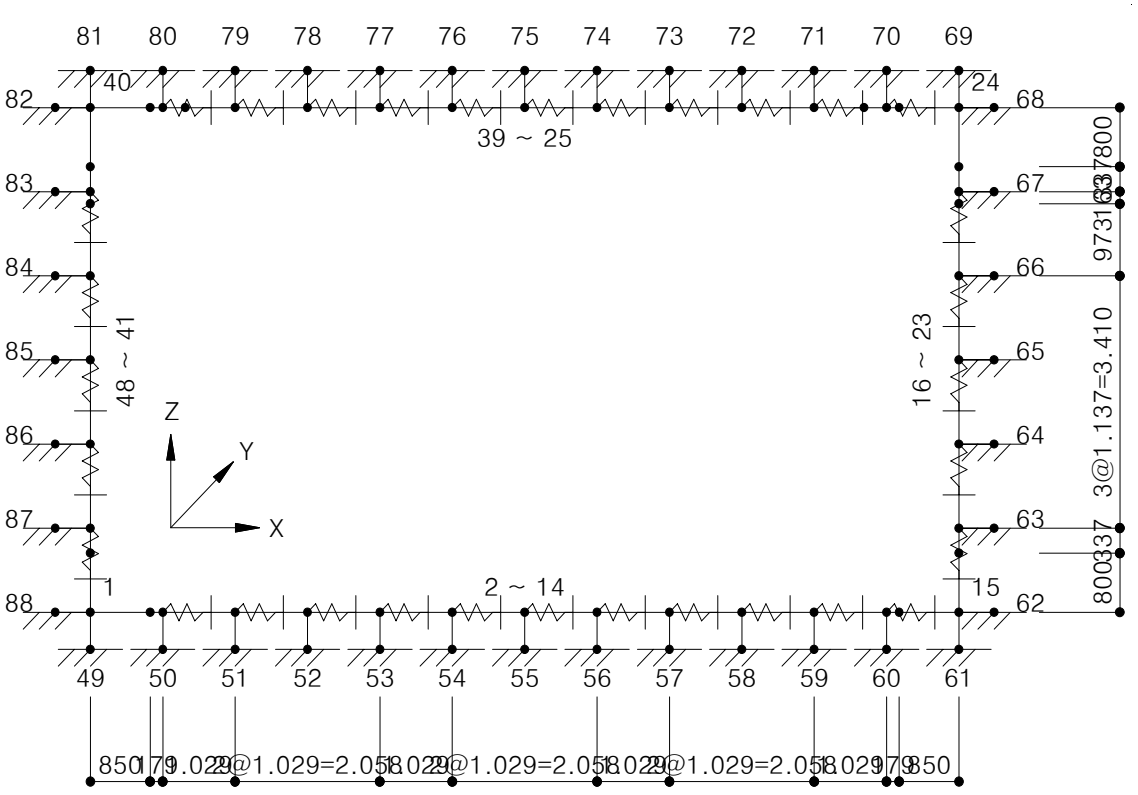
D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

6. 해석모델 및 단면제원 (지진시)

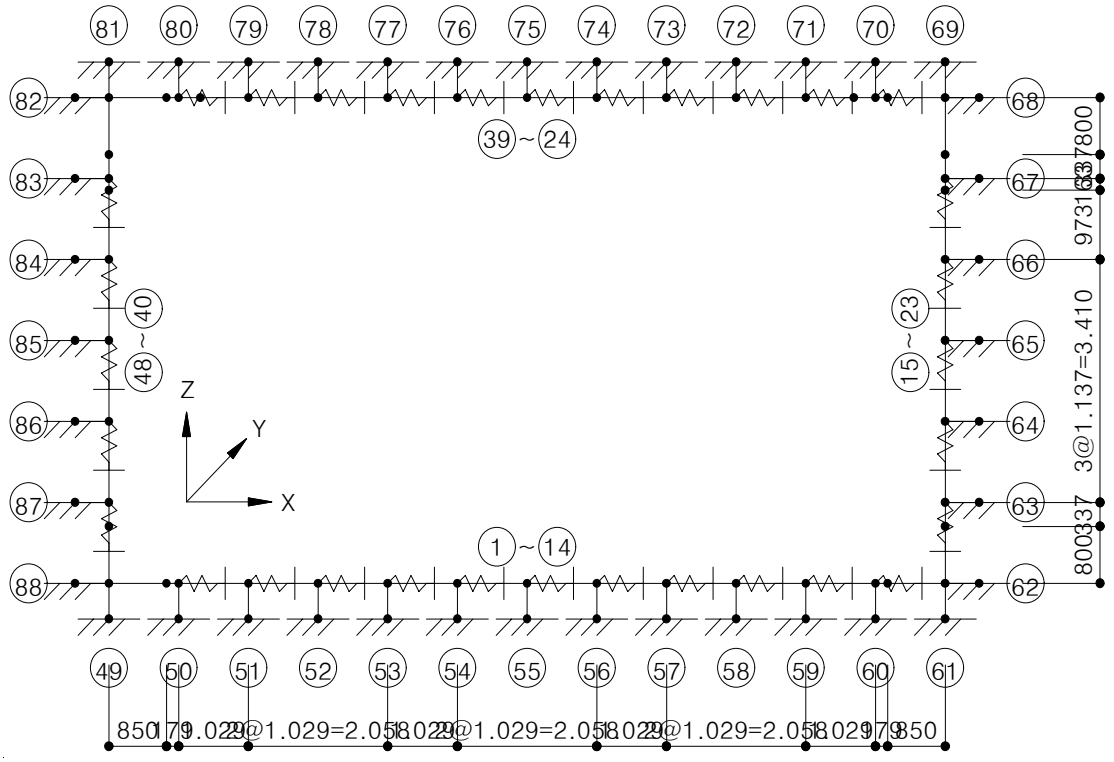
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.600 × 1.000	= 1.600	0.34133	1~14,27~36
2	1.700 × 1.000	= 1.700	0.40942	15~20,43~48
4	2.200 × 1.000	= 2.200	0.88733	23,40
5	2.100 × 1.000	= 2.100	0.77175	24,39

NO	A (m²)		I (m⁴)	절 점
3	1.863 × 1.000	= 1.863	0.53913	22,42
6	1.921 × 1.000	= 1.921	0.59059	26,38

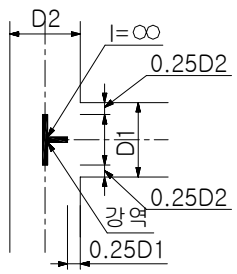
NO	Section(Tapper)	부 재
7	SEC 2 ~ 3	21
8	SEC 3 ~ 4	22
9	SEC 5 ~ 6	25
10	SEC 6 ~ 1	26
11	SEC 1 ~ 6	37
12	SEC 6 ~ 5	38
13	SEC 4 ~ 3	41
14	SEC 3 ~ 2	42

3) 단면좌표

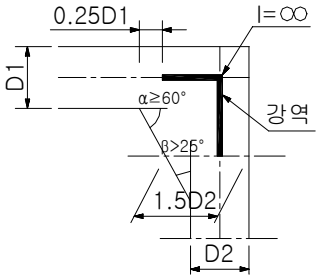
(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.500	0.500	45	0.500	3.910
2	1.350	0.500	46	0.500	2.773
3	1.529	0.500	47	0.500	1.637
4	2.558	0.500	48	0.500	1.300
5	3.587	0.500	49	0.500	0.000
6	4.617	0.500	50	1.529	0.000
7	5.646	0.500	51	2.558	0.000
8	6.675	0.500	52	3.587	0.000
9	7.704	0.500	53	4.617	0.000
10	8.733	0.500	54	5.646	0.000
11	9.762	0.500	55	6.675	0.000
12	10.792	0.500	56	7.704	0.000
13	11.821	0.500	57	8.733	0.000
14	12.000	0.500	58	9.762	0.000
15	12.850	0.500	59	10.792	0.000
16	12.850	1.300	60	11.821	0.000
17	12.850	1.637	61	12.850	0.000
18	12.850	2.773	62	13.350	0.500
19	12.850	3.910	63	13.350	1.637
20	12.850	5.047	64	13.350	2.773
21	12.850	6.020	65	13.350	3.910
22	12.850	6.183	66	13.350	5.047
23	12.850	6.520	67	13.350	6.183
24	12.850	7.320	68	13.350	7.320
25	12.000	7.320	69	12.850	7.820
26	11.821	7.320	70	11.821	7.820
27	11.500	7.320	71	10.792	7.820
28	10.792	7.320	72	9.762	7.820
29	9.762	7.320	73	8.733	7.820
30	8.733	7.320	74	7.704	7.820
31	7.704	7.320	75	6.675	7.820
32	6.675	7.320	76	5.646	7.820
33	5.646	7.320	77	4.617	7.820
34	4.617	7.320	78	3.587	7.820
35	3.587	7.320	79	2.558	7.820
36	2.558	7.320	80	1.529	7.820
37	1.850	7.320	81	0.500	7.820
38	1.529	7.320	82	0.000	7.320
39	1.350	7.320	83	0.000	6.183
40	0.500	7.320	84	0.000	5.047
41	0.500	6.520	85	0.000	3.910
42	0.500	6.183	86	0.000	2.773
43	0.500	6.020	87	0.000	1.637
44	0.500	5.047	88	0.000	0.500

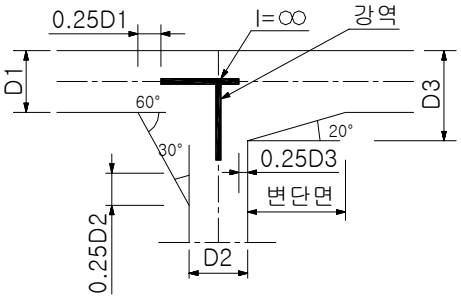
8) 강역설정



(가) 등단면의 경우



(나) 변단면의 경우(1)



(다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 40 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(2) 40 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(3) 24 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(4) 24 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

(7) 15 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(8) 15 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 2800 x N = 2800 x 50 = 84000.000 kN/m²

Bv = √(B × B) = √(14.050 × 14.050) = 14.05 m (L > B)

Kvo = 1 / 0.3 × 1 × 84000 = 280000.00 kN/m³

Kv = 280000.000 × (14.050 / 0.3) $^{-3 / 4}$ = 15640.18 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 21342 kN/m	1,15
Kv2	Kv x (1.029/2 + 1.029/2) = 16096 kN/m	3~13
Kh	1E10 kN/m (무한강성)	8

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 풍화암 (EL. : 9.736 ~ -11.700, N=50)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 631.0 = 504.8 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 504.8² = 519517.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 519517.0 = 1506599.3 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 631.0 = 315.5 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 315.5² = 202936.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 202936.0 = 588514.4 kN/m²

(2) 연암 (EL. : -11.700 ~ -14.300, N=50)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 1216.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 1216.0 = 972.8 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 972.8² = 1929337.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 1929337.0 = 5595077.3 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 1216.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 1216.0 = 608.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 608.0² = 753647.0 kN/m²
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 753647.0 = 2185576.3 kN/m²

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제8토층 ,풍화암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 1506599.3 = 5021997.67 kN/m³

Kv = 5021997.670 × (14.050 / 0.3)$^{-3 / 4}$ = 280517.66 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 280517.660 = 93505.89 kN/m³

(2) 하부슬래브 : 제9토층 , 연암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 5595077.3 = 18650257.67 kN/m³

Kv = 18650257.670 × (14.050 / 0.3)$^{-3 / 4}$ = 1041762.05 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 1041762.050 = 347254.02 kN/m³

(3) 측벽 : 제8토층 , 풍화암

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 1506599.3 = 5021997.67 kN/m³

Kh = 5021997.670 × (8.420 / 0.3)$^{-3 / 4}$ = 411844.60 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 411844.600 = 137281.53 kN/m³

(4) 측벽 : 제9토층 , 연암

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 5595077.3 = 18650257.67 kN/m³

Kh = 18650257.670 × (8.420 / 0.3)$^{-3 / 4}$ = 1529472.63 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 1529472.630 = 509824.21 kN/m³

(5) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 288700 kN/m	26,28~36,38
Ksb1	Ksb x (1.029/2 + 1.029/2) = 96233 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.137/2 + 1.137/2) = 1738506 kN/m	17,47
Kss1	Kss x (1.137/2 + 1.137/2) = 579502 kN/m	
Kh2	Kh x (1.137/2 + 1.137/2) = 468131 kN/m	18~20,22,42,44~46
Kss2	Kss x (1.137/2 + 1.137/2) = 156044 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 1072150 kN/m	3~13
Ksb1	Ksb x (1.029/2 + 1.029/2) = 357383 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 1421573 kN/m	1,15
Ksb1	Kh x (1.137/2 + 1.600/2) = 2092831 kN/m	
Kv2	Kv x (1.029/2 + 1.700/2) = 382790 kN/m	24,40
Ksb2	Kh x (1.137/2 + 1.600/2) = 563541 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제8토층 ,풍화암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 588514.4 = 1961714.67 kN/m³

Kv = 1961714.670 × (14.050 / 0.3) $^{-3 / 4}$ = 109577.03 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 109577.030 = 36525.68 kN/m³

(2) 하부슬래브 : 제9토층 , 연암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2185576.3 = 7285254.33 kN/m³

Kv = 7285254.330 × (14.050 / 0.3) $^{-3 / 4}$ = 406938.16 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 406938.160 = 135646.05 kN/m³

(3) 측벽 : 제8토층 , 풍화암

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 588514.4 = 1961714.67 kN/m³

Kh = 1961714.670 × (8.420 / 0.3) $^{-3 / 4}$ = 160876.54 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 160876.540 = 53625.51 kN/m³

(4) 측벽 : 제9토층 , 연암

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2185576.3 = 7285254.33 kN/m³

Kh = 7285254.330 × (8.420 / 0.3) $^{-3 / 4}$ = 597450.03 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 597450.030 = 199150.01 kN/m³

(5) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 112773 kN/m	26,28~36,38
Ksb1	Ksb x (1.029/2 + 1.029/2) = 37591 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.137/2 + 1.137/2) = 679104 kN/m	17,47
Kss1	Kss x (1.137/2 + 1.137/2) = 226368 kN/m	
Kh2	Kh x (1.137/2 + 1.137/2) = 182864 kN/m	18~20,22,42,44~46
Kss2	Kss x (1.137/2 + 1.137/2) = 60955 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 418809 kN/m	3~13
Ksb1	Ksb x (1.029/2 + 1.029/2) = 139603 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 555302 kN/m	1,15
Ksb1	Kh x (1.137/2 + 1.600/2) = 817512 kN/m	
Kv2	Kv x (1.029/2 + 1.700/2) = 149527 kN/m	24,40
Ksb2	Kh x (1.137/2 + 1.600/2) = 220133 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

	성능기준 / 재현주기	기 능 수 행	붕 괴 방 지
설계지진	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.16 = 0.091
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.16 = 0.224

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500 kN/m²
- 토 사	: 15.096 × 19.00	=	286.833 kN/m²
- 방 수	: 0.050 × 21.50	=	1.075 kN/m²
	∴ Total Wd1	=	299.409 kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500 kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00	=	9.500 kN/m²
- 흙(지하수위 이하)	: 14.596 × 10.00	=	145.965 kN/m²
- 방수	: 0.050 × 21.50	=	1.075 kN/m²
	∴ Total Wd2	=	168.040 kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

토피고(D,m)	도로면의 활하중 (kN/m²)	토피고(D,m)	도로면의 활하중 (kN/m²)
1.0	39.0	1.5	25.0
2.0	18.0	2.5	14.0
3.0	11.0	3.5	10.0
4.0	10.0	5.0	10.0
6.0	10.0	7.0	10.0
8.0	10.0	9.0	10.0
10.0	10.0		

주) 중간토피에 대한 것은 그 상위의 것을 취한다.

① 상부 슬래브에 작용하는 하중 (WI1) - 토피 4m 이상

- WI1 = 10.000 kN/m²

② 측벽에 작용하는 하중 (WI2)

- WI2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 15.947 × 19.000) × 0.500 = 157.242 kN/m²
Wh2 = 157.242 + 0.800 × 19.000 × 0.500 = 164.842 kN/m²
Wh3 = 164.842 + 0.337 × 19.000 × 0.500 = 168.041 kN/m²
Wh4 = 168.041 + 0.163 × 19.000 × 0.500 = 169.592 kN/m²
Wh5 = 169.592 + 0.973 × 19.000 × 0.500 = 178.838 kN/m²
Wh6 = 178.838 + 1.137 × 19.000 × 0.500 = 189.637 kN/m²
Wh7 = 189.637 + 1.137 × 19.000 × 0.500 = 200.436 kN/m²
Wh8 = 200.436 + 1.137 × 19.000 × 0.500 = 211.233 kN/m²
Wh9 = 211.233 + 0.337 × 19.000 × 0.500 = 214.432 kN/m²
Wh10 = 214.432 + 0.800 × 19.000 × 0.500 = 222.032 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 15.447 × 10.00 = 87.733 kN/m²
Wh2 = 87.733 + 0.800 × 10.000 × 0.500 = 91.733 kN/m²
Wh3 = 91.733 + 0.337 × 10.000 × 0.500 = 93.416 kN/m²
Wh4 = 93.416 + 0.163 × 10.000 × 0.500 = 94.233 kN/m²
Wh5 = 94.233 + 0.973 × 10.000 × 0.500 = 99.100 kN/m²
Wh6 = 99.100 + 1.137 × 10.000 × 0.500 = 104.783 kN/m²
Wh7 = 104.783 + 1.137 × 10.000 × 0.500 = 110.466 kN/m²
Wh8 = 110.466 + 1.137 × 10.000 × 0.500 = 116.150 kN/m²
Wh9 = 116.150 + 0.337 × 10.000 × 0.500 = 117.833 kN/m²
Wh10 = 117.833 + 0.800 × 10.000 × 0.500 = 121.833 kN/m²

6) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

7) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 15 \times 10^{-5}$
- 온도선팽창 계수 $\alpha = 1.0 \times 10^{-5}$
- $\Delta T = -\frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
성토재	0.037	248.600	248.600	19.000	0.001	0.001
실트질 자갈	2.800	156.000	156.000	20.000	0.072	0.072
점토	2.600	156.000	156.000	20.000	0.067	0.067
점토 섞인 모래(SC	1.600	156.000	156.000	20.000	0.041	0.041
점토 섞인 실트(ML	2.000	156.000	156.000	20.000	0.051	0.051
모래(SP)	2.000	289.000	289.000	20.000	0.028	0.028
와 자갈 섞인 호	0.600	289.000	289.000	20.000	0.008	0.008
모래(SP)	1.100	289.000	289.000	20.000	0.015	0.015
풍화암	8.700	631.000	631.000	20.000	0.055	0.055
연암	8.563	1216.000	1216.000	20.000	0.028	0.028
계					0.366	0.366

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.366 = 0.458	1.25 Tg' = 1.25 × 0.366 = 0.458

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575
To(sec)	To = 0.2 × Ts = 0.2 × 0.575 = 0.115	To = 0.2 × Ts = 0.2 × 0.575 = 0.115

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $C_d = \frac{1.5}{40h+1} + 0.5$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa) - 붕괴방지수준시(재현주기 1000년적용)

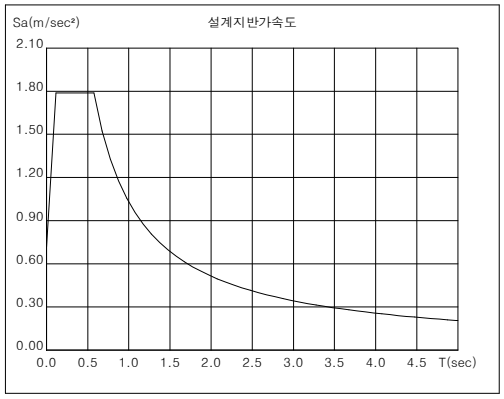
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 1.789 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 3.664 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg

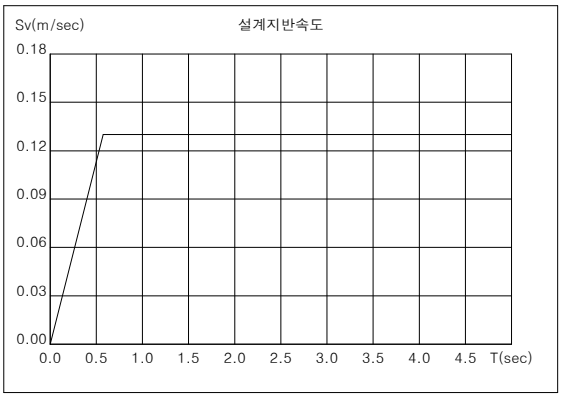
5) 속도 응답스펙트럼(Sv) - 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.458 / 2π × 1.789 = 0.130 m/s	Sv = Tg/2π × Sa = 0.458 / 2π × 3.664 = 0.267 m/s

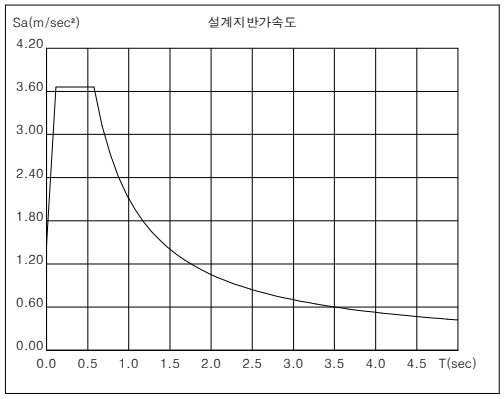
6) 설계응답 응답스펙트럼

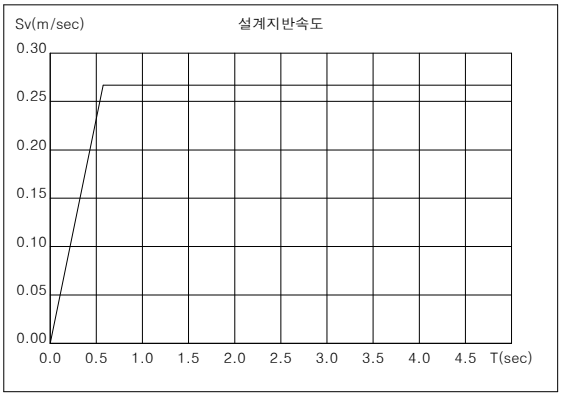
(1) 기능수행수준





(2) 붕괴방지수준





7) 층별 변위값 정리

- 제 1층의 두께(H1) = 12.737 m
- 제 2층의 두께(H2) = 17.263 m
- 제 1층의 습윤단위 체적중량(γ1) = 19.940 kN/m³
- 제 2층의 습윤단위 체적중량(γ2) = 20.000 kN/m³
- 제 1층의 평균전단파속도(Vsod1) = 194.182 m/sec
- 제 2층의 평균전단파속도(Vsod2) = 921.179 m/sec
- 제 1층과 제2층의 임피던스비(α)

  (γ1×Vsod1) / (γ2×Vsod2) = (19.940 × 194.182) / (20.000 × 921.179)

  = 0.210
- 지반의 설계 고유 진동수(Wo)

  (1+α)×cos[Wo×(H1/Vsod1 + H2/Vsod2)] + (1-α)×cos[Wo×(H1/Vsod1 - H2/Vsod2)] = 0

  (1 + 0.210) × cos[Wo × (12.737 / 194.182 + 17.263 / 921.179)] +

  (1 - 0.210) × cos[Wo × (12.737 / 194.182 - 17.263 / 921.179)] = 0

  에서 시행착오법으로 산정, Wo = 22.515
- 각 층별 변위 계산식
  - 제1층 변위 계산식

    $Uh1 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times x1/Vsod1)$

  - 제2층 변위 계산식

    $Uh2 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times H1/Vsod1) \times$

    $[\cos(Wo \times x2/Vsod2) - \sin(Wo \times x2/Vsod2) / \tan(Wo \times H2/Vsod2)]$

8) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 3.710 m
- 하부슬래브 EL. = 23.267 m
- 기반암 심도(H) = 30.000 m

Po = Ksb,top × (U(Zu) - U(Zb))

기능수행수준	붕괴방지수준
Po = 93505.890 × (0.000899 - 0.000453) = 41.704 kN/m²	Po = 36525.680 × (0.001847 - 0.000930) = 33.494 kN/m²

9) 측벽 지반변위 하중

P(z) = Kh × (Uh(z) - Uh(b))

(1) 기능수행수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
3.710	411844.600	0.000899	0.000446	183.683
17.247	411844.600	0.000848	0.000395	162.679
17.584	411844.600	0.000826	0.000373	153.618
17.747	411844.600	0.000816	0.000363	149.500
18.720	411844.600	0.000753	0.000300	123.553
19.857	411844.600	0.000678	0.000225	92.665
20.994	411844.600	0.000604	0.000151	62.189
22.130	1529472.630	0.000528	0.000075	114.710
22.467	1529472.630	0.000506	0.000053	81.062
23.267	1529472.630	0.000453	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
16.447	160876.540	0.001847	0.000917	147.524
17.247	160876.540	0.001741	0.000811	130.471
17.584	160876.540	0.001697	0.000767	123.392
17.747	160876.540	0.001675	0.000745	119.853
18.720	160876.540	0.001546	0.000616	99.100
19.857	160876.540	0.001393	0.000463	74.486
20.994	160876.540	0.001240	0.000310	49.872
22.130	597450.030	0.001085	0.000155	92.605
22.467	597450.030	0.001039	0.000109	65.122
23.267	597450.030	0.000930	0.000000	0.000

10) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

구분	기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
Vu	519517.000 × 0.000063 = 32.730	202936.000 × 0.000130 = 26.380
Vb	76622.000 × 0.000066 = 5.060	29924.000 × 0.000136 = 4.070
Vs	(32.730 + 5.060) / 2 = 18.900	(26.380 + 4.070) / 2 = 15.230

11) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fu = 1.600×25.000×0.091×(1 - 0.015×3.710) = 2.742	fu = 1.600×25.000×0.224×(1 - 0.015×3.710) = 6.750

② 하부슬래브

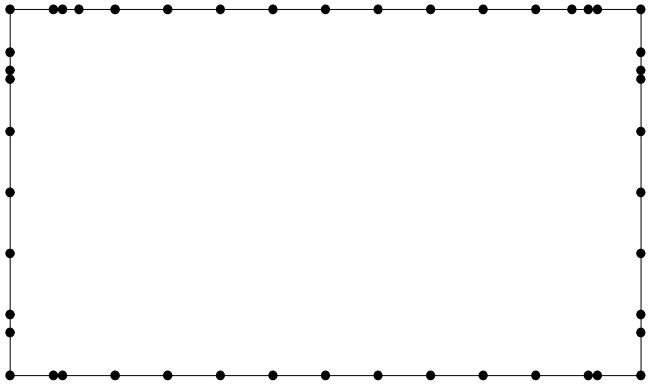
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fb = 1.600×25.000×0.091×(1 - 0.015×23.267) = 2.370	fb = 1.600×25.000×0.224×(1 - 0.015×23.267) = 5.833

③ 측벽

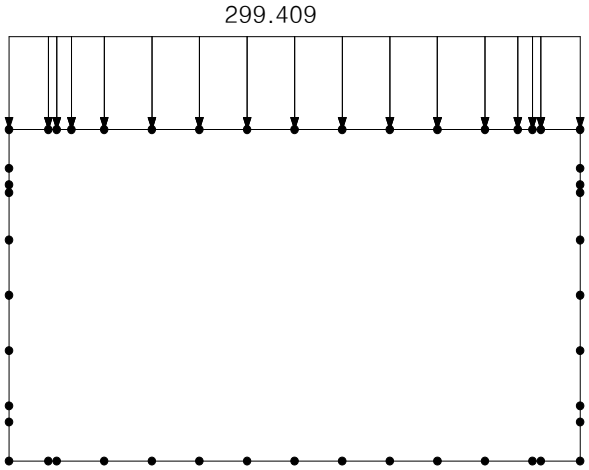
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
f1 = 1.700×25.000×0.091×(1-0.015×16.447) = 2.913	f1 = 1.700×25.000×0.224×(1-0.015×16.447) = 7.171
f2 = 1.700×25.000×0.091×(1-0.015×17.247) = 2.867	f2 = 1.700×25.000×0.224×(1-0.015×17.247) = 7.057
f3 = 1.700×25.000×0.091×(1-0.015×17.584) = 2.847	f3 = 1.700×25.000×0.224×(1-0.015×17.584) = 7.009
f4 = 1.700×25.000×0.091×(1-0.015×17.747) = 2.838	f4 = 1.700×25.000×0.224×(1-0.015×17.747) = 6.986
f5 = 1.700×25.000×0.091×(1-0.015×18.720) = 2.782	f5 = 1.700×25.000×0.224×(1-0.015×18.720) = 6.847
f6 = 1.700×25.000×0.091×(1-0.015×19.857) = 2.716	f6 = 1.700×25.000×0.224×(1-0.015×19.857) = 6.684
f7 = 1.700×25.000×0.091×(1-0.015×20.994) = 2.650	f7 = 1.700×25.000×0.224×(1-0.015×20.994) = 6.522
f8 = 1.700×25.000×0.091×(1-0.015×22.130) = 2.584	f8 = 1.700×25.000×0.224×(1-0.015×22.130) = 6.360
f9 = 1.700×25.000×0.091×(1-0.015×22.467) = 2.564	f9 = 1.700×25.000×0.224×(1-0.015×22.467) = 6.312
f10 = 1.700×25.000×0.091×(1-0.015×23.267) = 2.518	f10 = 1.700×25.000×0.224×(1-0.015×23.267) = 6.197

11. 하 중 재 하 (상시)

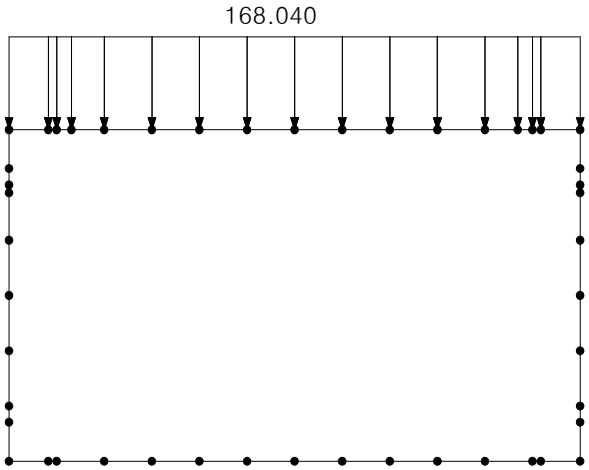
1) CASE1 - 구체자중(SW)



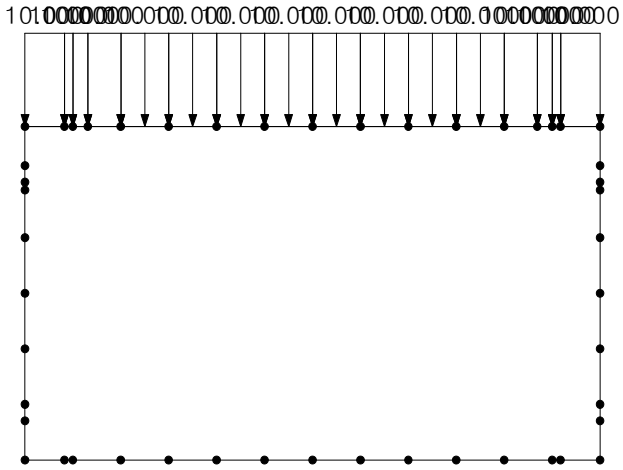
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



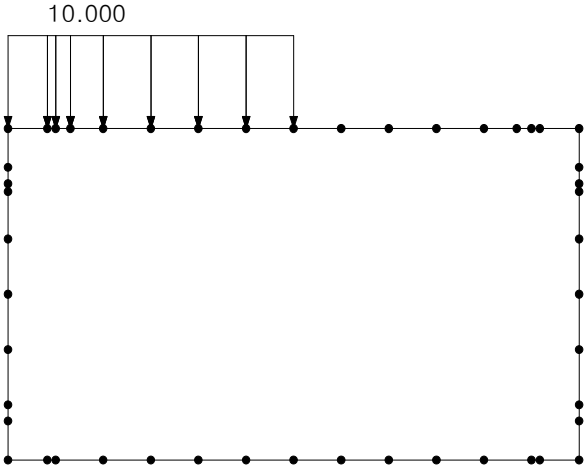
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



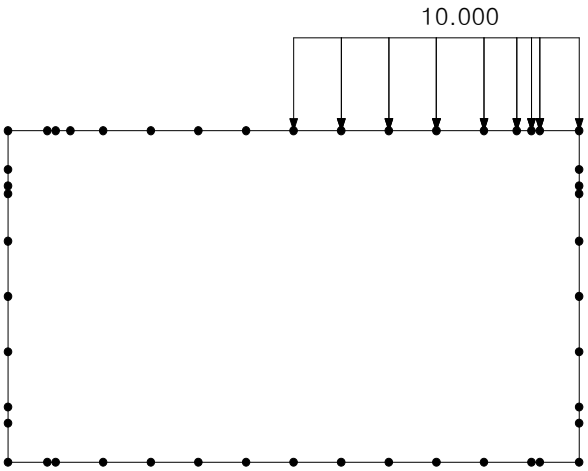
4) CASE4 - 만재활하중(LIVEFU)



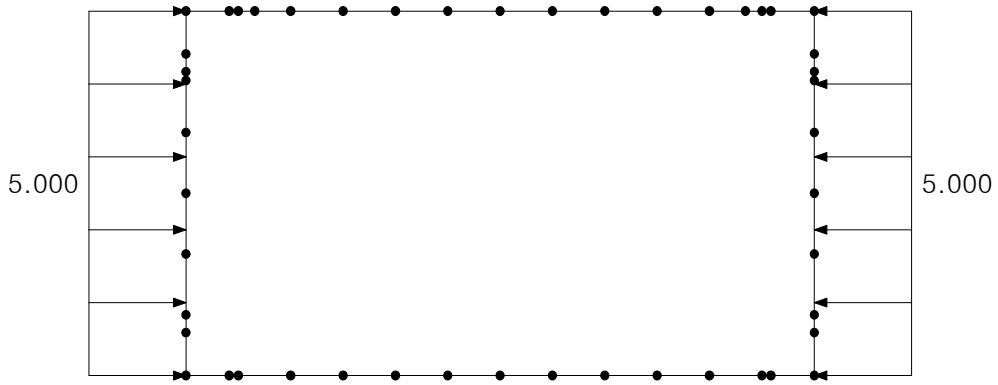
5) CASE5 - 편재활하중(좌측)(LIVELE)



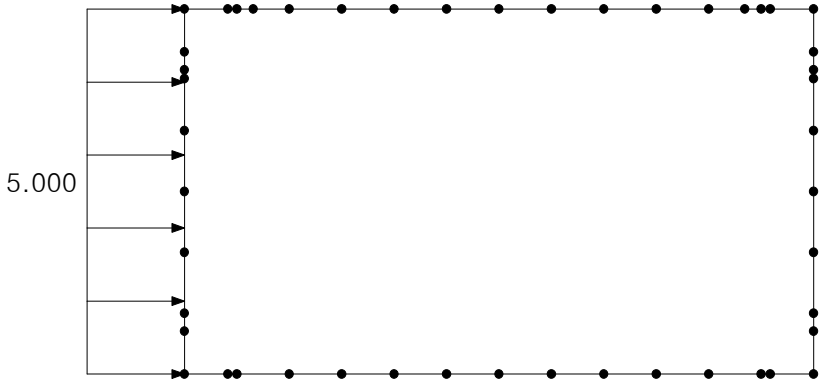
6) CASE6 - 편재활하중(우측)(LIVERI)



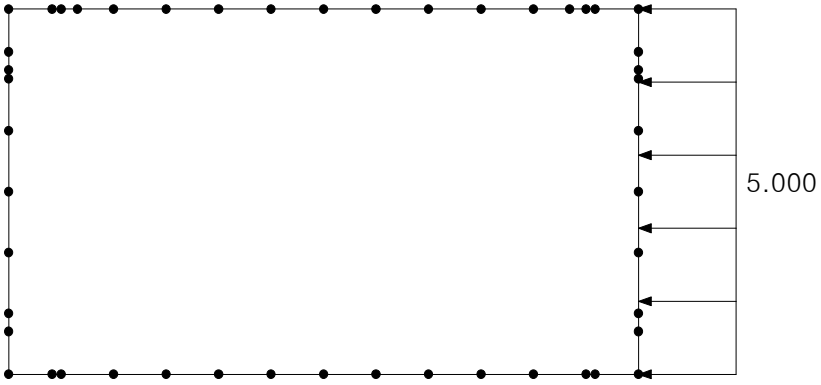
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



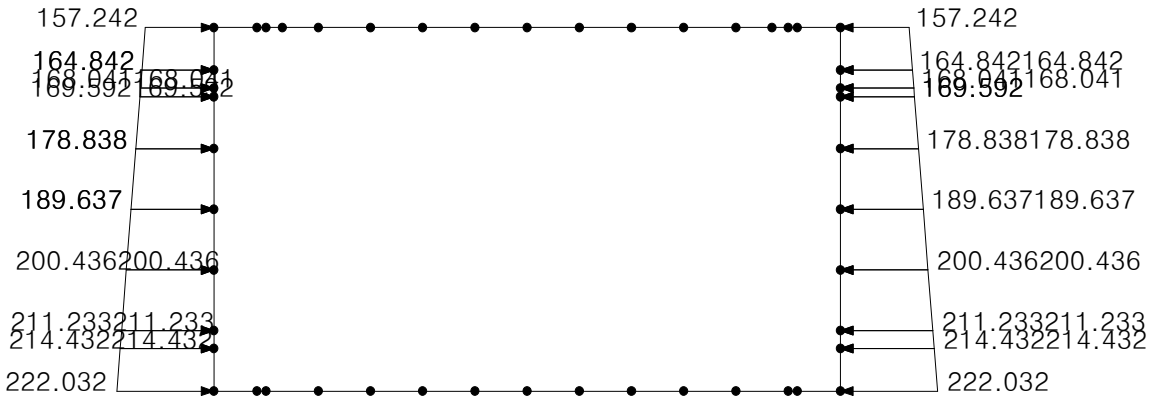
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



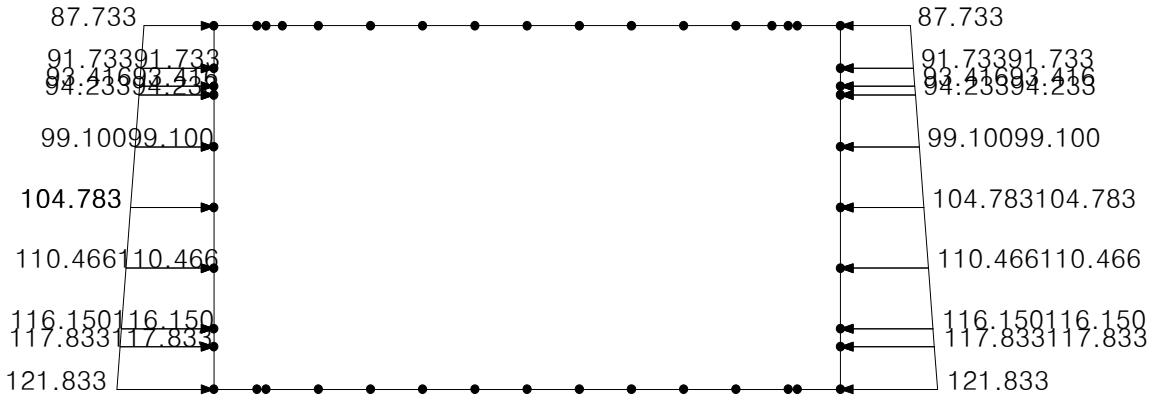
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



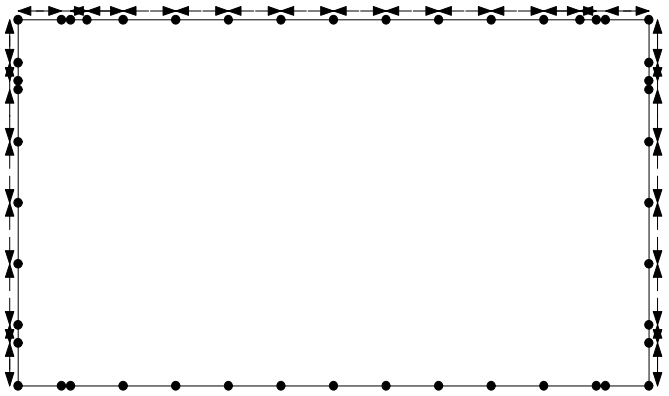
10) CASE10 - 양토압 : 지하수無(SOILB)



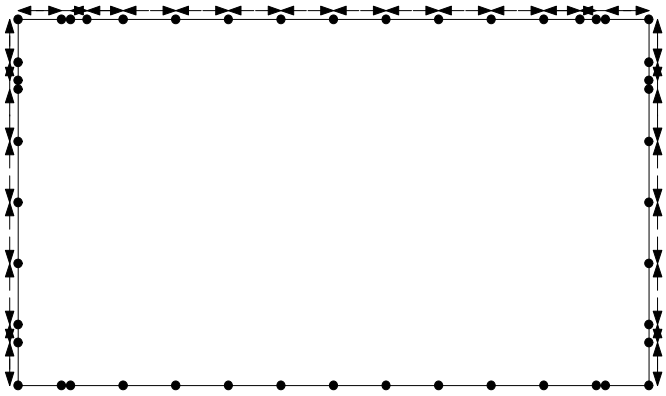
11) CASE11 - 양토압 : 지하수有(SOILBW)



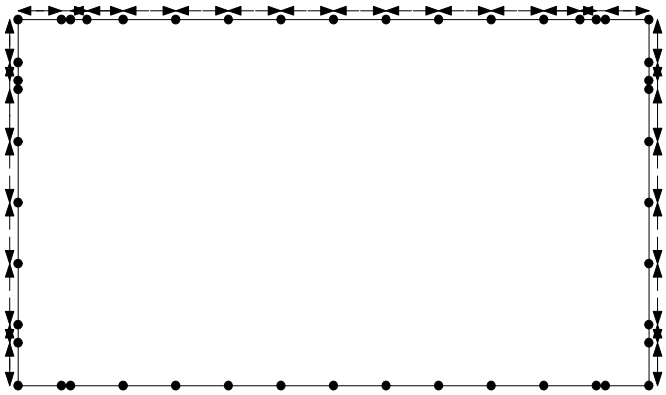
12) CASE12 - 온도변화(+) +10° C(TEMPPLUS)



13) CASE13 - 온도변화(-) -10° C(TEMPMINU)

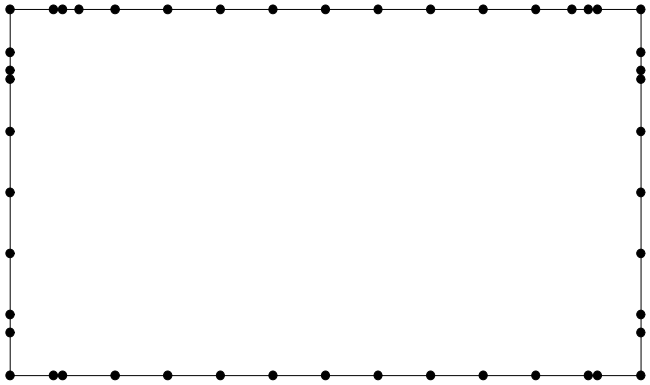


14) CASE14 - 건조수축 -15° C(SHRINK)

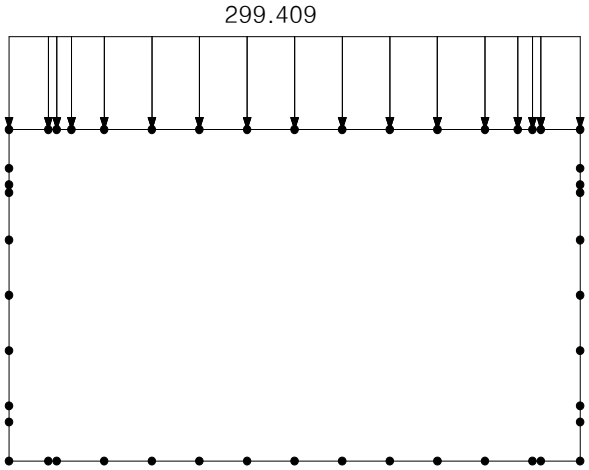


12. 하중 재하 (기능수행)

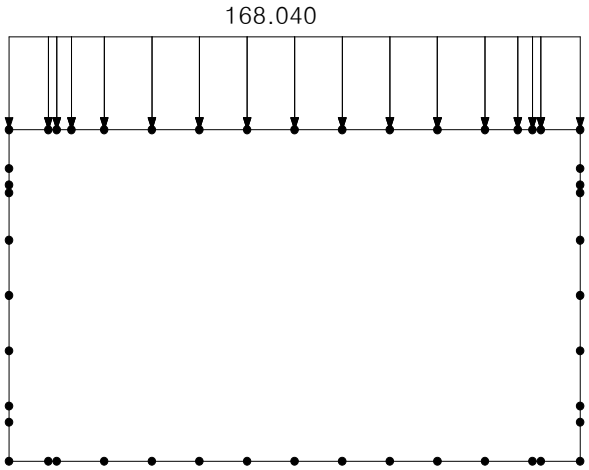
1) CASE1 - 구체자중(SW)



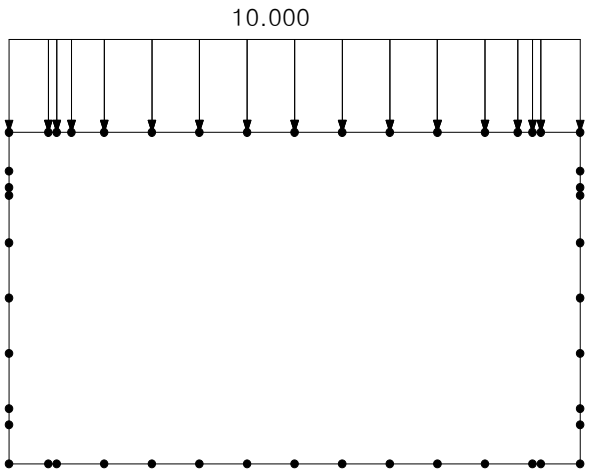
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



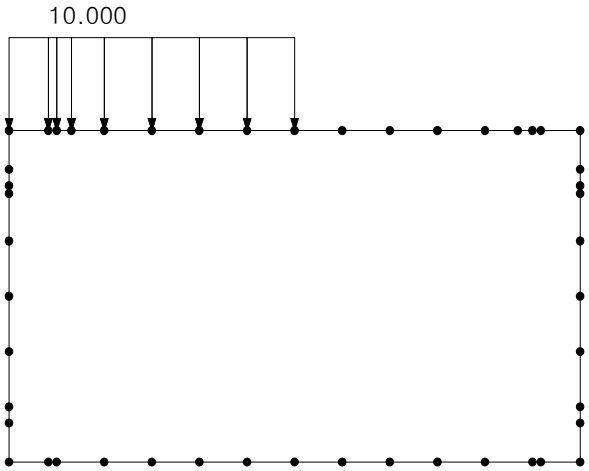
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



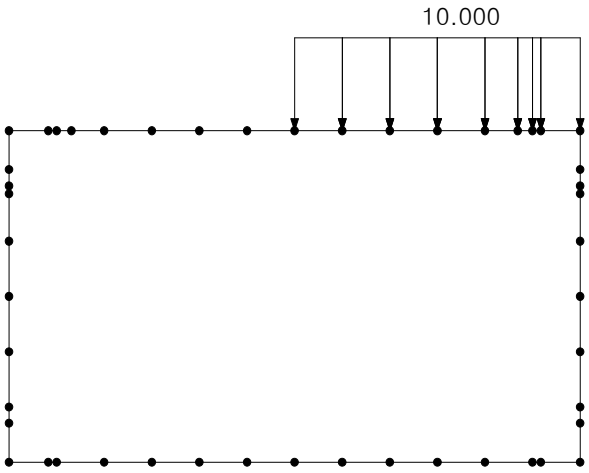
4) CASE4 - 지진시 만재활하중(LIVEFUE)



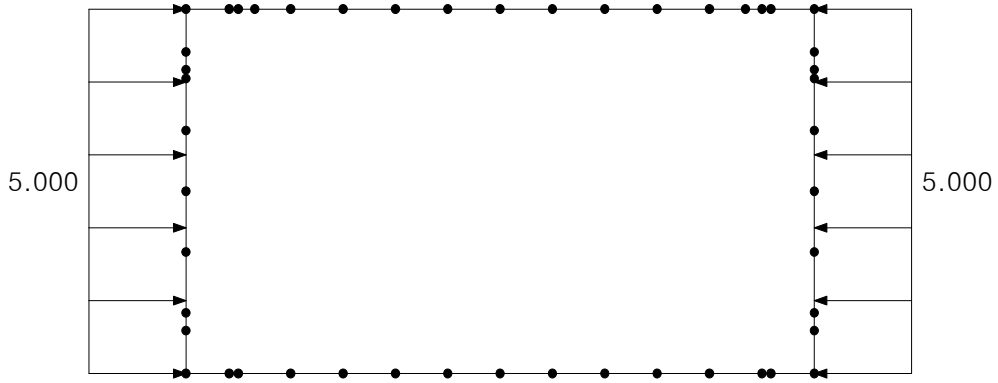
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



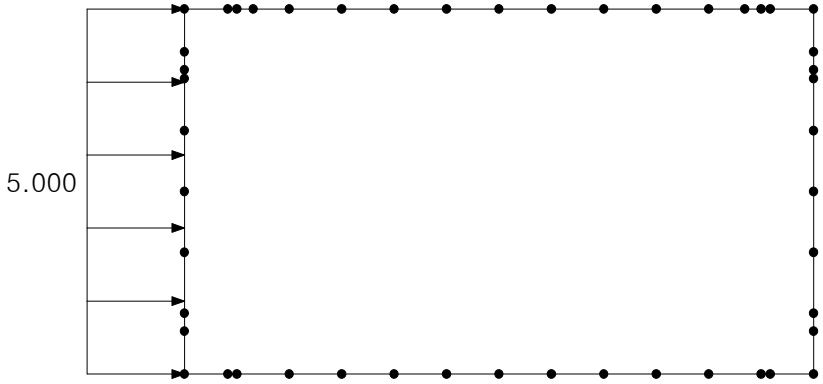
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



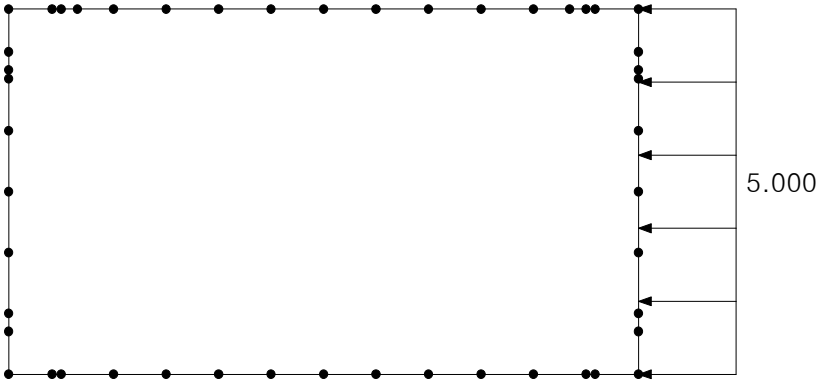
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)

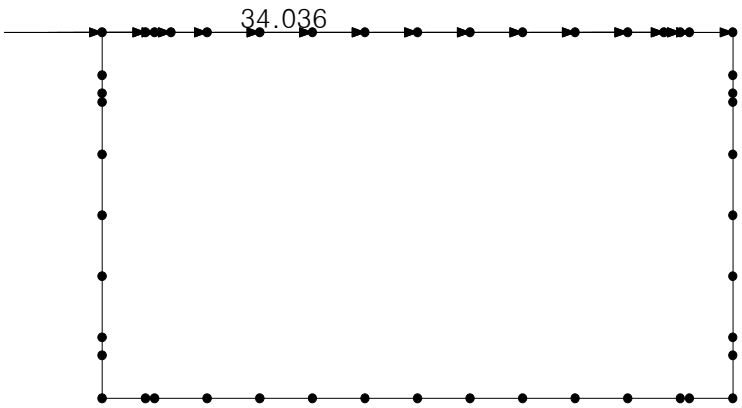


9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)

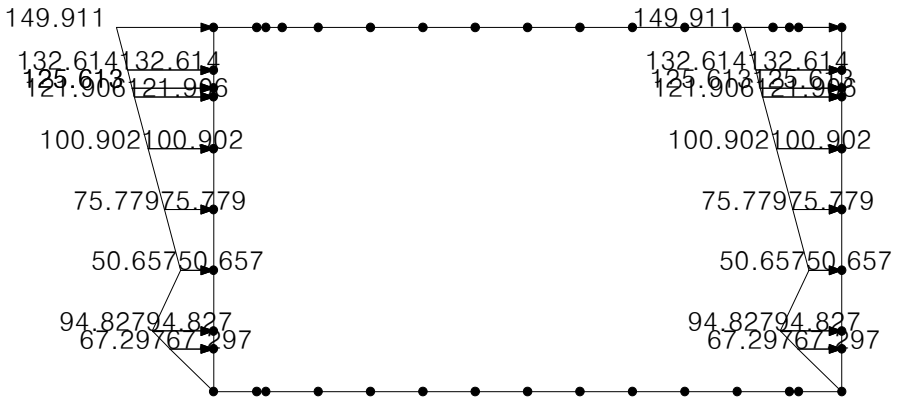


- 지진재하방향(좌측에서 우측으로)

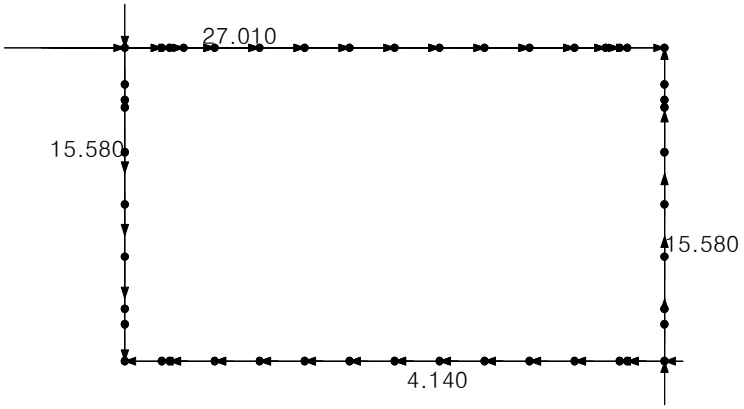
10) CASE10 - 슬래브 지반변위(기능수행)(FUNSLAB)



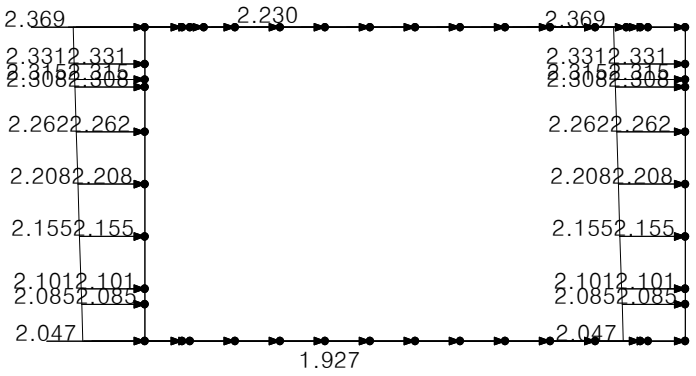
11) CASE11 - 벽체 지반변위(기능수행)(FUNWALL)



12) CASE12 - 주면전단력(기능수행)(FUNMS)

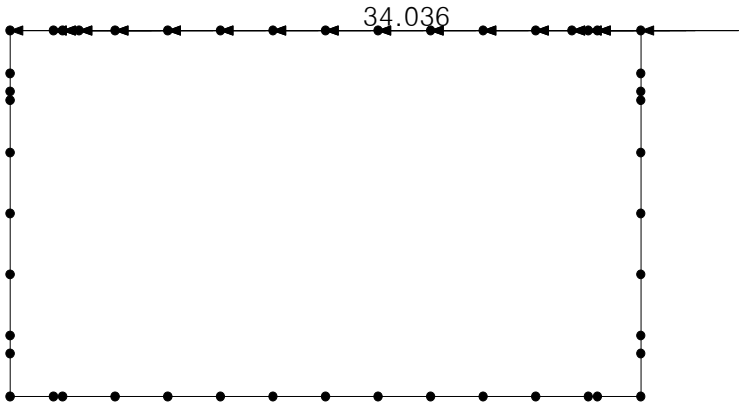


13) CASE13 - 구체 관성력(기능수행)(FUNINER)

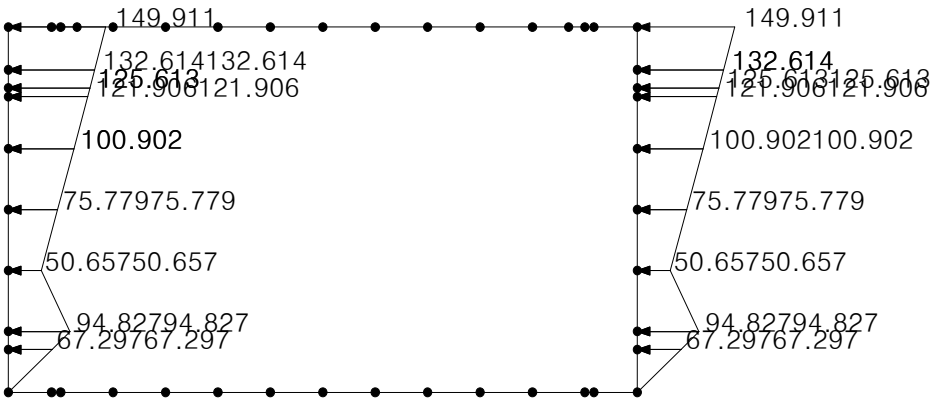


- 지진재하방향(우측에서 좌측으로)

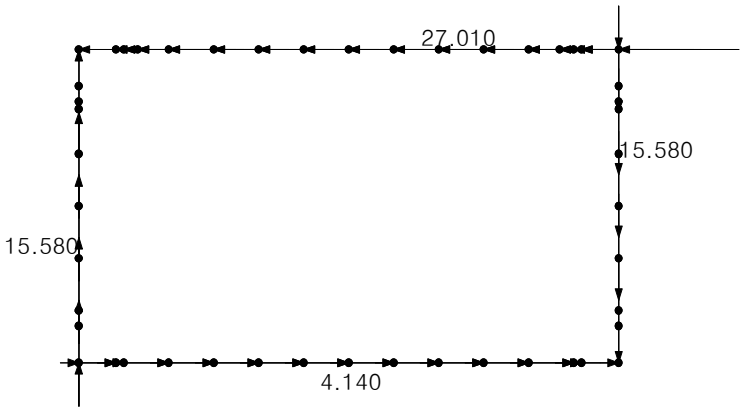
14) CASE14 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



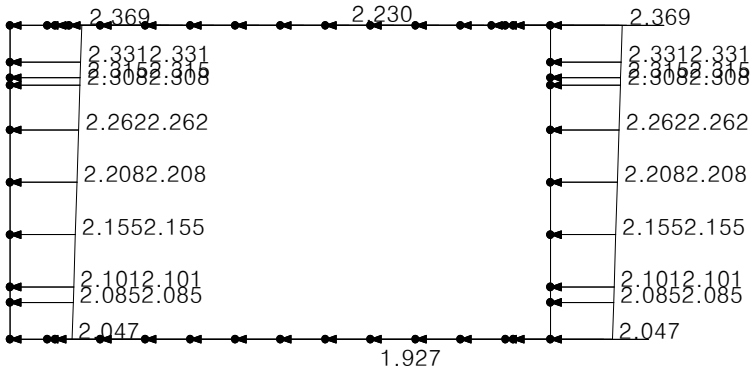
15) CASE15 - 벽체 지반변위(기능수행)2(FUNWALL2)



16) CASE16 - 주면전단력(기능수행)2(FUNMS2)

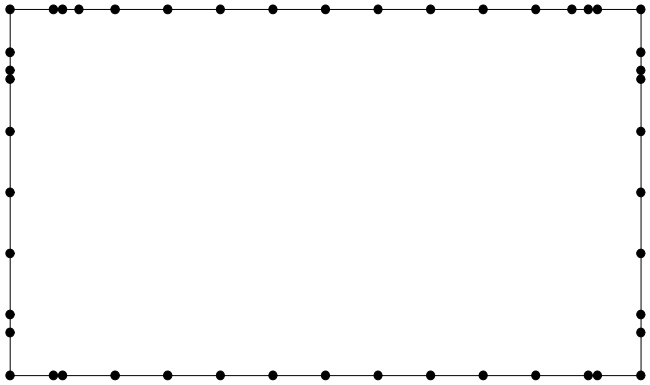


17) CASE17 - 구체 관성력(기능수행)2(FUNINER2)

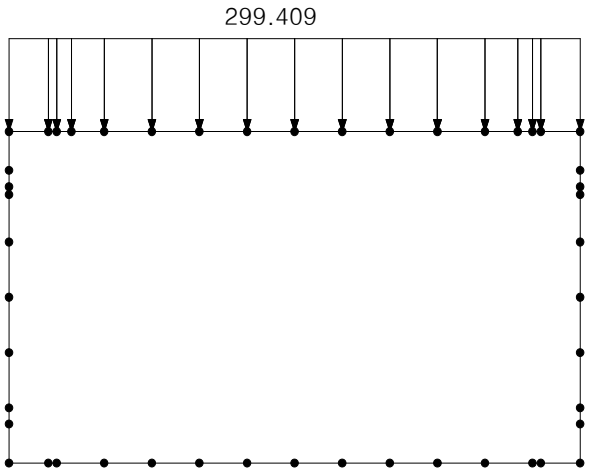


13. 하중 재하 (붕괴방지)

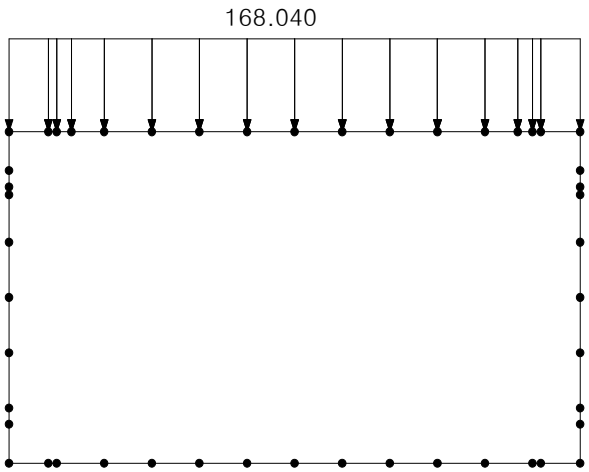
1) CASE1 - 구체자중(SW)



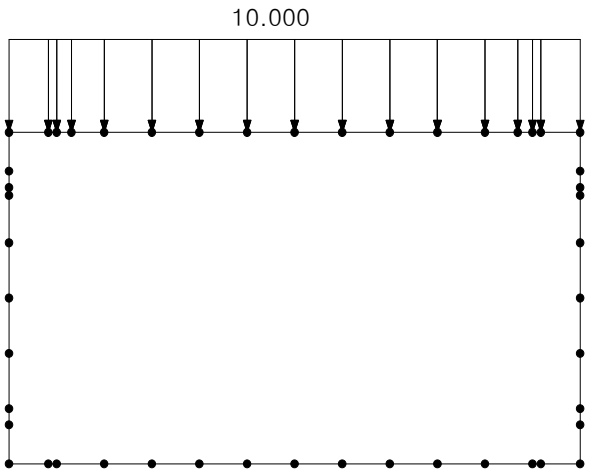
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



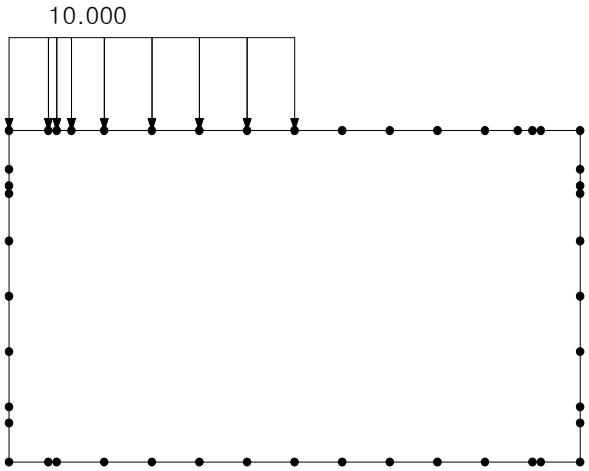
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



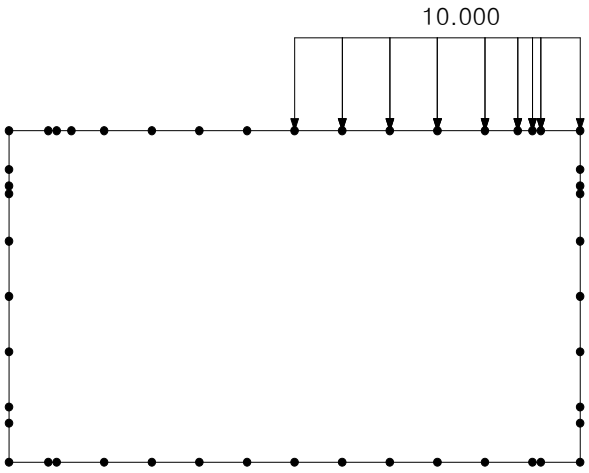
4) CASE4 - 지진시 만재활하중(LIVEFUE)



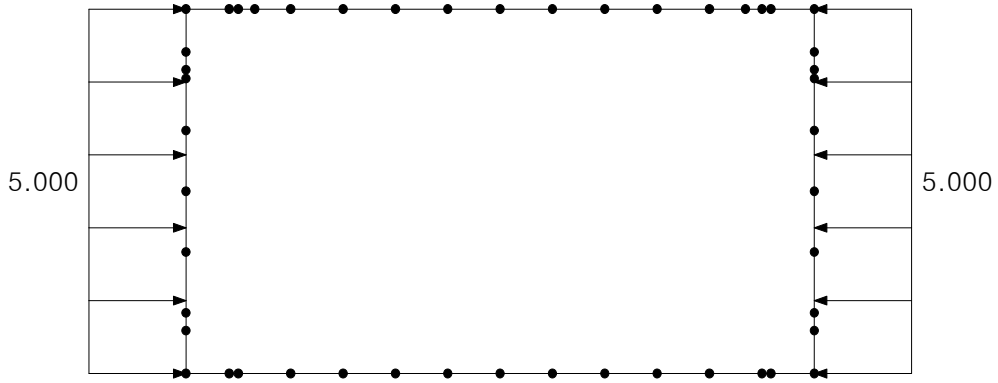
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



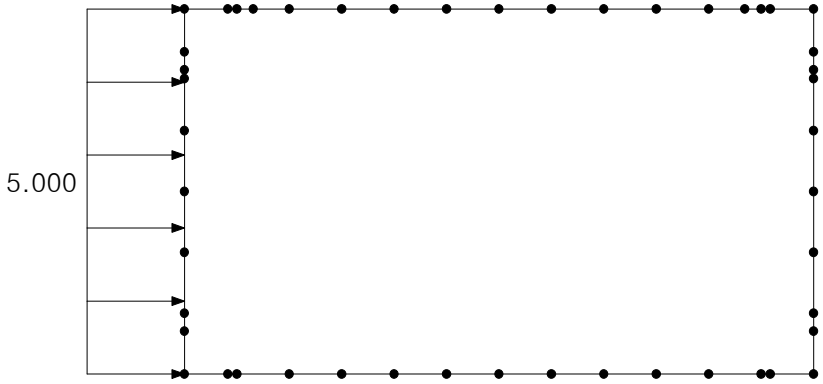
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



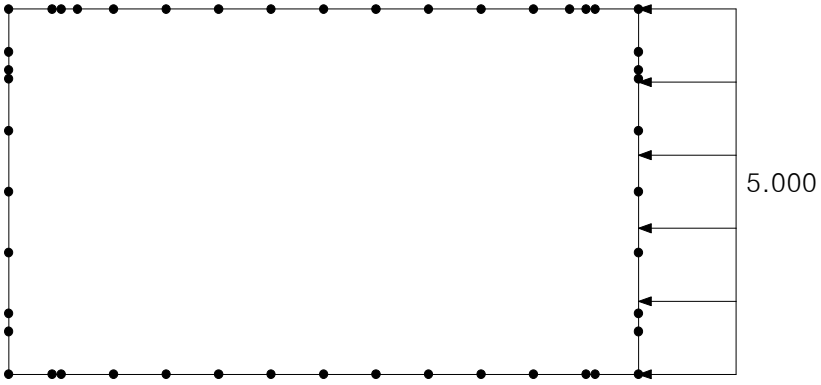
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)

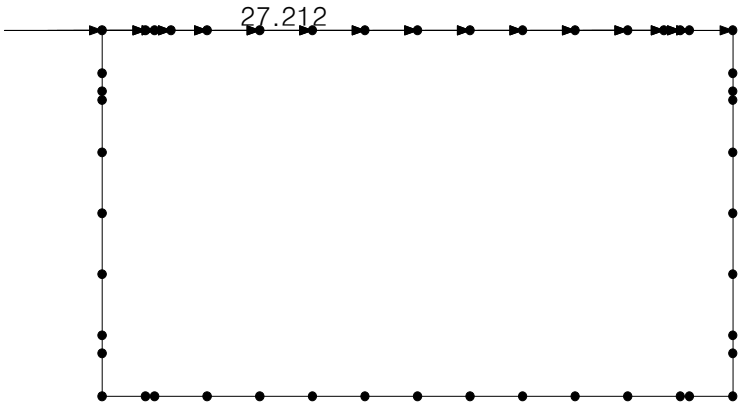


9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)

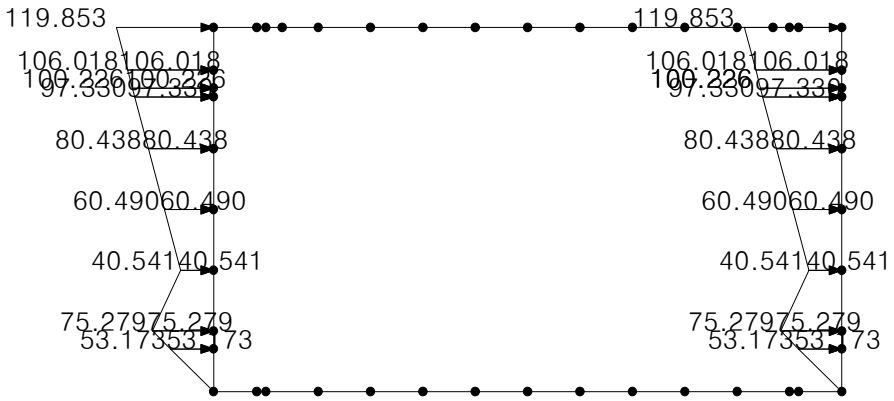


- 지진재하방향(좌측에서 우측으로)

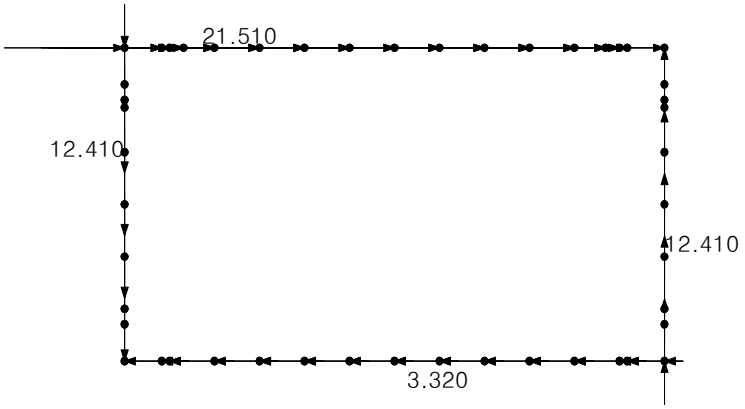
10) CASE10 - 슬래브 지반변위(붕괴방지)(COLSLAB)



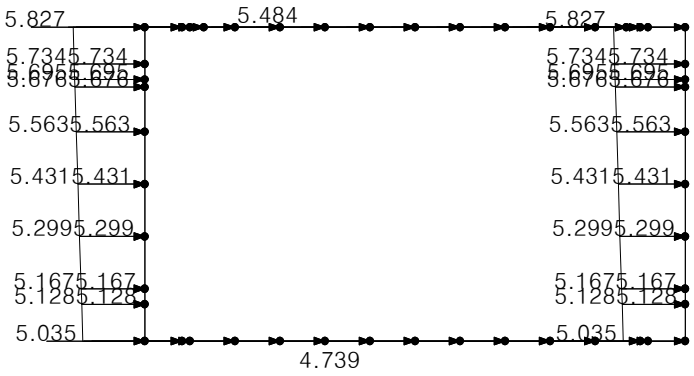
11) CASE11 - 벽체 지반변위(붕괴방지)(COLWALL)



12) CASE12 - 주면전단력(붕괴방지)(COLMS)

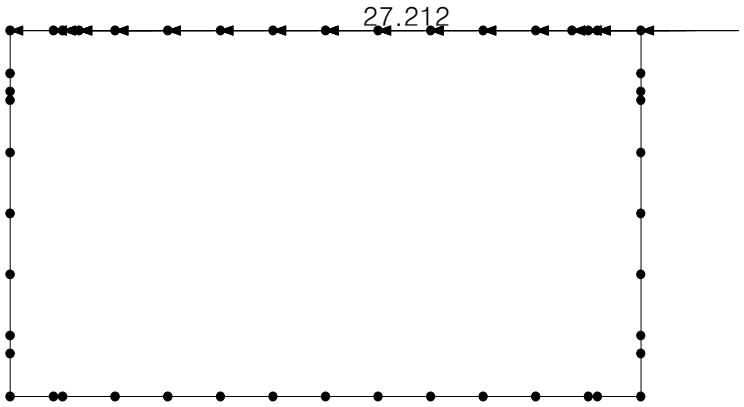


13) CASE13 - 구체 관성력(붕괴방지)(COLINER)

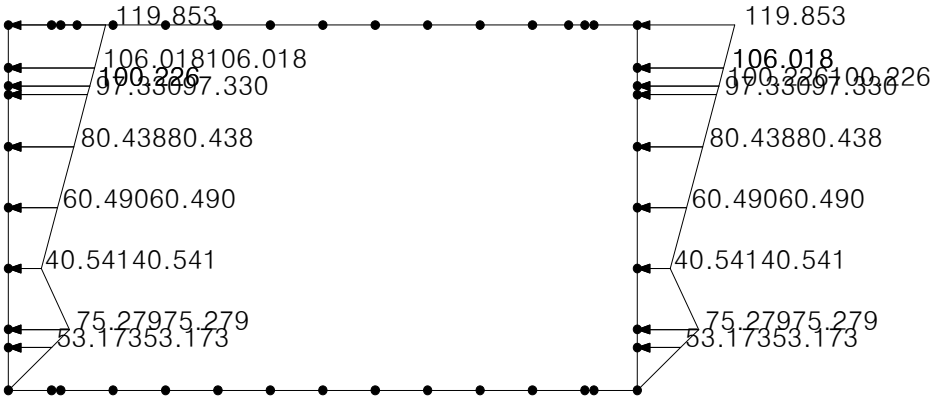


- 지진재하방향(우측에서 좌측으로)

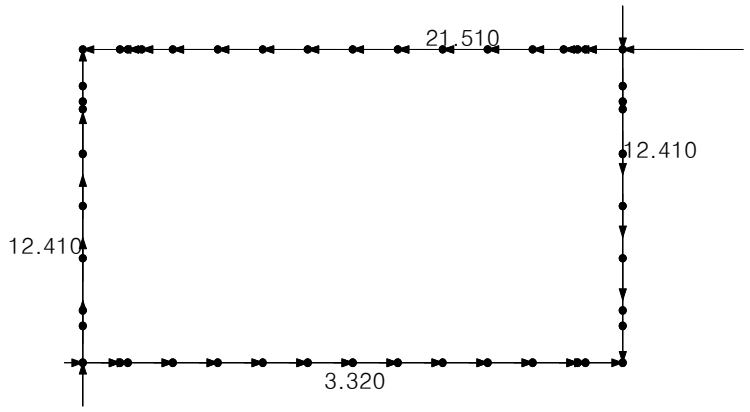
14) CASE14 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



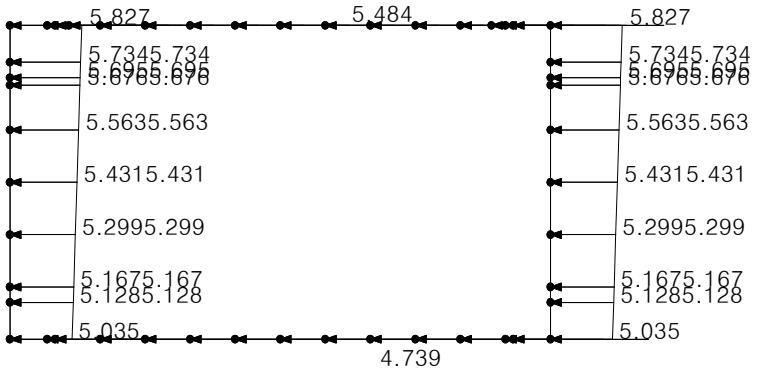
15) CASE15 - 벽체 지반변위(붕괴방지)2(COLWALL2)



16) CASE16 - 주면전단력(붕괴방지)2(COLMS2)



17) CASE17 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 1.000, h = 15.647 m

1) 계수하중

구 분	D	Hv	L	Hh	T	지하수 고려
LC1	1.200	1.588	1.600	1.600	1.200	
LC2	1.200	1.588	1.600	0.800	1.200	
LC3	0.900	1.600		1.600		
LC4	0.900	1.600		0.800		
LC5	1.200	1.588	1.600	1.600	1.200	●
LC6	1.200	1.588	1.600	0.800	1.200	●
LC7	0.900	1.600		1.600		●
LC8	0.900	1.600		0.800		●

2) 사용하중

구 분	D	Hv	L	Hh	T	지하수 고려
LC1	1.000	1.000	1.000	1.000	1.000	
LC2	1.000	1.000	1.000	0.500	1.000	
LC3	1.000	1.000		1.000		
LC4	1.000	1.000		0.500		
LC5	1.000	1.000	1.000	1.000	1.000	●
LC6	1.000	1.000	1.000	0.500	1.000	●
LC7	1.000	1.000		1.000		●
LC8	1.000	1.000		0.500		●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	E	지하수 고려
LC1	1.200	1.200	1.000	1.000		1.000	
LC2	1.200	1.200	1.000	0.500		1.000	
LC3	0.900	0.900		1.000		1.000	
LC4	0.900	0.900		0.500		1.000	
LC5	1.200	1.200	1.000	1.000		1.000	●
LC6	1.200	1.200	1.000	0.500		1.000	●
LC7	0.900	0.900		1.000		1.000	●
LC8	0.900	0.900		0.500		1.000	●

4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	E	지하수 고려
LC1	1.200	1.200	1.000	1.000		1.000	
LC2	1.200	1.200	1.000	0.500		1.000	
LC3	0.900	0.900		1.000		1.000	
LC4	0.900	0.900		0.500		1.000	
LC5	1.200	1.200	1.000	1.000		1.000	●
LC6	1.200	1.200	1.000	0.500		1.000	●
LC7	0.900	0.900		1.000		1.000	●
LC8	0.900	0.900		0.500		1.000	●

15. INPUT DATA (상시)

```
; ACulvert SAP2000 데이터파일 : 평상시
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.000 Y=     0.000 Z=     0.500
  2    X=     0.850 Y=     0.000 Z=     0.500
  3    X=     1.029 Y=     0.000 Z=     0.500
  4    X=     2.058 Y=     0.000 Z=     0.500
  5    X=     3.087 Y=     0.000 Z=     0.500
  6    X=     4.117 Y=     0.000 Z=     0.500
  7    X=     5.146 Y=     0.000 Z=     0.500
  8    X=     6.175 Y=     0.000 Z=     0.500
  9    X=     7.204 Y=     0.000 Z=     0.500
  10   X=     8.233 Y=     0.000 Z=     0.500
  11   X=     9.262 Y=     0.000 Z=     0.500
  12   X=    10.292 Y=     0.000 Z=     0.500
  13   X=    11.321 Y=     0.000 Z=     0.500
  14   X=    11.500 Y=     0.000 Z=     0.500
  15   X=    12.350 Y=     0.000 Z=     0.500
  16   X=    12.350 Y=     0.000 Z=     1.300
  17   X=    12.350 Y=     0.000 Z=     1.637
  18   X=    12.350 Y=     0.000 Z=     2.773
  19   X=    12.350 Y=     0.000 Z=     3.910
  20   X=    12.350 Y=     0.000 Z=     5.047
  21   X=    12.350 Y=     0.000 Z=     6.020
  22   X=    12.350 Y=     0.000 Z=     6.183
  23   X=    12.350 Y=     0.000 Z=     6.520
  24   X=    12.350 Y=     0.000 Z=     7.320
  25   X=    11.500 Y=     0.000 Z=     7.320
  26   X=    11.321 Y=     0.000 Z=     7.320
  27   X=    11.000 Y=     0.000 Z=     7.320
  28   X=    10.292 Y=     0.000 Z=     7.320
  29   X=     9.262 Y=     0.000 Z=     7.320
  30   X=     8.233 Y=     0.000 Z=     7.320
  31   X=     7.204 Y=     0.000 Z=     7.320
  32   X=     6.175 Y=     0.000 Z=     7.320
  33   X=     5.146 Y=     0.000 Z=     7.320
  34   X=     4.117 Y=     0.000 Z=     7.320
  35   X=     3.087 Y=     0.000 Z=     7.320
  36   X=     2.058 Y=     0.000 Z=     7.320
  37   X=     1.350 Y=     0.000 Z=     7.320
  38   X=     1.029 Y=     0.000 Z=     7.320
  39   X=     0.850 Y=     0.000 Z=     7.320
  40   X=     0.000 Y=     0.000 Z=     7.320
  41   X=     0.000 Y=     0.000 Z=     6.520
  42   X=     0.000 Y=     0.000 Z=     6.183
  43   X=     0.000 Y=     0.000 Z=     6.020
  44   X=     0.000 Y=     0.000 Z=     5.047
  45   X=     0.000 Y=     0.000 Z=     3.910
  46   X=     0.000 Y=     0.000 Z=     2.773
  47   X=     0.000 Y=     0.000 Z=     1.637
  48   X=     0.000 Y=     0.000 Z=     1.300
  49   X=     0.000 Y=     0.000 Z=     0.000
  50   X=     1.029 Y=     0.000 Z=     0.000
  51   X=     2.058 Y=     0.000 Z=     0.000
  52   X=     3.087 Y=     0.000 Z=     0.000
  53   X=     4.117 Y=     0.000 Z=     0.000
  54   X=     5.146 Y=     0.000 Z=     0.000
  55   X=     6.175 Y=     0.000 Z=     0.000
  56   X=     7.204 Y=     0.000 Z=     0.000
  57   X=     8.233 Y=     0.000 Z=     0.000
  58   X=     9.262 Y=     0.000 Z=     0.000
  59   X=    10.292 Y=     0.000 Z=     0.000
  60   X=    11.321 Y=     0.000 Z=     0.000
  61   X=    12.350 Y=     0.000 Z=     0.000
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=8 UX=1e+010
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=21342.4 CE=0.99999 K=21342.4 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=16096.4 CE=0.99999 K=16096.4 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-299.409, -299.409
      ADD=25 RD=0,1 UZ=-299.409, -299.409
      ADD=26 RD=0,1 UZ=-299.409, -299.409
      ADD=27 RD=0,1 UZ=-299.409, -299.409
```

```
      ADD=28 RD=0,1 UZ=-299.409, -299.409
      ADD=29 RD=0,1 UZ=-299.409, -299.409
      ADD=30 RD=0,1 UZ=-299.409, -299.409
      ADD=31 RD=0,1 UZ=-299.409, -299.409
      ADD=32 RD=0,1 UZ=-299.409, -299.409
      ADD=33 RD=0,1 UZ=-299.409, -299.409
      ADD=34 RD=0,1 UZ=-299.409, -299.409
      ADD=35 RD=0,1 UZ=-299.409, -299.409
      ADD=36 RD=0,1 UZ=-299.409, -299.409
      ADD=37 RD=0,1 UZ=-299.409, -299.409
      ADD=38 RD=0,1 UZ=-299.409, -299.409
      ADD=39 RD=0,1 UZ=-299.409, -299.409
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-168.04, -168.04
      ADD=25 RD=0,1 UZ=-168.04, -168.04
      ADD=26 RD=0,1 UZ=-168.04, -168.04
      ADD=27 RD=0,1 UZ=-168.04, -168.04
      ADD=28 RD=0,1 UZ=-168.04, -168.04
      ADD=29 RD=0,1 UZ=-168.04, -168.04
      ADD=30 RD=0,1 UZ=-168.04, -168.04
      ADD=31 RD=0,1 UZ=-168.04, -168.04
      ADD=32 RD=0,1 UZ=-168.04, -168.04
      ADD=33 RD=0,1 UZ=-168.04, -168.04
      ADD=34 RD=0,1 UZ=-168.04, -168.04
      ADD=35 RD=0,1 UZ=-168.04, -168.04
      ADD=36 RD=0,1 UZ=-168.04, -168.04
      ADD=37 RD=0,1 UZ=-168.04, -168.04
      ADD=38 RD=0,1 UZ=-168.04, -168.04
      ADD=39 RD=0,1 UZ=-168.04, -168.04
NAME=LIVEFU  ; 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELE  ; 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERI  ; 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUH  ; 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEH  ; 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIH  ; 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=SOILB  ; 양토압 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=157.242, 164.842
      ADD=41 RD=0,1 UX=164.842, 168.041
      ADD=42 RD=0,1 UX=168.041, 169.592
      ADD=43 RD=0,1 UX=169.592, 178.838
      ADD=44 RD=0,1 UX=178.838, 189.637
      ADD=45 RD=0,1 UX=189.637, 200.436
      ADD=46 RD=0,1 UX=200.436, 211.233
      ADD=47 RD=0,1 UX=211.233, 214.432
      ADD=48 RD=0,1 UX=214.432, 222.032
      ADD=15 RD=0,1 UX=-222.032, -214.432
      ADD=16 RD=0,1 UX=-214.432, -211.233
      ADD=17 RD=0,1 UX=-211.233, -200.436
      ADD=18 RD=0,1 UX=-200.436, -189.637
      ADD=19 RD=0,1 UX=-189.637, -178.838
      ADD=20 RD=0,1 UX=-178.838, -169.592
      ADD=21 RD=0,1 UX=-169.592, -168.041
      ADD=22 RD=0,1 UX=-168.041, -164.842
      ADD=23 RD=0,1 UX=-164.842, -157.242
NAME=SOILBW  ; 양토압 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=87.733, 91.733
      ADD=41 RD=0,1 UX=91.733, 93.416
      ADD=42 RD=0,1 UX=93.416, 94.233
      ADD=43 RD=0,1 UX=94.233, 99.1
      ADD=44 RD=0,1 UX=99.1, 104.783
      ADD=45 RD=0,1 UX=104.783, 110.466
      ADD=46 RD=0,1 UX=110.466, 116.15
      ADD=47 RD=0,1 UX=116.15, 117.833
      ADD=48 RD=0,1 UX=117.833, 121.833
      ADD=15 RD=0,1 UX=-121.833, -117.833
      ADD=16 RD=0,1 UX=-117.833, -116.15
      ADD=17 RD=0,1 UX=-116.15, -110.466
      ADD=18 RD=0,1 UX=-110.466, -104.783
      ADD=19 RD=0,1 UX=-104.783, -99.1
      ADD=20 RD=0,1 UX=-99.1, -94.233
      ADD=21 RD=0,1 UX=-94.233, -93.416
      ADD=22 RD=0,1 UX=-93.416, -91.733
      ADD=23 RD=0,1 UX=-91.733, -87.733
NAME=TEMPPLUS  ; 온도변화(+)
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=10
      ADD=16 T=10
      ADD=17 T=10
      ADD=18 T=10
      ADD=19 T=10
      ADD=20 T=10
      ADD=21 T=10
      ADD=22 T=10
      ADD=23 T=10
      ADD=24 T=10
      ADD=25 T=10
      ADD=26 T=10
      ADD=27 T=10
      ADD=28 T=10
      ADD=29 T=10
      ADD=30 T=10
      ADD=31 T=10
      ADD=32 T=10
      ADD=33 T=10
      ADD=34 T=10
      ADD=35 T=10
      ADD=36 T=10
      ADD=37 T=10
      ADD=38 T=10
      ADD=39 T=10
      ADD=40 T=10
      ADD=41 T=10
      ADD=42 T=10
```

```
      ADD=43 T=10
      ADD=44 T=10
      ADD=45 T=10
      ADD=46 T=10
      ADD=47 T=10
      ADD=48 T=10
NAME=TEMPMINU  ; 온도변화(-)
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=-10
      ADD=16 T=-10
      ADD=17 T=-10
      ADD=18 T=-10
      ADD=19 T=-10
      ADD=20 T=-10
      ADD=21 T=-10
      ADD=22 T=-10
      ADD=23 T=-10
      ADD=24 T=-10
      ADD=25 T=-10
      ADD=26 T=-10
      ADD=27 T=-10
      ADD=28 T=-10
      ADD=29 T=-10
      ADD=30 T=-10
      ADD=31 T=-10
      ADD=32 T=-10
      ADD=33 T=-10
      ADD=34 T=-10
      ADD=35 T=-10
      ADD=36 T=-10
      ADD=37 T=-10
      ADD=38 T=-10
      ADD=39 T=-10
      ADD=40 T=-10
      ADD=41 T=-10
      ADD=42 T=-10
      ADD=43 T=-10
      ADD=44 T=-10
      ADD=45 T=-10
      ADD=46 T=-10
      ADD=47 T=-10
      ADD=48 T=-10
NAME=SHRINK  ; 건조수축
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=-15
      ADD=16 T=-15
      ADD=17 T=-15
      ADD=18 T=-15
      ADD=19 T=-15
      ADD=20 T=-15
      ADD=21 T=-15
      ADD=22 T=-15
      ADD=23 T=-15
      ADD=24 T=-15
      ADD=25 T=-15
      ADD=26 T=-15
      ADD=27 T=-15
      ADD=28 T=-15
      ADD=29 T=-15
      ADD=30 T=-15
      ADD=31 T=-15
      ADD=32 T=-15
      ADD=33 T=-15
      ADD=34 T=-15
      ADD=35 T=-15
      ADD=36 T=-15
      ADD=37 T=-15
      ADD=38 T=-15
      ADD=39 T=-15
      ADD=40 T=-15
      ADD=41 T=-15
      ADD=42 T=-15
      ADD=43 T=-15
      ADD=44 T=-15
      ADD=45 T=-15
      ADD=46 T=-15
      ADD=47 T=-15
      ADD=48 T=-15
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFU
      LOAD=LIVELE
      LOAD=LIVERI
      LOAD=LIVEFUH
      LOAD=LIVELEH
      LOAD=LIVERIH
      LOAD=SOILB
      LOAD=SOILBW
      LOAD=TEMPPLUS
      LOAD=TEMPMINU
      LOAD=SHRINK
      NLLINK=*
HISTORY
   NAME=UL01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
      LOAD= LIVERIH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
      LOAD= LIVERIH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.588   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
```

```
    LOAD= LIVERIH       SF=0.800   AT=1
    LOAD= SOILB         SF=0.800   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVE          SF=1.588   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=0.800   AT=1
    LOAD= SOILB         SF=0.800   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=0.900   AT=1
    LOAD= PAVE          SF=1.600   AT=1
    LOAD= SOILB         SF=1.600   AT=1
NAME=UL14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=0.900   AT=1
    LOAD= PAVE          SF=1.600   AT=1
    LOAD= SOILB         SF=0.800   AT=1
NAME=UL15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVEFU        SF=1.600   AT=1
    LOAD= LIVEFUH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVEFU        SF=1.600   AT=1
    LOAD= LIVEFUH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVELE        SF=1.600   AT=1
    LOAD= LIVELEH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVELE        SF=1.600   AT=1
    LOAD= LIVELEH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVEFU        SF=1.600   AT=1
    LOAD= LIVEFUH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVEFU        SF=1.600   AT=1
    LOAD= LIVEFUH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVELE        SF=1.600   AT=1
    LOAD= LIVELEH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVELE        SF=1.600   AT=1
    LOAD= LIVELEH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.588   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=0.900   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
NAME=UL28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=0.900   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
NAME=SV01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILB         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
```

```
NAME=SV08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= SOILB           SF=1.000   AT=1
NAME=SV14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= SOILB           SF=0.500   AT=1
NAME=SV15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
NAME=SV28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
COMBO
   NAME=ENVUSE  TYPE=ENVE
      HIST=SV01 SF=1
      HIST=SV02 SF=1
      HIST=SV03 SF=1
      HIST=SV04 SF=1
      HIST=SV05 SF=1
      HIST=SV06 SF=1
      HIST=SV07 SF=1
      HIST=SV08 SF=1
      HIST=SV09 SF=1
      HIST=SV10 SF=1
      HIST=SV11 SF=1
      HIST=SV12 SF=1
      HIST=SV13 SF=1
      HIST=SV14 SF=1
      HIST=SV15 SF=1
      HIST=SV16 SF=1
      HIST=SV17 SF=1
      HIST=SV18 SF=1
      HIST=SV19 SF=1
      HIST=SV20 SF=1
      HIST=SV21 SF=1
      HIST=SV22 SF=1
      HIST=SV23 SF=1
      HIST=SV24 SF=1
      HIST=SV25 SF=1
      HIST=SV26 SF=1
```

```
      HIST=SV27 SF=1
      HIST=SV28 SF=1
   NAME=ENVULT  TYPE=ENVE
      HIST=UL01 SF=1
      HIST=UL02 SF=1
      HIST=UL03 SF=1
      HIST=UL04 SF=1
      HIST=UL05 SF=1
      HIST=UL06 SF=1
      HIST=UL07 SF=1
      HIST=UL08 SF=1
      HIST=UL09 SF=1
      HIST=UL10 SF=1
      HIST=UL11 SF=1
      HIST=UL12 SF=1
      HIST=UL13 SF=1
      HIST=UL14 SF=1
      HIST=UL15 SF=1
      HIST=UL16 SF=1
      HIST=UL17 SF=1
      HIST=UL18 SF=1
      HIST=UL19 SF=1
      HIST=UL20 SF=1
      HIST=UL21 SF=1
      HIST=UL22 SF=1
      HIST=UL23 SF=1
      HIST=UL24 SF=1
      HIST=UL25 SF=1
      HIST=UL26 SF=1
      HIST=UL27 SF=1
      HIST=UL28 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

16. INPUT DATA (기능수행)

```
; ACulvert SAP2000 데이터파일 : 내진(기능)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     1.350 Y=     0.000 Z=     0.500
  3    X=     1.529 Y=     0.000 Z=     0.500
  4    X=     2.558 Y=     0.000 Z=     0.500
  5    X=     3.587 Y=     0.000 Z=     0.500
  6    X=     4.617 Y=     0.000 Z=     0.500
  7    X=     5.646 Y=     0.000 Z=     0.500
  8    X=     6.675 Y=     0.000 Z=     0.500
  9    X=     7.704 Y=     0.000 Z=     0.500
  10   X=     8.733 Y=     0.000 Z=     0.500
  11   X=     9.762 Y=     0.000 Z=     0.500
  12   X=    10.792 Y=     0.000 Z=     0.500
  13   X=    11.821 Y=     0.000 Z=     0.500
  14   X=    12.000 Y=     0.000 Z=     0.500
  15   X=    12.850 Y=     0.000 Z=     0.500
  16   X=    12.850 Y=     0.000 Z=     1.300
  17   X=    12.850 Y=     0.000 Z=     1.637
  18   X=    12.850 Y=     0.000 Z=     2.773
  19   X=    12.850 Y=     0.000 Z=     3.910
  20   X=    12.850 Y=     0.000 Z=     5.047
  21   X=    12.850 Y=     0.000 Z=     6.020
  22   X=    12.850 Y=     0.000 Z=     6.183
  23   X=    12.850 Y=     0.000 Z=     6.520
  24   X=    12.850 Y=     0.000 Z=     7.320
  25   X=    12.000 Y=     0.000 Z=     7.320
  26   X=    11.821 Y=     0.000 Z=     7.320
  27   X=    11.500 Y=     0.000 Z=     7.320
  28   X=    10.792 Y=     0.000 Z=     7.320
  29   X=     9.762 Y=     0.000 Z=     7.320
  30   X=     8.733 Y=     0.000 Z=     7.320
  31   X=     7.704 Y=     0.000 Z=     7.320
  32   X=     6.675 Y=     0.000 Z=     7.320
  33   X=     5.646 Y=     0.000 Z=     7.320
  34   X=     4.617 Y=     0.000 Z=     7.320
  35   X=     3.587 Y=     0.000 Z=     7.320
  36   X=     2.558 Y=     0.000 Z=     7.320
  37   X=     1.850 Y=     0.000 Z=     7.320
  38   X=     1.529 Y=     0.000 Z=     7.320
  39   X=     1.350 Y=     0.000 Z=     7.320
  40   X=     0.500 Y=     0.000 Z=     7.320
  41   X=     0.500 Y=     0.000 Z=     6.520
  42   X=     0.500 Y=     0.000 Z=     6.183
  43   X=     0.500 Y=     0.000 Z=     6.020
  44   X=     0.500 Y=     0.000 Z=     5.047
  45   X=     0.500 Y=     0.000 Z=     3.910
  46   X=     0.500 Y=     0.000 Z=     2.773
  47   X=     0.500 Y=     0.000 Z=     1.637
  48   X=     0.500 Y=     0.000 Z=     1.300
  49   X=     0.500 Y=     0.000 Z=     0.000
  50   X=     1.529 Y=     0.000 Z=     0.000
  51   X=     2.558 Y=     0.000 Z=     0.000
  52   X=     3.587 Y=     0.000 Z=     0.000
  53   X=     4.617 Y=     0.000 Z=     0.000
  54   X=     5.646 Y=     0.000 Z=     0.000
  55   X=     6.675 Y=     0.000 Z=     0.000
  56   X=     7.704 Y=     0.000 Z=     0.000
  57   X=     8.733 Y=     0.000 Z=     0.000
  58   X=     9.762 Y=     0.000 Z=     0.000
  59   X=    10.792 Y=     0.000 Z=     0.000
  60   X=    11.821 Y=     0.000 Z=     0.000
  61   X=    12.850 Y=     0.000 Z=     0.000
  62   X=    13.350 Y=     0.000 Z=     0.500
  63   X=    13.350 Y=     0.000 Z=     1.637
  64   X=    13.350 Y=     0.000 Z=     2.773
  65   X=    13.350 Y=     0.000 Z=     3.910
  66   X=    13.350 Y=     0.000 Z=     5.047
  67   X=    13.350 Y=     0.000 Z=     6.183
  68   X=    13.350 Y=     0.000 Z=     7.320
  69   X=    12.850 Y=     0.000 Z=     7.820
  70   X=    11.821 Y=     0.000 Z=     7.820
  71   X=    10.792 Y=     0.000 Z=     7.820
  72   X=     9.762 Y=     0.000 Z=     7.820
  73   X=     8.733 Y=     0.000 Z=     7.820
  74   X=     7.704 Y=     0.000 Z=     7.820
  75   X=     6.675 Y=     0.000 Z=     7.820
  76   X=     5.646 Y=     0.000 Z=     7.820
  77   X=     4.617 Y=     0.000 Z=     7.820
  78   X=     3.587 Y=     0.000 Z=     7.820
  79   X=     2.558 Y=     0.000 Z=     7.820
  80   X=     1.529 Y=     0.000 Z=     7.820
  81   X=     0.500 Y=     0.000 Z=     7.820
  82   X=     0.000 Y=     0.000 Z=     7.320
  83   X=     0.000 Y=     0.000 Z=     6.183
  84   X=     0.000 Y=     0.000 Z=     5.047
  85   X=     0.000 Y=     0.000 Z=     3.910
  86   X=     0.000 Y=     0.000 Z=     2.773
  87   X=     0.000 Y=     0.000 Z=     1.637
  88   X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=62 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=63 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=64 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=65 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=66 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=67 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=68 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=69 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=70 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=71 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=72 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=357383
  ADD=4 UX=357383
  ADD=5 UX=357383
  ADD=6 UX=357383
  ADD=7 UX=357383
  ADD=8 UX=357383
  ADD=9 UX=357383
  ADD=10 UX=357383
  ADD=11 UX=357383
  ADD=12 UX=357383
  ADD=13 UX=357383
  ADD=17 UZ=579502
  ADD=18 UZ=156044
  ADD=19 UZ=156044
  ADD=20 UZ=156044
  ADD=22 UZ=156044
  ADD=26 UX=96233.5
  ADD=28 UX=96233.5
  ADD=29 UX=96233.5
  ADD=30 UX=96233.5
  ADD=31 UX=96233.5
  ADD=32 UX=96233.5
  ADD=33 UX=96233.5
  ADD=34 UX=96233.5
  ADD=35 UX=96233.5
  ADD=36 UX=96233.5
  ADD=38 UX=96233.5
  ADD=42 UZ=156044
  ADD=44 UZ=156044
  ADD=45 UZ=156044
  ADD=46 UZ=156044
  ADD=47 UZ=579502
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=1.42157e+006 CE=0.99999 K=1.42157e+006 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=1.07215e+006 CE=0.99999 K=1.07215e+006 OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
```

```
        DOF=U1 KE=2.09283e+006 CE=0.99999 K=2.09283e+006 OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=1.73851e+006 CE=0.99999 K=1.73851e+006 OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=468131. CE=0.99999 K=468131. OPEN=0
  NAME=6 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=563541. CE=0.99999 K=563541. OPEN=0
  NAME=7 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=382790. CE=0.99999 K=382790. OPEN=0
  NAME=8 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=288700. CE=0.99999 K=288700. OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
    14 J=15,62 NLP=3 ANG=0
    15 J=17,63 NLP=4 ANG=0
    16 J=18,64 NLP=5 ANG=0
    17 J=19,65 NLP=5 ANG=0
    18 J=20,66 NLP=5 ANG=0
    19 J=22,67 NLP=5 ANG=0
    20 J=24,68 NLP=6 ANG=0
    21 J=24,69 NLP=7 ANG=0
    22 J=26,70 NLP=8 ANG=0
    23 J=28,71 NLP=8 ANG=0
    24 J=29,72 NLP=8 ANG=0
    25 J=30,73 NLP=8 ANG=0
    26 J=31,74 NLP=8 ANG=0
    27 J=32,75 NLP=8 ANG=0
    28 J=33,76 NLP=8 ANG=0
    29 J=34,77 NLP=8 ANG=0
    30 J=35,78 NLP=8 ANG=0
    31 J=36,79 NLP=8 ANG=0
    32 J=38,80 NLP=8 ANG=0
    33 J=40,81 NLP=7 ANG=0
    34 J=40,82 NLP=6 ANG=0
    35 J=42,83 NLP=5 ANG=0
    36 J=44,84 NLP=5 ANG=0
    37 J=45,85 NLP=5 ANG=0
    38 J=46,86 NLP=5 ANG=0
    39 J=47,87 NLP=4 ANG=0
    40 J= 1,88 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-299.409, -299.409
      ADD=25 RD=0,1 UZ=-299.409, -299.409
      ADD=26 RD=0,1 UZ=-299.409, -299.409
      ADD=27 RD=0,1 UZ=-299.409, -299.409
      ADD=28 RD=0,1 UZ=-299.409, -299.409
      ADD=29 RD=0,1 UZ=-299.409, -299.409
      ADD=30 RD=0,1 UZ=-299.409, -299.409
      ADD=31 RD=0,1 UZ=-299.409, -299.409
      ADD=32 RD=0,1 UZ=-299.409, -299.409
      ADD=33 RD=0,1 UZ=-299.409, -299.409
      ADD=34 RD=0,1 UZ=-299.409, -299.409
      ADD=35 RD=0,1 UZ=-299.409, -299.409
      ADD=36 RD=0,1 UZ=-299.409, -299.409
      ADD=37 RD=0,1 UZ=-299.409, -299.409
      ADD=38 RD=0,1 UZ=-299.409, -299.409
      ADD=39 RD=0,1 UZ=-299.409, -299.409
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-168.04, -168.04
      ADD=25 RD=0,1 UZ=-168.04, -168.04
      ADD=26 RD=0,1 UZ=-168.04, -168.04
      ADD=27 RD=0,1 UZ=-168.04, -168.04
      ADD=28 RD=0,1 UZ=-168.04, -168.04
      ADD=29 RD=0,1 UZ=-168.04, -168.04
      ADD=30 RD=0,1 UZ=-168.04, -168.04
      ADD=31 RD=0,1 UZ=-168.04, -168.04
      ADD=32 RD=0,1 UZ=-168.04, -168.04
      ADD=33 RD=0,1 UZ=-168.04, -168.04
      ADD=34 RD=0,1 UZ=-168.04, -168.04
      ADD=35 RD=0,1 UZ=-168.04, -168.04
      ADD=36 RD=0,1 UZ=-168.04, -168.04
      ADD=37 RD=0,1 UZ=-168.04, -168.04
      ADD=38 RD=0,1 UZ=-168.04, -168.04
      ADD=39 RD=0,1 UZ=-168.04, -168.04
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
```

```
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=FUNSLAB  ; 슬래브 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=34.036, 34.036
      ADD=25 RD=0,1 UX=34.036, 34.036
      ADD=26 RD=0,1 UX=34.036, 34.036
      ADD=27 RD=0,1 UX=34.036, 34.036
      ADD=28 RD=0,1 UX=34.036, 34.036
      ADD=29 RD=0,1 UX=34.036, 34.036
      ADD=30 RD=0,1 UX=34.036, 34.036
      ADD=31 RD=0,1 UX=34.036, 34.036
      ADD=32 RD=0,1 UX=34.036, 34.036
      ADD=33 RD=0,1 UX=34.036, 34.036
      ADD=34 RD=0,1 UX=34.036, 34.036
      ADD=35 RD=0,1 UX=34.036, 34.036
      ADD=36 RD=0,1 UX=34.036, 34.036
      ADD=37 RD=0,1 UX=34.036, 34.036
      ADD=38 RD=0,1 UX=34.036, 34.036
      ADD=39 RD=0,1 UX=34.036, 34.036
NAME=FUNWALL  ; 벽체 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=149.911, 132.614
      ADD=41 RD=0,1 UX=132.614, 125.613
      ADD=42 RD=0,1 UX=125.613, 121.906
      ADD=43 RD=0,1 UX=121.906, 100.902
      ADD=44 RD=0,1 UX=100.902, 75.779
      ADD=45 RD=0,1 UX=75.779, 50.657
      ADD=46 RD=0,1 UX=50.657, 94.827
      ADD=47 RD=0,1 UX=94.827, 67.297
      ADD=48 RD=0,1 UX=67.297, 0
      ADD=15 RD=0,1 UX=0, 67.297
      ADD=16 RD=0,1 UX=67.297, 94.827
      ADD=17 RD=0,1 UX=94.827, 50.657
      ADD=18 RD=0,1 UX=50.657, 75.779
      ADD=19 RD=0,1 UX=75.779, 100.902
      ADD=20 RD=0,1 UX=100.902, 121.906
      ADD=21 RD=0,1 UX=121.906, 125.613
      ADD=22 RD=0,1 UX=125.613, 132.614
      ADD=23 RD=0,1 UX=132.614, 149.911
NAME=FUNMS  ; 주면전단력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=27.01, 27.01
      ADD=25 RD=0,1 UX=27.01, 27.01
      ADD=26 RD=0,1 UX=27.01, 27.01
      ADD=27 RD=0,1 UX=27.01, 27.01
      ADD=28 RD=0,1 UX=27.01, 27.01
      ADD=29 RD=0,1 UX=27.01, 27.01
      ADD=30 RD=0,1 UX=27.01, 27.01
      ADD=31 RD=0,1 UX=27.01, 27.01
      ADD=32 RD=0,1 UX=27.01, 27.01
      ADD=33 RD=0,1 UX=27.01, 27.01
      ADD=34 RD=0,1 UX=27.01, 27.01
      ADD=35 RD=0,1 UX=27.01, 27.01
      ADD=36 RD=0,1 UX=27.01, 27.01
      ADD=37 RD=0,1 UX=27.01, 27.01
      ADD=38 RD=0,1 UX=27.01, 27.01
      ADD=39 RD=0,1 UX=27.01, 27.01
      ADD=40 RD=0,1 UZ=-15.58, -15.58
      ADD=41 RD=0,1 UZ=-15.58, -15.58
      ADD=42 RD=0,1 UZ=-15.58, -15.58
      ADD=43 RD=0,1 UZ=-15.58, -15.58
      ADD=44 RD=0,1 UZ=-15.58, -15.58
      ADD=45 RD=0,1 UZ=-15.58, -15.58
      ADD=46 RD=0,1 UZ=-15.58, -15.58
      ADD=47 RD=0,1 UZ=-15.58, -15.58
      ADD=48 RD=0,1 UZ=-15.58, -15.58
      ADD=15 RD=0,1 UZ=15.58, 15.58
      ADD=16 RD=0,1 UZ=15.58, 15.58
      ADD=17 RD=0,1 UZ=15.58, 15.58
      ADD=18 RD=0,1 UZ=15.58, 15.58
      ADD=19 RD=0,1 UZ=15.58, 15.58
      ADD=20 RD=0,1 UZ=15.58, 15.58
      ADD=21 RD=0,1 UZ=15.58, 15.58
      ADD=22 RD=0,1 UZ=15.58, 15.58
      ADD=23 RD=0,1 UZ=15.58, 15.58
      ADD=1 RD=0,1 UX=-4.14, -4.14
      ADD=2 RD=0,1 UX=-4.14, -4.14
      ADD=3 RD=0,1 UX=-4.14, -4.14
      ADD=4 RD=0,1 UX=-4.14, -4.14
      ADD=5 RD=0,1 UX=-4.14, -4.14
      ADD=6 RD=0,1 UX=-4.14, -4.14
      ADD=7 RD=0,1 UX=-4.14, -4.14
      ADD=8 RD=0,1 UX=-4.14, -4.14
      ADD=9 RD=0,1 UX=-4.14, -4.14
      ADD=10 RD=0,1 UX=-4.14, -4.14
      ADD=11 RD=0,1 UX=-4.14, -4.14
      ADD=12 RD=0,1 UX=-4.14, -4.14
      ADD=13 RD=0,1 UX=-4.14, -4.14
      ADD=14 RD=0,1 UX=-4.14, -4.14
NAME=FUNINER  ; 구체 관성력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=2.23, 2.23
      ADD=25 RD=0,1 UX=2.23, 2.23
      ADD=26 RD=0,1 UX=2.23, 2.23
      ADD=27 RD=0,1 UX=2.23, 2.23
      ADD=28 RD=0,1 UX=2.23, 2.23
      ADD=29 RD=0,1 UX=2.23, 2.23
      ADD=30 RD=0,1 UX=2.23, 2.23
      ADD=31 RD=0,1 UX=2.23, 2.23
      ADD=32 RD=0,1 UX=2.23, 2.23
      ADD=33 RD=0,1 UX=2.23, 2.23
      ADD=34 RD=0,1 UX=2.23, 2.23
      ADD=35 RD=0,1 UX=2.23, 2.23
      ADD=36 RD=0,1 UX=2.23, 2.23
      ADD=37 RD=0,1 UX=2.23, 2.23
      ADD=38 RD=0,1 UX=2.23, 2.23
      ADD=39 RD=0,1 UX=2.23, 2.23
      ADD=40 RD=0,1 UX=2.369, 2.331
      ADD=41 RD=0,1 UX=2.331, 2.315
      ADD=42 RD=0,1 UX=2.315, 2.308
      ADD=43 RD=0,1 UX=2.308, 2.262
      ADD=44 RD=0,1 UX=2.262, 2.208
      ADD=45 RD=0,1 UX=2.208, 2.155
      ADD=46 RD=0,1 UX=2.155, 2.101
      ADD=47 RD=0,1 UX=2.101, 2.085
      ADD=48 RD=0,1 UX=2.085, 2.047
      ADD=15 RD=0,1 UX=2.047, 2.085
      ADD=16 RD=0,1 UX=2.085, 2.101
      ADD=17 RD=0,1 UX=2.101, 2.155
      ADD=18 RD=0,1 UX=2.155, 2.208
      ADD=19 RD=0,1 UX=2.208, 2.262
      ADD=20 RD=0,1 UX=2.262, 2.308
      ADD=21 RD=0,1 UX=2.308, 2.315
      ADD=22 RD=0,1 UX=2.315, 2.331
      ADD=23 RD=0,1 UX=2.331, 2.369
      ADD=1 RD=0,1 UX=1.927, 1.927
      ADD=2 RD=0,1 UX=1.927, 1.927
```

```
      ADD=3 RD=0,1 UX=1.927, 1.927
      ADD=4 RD=0,1 UX=1.927, 1.927
      ADD=5 RD=0,1 UX=1.927, 1.927
      ADD=6 RD=0,1 UX=1.927, 1.927
      ADD=7 RD=0,1 UX=1.927, 1.927
      ADD=8 RD=0,1 UX=1.927, 1.927
      ADD=9 RD=0,1 UX=1.927, 1.927
      ADD=10 RD=0,1 UX=1.927, 1.927
      ADD=11 RD=0,1 UX=1.927, 1.927
      ADD=12 RD=0,1 UX=1.927, 1.927
      ADD=13 RD=0,1 UX=1.927, 1.927
      ADD=14 RD=0,1 UX=1.927, 1.927
NAME=FUNSLAB2  ; 슬래브 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-34.036, -34.036
      ADD=25 RD=0,1 UX=-34.036, -34.036
      ADD=26 RD=0,1 UX=-34.036, -34.036
      ADD=27 RD=0,1 UX=-34.036, -34.036
      ADD=28 RD=0,1 UX=-34.036, -34.036
      ADD=29 RD=0,1 UX=-34.036, -34.036
      ADD=30 RD=0,1 UX=-34.036, -34.036
      ADD=31 RD=0,1 UX=-34.036, -34.036
      ADD=32 RD=0,1 UX=-34.036, -34.036
      ADD=33 RD=0,1 UX=-34.036, -34.036
      ADD=34 RD=0,1 UX=-34.036, -34.036
      ADD=35 RD=0,1 UX=-34.036, -34.036
      ADD=36 RD=0,1 UX=-34.036, -34.036
      ADD=37 RD=0,1 UX=-34.036, -34.036
      ADD=38 RD=0,1 UX=-34.036, -34.036
      ADD=39 RD=0,1 UX=-34.036, -34.036
NAME=FUNWALL2  ; 벽체 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=-149.911, -132.614
      ADD=41 RD=0,1 UX=-132.614, -125.613
      ADD=42 RD=0,1 UX=-125.613, -121.906
      ADD=43 RD=0,1 UX=-121.906, -100.902
      ADD=44 RD=0,1 UX=-100.902, -75.779
      ADD=45 RD=0,1 UX=-75.779, -50.657
      ADD=46 RD=0,1 UX=-50.657, -94.827
      ADD=47 RD=0,1 UX=-94.827, -67.297
      ADD=48 RD=0,1 UX=-67.297, -0
      ADD=15 RD=0,1 UX=-0, -67.297
      ADD=16 RD=0,1 UX=-67.297, -94.827
      ADD=17 RD=0,1 UX=-94.827, -50.657
      ADD=18 RD=0,1 UX=-50.657, -75.779
      ADD=19 RD=0,1 UX=-75.779, -100.902
      ADD=20 RD=0,1 UX=-100.902, -121.906
      ADD=21 RD=0,1 UX=-121.906, -125.613
      ADD=22 RD=0,1 UX=-125.613, -132.614
      ADD=23 RD=0,1 UX=-132.614, -149.911
NAME=FUNMS2  ; 주면전단력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-27.01, -27.01
      ADD=25 RD=0,1 UX=-27.01, -27.01
      ADD=26 RD=0,1 UX=-27.01, -27.01
      ADD=27 RD=0,1 UX=-27.01, -27.01
      ADD=28 RD=0,1 UX=-27.01, -27.01
      ADD=29 RD=0,1 UX=-27.01, -27.01
      ADD=30 RD=0,1 UX=-27.01, -27.01
      ADD=31 RD=0,1 UX=-27.01, -27.01
      ADD=32 RD=0,1 UX=-27.01, -27.01
      ADD=33 RD=0,1 UX=-27.01, -27.01
      ADD=34 RD=0,1 UX=-27.01, -27.01
      ADD=35 RD=0,1 UX=-27.01, -27.01
      ADD=36 RD=0,1 UX=-27.01, -27.01
      ADD=37 RD=0,1 UX=-27.01, -27.01
      ADD=38 RD=0,1 UX=-27.01, -27.01
      ADD=39 RD=0,1 UX=-27.01, -27.01
      ADD=40 RD=0,1 UZ=15.58, 15.58
      ADD=41 RD=0,1 UZ=15.58, 15.58
      ADD=42 RD=0,1 UZ=15.58, 15.58
      ADD=43 RD=0,1 UZ=15.58, 15.58
      ADD=44 RD=0,1 UZ=15.58, 15.58
      ADD=45 RD=0,1 UZ=15.58, 15.58
      ADD=46 RD=0,1 UZ=15.58, 15.58
      ADD=47 RD=0,1 UZ=15.58, 15.58
      ADD=48 RD=0,1 UZ=15.58, 15.58
      ADD=15 RD=0,1 UZ=-15.58, -15.58
      ADD=16 RD=0,1 UZ=-15.58, -15.58
      ADD=17 RD=0,1 UZ=-15.58, -15.58
      ADD=18 RD=0,1 UZ=-15.58, -15.58
      ADD=19 RD=0,1 UZ=-15.58, -15.58
      ADD=20 RD=0,1 UZ=-15.58, -15.58
      ADD=21 RD=0,1 UZ=-15.58, -15.58
      ADD=22 RD=0,1 UZ=-15.58, -15.58
      ADD=23 RD=0,1 UZ=-15.58, -15.58
      ADD=1 RD=0,1 UX=4.14, 4.14
      ADD=2 RD=0,1 UX=4.14, 4.14
      ADD=3 RD=0,1 UX=4.14, 4.14
      ADD=4 RD=0,1 UX=4.14, 4.14
      ADD=5 RD=0,1 UX=4.14, 4.14
      ADD=6 RD=0,1 UX=4.14, 4.14
      ADD=7 RD=0,1 UX=4.14, 4.14
      ADD=8 RD=0,1 UX=4.14, 4.14
      ADD=9 RD=0,1 UX=4.14, 4.14
      ADD=10 RD=0,1 UX=4.14, 4.14
      ADD=11 RD=0,1 UX=4.14, 4.14
      ADD=12 RD=0,1 UX=4.14, 4.14
      ADD=13 RD=0,1 UX=4.14, 4.14
      ADD=14 RD=0,1 UX=4.14, 4.14
NAME=FUNINER2  ; 구체 관성력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-2.23, -2.23
      ADD=25 RD=0,1 UX=-2.23, -2.23
      ADD=26 RD=0,1 UX=-2.23, -2.23
      ADD=27 RD=0,1 UX=-2.23, -2.23
      ADD=28 RD=0,1 UX=-2.23, -2.23
      ADD=29 RD=0,1 UX=-2.23, -2.23
      ADD=30 RD=0,1 UX=-2.23, -2.23
      ADD=31 RD=0,1 UX=-2.23, -2.23
      ADD=32 RD=0,1 UX=-2.23, -2.23
      ADD=33 RD=0,1 UX=-2.23, -2.23
      ADD=34 RD=0,1 UX=-2.23, -2.23
      ADD=35 RD=0,1 UX=-2.23, -2.23
      ADD=36 RD=0,1 UX=-2.23, -2.23
      ADD=37 RD=0,1 UX=-2.23, -2.23
      ADD=38 RD=0,1 UX=-2.23, -2.23
      ADD=39 RD=0,1 UX=-2.23, -2.23
      ADD=40 RD=0,1 UX=-2.369, -2.331
      ADD=41 RD=0,1 UX=-2.331, -2.315
      ADD=42 RD=0,1 UX=-2.315, -2.308
      ADD=43 RD=0,1 UX=-2.308, -2.262
      ADD=44 RD=0,1 UX=-2.262, -2.208
      ADD=45 RD=0,1 UX=-2.208, -2.155
      ADD=46 RD=0,1 UX=-2.155, -2.101
      ADD=47 RD=0,1 UX=-2.101, -2.085
      ADD=48 RD=0,1 UX=-2.085, -2.047
      ADD=15 RD=0,1 UX=-2.047, -2.085
      ADD=16 RD=0,1 UX=-2.085, -2.101
      ADD=17 RD=0,1 UX=-2.101, -2.155
      ADD=18 RD=0,1 UX=-2.155, -2.208
      ADD=19 RD=0,1 UX=-2.208, -2.262
      ADD=20 RD=0,1 UX=-2.262, -2.308
      ADD=21 RD=0,1 UX=-2.308, -2.315
      ADD=22 RD=0,1 UX=-2.315, -2.331
      ADD=23 RD=0,1 UX=-2.331, -2.369
      ADD=1 RD=0,1 UX=-1.927, -1.927
      ADD=2 RD=0,1 UX=-1.927, -1.927
      ADD=3 RD=0,1 UX=-1.927, -1.927
      ADD=4 RD=0,1 UX=-1.927, -1.927
      ADD=5 RD=0,1 UX=-1.927, -1.927
      ADD=6 RD=0,1 UX=-1.927, -1.927
      ADD=7 RD=0,1 UX=-1.927, -1.927
      ADD=8 RD=0,1 UX=-1.927, -1.927
      ADD=9 RD=0,1 UX=-1.927, -1.927
      ADD=10 RD=0,1 UX=-1.927, -1.927
      ADD=11 RD=0,1 UX=-1.927, -1.927
      ADD=12 RD=0,1 UX=-1.927, -1.927
      ADD=13 RD=0,1 UX=-1.927, -1.927
      ADD=14 RD=0,1 UX=-1.927, -1.927
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=FUNSLAB
      LOAD=FUNWALL
      LOAD=FUNMS
      LOAD=FUNINER
      LOAD=FUNSLAB2
      LOAD=FUNWALL2
      LOAD=FUNMS2
      LOAD=FUNINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
```

```
NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=0.500   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=0.500   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=0.500   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=0.500   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=0.500   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=0.500   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
   LOAD= FUNINER2        SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= FUNSLAB         SF=1.000   AT=1
   LOAD= FUNWALL         SF=1.000   AT=1
   LOAD= FUNMS           SF=1.000   AT=1
   LOAD= FUNINER         SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= FUNSLAB2        SF=1.000   AT=1
   LOAD= FUNWALL2        SF=1.000   AT=1
   LOAD= FUNMS2          SF=1.000   AT=1
```

```
      LOAD= FUNINER2       SF=1.000   AT=1                                  HIST=UE06 SF=1
   NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE07 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE08 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE09 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                  HIST=UE10 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                  HIST=UE11 SF=1
      LOAD= FUNSLAB        SF=1.000   AT=1                                  HIST=UE12 SF=1
      LOAD= FUNWALL        SF=1.000   AT=1                                  HIST=UE13 SF=1
      LOAD= FUNMS          SF=1.000   AT=1                                  HIST=UE14 SF=1
      LOAD= FUNINER        SF=1.000   AT=1                                  HIST=UE15 SF=1
   NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE16 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE17 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE18 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                  HIST=UE19 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                  HIST=UE20 SF=1
      LOAD= FUNSLAB2       SF=1.000   AT=1                                  HIST=UE21 SF=1
      LOAD= FUNWALL2       SF=1.000   AT=1                                  HIST=UE22 SF=1
      LOAD= FUNMS2         SF=1.000   AT=1                                  HIST=UE23 SF=1
      LOAD= FUNINER2       SF=1.000   AT=1                                  HIST=UE24 SF=1
   NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE25 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE26 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE27 SF=1
      LOAD= LIVELEE        SF=1.000   AT=1                                  HIST=UE28 SF=1
      LOAD= LIVELEHE       SF=0.500   AT=1                                  HIST=UE29 SF=1
      LOAD= FUNSLAB        SF=1.000   AT=1                                  HIST=UE30 SF=1
      LOAD= FUNWALL        SF=1.000   AT=1                                  HIST=UE31 SF=1
      LOAD= FUNMS          SF=1.000   AT=1                                  HIST=UE32 SF=1
      LOAD= FUNINER        SF=1.000   AT=1                            OUTPUT
   NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= SW             SF=1.200   AT=1                                  ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVELEE        SF=1.000   AT=1
      LOAD= LIVELEHE       SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
```

17. INPUT DATA (붕괴방지)

```
; ACulvert SAP2000 데이터파일 : 내진(붕괴)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     1.350 Y=     0.000 Z=     0.500
  3    X=     1.529 Y=     0.000 Z=     0.500
  4    X=     2.558 Y=     0.000 Z=     0.500
  5    X=     3.587 Y=     0.000 Z=     0.500
  6    X=     4.617 Y=     0.000 Z=     0.500
  7    X=     5.646 Y=     0.000 Z=     0.500
  8    X=     6.675 Y=     0.000 Z=     0.500
  9    X=     7.704 Y=     0.000 Z=     0.500
  10   X=     8.733 Y=     0.000 Z=     0.500
  11   X=     9.762 Y=     0.000 Z=     0.500
  12   X=    10.792 Y=     0.000 Z=     0.500
  13   X=    11.821 Y=     0.000 Z=     0.500
  14   X=    12.000 Y=     0.000 Z=     0.500
  15   X=    12.850 Y=     0.000 Z=     0.500
  16   X=    12.850 Y=     0.000 Z=     1.300
  17   X=    12.850 Y=     0.000 Z=     1.637
  18   X=    12.850 Y=     0.000 Z=     2.773
  19   X=    12.850 Y=     0.000 Z=     3.910
  20   X=    12.850 Y=     0.000 Z=     5.047
  21   X=    12.850 Y=     0.000 Z=     6.020
  22   X=    12.850 Y=     0.000 Z=     6.183
  23   X=    12.850 Y=     0.000 Z=     6.520
  24   X=    12.850 Y=     0.000 Z=     7.320
  25   X=    12.000 Y=     0.000 Z=     7.320
  26   X=    11.821 Y=     0.000 Z=     7.320
  27   X=    11.500 Y=     0.000 Z=     7.320
  28   X=    10.792 Y=     0.000 Z=     7.320
  29   X=     9.762 Y=     0.000 Z=     7.320
  30   X=     8.733 Y=     0.000 Z=     7.320
  31   X=     7.704 Y=     0.000 Z=     7.320
  32   X=     6.675 Y=     0.000 Z=     7.320
  33   X=     5.646 Y=     0.000 Z=     7.320
  34   X=     4.617 Y=     0.000 Z=     7.320
  35   X=     3.587 Y=     0.000 Z=     7.320
  36   X=     2.558 Y=     0.000 Z=     7.320
  37   X=     1.850 Y=     0.000 Z=     7.320
  38   X=     1.529 Y=     0.000 Z=     7.320
  39   X=     1.350 Y=     0.000 Z=     7.320
  40   X=     0.500 Y=     0.000 Z=     7.320
  41   X=     0.500 Y=     0.000 Z=     6.520
  42   X=     0.500 Y=     0.000 Z=     6.183
  43   X=     0.500 Y=     0.000 Z=     6.020
  44   X=     0.500 Y=     0.000 Z=     5.047
  45   X=     0.500 Y=     0.000 Z=     3.910
  46   X=     0.500 Y=     0.000 Z=     2.773
  47   X=     0.500 Y=     0.000 Z=     1.637
  48   X=     0.500 Y=     0.000 Z=     1.300
  49   X=     0.500 Y=     0.000 Z=     0.000
  50   X=     1.529 Y=     0.000 Z=     0.000
  51   X=     2.558 Y=     0.000 Z=     0.000
  52   X=     3.587 Y=     0.000 Z=     0.000
  53   X=     4.617 Y=     0.000 Z=     0.000
  54   X=     5.646 Y=     0.000 Z=     0.000
  55   X=     6.675 Y=     0.000 Z=     0.000
  56   X=     7.704 Y=     0.000 Z=     0.000
  57   X=     8.733 Y=     0.000 Z=     0.000
  58   X=     9.762 Y=     0.000 Z=     0.000
  59   X=    10.792 Y=     0.000 Z=     0.000
  60   X=    11.821 Y=     0.000 Z=     0.000
  61   X=    12.850 Y=     0.000 Z=     0.000
  62   X=    13.350 Y=     0.000 Z=     0.500
  63   X=    13.350 Y=     0.000 Z=     1.637
  64   X=    13.350 Y=     0.000 Z=     2.773
  65   X=    13.350 Y=     0.000 Z=     3.910
  66   X=    13.350 Y=     0.000 Z=     5.047
  67   X=    13.350 Y=     0.000 Z=     6.183
  68   X=    13.350 Y=     0.000 Z=     7.320
  69   X=    12.850 Y=     0.000 Z=     7.820
  70   X=    11.821 Y=     0.000 Z=     7.820
  71   X=    10.792 Y=     0.000 Z=     7.820
  72   X=     9.762 Y=     0.000 Z=     7.820
  73   X=     8.733 Y=     0.000 Z=     7.820
  74   X=     7.704 Y=     0.000 Z=     7.820
  75   X=     6.675 Y=     0.000 Z=     7.820
  76   X=     5.646 Y=     0.000 Z=     7.820
  77   X=     4.617 Y=     0.000 Z=     7.820
  78   X=     3.587 Y=     0.000 Z=     7.820
  79   X=     2.558 Y=     0.000 Z=     7.820
  80   X=     1.529 Y=     0.000 Z=     7.820
  81   X=     0.500 Y=     0.000 Z=     7.820
  82   X=     0.000 Y=     0.000 Z=     7.320
  83   X=     0.000 Y=     0.000 Z=     6.183
  84   X=     0.000 Y=     0.000 Z=     5.047
  85   X=     0.000 Y=     0.000 Z=     3.910
  86   X=     0.000 Y=     0.000 Z=     2.773
  87   X=     0.000 Y=     0.000 Z=     1.637
  88   X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=62 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=63 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=64 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=65 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=66 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=67 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=68 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=69 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=70 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=71 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=72 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=139603
  ADD=4 UX=139603
  ADD=5 UX=139603
  ADD=6 UX=139603
  ADD=7 UX=139603
  ADD=8 UX=139603
  ADD=9 UX=139603
  ADD=10 UX=139603
  ADD=11 UX=139603
  ADD=12 UX=139603
  ADD=13 UX=139603
  ADD=17 UZ=226368
  ADD=18 UZ=60954.5
  ADD=19 UZ=60954.5
  ADD=20 UZ=60954.5
  ADD=22 UZ=60954.5
  ADD=26 UX=37591.1
  ADD=28 UX=37591.1
  ADD=29 UX=37591.1
  ADD=30 UX=37591.1
  ADD=31 UX=37591.1
  ADD=32 UX=37591.1
  ADD=33 UX=37591.1
  ADD=34 UX=37591.1
  ADD=35 UX=37591.1
  ADD=36 UX=37591.1
  ADD=38 UX=37591.1
  ADD=42 UZ=60954.5
  ADD=44 UZ=60954.5
  ADD=45 UZ=60954.5
  ADD=46 UZ=60954.5
  ADD=47 UZ=226368
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=555302. CE=0.99999 K=555302. OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=418809. CE=0.99999 K=418809. OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
```

```
        DOF=U1 KE=817512. CE=0.99999 K=817512. OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=679104. CE=0.99999 K=679104. OPEN=0
  NAME=5 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=182864. CE=0.99999 K=182864. OPEN=0
  NAME=6 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=220133. CE=0.99999 K=220133. OPEN=0
  NAME=7 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=149527. CE=0.99999 K=149527. OPEN=0
  NAME=8 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=112773. CE=0.99999 K=112773. OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
    14 J=15,62 NLP=3 ANG=0
    15 J=17,63 NLP=4 ANG=0
    16 J=18,64 NLP=5 ANG=0
    17 J=19,65 NLP=5 ANG=0
    18 J=20,66 NLP=5 ANG=0
    19 J=22,67 NLP=5 ANG=0
    20 J=24,68 NLP=6 ANG=0
    21 J=24,69 NLP=7 ANG=0
    22 J=26,70 NLP=8 ANG=0
    23 J=28,71 NLP=8 ANG=0
    24 J=29,72 NLP=8 ANG=0
    25 J=30,73 NLP=8 ANG=0
    26 J=31,74 NLP=8 ANG=0
    27 J=32,75 NLP=8 ANG=0
    28 J=33,76 NLP=8 ANG=0
    29 J=34,77 NLP=8 ANG=0
    30 J=35,78 NLP=8 ANG=0
    31 J=36,79 NLP=8 ANG=0
    32 J=38,80 NLP=8 ANG=0
    33 J=40,81 NLP=7 ANG=0
    34 J=40,82 NLP=6 ANG=0
    35 J=42,83 NLP=5 ANG=0
    36 J=44,84 NLP=5 ANG=0
    37 J=45,85 NLP=5 ANG=0
    38 J=46,86 NLP=5 ANG=0
    39 J=47,87 NLP=4 ANG=0
    40 J= 1,88 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-299.409, -299.409
      ADD=25 RD=0,1 UZ=-299.409, -299.409
      ADD=26 RD=0,1 UZ=-299.409, -299.409
      ADD=27 RD=0,1 UZ=-299.409, -299.409
      ADD=28 RD=0,1 UZ=-299.409, -299.409
      ADD=29 RD=0,1 UZ=-299.409, -299.409
      ADD=30 RD=0,1 UZ=-299.409, -299.409
      ADD=31 RD=0,1 UZ=-299.409, -299.409
      ADD=32 RD=0,1 UZ=-299.409, -299.409
      ADD=33 RD=0,1 UZ=-299.409, -299.409
      ADD=34 RD=0,1 UZ=-299.409, -299.409
      ADD=35 RD=0,1 UZ=-299.409, -299.409
      ADD=36 RD=0,1 UZ=-299.409, -299.409
      ADD=37 RD=0,1 UZ=-299.409, -299.409
      ADD=38 RD=0,1 UZ=-299.409, -299.409
      ADD=39 RD=0,1 UZ=-299.409, -299.409
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-168.04, -168.04
      ADD=25 RD=0,1 UZ=-168.04, -168.04
      ADD=26 RD=0,1 UZ=-168.04, -168.04
      ADD=27 RD=0,1 UZ=-168.04, -168.04
      ADD=28 RD=0,1 UZ=-168.04, -168.04
      ADD=29 RD=0,1 UZ=-168.04, -168.04
      ADD=30 RD=0,1 UZ=-168.04, -168.04
      ADD=31 RD=0,1 UZ=-168.04, -168.04
      ADD=32 RD=0,1 UZ=-168.04, -168.04
      ADD=33 RD=0,1 UZ=-168.04, -168.04
      ADD=34 RD=0,1 UZ=-168.04, -168.04
      ADD=35 RD=0,1 UZ=-168.04, -168.04
      ADD=36 RD=0,1 UZ=-168.04, -168.04
      ADD=37 RD=0,1 UZ=-168.04, -168.04
      ADD=38 RD=0,1 UZ=-168.04, -168.04
      ADD=39 RD=0,1 UZ=-168.04, -168.04
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
```

```
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=COLSLAB  ; 슬래브 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=27.212, 27.212
      ADD=25 RD=0,1 UX=27.212, 27.212
      ADD=26 RD=0,1 UX=27.212, 27.212
      ADD=27 RD=0,1 UX=27.212, 27.212
      ADD=28 RD=0,1 UX=27.212, 27.212
      ADD=29 RD=0,1 UX=27.212, 27.212
      ADD=30 RD=0,1 UX=27.212, 27.212
      ADD=31 RD=0,1 UX=27.212, 27.212
      ADD=32 RD=0,1 UX=27.212, 27.212
      ADD=33 RD=0,1 UX=27.212, 27.212
      ADD=34 RD=0,1 UX=27.212, 27.212
      ADD=35 RD=0,1 UX=27.212, 27.212
      ADD=36 RD=0,1 UX=27.212, 27.212
      ADD=37 RD=0,1 UX=27.212, 27.212
      ADD=38 RD=0,1 UX=27.212, 27.212
      ADD=39 RD=0,1 UX=27.212, 27.212
NAME=COLWALL  ; 벽체 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=119.853, 106.018
      ADD=41 RD=0,1 UX=106.018, 100.226
      ADD=42 RD=0,1 UX=100.226, 97.33
      ADD=43 RD=0,1 UX=97.33, 80.438
      ADD=44 RD=0,1 UX=80.438, 60.49
      ADD=45 RD=0,1 UX=60.49, 40.541
      ADD=46 RD=0,1 UX=40.541, 75.279
      ADD=47 RD=0,1 UX=75.279, 53.173
      ADD=48 RD=0,1 UX=53.173, 0
      ADD=15 RD=0,1 UX=0, 53.173
      ADD=16 RD=0,1 UX=53.173, 75.279
      ADD=17 RD=0,1 UX=75.279, 40.541
      ADD=18 RD=0,1 UX=40.541, 60.49
      ADD=19 RD=0,1 UX=60.49, 80.438
      ADD=20 RD=0,1 UX=80.438, 97.33
      ADD=21 RD=0,1 UX=97.33, 100.226
      ADD=22 RD=0,1 UX=100.226, 106.018
      ADD=23 RD=0,1 UX=106.018, 119.853
NAME=COLMS  ; 주면전단력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=21.51, 21.51
      ADD=25 RD=0,1 UX=21.51, 21.51
      ADD=26 RD=0,1 UX=21.51, 21.51
      ADD=27 RD=0,1 UX=21.51, 21.51
      ADD=28 RD=0,1 UX=21.51, 21.51
      ADD=29 RD=0,1 UX=21.51, 21.51
      ADD=30 RD=0,1 UX=21.51, 21.51
      ADD=31 RD=0,1 UX=21.51, 21.51
      ADD=32 RD=0,1 UX=21.51, 21.51
      ADD=33 RD=0,1 UX=21.51, 21.51
      ADD=34 RD=0,1 UX=21.51, 21.51
      ADD=35 RD=0,1 UX=21.51, 21.51
      ADD=36 RD=0,1 UX=21.51, 21.51
      ADD=37 RD=0,1 UX=21.51, 21.51
      ADD=38 RD=0,1 UX=21.51, 21.51
      ADD=39 RD=0,1 UX=21.51, 21.51
      ADD=40 RD=0,1 UZ=-12.41, -12.41
      ADD=41 RD=0,1 UZ=-12.41, -12.41
      ADD=42 RD=0,1 UZ=-12.41, -12.41
      ADD=43 RD=0,1 UZ=-12.41, -12.41
      ADD=44 RD=0,1 UZ=-12.41, -12.41
      ADD=45 RD=0,1 UZ=-12.41, -12.41
      ADD=46 RD=0,1 UZ=-12.41, -12.41
      ADD=47 RD=0,1 UZ=-12.41, -12.41
      ADD=48 RD=0,1 UZ=-12.41, -12.41
      ADD=15 RD=0,1 UZ=12.41, 12.41
      ADD=16 RD=0,1 UZ=12.41, 12.41
      ADD=17 RD=0,1 UZ=12.41, 12.41
      ADD=18 RD=0,1 UZ=12.41, 12.41
      ADD=19 RD=0,1 UZ=12.41, 12.41
      ADD=20 RD=0,1 UZ=12.41, 12.41
      ADD=21 RD=0,1 UZ=12.41, 12.41
      ADD=22 RD=0,1 UZ=12.41, 12.41
      ADD=23 RD=0,1 UZ=12.41, 12.41
      ADD=1 RD=0,1 UX=-3.32, -3.32
      ADD=2 RD=0,1 UX=-3.32, -3.32
      ADD=3 RD=0,1 UX=-3.32, -3.32
      ADD=4 RD=0,1 UX=-3.32, -3.32
      ADD=5 RD=0,1 UX=-3.32, -3.32
      ADD=6 RD=0,1 UX=-3.32, -3.32
      ADD=7 RD=0,1 UX=-3.32, -3.32
      ADD=8 RD=0,1 UX=-3.32, -3.32
      ADD=9 RD=0,1 UX=-3.32, -3.32
      ADD=10 RD=0,1 UX=-3.32, -3.32
      ADD=11 RD=0,1 UX=-3.32, -3.32
      ADD=12 RD=0,1 UX=-3.32, -3.32
      ADD=13 RD=0,1 UX=-3.32, -3.32
      ADD=14 RD=0,1 UX=-3.32, -3.32
NAME=COLINER  ; 구체 관성력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=5.484, 5.484
      ADD=25 RD=0,1 UX=5.484, 5.484
      ADD=26 RD=0,1 UX=5.484, 5.484
      ADD=27 RD=0,1 UX=5.484, 5.484
      ADD=28 RD=0,1 UX=5.484, 5.484
      ADD=29 RD=0,1 UX=5.484, 5.484
      ADD=30 RD=0,1 UX=5.484, 5.484
      ADD=31 RD=0,1 UX=5.484, 5.484
      ADD=32 RD=0,1 UX=5.484, 5.484
      ADD=33 RD=0,1 UX=5.484, 5.484
      ADD=34 RD=0,1 UX=5.484, 5.484
      ADD=35 RD=0,1 UX=5.484, 5.484
      ADD=36 RD=0,1 UX=5.484, 5.484
      ADD=37 RD=0,1 UX=5.484, 5.484
      ADD=38 RD=0,1 UX=5.484, 5.484
      ADD=39 RD=0,1 UX=5.484, 5.484
      ADD=40 RD=0,1 UX=5.827, 5.734
      ADD=41 RD=0,1 UX=5.734, 5.695
      ADD=42 RD=0,1 UX=5.695, 5.676
      ADD=43 RD=0,1 UX=5.676, 5.563
      ADD=44 RD=0,1 UX=5.563, 5.431
      ADD=45 RD=0,1 UX=5.431, 5.299
      ADD=46 RD=0,1 UX=5.299, 5.167
      ADD=47 RD=0,1 UX=5.167, 5.128
      ADD=48 RD=0,1 UX=5.128, 5.035
      ADD=15 RD=0,1 UX=5.035, 5.128
      ADD=16 RD=0,1 UX=5.128, 5.167
      ADD=17 RD=0,1 UX=5.167, 5.299
      ADD=18 RD=0,1 UX=5.299, 5.431
      ADD=19 RD=0,1 UX=5.431, 5.563
      ADD=20 RD=0,1 UX=5.563, 5.676
      ADD=21 RD=0,1 UX=5.676, 5.695
      ADD=22 RD=0,1 UX=5.695, 5.734
      ADD=23 RD=0,1 UX=5.734, 5.827
      ADD=1 RD=0,1 UX=4.739, 4.739
      ADD=2 RD=0,1 UX=4.739, 4.739
```

```
      ADD=3 RD=0,1 UX=4.739, 4.739
      ADD=4 RD=0,1 UX=4.739, 4.739
      ADD=5 RD=0,1 UX=4.739, 4.739
      ADD=6 RD=0,1 UX=4.739, 4.739
      ADD=7 RD=0,1 UX=4.739, 4.739
      ADD=8 RD=0,1 UX=4.739, 4.739
      ADD=9 RD=0,1 UX=4.739, 4.739
      ADD=10 RD=0,1 UX=4.739, 4.739
      ADD=11 RD=0,1 UX=4.739, 4.739
      ADD=12 RD=0,1 UX=4.739, 4.739
      ADD=13 RD=0,1 UX=4.739, 4.739
      ADD=14 RD=0,1 UX=4.739, 4.739
NAME=COLSLAB2  ; 슬래브 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-27.212, -27.212
      ADD=25 RD=0,1 UX=-27.212, -27.212
      ADD=26 RD=0,1 UX=-27.212, -27.212
      ADD=27 RD=0,1 UX=-27.212, -27.212
      ADD=28 RD=0,1 UX=-27.212, -27.212
      ADD=29 RD=0,1 UX=-27.212, -27.212
      ADD=30 RD=0,1 UX=-27.212, -27.212
      ADD=31 RD=0,1 UX=-27.212, -27.212
      ADD=32 RD=0,1 UX=-27.212, -27.212
      ADD=33 RD=0,1 UX=-27.212, -27.212
      ADD=34 RD=0,1 UX=-27.212, -27.212
      ADD=35 RD=0,1 UX=-27.212, -27.212
      ADD=36 RD=0,1 UX=-27.212, -27.212
      ADD=37 RD=0,1 UX=-27.212, -27.212
      ADD=38 RD=0,1 UX=-27.212, -27.212
      ADD=39 RD=0,1 UX=-27.212, -27.212
NAME=COLWALL2  ; 벽체 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=-119.853, -106.018
      ADD=41 RD=0,1 UX=-106.018, -100.226
      ADD=42 RD=0,1 UX=-100.226, -97.33
      ADD=43 RD=0,1 UX=-97.33, -80.438
      ADD=44 RD=0,1 UX=-80.438, -60.49
      ADD=45 RD=0,1 UX=-60.49, -40.541
      ADD=46 RD=0,1 UX=-40.541, -75.279
      ADD=47 RD=0,1 UX=-75.279, -53.173
      ADD=48 RD=0,1 UX=-53.173, -0
      ADD=15 RD=0,1 UX=-0, -53.173
      ADD=16 RD=0,1 UX=-53.173, -75.279
      ADD=17 RD=0,1 UX=-75.279, -40.541
      ADD=18 RD=0,1 UX=-40.541, -60.49
      ADD=19 RD=0,1 UX=-60.49, -80.438
      ADD=20 RD=0,1 UX=-80.438, -97.33
      ADD=21 RD=0,1 UX=-97.33, -100.226
      ADD=22 RD=0,1 UX=-100.226, -106.018
      ADD=23 RD=0,1 UX=-106.018, -119.853
NAME=COLMS2  ; 주면전단력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-21.51, -21.51
      ADD=25 RD=0,1 UX=-21.51, -21.51
      ADD=26 RD=0,1 UX=-21.51, -21.51
      ADD=27 RD=0,1 UX=-21.51, -21.51
      ADD=28 RD=0,1 UX=-21.51, -21.51
      ADD=29 RD=0,1 UX=-21.51, -21.51
      ADD=30 RD=0,1 UX=-21.51, -21.51
      ADD=31 RD=0,1 UX=-21.51, -21.51
      ADD=32 RD=0,1 UX=-21.51, -21.51
      ADD=33 RD=0,1 UX=-21.51, -21.51
      ADD=34 RD=0,1 UX=-21.51, -21.51
      ADD=35 RD=0,1 UX=-21.51, -21.51
      ADD=36 RD=0,1 UX=-21.51, -21.51
      ADD=37 RD=0,1 UX=-21.51, -21.51
      ADD=38 RD=0,1 UX=-21.51, -21.51
      ADD=39 RD=0,1 UX=-21.51, -21.51
      ADD=40 RD=0,1 UZ=12.41, 12.41
      ADD=41 RD=0,1 UZ=12.41, 12.41
      ADD=42 RD=0,1 UZ=12.41, 12.41
      ADD=43 RD=0,1 UZ=12.41, 12.41
      ADD=44 RD=0,1 UZ=12.41, 12.41
      ADD=45 RD=0,1 UZ=12.41, 12.41
      ADD=46 RD=0,1 UZ=12.41, 12.41
      ADD=47 RD=0,1 UZ=12.41, 12.41
      ADD=48 RD=0,1 UZ=12.41, 12.41
      ADD=15 RD=0,1 UZ=-12.41, -12.41
      ADD=16 RD=0,1 UZ=-12.41, -12.41
      ADD=17 RD=0,1 UZ=-12.41, -12.41
      ADD=18 RD=0,1 UZ=-12.41, -12.41
      ADD=19 RD=0,1 UZ=-12.41, -12.41
      ADD=20 RD=0,1 UZ=-12.41, -12.41
      ADD=21 RD=0,1 UZ=-12.41, -12.41
      ADD=22 RD=0,1 UZ=-12.41, -12.41
      ADD=23 RD=0,1 UZ=-12.41, -12.41
      ADD=1 RD=0,1 UX=3.32, 3.32
      ADD=2 RD=0,1 UX=3.32, 3.32
      ADD=3 RD=0,1 UX=3.32, 3.32
      ADD=4 RD=0,1 UX=3.32, 3.32
      ADD=5 RD=0,1 UX=3.32, 3.32
      ADD=6 RD=0,1 UX=3.32, 3.32
      ADD=7 RD=0,1 UX=3.32, 3.32
      ADD=8 RD=0,1 UX=3.32, 3.32
      ADD=9 RD=0,1 UX=3.32, 3.32
      ADD=10 RD=0,1 UX=3.32, 3.32
      ADD=11 RD=0,1 UX=3.32, 3.32
      ADD=12 RD=0,1 UX=3.32, 3.32
      ADD=13 RD=0,1 UX=3.32, 3.32
      ADD=14 RD=0,1 UX=3.32, 3.32
NAME=COLINER2  ; 구체 관성력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-5.484, -5.484
      ADD=25 RD=0,1 UX=-5.484, -5.484
      ADD=26 RD=0,1 UX=-5.484, -5.484
      ADD=27 RD=0,1 UX=-5.484, -5.484
      ADD=28 RD=0,1 UX=-5.484, -5.484
      ADD=29 RD=0,1 UX=-5.484, -5.484
      ADD=30 RD=0,1 UX=-5.484, -5.484
      ADD=31 RD=0,1 UX=-5.484, -5.484
      ADD=32 RD=0,1 UX=-5.484, -5.484
      ADD=33 RD=0,1 UX=-5.484, -5.484
      ADD=34 RD=0,1 UX=-5.484, -5.484
      ADD=35 RD=0,1 UX=-5.484, -5.484
      ADD=36 RD=0,1 UX=-5.484, -5.484
      ADD=37 RD=0,1 UX=-5.484, -5.484
      ADD=38 RD=0,1 UX=-5.484, -5.484
      ADD=39 RD=0,1 UX=-5.484, -5.484
      ADD=40 RD=0,1 UX=-5.827, -5.734
      ADD=41 RD=0,1 UX=-5.734, -5.695
      ADD=42 RD=0,1 UX=-5.695, -5.676
      ADD=43 RD=0,1 UX=-5.676, -5.563
      ADD=44 RD=0,1 UX=-5.563, -5.431
      ADD=45 RD=0,1 UX=-5.431, -5.299
      ADD=46 RD=0,1 UX=-5.299, -5.167
      ADD=47 RD=0,1 UX=-5.167, -5.128
      ADD=48 RD=0,1 UX=-5.128, -5.035
      ADD=15 RD=0,1 UX=-5.035, -5.128
      ADD=16 RD=0,1 UX=-5.128, -5.167
      ADD=17 RD=0,1 UX=-5.167, -5.299
      ADD=18 RD=0,1 UX=-5.299, -5.431
      ADD=19 RD=0,1 UX=-5.431, -5.563
      ADD=20 RD=0,1 UX=-5.563, -5.676
      ADD=21 RD=0,1 UX=-5.676, -5.695
      ADD=22 RD=0,1 UX=-5.695, -5.734
      ADD=23 RD=0,1 UX=-5.734, -5.827
      ADD=1 RD=0,1 UX=-4.739, -4.739
      ADD=2 RD=0,1 UX=-4.739, -4.739
      ADD=3 RD=0,1 UX=-4.739, -4.739
      ADD=4 RD=0,1 UX=-4.739, -4.739
      ADD=5 RD=0,1 UX=-4.739, -4.739
      ADD=6 RD=0,1 UX=-4.739, -4.739
      ADD=7 RD=0,1 UX=-4.739, -4.739
      ADD=8 RD=0,1 UX=-4.739, -4.739
      ADD=9 RD=0,1 UX=-4.739, -4.739
      ADD=10 RD=0,1 UX=-4.739, -4.739
      ADD=11 RD=0,1 UX=-4.739, -4.739
      ADD=12 RD=0,1 UX=-4.739, -4.739
      ADD=13 RD=0,1 UX=-4.739, -4.739
      ADD=14 RD=0,1 UX=-4.739, -4.739
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=COLSLAB
      LOAD=COLWALL
      LOAD=COLMS
      LOAD=COLINER
      LOAD=COLSLAB2
      LOAD=COLWALL2
      LOAD=COLMS2
      LOAD=COLINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
```

```
NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=0.500   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=0.500   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=0.500   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=0.500   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=0.500   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVE            SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=0.500   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=0.900   AT=1
   LOAD= PAVE            SF=0.900   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVEFUE         SF=1.000   AT=1
   LOAD= LIVEFUHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVELEE         SF=1.000   AT=1
   LOAD= LIVELEHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
   LOAD= COLINER2        SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= COLSLAB         SF=1.000   AT=1
   LOAD= COLWALL         SF=1.000   AT=1
   LOAD= COLMS           SF=1.000   AT=1
   LOAD= COLINER         SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.200   AT=1
   LOAD= PAVEW           SF=1.200   AT=1
   LOAD= LIVERIE         SF=1.000   AT=1
   LOAD= LIVERIHE        SF=1.000   AT=1
   LOAD= COLSLAB2        SF=1.000   AT=1
   LOAD= COLWALL2        SF=1.000   AT=1
   LOAD= COLMS2          SF=1.000   AT=1
```

```
      LOAD= COLINER2       SF=1.000   AT=1                                  HIST=UE06 SF=1
   NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE07 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE08 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE09 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                  HIST=UE10 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                  HIST=UE11 SF=1
      LOAD= COLSLAB        SF=1.000   AT=1                                  HIST=UE12 SF=1
      LOAD= COLWALL        SF=1.000   AT=1                                  HIST=UE13 SF=1
      LOAD= COLMS          SF=1.000   AT=1                                  HIST=UE14 SF=1
      LOAD= COLINER        SF=1.000   AT=1                                  HIST=UE15 SF=1
   NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE16 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE17 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE18 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                  HIST=UE19 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                  HIST=UE20 SF=1
      LOAD= COLSLAB2       SF=1.000   AT=1                                  HIST=UE21 SF=1
      LOAD= COLWALL2       SF=1.000   AT=1                                  HIST=UE22 SF=1
      LOAD= COLMS2         SF=1.000   AT=1                                  HIST=UE23 SF=1
      LOAD= COLINER2       SF=1.000   AT=1                                  HIST=UE24 SF=1
   NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1       HIST=UE25 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE26 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE27 SF=1
      LOAD= LIVELEE        SF=1.000   AT=1                                  HIST=UE28 SF=1
      LOAD= LIVELEHE       SF=0.500   AT=1                                  HIST=UE29 SF=1
      LOAD= COLSLAB        SF=1.000   AT=1                                  HIST=UE30 SF=1
      LOAD= COLWALL        SF=1.000   AT=1                                  HIST=UE31 SF=1
      LOAD= COLMS          SF=1.000   AT=1                                  HIST=UE32 SF=1
      LOAD= COLINER        SF=1.000   AT=1                            OUTPUT
   NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= SW             SF=1.200   AT=1                                 ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVELEE        SF=1.000   AT=1
      LOAD= LIVELEHE       SF=0.500   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
```

18. OUTPUT DATA (상시)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVULT MAX	0.52941	0.00000	0.00000	0.00000
1	ENVULT MAX	0.64706	0.00000	0.00000	0.00000
1	ENVULT MAX	0.76471	0.00000	0.00000	0.00000
1	ENVULT MAX	0.88235	0.00000	0.00000	0.00000
1	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
1	ENVULT MIN	0.52941	-1114.71200	-2890.32500	-4129.70700
1	ENVULT MIN	0.64706	-1114.71200	-2895.12500	-3842.73600
1	ENVULT MIN	0.76471	-1114.71200	-2899.92500	-3555.28600
1	ENVULT MIN	0.88235	-1114.71200	-2904.72500	-3267.35600
1	ENVULT MIN	1.00000	-1114.71200	-2909.52500	-2978.94500
2	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
2	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
2	ENVULT MIN	0.00000	-1114.71200	-2909.52500	-2978.94500
2	ENVULT MIN	0.25000	-1114.71200	-2911.67300	-2849.72600
2	ENVULT MIN	0.50000	-1114.71200	-2913.82100	-2720.41100
2	ENVULT MIN	0.75000	-1114.71200	-2915.96900	-2591.00000
2	ENVULT MIN	1.00000	-1114.71200	-2918.11700	-2461.49200
3	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
3	ENVULT MAX	1.00000	0.00000	0.00000	505.50757
3	ENVULT MIN	0.00000	-1114.71200	-2299.71700	-2461.49200
3	ENVULT MIN	0.25000	-1114.71200	-2312.06500	-1872.96900
3	ENVULT MIN	0.50000	-1114.71200	-2324.41300	-1281.26900
3	ENVULT MIN	0.75000	-1114.71200	-2336.76100	-686.39332
3	ENVULT MIN	1.00000	-1114.71200	-2349.10900	-205.80904
4	ENVULT MAX	0.00000	0.00000	0.00000	505.50757
4	ENVULT MAX	0.25000	0.00000	0.00000	924.96782
4	ENVULT MAX	0.50000	0.00000	0.00000	1359.55300
4	ENVULT MAX	0.75000	0.00000	0.00000	1813.88200
4	ENVULT MAX	1.00000	0.00000	0.00000	2271.38800
4	ENVULT MIN	0.00000	-1114.71200	-1752.42500	-205.80903
4	ENVULT MIN	0.25000	-1114.71200	-1764.77300	0.00000
4	ENVULT MIN	0.50000	-1114.71200	-1777.12100	0.00000
4	ENVULT MIN	0.75000	-1114.71200	-1789.46900	0.00000
4	ENVULT MIN	1.00000	-1114.71200	-1801.81700	0.00000
5	ENVULT MAX	0.00000	0.00000	0.00000	2271.38800
5	ENVULT MAX	0.25000	0.00000	0.00000	2585.08700
5	ENVULT MAX	0.50000	0.00000	0.00000	2901.96800
5	ENVULT MAX	0.75000	0.00000	0.00000	3222.03200
5	ENVULT MAX	1.00000	0.00000	0.00000	3545.27900
5	ENVULT MIN	0.00000	-1114.71200	-1226.52700	0.00000
5	ENVULT MIN	0.25000	-1114.71200	-1238.88700	0.00000
5	ENVULT MIN	0.50000	-1114.71200	-1251.24700	0.00000
5	ENVULT MIN	0.75000	-1114.71200	-1263.60700	0.00000
5	ENVULT MIN	1.00000	-1114.71200	-1275.96700	0.00000
6	ENVULT MAX	0.00000	0.00000	0.00000	3545.27900
6	ENVULT MAX	0.25000	0.00000	0.00000	3729.21200
6	ENVULT MAX	0.50000	0.00000	0.00000	3916.32100
6	ENVULT MAX	0.75000	0.00000	0.00000	4106.60700
6	ENVULT MAX	1.00000	0.00000	0.00000	4300.07000
6	ENVULT MIN	0.00000	-1114.71200	-718.36224	0.00000
6	ENVULT MIN	0.25000	-1114.71200	-730.71024	0.00000
6	ENVULT MIN	0.50000	-1114.71200	-743.05824	0.00000
6	ENVULT MIN	0.75000	-1114.71200	-755.40624	0.00000
6	ENVULT MIN	1.00000	-1114.71200	-767.75424	0.00000
7	ENVULT MAX	0.00000	0.00000	0.00000	4300.07000
7	ENVULT MAX	0.25000	0.00000	0.00000	4357.83400
7	ENVULT MAX	0.50000	0.00000	0.00000	4418.77500
7	ENVULT MAX	0.75000	0.00000	0.00000	4482.89200
7	ENVULT MAX	1.00000	0.00000	0.00000	4550.18600
7	ENVULT MIN	0.00000	-1114.71200	-225.32191	0.00000
7	ENVULT MIN	0.25000	-1114.71200	-237.66991	0.00000
7	ENVULT MIN	0.50000	-1114.71200	-250.01791	0.00000
7	ENVULT MIN	0.75000	-1114.71200	-262.36591	0.00000
7	ENVULT MIN	1.00000	-1114.71200	-274.71391	0.00000
8	ENVULT MAX	0.00000	0.00000	274.59762	4550.18600
8	ENVULT MAX	0.25000	0.00000	262.24962	4482.92200
8	ENVULT MAX	0.50000	0.00000	249.90162	4418.83400
8	ENVULT MAX	0.75000	0.00000	237.55362	4357.92400
8	ENVULT MAX	1.00000	0.00000	225.20562	4300.18900
8	ENVULT MIN	0.00000	-1114.71200	0.00000	0.00000
8	ENVULT MIN	0.25000	-1114.71200	0.00000	0.00000
8	ENVULT MIN	0.50000	-1114.71200	0.00000	0.00000
8	ENVULT MIN	0.75000	-1114.71200	0.00000	0.00000
8	ENVULT MIN	1.00000	-1114.71200	0.00000	0.00000
9	ENVULT MAX	0.00000	0.00000	767.64197	4300.18900
9	ENVULT MAX	0.25000	0.00000	755.29397	4106.75600
9	ENVULT MAX	0.50000	0.00000	742.94597	3916.49800
9	ENVULT MAX	0.75000	0.00000	730.59797	3729.41700
9	ENVULT MAX	1.00000	0.00000	718.24997	3545.51300
9	ENVULT MIN	0.00000	-1114.71200	0.00000	0.00000
9	ENVULT MIN	0.25000	-1114.71200	0.00000	0.00000
9	ENVULT MIN	0.50000	-1114.71200	0.00000	0.00000
9	ENVULT MIN	0.75000	-1114.71200	0.00000	0.00000
9	ENVULT MIN	1.00000	-1114.71200	0.00000	0.00000
10	ENVULT MAX	0.00000	0.00000	1275.86600	3545.51300
10	ENVULT MAX	0.25000	0.00000	1263.51800	3222.60400
10	ENVULT MAX	0.50000	0.00000	1251.17000	2902.87200
10	ENVULT MAX	0.75000	0.00000	1238.82200	2586.31600
10	ENVULT MAX	1.00000	0.00000	1226.47400	2272.93700
10	ENVULT MIN	0.00000	-1114.71200	0.00000	0.00000
10	ENVULT MIN	0.25000	-1114.71200	0.00000	0.00000
10	ENVULT MIN	0.50000	-1114.71200	0.00000	0.00000
10	ENVULT MIN	0.75000	-1114.71200	0.00000	0.00000
10	ENVULT MIN	1.00000	-1114.71200	0.00000	0.00000
11	ENVULT MAX	0.00000	0.00000	1801.76200	2272.93700
11	ENVULT MAX	0.25000	0.00000	1789.40200	1815.00200
11	ENVULT MAX	0.50000	0.00000	1777.04200	1360.25000
11	ENVULT MAX	0.75000	0.00000	1764.68200	925.23276
11	ENVULT MAX	1.00000	0.00000	1752.32200	505.38837
11	ENVULT MIN	0.00000	-1114.71200	0.00000	0.00000
11	ENVULT MIN	0.25000	-1114.71200	0.00000	0.00000
11	ENVULT MIN	0.50000	-1114.71200	0.00000	0.00000
11	ENVULT MIN	0.75000	-1114.71200	0.00000	0.00000
11	ENVULT MIN	1.00000	-1114.71200	0.00000	-205.89544
12	ENVULT MAX	0.00000	0.00000	2349.03100	505.38837
12	ENVULT MAX	0.25000	0.00000	2336.68300	0.00000
12	ENVULT MAX	0.50000	0.00000	2324.33500	0.00000
12	ENVULT MAX	0.75000	0.00000	2311.98700	0.00000
12	ENVULT MAX	1.00000	0.00000	2299.63900	0.00000
12	ENVULT MIN	0.00000	-1114.71200	0.00000	-205.89545
12	ENVULT MIN	0.25000	-1114.71200	0.00000	-686.50110
12	ENVULT MIN	0.50000	-1114.71200	0.00000	-1281.35700
12	ENVULT MIN	0.75000	-1114.71200	0.00000	-1873.03700
12	ENVULT MIN	1.00000	-1114.71200	0.00000	-2461.54000
13	ENVULT MAX	0.00000	0.00000	2918.06900	0.00000
13	ENVULT MAX	0.25000	0.00000	2915.92100	0.00000
13	ENVULT MAX	0.50000	0.00000	2913.77300	0.00000
13	ENVULT MAX	0.75000	0.00000	2911.62500	0.00000
13	ENVULT MAX	1.00000	0.00000	2909.47700	0.00000
13	ENVULT MIN	0.00000	-1114.71200	0.00000	-2461.54000
13	ENVULT MIN	0.25000	-1114.71200	0.00000	-2591.04500
13	ENVULT MIN	0.50000	-1114.71200	0.00000	-2720.45400
13	ENVULT MIN	0.75000	-1114.71200	0.00000	-2849.76700
13	ENVULT MIN	1.00000	-1114.71200	0.00000	-2978.98400
14	ENVULT MAX	0.00000	0.00000	2909.47700	0.00000
14	ENVULT MAX	0.11765	0.00000	2904.67700	0.00000
14	ENVULT MAX	0.23529	0.00000	2899.87700	0.00000
14	ENVULT MAX	0.35294	0.00000	2895.07700	0.00000
14	ENVULT MAX	0.47059	0.00000	2890.27700	0.00000
14	ENVULT MIN	0.00000	-1114.71200	0.00000	-2978.98400
14	ENVULT MIN	0.11765	-1114.71200	0.00000	-3267.39000
14	ENVULT MIN	0.23529	-1114.71200	0.00000	-3555.31600
14	ENVULT MIN	0.35294	-1114.71200	0.00000	-3842.76100
14	ENVULT MIN	0.47059	-1114.71200	0.00000	-4129.72700
15	ENVULT MAX	0.46875	0.00000	0.00000	0.00000
15	ENVULT MAX	0.60156	0.00000	0.00000	0.00000
15	ENVULT MAX	0.73438	0.00000	0.00000	0.00000
15	ENVULT MAX	0.86719	0.00000	0.00000	0.00000
15	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
15	ENVULT MIN	0.46875	-3692.12100	-979.56163	-5030.89800
15	ENVULT MIN	0.60156	-3686.70200	-941.65761	-4963.02000
15	ENVULT MIN	0.73438	-3681.28300	-903.92518	-4916.21100
15	ENVULT MIN	0.86719	-3675.86400	-866.36435	-4871.40200
15	ENVULT MIN	1.00000	-3670.44600	-828.97512	-4828.58400
16	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
16	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
16	ENVULT MIN	0.00000	-3670.44600	-828.97512	-4828.58400
16	ENVULT MIN	0.25000	-3666.14900	-799.44959	-4796.04100
16	ENVULT MIN	0.50000	-3661.85200	-770.03186	-4764.73900
16	ENVULT MIN	0.75000	-3657.55500	-740.72194	-4734.67400
16	ENVULT MIN	1.00000	-3653.25900	-711.51983	-4705.84200
17	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.75000	0.00000	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
17	ENVULT MIN	0.00000	-3653.25900	-711.51983	-4705.84200
17	ENVULT MIN	0.25000	-3638.77500	-613.87683	-4617.67000
17	ENVULT MIN	0.50000	-3624.29100	-517.46036	-4543.27700
17	ENVULT MIN	0.75000	-3609.80700	-422.27043	-4482.48700
17	ENVULT MIN	1.00000	-3595.32300	-328.30705	-4435.12800
18	ENVULT MAX	0.00000	0.00000	0.27751	0.00000
18	ENVULT MAX	0.25000	0.00000	45.54969	0.00000
18	ENVULT MAX	0.50000	0.00000	90.20795	0.00000
18	ENVULT MAX	0.75000	0.00000	134.25229	0.00000
18	ENVULT MAX	1.00000	0.00000	192.12345	0.00000
18	ENVULT MIN	0.00000	-3595.32300	-328.30705	-4435.12800
18	ENVULT MIN	0.25000	-3580.82600	-235.48868	-4400.99900
18	ENVULT MIN	0.50000	-3566.32900	-164.69143	-4379.97600
18	ENVULT MIN	0.75000	-3551.83200	-113.79289	-4371.88200
18	ENVULT MIN	1.00000	-3537.33600	-64.01614	-4381.11500
19	ENVULT MAX	0.00000	0.00000	191.63402	0.00000
19	ENVULT MAX	0.25000	0.00000	277.26701	0.00000
19	ENVULT MAX	0.50000	0.00000	361.67215	0.00000
19	ENVULT MAX	0.75000	0.00000	444.84944	0.00000
19	ENVULT MAX	1.00000	0.00000	526.79888	0.00000
19	ENVULT MIN	0.00000	-3537.33600	-64.01614	-4381.11500
19	ENVULT MIN	0.25000	-3522.83900	-39.21303	-4425.55400
19	ENVULT MIN	0.50000	-3508.34200	-14.73299	-4482.40100
19	ENVULT MIN	0.75000	-3493.84500	0.00000	-4551.47900
19	ENVULT MIN	1.00000	-3479.34900	0.00000	-4632.61500
20	ENVULT MAX	0.00000	0.00000	526.53199	0.00000
20	ENVULT MAX	0.25000	0.00000	595.68592	0.00000
20	ENVULT MAX	0.50000	0.00000	663.94022	0.00000
20	ENVULT MAX	0.75000	0.00000	731.29488	0.00000
20	ENVULT MAX	1.00000	0.00000	797.74990	0.00000
20	ENVULT MIN	0.00000	-3479.34900	0.00000	-4632.61500
20	ENVULT MIN	0.25000	-3466.94300	0.00000	-4711.49000
20	ENVULT MIN	0.50000	-3454.53700	0.00000	-4798.95800
20	ENVULT MIN	0.75000	-3442.13100	0.00000	-4894.90900
20	ENVULT MIN	1.00000	-3429.72600	0.00000	-4999.23400
21	ENVULT MAX	0.00000	0.00000	797.64101	0.00000
21	ENVULT MAX	0.25000	0.00000	808.68577	0.00000
21	ENVULT MAX	0.50000	0.00000	819.70525	0.00000
21	ENVULT MAX	0.75000	0.00000	830.69944	0.00000
21	ENVULT MAX	1.00000	0.00000	841.66836	0.00000
21	ENVULT MIN	0.00000	-3429.72600	0.00000	-4999.23400
21	ENVULT MIN	0.25000	-3427.62300	0.00000	-5017.52200
21	ENVULT MIN	0.50000	-3425.46900	0.00000	-5036.04200
21	ENVULT MIN	0.75000	-3423.26600	0.00000	-5054.79200
21	ENVULT MIN	1.00000	-3421.01300	0.00000	-5073.77300
22	ENVULT MAX	0.00000	0.00000	841.61428	0.00000
22	ENVULT MAX	0.25000	0.00000	864.21230	0.00000
22	ENVULT MAX	0.50000	0.00000	886.70252	0.00000
22	ENVULT MAX	0.75000	0.00000	909.08493	0.00000
22	ENVULT MAX	1.00000	0.00000	931.35953	0.00000
22	ENVULT MIN	0.00000	-3421.01300	0.00000	-5073.77300
22	ENVULT MIN	0.25000	-3416.19700	0.00000	-5113.74400
22	ENVULT MIN	0.50000	-3411.16900	0.00000	-5154.69300
22	ENVULT MIN	0.75000	-3405.92700	0.00000	-5196.61500
22	ENVULT MIN	1.00000	-3400.47300	0.00000	-5239.50700
23	ENVULT MAX	0.00000	0.00000	931.19486	0.00000
23	ENVULT MAX	0.10937	0.00000	954.21455	0.00000
23	ENVULT MAX	0.21875	0.00000	977.11787	0.00000
23	ENVULT MAX	0.32812	0.00000	999.90481	0.00000
23	ENVULT MAX	0.43750	0.00000	1022.57500	0.00000
23	ENVULT MIN	0.00000	-3400.47300	0.00000	-5239.50700
23	ENVULT MIN	0.10937	-3394.69800	0.00000	-5285.07400
23	ENVULT MIN	0.21875	-3388.92300	0.00000	-5331.67600
23	ENVULT MIN	0.32812	-3383.14800	0.00000	-5379.30800
23	ENVULT MIN	0.43750	-3377.37300	0.00000	-5427.96500
24	ENVULT MAX	0.64706	0.00000	0.00000	0.00000
24	ENVULT MAX	0.73529	0.00000	0.00000	0.00000
24	ENVULT MAX	0.82353	0.00000	0.00000	0.00000
24	ENVULT MAX	0.91176	0.00000	0.00000	0.00000
24	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
24	ENVULT MIN	0.64706	-1136.65300	-3042.71900	-4147.94600
24	ENVULT MIN	0.73529	-1136.65300	-3001.13500	-3921.30100
24	ENVULT MIN	0.82353	-1136.65300	-2959.55000	-3697.77600
24	ENVULT MIN	0.91176	-1136.65300	-2917.96600	-3477.36900
24	ENVULT MIN	1.00000	-1136.65300	-2876.38100	-3260.08100
25	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
25	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
25	ENVULT MIN	0.00000	-1136.33200	-2876.38100	-3260.08100
25	ENVULT MIN	0.25000	-1136.33200	-2851.59900	-3131.91800
25	ENVULT MIN	0.50000	-1136.33200	-2826.87700	-3004.86200
25	ENVULT MIN	0.75000	-1136.33200	-2802.21500	-2879.56200
25	ENVULT MIN	1.00000	-1136.33200	-2777.61300	-2757.10000
26	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
26	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
26	ENVULT MIN	0.00000	-1136.19900	-2777.61300	-2757.10000
26	ENVULT MIN	0.25000	-1136.19900	-2733.64600	-2540.16300
26	ENVULT MIN	0.50000	-1136.19900	-2689.87100	-2326.64200
26	ENVULT MIN	0.75000	-1136.19900	-2646.29000	-2116.52400
26	ENVULT MIN	1.00000	-1136.19900	-2602.90200	-1909.79300
27	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
27	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
27	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
27	ENVULT MAX	0.75000	0.00000	0.00000	213.11517
27	ENVULT MAX	1.00000	0.00000	0.00000	452.83542
27	ENVULT MIN	0.00000	-1135.97800	-2602.90200	-1909.79300
27	ENVULT MIN	0.25000	-1135.97800	-2507.41700	-1472.17500
27	ENVULT MIN	0.50000	-1135.97800	-2411.93200	-1056.51000
27	ENVULT MIN	0.75000	-1135.97800	-2316.44700	-657.82792
27	ENVULT MIN	1.00000	-1135.97800	-2220.96300	-285.56791
28	ENVULT MAX	0.00000	0.00000	0.00000	452.83542
28	ENVULT MAX	0.25000	0.00000	0.00000	946.51771
28	ENVULT MAX	0.50000	0.00000	0.00000	1458.08700
28	ENVULT MAX	0.75000	0.00000	0.00000	1933.88600
28	ENVULT MAX	1.00000	0.00000	0.00000	2373.91500
28	ENVULT MIN	0.00000	-1135.68100	-2220.96300	-285.56791
28	ENVULT MIN	0.25000	-1135.68100	-2082.05100	0.00000
28	ENVULT MIN	0.50000	-1135.68100	-1943.14000	0.00000
28	ENVULT MIN	0.75000	-1135.68100	-1804.22900	0.00000
28	ENVULT MIN	1.00000	-1135.68100	-1665.31700	0.00000
29	ENVULT MAX	0.00000	0.00000	0.00000	2373.91500
29	ENVULT MAX	0.25000	0.00000	0.00000	2777.80000
29	ENVULT MAX	0.50000	0.00000	0.00000	3145.98400
29	ENVULT MAX	0.75000	0.00000	0.00000	3485.00400
29	ENVULT MAX	1.00000	0.00000	0.00000	3788.45600
29	ENVULT MIN	0.00000	-1135.42800	-1665.31700	0.00000
29	ENVULT MIN	0.25000	-1135.42800	-1526.54100	0.00000
29	ENVULT MIN	0.50000	-1135.42800	-1387.76500	0.00000
29	ENVULT MIN	0.75000	-1135.42800	-1248.98800	0.00000
29	ENVULT MIN	1.00000	-1135.42800	-1110.21200	0.00000
30	ENVULT MAX	0.00000	0.00000	0.00000	3788.45600
30	ENVULT MAX	0.25000	0.00000	0.00000	4056.20800
30	ENVULT MAX	0.50000	0.00000	0.00000	4288.25900
30	ENVULT MAX	0.75000	0.00000	0.00000	4484.61000
30	ENVULT MAX	1.00000	0.00000	0.00000	4645.26200
30	ENVULT MIN	0.00000	-1135.26400	-1110.21200	0.00000
30	ENVULT MIN	0.25000	-1135.26400	-971.97792	0.00000
30	ENVULT MIN	0.50000	-1135.26400	-837.31745	0.00000
30	ENVULT MIN	0.75000	-1135.26400	-702.65699	0.00000
30	ENVULT MIN	1.00000	-1135.26400	-567.99652	0.00000
31	ENVULT MAX	0.00000	0.00000	0.00000	4645.26200
31	ENVULT MAX	0.25000	0.00000	0.00000	4770.21200
31	ENVULT MAX	0.50000	0.00000	0.00000	4859.46300
31	ENVULT MAX	0.75000	0.00000	0.00000	4913.01300
31	ENVULT MAX	1.00000	0.00000	38.23907	4930.86300
31	ENVULT MIN	0.00000	-1135.18300	-567.99652	0.00000
31	ENVULT MIN	0.25000	-1135.18300	-433.33605	0.00000
31	ENVULT MIN	0.50000	-1135.18300	-298.67558	0.00000
31	ENVULT MIN	0.75000	-1135.18300	-164.01511	0.00000
31	ENVULT MIN	1.00000	-1135.18300	-29.35472	0.00000
32	ENVULT MAX	0.00000	0.00000	29.35501	4930.86300
32	ENVULT MAX	0.25000	0.00000	164.01548	4913.01300
32	ENVULT MAX	0.50000	0.00000	298.67595	4859.46300
32	ENVULT MAX	0.75000	0.00000	433.33642	4770.21200
32	ENVULT MAX	1.00000	0.00000	567.99689	4645.26100
32	ENVULT MIN	0.00000	-1135.18300	-38.23757	0.00000
32	ENVULT MIN	0.25000	-1135.18300	0.00000	0.00000
32	ENVULT MIN	0.50000	-1135.18300	0.00000	0.00000
32	ENVULT MIN	0.75000	-1135.18300	0.00000	0.00000
32	ENVULT MIN	1.00000	-1135.18300	0.00000	0.00000
33	ENVULT MAX	0.00000	0.00000	567.99689	4645.26100
33	ENVULT MAX	0.25000	0.00000	702.65736	4484.61000
33	ENVULT MAX	0.50000	0.00000	837.31783	4288.25900
33	ENVULT MAX	0.75000	0.00000	971.97829	4056.20700
33	ENVULT MAX	1.00000	0.00000	1110.21200	3788.45500
33	ENVULT MIN	0.00000	-1135.26400	0.00000	0.00000
33	ENVULT MIN	0.25000	-1135.26400	0.00000	0.00000
33	ENVULT MIN	0.50000	-1135.26400	0.00000	0.00000
33	ENVULT MIN	0.75000	-1135.26400	0.00000	0.00000
33	ENVULT MIN	1.00000	-1135.26400	0.00000	0.00000
34	ENVULT MAX	0.00000	0.00000	1110.21200	3788.45500
34	ENVULT MAX	0.25000	0.00000	1249.12300	3484.69100
34	ENVULT MAX	0.50000	0.00000	1388.03500	3145.30200
34	ENVULT MAX	0.75000	0.00000	1526.94600	2776.67300
34	ENVULT MAX	1.00000	0.00000	1665.85700	2372.27400
34	ENVULT MIN	0.00000	-1135.42900	0.00000	0.00000
34	ENVULT MIN	0.25000	-1135.42900	0.00000	0.00000
34	ENVULT MIN	0.50000	-1135.42900	0.00000	0.00000
34	ENVULT MIN	0.75000	-1135.42900	0.00000	0.00000
34	ENVULT MIN	1.00000	-1135.42900	0.00000	0.00000
35	ENVULT MAX	0.00000	0.00000	1665.85700	2372.27400
35	ENVULT MAX	0.25000	0.00000	1804.63400	1932.55000

FRAME	LOAD	DIST	P	V2	M3
35	ENVULT MAX	0.50000	0.00000	1943.41000	1457.12600
35	ENVULT MAX	0.75000	0.00000	2082.18700	946.00211
35	ENVULT MAX	1.00000	0.00000	2220.96300	452.83445
35	ENVULT MIN	0.00000	-1135.68200	0.00000	0.00000
35	ENVULT MIN	0.25000	-1135.68200	0.00000	0.00000
35	ENVULT MIN	0.50000	-1135.68200	0.00000	0.00000
35	ENVULT MIN	0.75000	-1135.68200	0.00000	0.00000
35	ENVULT MIN	1.00000	-1135.68200	0.00000	-285.57452
36	ENVULT MAX	0.00000	0.00000	2220.96300	452.83445
36	ENVULT MAX	0.25000	0.00000	2316.44800	213.11059
36	ENVULT MAX	0.50000	0.00000	2411.93300	0.00000
36	ENVULT MAX	0.75000	0.00000	2507.41700	0.00000
36	ENVULT MAX	1.00000	0.00000	2602.90200	0.00000
36	ENVULT MIN	0.00000	-1135.97900	0.00000	-285.57452
36	ENVULT MIN	0.25000	-1135.97900	0.00000	-657.83486
36	ENVULT MIN	0.50000	-1135.97900	0.00000	-1056.51200
36	ENVULT MIN	0.75000	-1135.97900	0.00000	-1472.17700
36	ENVULT MIN	1.00000	-1135.97900	0.00000	-1909.79500
37	ENVULT MAX	0.00000	0.00000	2602.90200	0.00000
37	ENVULT MAX	0.25000	0.00000	2646.29000	0.00000
37	ENVULT MAX	0.50000	0.00000	2689.87200	0.00000
37	ENVULT MAX	0.75000	0.00000	2733.64600	0.00000
37	ENVULT MAX	1.00000	0.00000	2777.61400	0.00000
37	ENVULT MIN	0.00000	-1136.20000	0.00000	-1909.79500
37	ENVULT MIN	0.25000	-1136.20000	0.00000	-2116.52600
37	ENVULT MIN	0.50000	-1136.20000	0.00000	-2326.64400
37	ENVULT MIN	0.75000	-1136.20000	0.00000	-2540.16400
37	ENVULT MIN	1.00000	-1136.20000	0.00000	-2757.10200
38	ENVULT MAX	0.00000	0.00000	2777.61400	0.00000
38	ENVULT MAX	0.25000	0.00000	2802.21600	0.00000
38	ENVULT MAX	0.50000	0.00000	2826.87700	0.00000
38	ENVULT MAX	0.75000	0.00000	2851.59900	0.00000
38	ENVULT MAX	1.00000	0.00000	2876.38100	0.00000
38	ENVULT MIN	0.00000	-1136.33400	0.00000	-2757.10200
38	ENVULT MIN	0.25000	-1136.33400	0.00000	-2879.56400
38	ENVULT MIN	0.50000	-1136.33400	0.00000	-3004.86400
38	ENVULT MIN	0.75000	-1136.33400	0.00000	-3131.92000
38	ENVULT MIN	1.00000	-1136.33400	0.00000	-3260.08300
39	ENVULT MAX	0.00000	0.00000	2876.38100	0.00000
39	ENVULT MAX	0.08824	0.00000	2917.96600	0.00000
39	ENVULT MAX	0.17647	0.00000	2959.55100	0.00000
39	ENVULT MAX	0.26471	0.00000	3001.13500	0.00000
39	ENVULT MAX	0.35294	0.00000	3042.72000	0.00000
39	ENVULT MIN	0.00000	-1136.65400	0.00000	-3260.08300
39	ENVULT MIN	0.08824	-1136.65400	0.00000	-3477.37100
39	ENVULT MIN	0.17647	-1136.65400	0.00000	-3697.77800
39	ENVULT MIN	0.26471	-1136.65400	0.00000	-3921.30400
39	ENVULT MIN	0.35294	-1136.65400	0.00000	-4147.94800
40	ENVULT MAX	0.56250	0.00000	0.00000	0.00000
40	ENVULT MAX	0.67188	0.00000	0.00000	0.00000
40	ENVULT MAX	0.78125	0.00000	0.00000	0.00000
40	ENVULT MAX	0.89063	0.00000	0.00000	0.00000
40	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
40	ENVULT MIN	0.56250	-3377.37400	-1022.57700	-5427.96800
40	ENVULT MIN	0.67188	-3383.14900	-999.90643	-5379.31100
40	ENVULT MIN	0.78125	-3388.92400	-977.11949	-5331.67800
40	ENVULT MIN	0.89063	-3394.69900	-954.21617	-5285.07600
40	ENVULT MIN	1.00000	-3400.47400	-931.19648	-5239.50900
41	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
41	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
41	ENVULT MIN	0.00000	-3400.47400	-931.36130	-5239.50900
41	ENVULT MIN	0.25000	-3405.92800	-909.08670	-5196.61800
41	ENVULT MIN	0.50000	-3411.16900	-886.70429	-5154.69600
41	ENVULT MIN	0.75000	-3416.19800	-864.21407	-5113.74700
41	ENVULT MIN	1.00000	-3421.01400	-841.61605	-5073.77600
42	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
42	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
42	ENVULT MIN	0.00000	-3421.01400	-841.67018	-5073.77600
42	ENVULT MIN	0.25000	-3423.26700	-830.70127	-5054.79500
42	ENVULT MIN	0.50000	-3425.47000	-819.70707	-5036.04400
42	ENVULT MIN	0.75000	-3427.62300	-808.68760	-5017.52500
42	ENVULT MIN	1.00000	-3429.72600	-797.64284	-4999.23700
43	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
43	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
43	ENVULT MIN	0.00000	-3429.72600	-797.75185	-4999.23700
43	ENVULT MIN	0.25000	-3442.13200	-731.29682	-4894.91200
43	ENVULT MIN	0.50000	-3454.53800	-663.94216	-4798.96000
43	ENVULT MIN	0.75000	-3466.94300	-595.68787	-4711.49200
43	ENVULT MIN	1.00000	-3479.34900	-526.53393	-4632.61700
44	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
44	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
44	ENVULT MAX	0.50000	0.00000	14.73286	0.00000
44	ENVULT MAX	0.75000	0.00000	39.21290	0.00000
44	ENVULT MAX	1.00000	0.00000	64.01601	0.00000
44	ENVULT MIN	0.00000	-3479.34900	-526.80099	-4632.61700
44	ENVULT MIN	0.25000	-3493.84600	-444.85155	-4551.48200
44	ENVULT MIN	0.50000	-3508.34300	-361.67426	-4482.40300
44	ENVULT MIN	0.75000	-3522.83900	-277.26912	-4425.55700
44	ENVULT MIN	1.00000	-3537.33600	-191.63613	-4381.11700
45	ENVULT MAX	0.00000	0.00000	64.01601	0.00000
45	ENVULT MAX	0.25000	0.00000	113.79281	0.00000
45	ENVULT MAX	0.50000	0.00000	164.69135	0.00000
45	ENVULT MAX	0.75000	0.00000	235.48860	0.00000
45	ENVULT MAX	1.00000	0.00000	328.30697	0.00000
45	ENVULT MIN	0.00000	-3537.33600	-192.12569	-4381.11700
45	ENVULT MIN	0.25000	-3551.83300	-134.25454	-4371.88500
45	ENVULT MIN	0.50000	-3566.33000	-90.21020	-4379.97800
45	ENVULT MIN	0.75000	-3580.82600	-45.55194	-4401.00200
45	ENVULT MIN	1.00000	-3595.32300	-0.27976	-4435.13000
46	ENVULT MAX	0.00000	0.00000	328.30697	0.00000
46	ENVULT MAX	0.25000	0.00000	422.27035	0.00000
46	ENVULT MAX	0.50000	0.00000	517.46028	0.00000
46	ENVULT MAX	0.75000	0.00000	613.87675	0.00000
46	ENVULT MAX	1.00000	0.00000	711.51975	0.00000
46	ENVULT MIN	0.00000	-3595.32300	0.00000	-4435.13000
46	ENVULT MIN	0.25000	-3609.80700	0.00000	-4482.49000
46	ENVULT MIN	0.50000	-3624.29100	0.00000	-4543.27900
46	ENVULT MIN	0.75000	-3638.77500	0.00000	-4617.67300
46	ENVULT MIN	1.00000	-3653.25900	0.00000	-4705.84500
47	ENVULT MAX	0.00000	0.00000	711.51975	0.00000
47	ENVULT MAX	0.25000	0.00000	740.72187	0.00000
47	ENVULT MAX	0.50000	0.00000	770.03178	0.00000
47	ENVULT MAX	0.75000	0.00000	799.44951	0.00000
47	ENVULT MAX	1.00000	0.00000	828.97504	0.00000
47	ENVULT MIN	0.00000	-3653.25900	0.00000	-4705.84500
47	ENVULT MIN	0.25000	-3657.55600	0.00000	-4734.67700
47	ENVULT MIN	0.50000	-3661.85300	0.00000	-4764.74100
47	ENVULT MIN	0.75000	-3666.14900	0.00000	-4796.04300
47	ENVULT MIN	1.00000	-3670.44600	0.00000	-4828.58600
48	ENVULT MAX	0.00000	0.00000	828.97504	0.00000
48	ENVULT MAX	0.13281	0.00000	866.36427	0.00000
48	ENVULT MAX	0.26563	0.00000	903.92511	0.00000
48	ENVULT MAX	0.39844	0.00000	941.65753	0.00000
48	ENVULT MAX	0.53125	0.00000	979.56155	0.00000
48	ENVULT MIN	0.00000	-3670.44600	0.00000	-4828.58600
48	ENVULT MIN	0.13281	-3675.86500	0.00000	-4871.40400
48	ENVULT MIN	0.26563	-3681.28400	0.00000	-4916.21300
48	ENVULT MIN	0.39844	-3686.70200	0.00000	-4963.02200
48	ENVULT MIN	0.53125	-3692.12100	0.00000	-5030.90000

2) 사용하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVUSE MAX	0.52941	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.64706	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.76471	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.88235	0.00000	0.00000	0.00000
1	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
1	ENVUSE MIN	0.52941	-732.79483	-1922.56900	-2807.27300
1	ENVUSE MIN	0.64706	-732.79483	-1926.56900	-2616.25500
1	ENVUSE MIN	0.76471	-732.79483	-1930.56900	-2424.83700
1	ENVUSE MIN	0.88235	-732.79483	-1934.56900	-2233.01900
1	ENVUSE MIN	1.00000	-732.79483	-1938.56900	-2040.80100
2	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
2	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
2	ENVUSE MIN	0.00000	-732.79483	-1938.56900	-2040.80100
2	ENVUSE MIN	0.25000	-732.79483	-1940.35900	-1954.65400
2	ENVUSE MIN	0.50000	-732.79483	-1942.14900	-1868.42600
2	ENVUSE MIN	0.75000	-732.79483	-1943.93900	-1782.11900
2	ENVUSE MIN	1.00000	-732.79483	-1945.72900	-1695.73200
3	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
3	ENVUSE MAX	1.00000	0.00000	0.00000	344.10747
3	ENVUSE MIN	0.00000	-732.79483	-1526.76800	-1695.73200
3	ENVUSE MIN	0.25000	-732.79483	-1537.05800	-1304.56400
3	ENVUSE MIN	0.50000	-732.79483	-1547.34800	-910.74945
3	ENVUSE MIN	0.75000	-732.79483	-1557.63800	-514.28771
3	ENVUSE MIN	1.00000	-732.79483	-1567.92800	-191.10035
4	ENVUSE MAX	0.00000	0.00000	0.00000	344.10747
4	ENVUSE MAX	0.25000	0.00000	0.00000	633.13686
4	ENVUSE MAX	0.50000	0.00000	0.00000	924.81335
4	ENVUSE MAX	0.75000	0.00000	0.00000	1219.13700
4	ENVUSE MAX	1.00000	0.00000	0.00000	1516.10800
4	ENVUSE MIN	0.00000	-732.79483	-1162.93700	-191.10034
4	ENVUSE MIN	0.25000	-732.79483	-1173.22700	-3.44314
4	ENVUSE MIN	0.50000	-732.79483	-1183.51700	0.00000
4	ENVUSE MIN	0.75000	-732.79483	-1193.80700	0.00000
4	ENVUSE MIN	1.00000	-732.79483	-1204.09700	0.00000
5	ENVUSE MAX	0.00000	0.00000	0.00000	1516.10800
5	ENVUSE MAX	0.25000	0.00000	0.00000	1718.18100
5	ENVUSE MAX	0.50000	0.00000	0.00000	1922.90700
5	ENVUSE MAX	0.75000	0.00000	0.00000	2130.28600
5	ENVUSE MAX	1.00000	0.00000	0.00000	2343.07200
5	ENVUSE MIN	0.00000	-732.79483	-812.97285	0.00000
5	ENVUSE MIN	0.25000	-732.79483	-823.27285	0.00000
5	ENVUSE MIN	0.50000	-732.79483	-833.57285	0.00000
5	ENVUSE MIN	0.75000	-732.79483	-843.87285	0.00000
5	ENVUSE MIN	1.00000	-732.79483	-854.17285	0.00000
6	ENVUSE MAX	0.00000	0.00000	0.00000	2343.07200
6	ENVUSE MAX	0.25000	0.00000	0.00000	2464.63500
6	ENVUSE MAX	0.50000	0.00000	0.00000	2588.84500
6	ENVUSE MAX	0.75000	0.00000	0.00000	2715.70200
6	ENVUSE MAX	1.00000	0.00000	0.00000	2845.20700
6	ENVUSE MIN	0.00000	-732.79483	-474.55369	0.00000
6	ENVUSE MIN	0.25000	-732.79483	-484.84369	0.00000
6	ENVUSE MIN	0.50000	-732.79483	-495.13369	0.00000
6	ENVUSE MIN	0.75000	-732.79483	-505.42369	0.00000
6	ENVUSE MIN	1.00000	-732.79483	-515.71369	0.00000
7	ENVUSE MAX	0.00000	0.00000	0.00000	2845.20700
7	ENVUSE MAX	0.25000	0.00000	0.00000	2882.83600
7	ENVUSE MAX	0.50000	0.00000	0.00000	2923.11200
7	ENVUSE MAX	0.75000	0.00000	0.00000	2966.03600
7	ENVUSE MAX	1.00000	0.00000	0.00000	3011.60600
7	ENVUSE MIN	0.00000	-732.79483	-145.88755	0.00000
7	ENVUSE MIN	0.25000	-732.79483	-156.17755	0.00000
7	ENVUSE MIN	0.50000	-732.79483	-166.46755	0.00000
7	ENVUSE MIN	0.75000	-732.79483	-176.75755	0.00000
7	ENVUSE MIN	1.00000	-732.79483	-187.04755	0.00000
8	ENVUSE MAX	0.00000	0.00000	186.96824	3011.60600
8	ENVUSE MAX	0.25000	0.00000	176.67824	2966.05600
8	ENVUSE MAX	0.50000	0.00000	166.38824	2923.15300
8	ENVUSE MAX	0.75000	0.00000	156.09824	2882.89700
8	ENVUSE MAX	1.00000	0.00000	145.80824	2845.28900
8	ENVUSE MIN	0.00000	-732.79487	0.00000	0.00000
8	ENVUSE MIN	0.25000	-732.79487	0.00000	0.00000
8	ENVUSE MIN	0.50000	-732.79487	0.00000	0.00000
8	ENVUSE MIN	0.75000	-732.79487	0.00000	0.00000
8	ENVUSE MIN	1.00000	-732.79487	0.00000	0.00000
9	ENVUSE MAX	0.00000	0.00000	515.63717	2845.28900
9	ENVUSE MAX	0.25000	0.00000	505.34717	2715.80300
9	ENVUSE MAX	0.50000	0.00000	495.05717	2588.96500
9	ENVUSE MAX	0.75000	0.00000	484.76717	2464.77500
9	ENVUSE MAX	1.00000	0.00000	474.47717	2343.23100
9	ENVUSE MIN	0.00000	-732.79487	0.00000	0.00000
9	ENVUSE MIN	0.25000	-732.79487	0.00000	0.00000
9	ENVUSE MIN	0.50000	-732.79487	0.00000	0.00000
9	ENVUSE MIN	0.75000	-732.79487	0.00000	0.00000
9	ENVUSE MIN	1.00000	-732.79487	0.00000	0.00000
10	ENVUSE MAX	0.00000	0.00000	854.10389	2343.23100
10	ENVUSE MAX	0.25000	0.00000	843.81389	2130.66100
10	ENVUSE MAX	0.50000	0.00000	833.52389	1923.49700
10	ENVUSE MAX	0.75000	0.00000	823.23389	1718.98000
10	ENVUSE MAX	1.00000	0.00000	812.94389	1517.11100
10	ENVUSE MIN	0.00000	-732.79487	0.00000	0.00000
10	ENVUSE MIN	0.25000	-732.79487	0.00000	0.00000
10	ENVUSE MIN	0.50000	-732.79487	0.00000	0.00000
10	ENVUSE MIN	0.75000	-732.79487	0.00000	0.00000
10	ENVUSE MIN	1.00000	-732.79487	0.00000	0.00000
11	ENVUSE MAX	0.00000	0.00000	1204.06800	1517.11100
11	ENVUSE MAX	0.25000	0.00000	1193.76800	1219.86000
11	ENVUSE MAX	0.50000	0.00000	1183.46800	925.26166
11	ENVUSE MAX	0.75000	0.00000	1173.16800	633.31557
11	ENVUSE MAX	1.00000	0.00000	1162.86800	344.02173
11	ENVUSE MIN	0.00000	-732.79487	0.00000	0.00000
11	ENVUSE MIN	0.25000	-732.79487	0.00000	0.00000
11	ENVUSE MIN	0.50000	-732.79487	0.00000	0.00000
11	ENVUSE MIN	0.75000	-732.79487	0.00000	-3.33195
11	ENVUSE MIN	1.00000	-732.79487	0.00000	-191.16093
12	ENVUSE MAX	0.00000	0.00000	1567.87500	344.02173
12	ENVUSE MAX	0.25000	0.00000	1557.58500	0.00000
12	ENVUSE MAX	0.50000	0.00000	1547.29500	0.00000
12	ENVUSE MAX	0.75000	0.00000	1537.00500	0.00000
12	ENVUSE MAX	1.00000	0.00000	1526.71500	0.00000
12	ENVUSE MIN	0.00000	-732.79487	0.00000	-191.16094
12	ENVUSE MIN	0.25000	-732.79487	0.00000	-514.36078
12	ENVUSE MIN	0.50000	-732.79487	0.00000	-910.80896
12	ENVUSE MIN	0.75000	-732.79487	0.00000	-1304.61000
12	ENVUSE MIN	1.00000	-732.79487	0.00000	-1695.76400
13	ENVUSE MAX	0.00000	0.00000	1945.69600	0.00000
13	ENVUSE MAX	0.25000	0.00000	1943.90600	0.00000
13	ENVUSE MAX	0.50000	0.00000	1942.11600	0.00000
13	ENVUSE MAX	0.75000	0.00000	1940.32600	0.00000
13	ENVUSE MAX	1.00000	0.00000	1938.53600	0.00000
13	ENVUSE MIN	0.00000	-732.79487	0.00000	-1695.76400
13	ENVUSE MIN	0.25000	-732.79487	0.00000	-1782.15000
13	ENVUSE MIN	0.50000	-732.79487	0.00000	-1868.45600
13	ENVUSE MIN	0.75000	-732.79487	0.00000	-1954.68200
13	ENVUSE MIN	1.00000	-732.79487	0.00000	-2040.82700
14	ENVUSE MAX	0.00000	0.00000	1938.53600	0.00000
14	ENVUSE MAX	0.11765	0.00000	1934.53600	0.00000
14	ENVUSE MAX	0.23529	0.00000	1930.53600	0.00000
14	ENVUSE MAX	0.35294	0.00000	1926.53600	0.00000
14	ENVUSE MAX	0.47059	0.00000	1922.53600	0.00000
14	ENVUSE MIN	0.00000	-732.79487	0.00000	-2040.82700
14	ENVUSE MIN	0.11765	-732.79487	0.00000	-2233.04200
14	ENVUSE MIN	0.23529	-732.79487	0.00000	-2424.85700
14	ENVUSE MIN	0.35294	-732.79487	0.00000	-2616.27100
14	ENVUSE MIN	0.47059	-732.79487	0.00000	-2807.28600
15	ENVUSE MAX	0.46875	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.60156	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.73438	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.86719	0.00000	0.00000	0.00000
15	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
15	ENVUSE MIN	0.46875	-2458.38900	-648.32584	-3408.21900
15	ENVUSE MIN	0.60156	-2453.87300	-624.63583	-3361.95900
15	ENVUSE MIN	0.73438	-2449.35800	-601.05307	-3328.86800
15	ENVUSE MIN	0.86719	-2444.84200	-577.57755	-3297.02700
15	ENVUSE MIN	1.00000	-2440.32600	-554.20927	-3266.43000
16	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
16	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
16	ENVUSE MIN	0.00000	-2440.32600	-554.20927	-3266.43000
16	ENVUSE MIN	0.25000	-2436.74600	-535.75582	-3243.04900
16	ENVUSE MIN	0.50000	-2433.16500	-517.36974	-3220.44400
16	ENVUSE MIN	0.75000	-2429.58500	-499.05104	-3198.61300
16	ENVUSE MIN	1.00000	-2426.00400	-480.79972	-3177.55100
17	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
17	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
17	ENVUSE MIN	0.00000	-2426.00400	-480.79972	-3177.55100

FRAME	LOAD	DIST	P	V2	M3
17	ENVUSE MIN	0.25000	-2413.93400	-419.77284	-3112.19100
17	ENVUSE MIN	0.50000	-2401.86400	-359.51255	-3055.44300
17	ENVUSE MIN	0.75000	-2389.79400	-300.01885	-3007.19700
17	ENVUSE MIN	1.00000	-2377.72400	-241.29173	-2967.34500
18	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
18	ENVUSE MAX	0.25000	0.00000	8.48168	0.00000
18	ENVUSE MAX	0.50000	0.00000	36.39310	0.00000
18	ENVUSE MAX	0.75000	0.00000	63.92081	0.00000
18	ENVUSE MAX	1.00000	0.00000	100.09028	0.00000
18	ENVUSE MIN	0.00000	-2377.72400	-241.29173	-2967.34500
18	ENVUSE MIN	0.25000	-2365.64300	-183.28025	-2935.75400
18	ENVUSE MIN	0.50000	-2353.56300	-139.43787	-2912.35200
18	ENVUSE MIN	0.75000	-2341.48200	-107.62628	-2897.03300
18	ENVUSE MIN	1.00000	-2329.40100	-76.51581	-2893.49400
19	ENVUSE MAX	0.00000	0.00000	99.81758	0.00000
19	ENVUSE MAX	0.25000	0.00000	153.33820	0.00000
19	ENVUSE MAX	0.50000	0.00000	206.09141	0.00000
19	ENVUSE MAX	0.75000	0.00000	258.07722	0.00000
19	ENVUSE MAX	1.00000	0.00000	309.29562	0.00000
19	ENVUSE MIN	0.00000	-2329.40100	-76.51581	-2893.49400
19	ENVUSE MIN	0.25000	-2317.32100	-61.01387	-2916.67300
19	ENVUSE MIN	0.50000	-2305.24000	-45.71384	-2947.60700
19	ENVUSE MIN	0.75000	-2293.16000	-30.61575	-2986.18500
19	ENVUSE MIN	1.00000	-2281.07900	-15.71957	-3032.29900
20	ENVUSE MAX	0.00000	0.00000	309.15537	0.00000
20	ENVUSE MAX	0.25000	0.00000	352.37658	0.00000
20	ENVUSE MAX	0.50000	0.00000	395.03551	0.00000
20	ENVUSE MAX	0.75000	0.00000	437.13218	0.00000
20	ENVUSE MAX	1.00000	0.00000	478.66657	0.00000
20	ENVUSE MIN	0.00000	-2281.07900	-15.71956	-3032.29900
20	ENVUSE MIN	0.25000	-2270.74100	-3.13239	-3077.66400
20	ENVUSE MIN	0.50000	-2260.40300	0.00000	-3128.39900
20	ENVUSE MIN	0.75000	-2250.06500	0.00000	-3184.43600
20	ENVUSE MIN	1.00000	-2239.72600	0.00000	-3245.70600
21	ENVUSE MAX	0.00000	0.00000	478.60815	0.00000
21	ENVUSE MAX	0.25000	0.00000	485.51113	0.00000
21	ENVUSE MAX	0.50000	0.00000	492.39830	0.00000
21	ENVUSE MAX	0.75000	0.00000	499.26967	0.00000
21	ENVUSE MAX	1.00000	0.00000	506.12524	0.00000
21	ENVUSE MIN	0.00000	-2239.72600	0.00000	-3245.70600
21	ENVUSE MIN	0.25000	-2237.97400	0.00000	-3256.47800
21	ENVUSE MIN	0.50000	-2236.18000	0.00000	-3267.39400
21	ENVUSE MIN	0.75000	-2234.34400	0.00000	-3278.45400
21	ENVUSE MIN	1.00000	-2232.46600	0.00000	-3289.65800
22	ENVUSE MAX	0.00000	0.00000	506.09572	0.00000
22	ENVUSE MAX	0.25000	0.00000	520.21949	0.00000
22	ENVUSE MAX	0.50000	0.00000	534.27587	0.00000
22	ENVUSE MAX	0.75000	0.00000	548.26488	0.00000
22	ENVUSE MAX	1.00000	0.00000	562.18651	0.00000
22	ENVUSE MIN	0.00000	-2232.46600	0.00000	-3289.65800
22	ENVUSE MIN	0.25000	-2228.45300	0.00000	-3313.27800
22	ENVUSE MIN	0.50000	-2224.26200	0.00000	-3337.50900
22	ENVUSE MIN	0.75000	-2219.89500	0.00000	-3362.34800
22	ENVUSE MIN	1.00000	-2215.34900	0.00000	-3387.79300
23	ENVUSE MAX	0.00000	0.00000	562.09180	0.00000
23	ENVUSE MAX	0.10937	0.00000	576.47911	0.00000
23	ENVUSE MAX	0.21875	0.00000	590.79368	0.00000
23	ENVUSE MAX	0.32812	0.00000	605.03552	0.00000
23	ENVUSE MAX	0.43750	0.00000	619.20463	0.00000
23	ENVUSE MIN	0.00000	-2215.34900	0.00000	-3387.79300
23	ENVUSE MIN	0.10937	-2210.53700	0.00000	-3414.85800
23	ENVUSE MIN	0.21875	-2205.72400	0.00000	-3442.57000
23	ENVUSE MIN	0.32812	-2200.91200	0.00000	-3470.92500
23	ENVUSE MIN	0.43750	-2196.09900	0.00000	-3499.92200
24	ENVUSE MAX	0.64706	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.73529	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.82353	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.91176	0.00000	0.00000	0.00000
24	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
24	ENVUSE MIN	0.64706	-690.50284	-1972.29900	-2651.48000
24	ENVUSE MIN	0.73529	-690.50284	-1945.15600	-2504.57500
24	ENVUSE MIN	0.82353	-690.50284	-1918.01300	-2359.70600
24	ENVUSE MIN	0.91176	-690.50284	-1890.87000	-2219.78200
24	ENVUSE MIN	1.00000	-690.50284	-1863.72700	-2083.00700
25	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
25	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
25	ENVUSE MIN	0.00000	-690.30273	-1863.72700	-2083.00700
25	ENVUSE MIN	0.25000	-690.30273	-1847.55600	-2002.34000
25	ENVUSE MIN	0.50000	-690.30273	-1831.43600	-1922.37600
25	ENVUSE MIN	0.75000	-690.30273	-1815.36600	-1843.11100
25	ENVUSE MIN	1.00000	-690.30273	-1799.34600	-1764.54500
26	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
26	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
26	ENVUSE MIN	0.00000	-690.21929	-1799.34600	-1764.54500
26	ENVUSE MIN	0.25000	-690.21929	-1770.74300	-1625.39400
26	ENVUSE MIN	0.50000	-690.21929	-1742.30000	-1488.46700
26	ENVUSE MIN	0.75000	-690.21929	-1714.01900	-1353.75200
26	ENVUSE MIN	1.00000	-690.21929	-1685.89800	-1221.23600
27	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
27	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
27	ENVUSE MAX	0.50000	0.00000	0.00000	66.10714
27	ENVUSE MAX	0.75000	0.00000	0.00000	225.33906
27	ENVUSE MAX	1.00000	0.00000	0.00000	383.20579
27	ENVUSE MIN	0.00000	-690.08178	-1685.89800	-1221.23600
27	ENVUSE MIN	0.25000	-690.08178	-1624.05300	-936.68889
27	ENVUSE MIN	0.50000	-690.08178	-1562.20800	-662.77516
27	ENVUSE MIN	0.75000	-690.08178	-1500.36200	-400.65857
27	ENVUSE MIN	1.00000	-690.08178	-1438.51700	-155.78964
28	ENVUSE MAX	0.00000	0.00000	0.00000	383.20580
28	ENVUSE MAX	0.25000	0.00000	0.00000	704.51423
28	ENVUSE MAX	0.50000	0.00000	0.00000	1036.00900
28	ENVUSE MAX	0.75000	0.00000	0.00000	1344.33500
28	ENVUSE MAX	1.00000	0.00000	0.00000	1629.49300
28	ENVUSE MIN	0.00000	-689.89620	-1438.51700	-155.78964
28	ENVUSE MIN	0.25000	-689.89620	-1348.54400	0.00000
28	ENVUSE MIN	0.50000	-689.89620	-1258.57100	0.00000
28	ENVUSE MIN	0.75000	-689.89620	-1168.59800	0.00000
28	ENVUSE MIN	1.00000	-689.89620	-1078.62500	0.00000
29	ENVUSE MAX	0.00000	0.00000	0.00000	1629.49300
29	ENVUSE MAX	0.25000	0.00000	0.00000	1891.24100
29	ENVUSE MAX	0.50000	0.00000	0.00000	2129.86500
29	ENVUSE MAX	0.75000	0.00000	0.00000	2349.45100
29	ENVUSE MAX	1.00000	0.00000	0.00000	2545.99700
29	ENVUSE MIN	0.00000	-689.73825	-1078.62500	0.00000
29	ENVUSE MIN	0.25000	-689.73825	-988.74001	0.00000
29	ENVUSE MIN	0.50000	-689.73825	-898.85454	0.00000
29	ENVUSE MIN	0.75000	-689.73825	-808.96908	0.00000
29	ENVUSE MIN	1.00000	-689.73825	-719.08361	0.00000
30	ENVUSE MAX	0.00000	0.00000	0.00000	2545.99700
30	ENVUSE MAX	0.25000	0.00000	0.00000	2719.41900
30	ENVUSE MAX	0.50000	0.00000	0.00000	2869.71900
30	ENVUSE MAX	0.75000	0.00000	0.00000	2996.89600
30	ENVUSE MAX	1.00000	0.00000	0.00000	3100.94900
30	ENVUSE MIN	0.00000	-689.63583	-719.08361	0.00000
30	ENVUSE MIN	0.25000	-689.63583	-629.53741	0.00000
30	ENVUSE MIN	0.50000	-689.63583	-542.22444	0.00000
30	ENVUSE MIN	0.75000	-689.63583	-454.91148	0.00000
30	ENVUSE MIN	1.00000	-689.63583	-367.59851	0.00000
31	ENVUSE MAX	0.00000	0.00000	0.00000	3100.94900
31	ENVUSE MAX	0.25000	0.00000	0.00000	3181.88000
31	ENVUSE MAX	0.50000	0.00000	0.00000	3239.68800
31	ENVUSE MAX	0.75000	0.00000	0.00000	3274.37200
31	ENVUSE MAX	1.00000	0.00000	24.41744	3285.93400
31	ENVUSE MIN	0.00000	-689.58544	-367.59851	0.00000
31	ENVUSE MIN	0.25000	-689.58544	-280.28555	0.00000
31	ENVUSE MIN	0.50000	-689.58544	-192.97258	0.00000
31	ENVUSE MIN	0.75000	-689.58544	-105.65962	0.00000
31	ENVUSE MIN	1.00000	-689.58544	-18.34670	0.00000
32	ENVUSE MAX	0.00000	0.00000	18.34689	3285.93400
32	ENVUSE MAX	0.25000	0.00000	105.65985	3274.37200
32	ENVUSE MAX	0.50000	0.00000	192.97282	3239.68700
32	ENVUSE MAX	0.75000	0.00000	280.28578	3181.88000
32	ENVUSE MAX	1.00000	0.00000	367.59875	3100.94900
32	ENVUSE MIN	0.00000	-689.58552	-24.41644	0.00000
32	ENVUSE MIN	0.25000	-689.58552	0.00000	0.00000
32	ENVUSE MIN	0.50000	-689.58552	0.00000	0.00000
32	ENVUSE MIN	0.75000	-689.58552	0.00000	0.00000
32	ENVUSE MIN	1.00000	-689.58552	0.00000	0.00000
33	ENVUSE MAX	0.00000	0.00000	367.59875	3100.94900
33	ENVUSE MAX	0.25000	0.00000	454.91171	2996.89600
33	ENVUSE MAX	0.50000	0.00000	542.22468	2869.71900
33	ENVUSE MAX	0.75000	0.00000	629.53765	2719.41900
33	ENVUSE MAX	1.00000	0.00000	719.08386	2545.99600
33	ENVUSE MIN	0.00000	-689.63609	0.00000	0.00000
33	ENVUSE MIN	0.25000	-689.63609	0.00000	0.00000
33	ENVUSE MIN	0.50000	-689.63609	0.00000	0.00000
33	ENVUSE MIN	0.75000	-689.63609	0.00000	0.00000
33	ENVUSE MIN	1.00000	-689.63609	0.00000	0.00000
34	ENVUSE MAX	0.00000	0.00000	719.08386	2545.99600
34	ENVUSE MAX	0.25000	0.00000	809.05668	2349.24800
34	ENVUSE MAX	0.50000	0.00000	899.02950	2129.42300
34	ENVUSE MAX	0.75000	0.00000	989.00232	1890.51100
34	ENVUSE MAX	1.00000	0.00000	1078.97500	1628.43000
34	ENVUSE MIN	0.00000	-689.73872	0.00000	0.00000
34	ENVUSE MIN	0.25000	-689.73872	0.00000	0.00000
34	ENVUSE MIN	0.50000	-689.73872	0.00000	0.00000
34	ENVUSE MIN	0.75000	-689.73872	0.00000	0.00000
34	ENVUSE MIN	1.00000	-689.73872	0.00000	0.00000
35	ENVUSE MAX	0.00000	0.00000	1078.97500	1628.43000
35	ENVUSE MAX	0.25000	0.00000	1168.86100	1343.47000
35	ENVUSE MAX	0.50000	0.00000	1258.74600	1035.38700
35	ENVUSE MAX	0.75000	0.00000	1348.63200	704.18016

FRAME	LOAD	DIST	P	V2	M3
35	ENVUSE MAX	1.00000	0.00000	1438.51700	383.20519
35	ENVUSE MIN	0.00000	-689.89690	0.00000	0.00000
35	ENVUSE MIN	0.25000	-689.89690	0.00000	0.00000
35	ENVUSE MIN	0.50000	-689.89690	0.00000	0.00000
35	ENVUSE MIN	0.75000	-689.89690	0.00000	0.00000
35	ENVUSE MIN	1.00000	-689.89690	0.00000	-155.79433
36	ENVUSE MAX	0.00000	0.00000	1438.51700	383.20518
36	ENVUSE MAX	0.25000	0.00000	1500.36200	225.33594
36	ENVUSE MAX	0.50000	0.00000	1562.20800	66.10386
36	ENVUSE MAX	0.75000	0.00000	1624.05300	0.00000
36	ENVUSE MAX	1.00000	0.00000	1685.89900	0.00000
36	ENVUSE MIN	0.00000	-690.08252	0.00000	-155.79433
36	ENVUSE MIN	0.25000	-690.08252	0.00000	-400.66350
36	ENVUSE MIN	0.50000	-690.08252	0.00000	-662.77634
36	ENVUSE MIN	0.75000	-690.08252	0.00000	-936.69012
36	ENVUSE MIN	1.00000	-690.08252	0.00000	-1221.23700
37	ENVUSE MAX	0.00000	0.00000	1685.89900	0.00000
37	ENVUSE MAX	0.25000	0.00000	1714.01900	0.00000
37	ENVUSE MAX	0.50000	0.00000	1742.30100	0.00000
37	ENVUSE MAX	0.75000	0.00000	1770.74300	0.00000
37	ENVUSE MAX	1.00000	0.00000	1799.34600	0.00000
37	ENVUSE MIN	0.00000	-690.22012	0.00000	-1221.23700
37	ENVUSE MIN	0.25000	-690.22012	0.00000	-1353.75400
37	ENVUSE MIN	0.50000	-690.22012	0.00000	-1488.46900
37	ENVUSE MIN	0.75000	-690.22012	0.00000	-1625.39500
37	ENVUSE MIN	1.00000	-690.22012	0.00000	-1764.54700
38	ENVUSE MAX	0.00000	0.00000	1799.34600	0.00000
38	ENVUSE MAX	0.25000	0.00000	1815.36600	0.00000
38	ENVUSE MAX	0.50000	0.00000	1831.43600	0.00000
38	ENVUSE MAX	0.75000	0.00000	1847.55700	0.00000
38	ENVUSE MAX	1.00000	0.00000	1863.72700	0.00000
38	ENVUSE MIN	0.00000	-690.30360	0.00000	-1764.54700
38	ENVUSE MIN	0.25000	-690.30360	0.00000	-1843.11300
38	ENVUSE MIN	0.50000	-690.30360	0.00000	-1922.37700
38	ENVUSE MIN	0.75000	-690.30360	0.00000	-2002.34100
38	ENVUSE MIN	1.00000	-690.30360	0.00000	-2083.00800
39	ENVUSE MAX	0.00000	0.00000	1863.72700	0.00000
39	ENVUSE MAX	0.08824	0.00000	1890.87000	0.00000
39	ENVUSE MAX	0.17647	0.00000	1918.01300	0.00000
39	ENVUSE MAX	0.26471	0.00000	1945.15700	0.00000
39	ENVUSE MAX	0.35294	0.00000	1972.30000	0.00000
39	ENVUSE MIN	0.00000	-690.50382	0.00000	-2083.00800
39	ENVUSE MIN	0.08824	-690.50382	0.00000	-2219.78400
39	ENVUSE MIN	0.17647	-690.50382	0.00000	-2359.70800
39	ENVUSE MIN	0.26471	-690.50382	0.00000	-2504.57700
39	ENVUSE MIN	0.35294	-690.50382	0.00000	-2651.48100
40	ENVUSE MAX	0.56250	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.67188	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.78125	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.89063	0.00000	0.00000	0.00000
40	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
40	ENVUSE MIN	0.56250	-2196.10000	-619.20579	-3499.92300
40	ENVUSE MIN	0.67188	-2200.91200	-605.03669	-3470.92700
40	ENVUSE MIN	0.78125	-2205.72500	-590.79485	-3442.57200
40	ENVUSE MIN	0.89063	-2210.53700	-576.48027	-3414.86000
40	ENVUSE MIN	1.00000	-2215.35000	-562.09297	-3387.79500
41	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
41	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
41	ENVUSE MIN	0.00000	-2215.35000	-562.18778	-3387.79500
41	ENVUSE MIN	0.25000	-2219.89500	-548.26615	-3362.35000
41	ENVUSE MIN	0.50000	-2224.26300	-534.27715	-3337.51100
41	ENVUSE MIN	0.75000	-2228.45300	-520.22076	-3313.28000
41	ENVUSE MIN	1.00000	-2232.46600	-506.09700	-3289.66000
42	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
42	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
42	ENVUSE MIN	0.00000	-2232.46600	-506.12656	-3289.66000
42	ENVUSE MIN	0.25000	-2234.34400	-499.27099	-3278.45600
42	ENVUSE MIN	0.50000	-2236.18000	-492.39961	-3267.39500
42	ENVUSE MIN	0.75000	-2237.97400	-485.51244	-3256.47900
42	ENVUSE MIN	1.00000	-2239.72700	-478.60947	-3245.70800
43	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
43	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
43	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
43	ENVUSE MAX	0.75000	0.00000	3.13231	0.00000
43	ENVUSE MAX	1.00000	0.00000	15.71948	0.00000
43	ENVUSE MIN	0.00000	-2239.72700	-478.66796	-3245.70800
43	ENVUSE MIN	0.25000	-2250.06500	-437.13357	-3184.43700
43	ENVUSE MIN	0.50000	-2260.40300	-395.03691	-3128.40000
43	ENVUSE MIN	0.75000	-2270.74100	-352.37798	-3077.66600
43	ENVUSE MIN	1.00000	-2281.07900	-309.15677	-3032.30100
44	ENVUSE MAX	0.00000	0.00000	15.71949	0.00000
44	ENVUSE MAX	0.25000	0.00000	30.61567	0.00000
44	ENVUSE MAX	0.50000	0.00000	45.71376	0.00000
44	ENVUSE MAX	0.75000	0.00000	61.01379	0.00000
44	ENVUSE MAX	1.00000	0.00000	76.51573	0.00000
44	ENVUSE MIN	0.00000	-2281.07900	-309.29714	-3032.30100
44	ENVUSE MIN	0.25000	-2293.16000	-258.07873	-2986.18700
44	ENVUSE MIN	0.50000	-2305.24000	-206.09293	-2947.60800
44	ENVUSE MIN	0.75000	-2317.32100	-153.33972	-2916.67500
44	ENVUSE MIN	1.00000	-2329.40200	-99.81910	-2893.49500
45	ENVUSE MAX	0.00000	0.00000	76.51573	0.00000
45	ENVUSE MAX	0.25000	0.00000	107.62623	0.00000
45	ENVUSE MAX	0.50000	0.00000	139.43782	0.00000
45	ENVUSE MAX	0.75000	0.00000	183.28020	0.00000
45	ENVUSE MAX	1.00000	0.00000	241.29168	0.00000
45	ENVUSE MIN	0.00000	-2329.40200	-100.09190	-2893.49500
45	ENVUSE MIN	0.25000	-2341.48200	-63.92243	-2897.03400
45	ENVUSE MIN	0.50000	-2353.56300	-36.39472	-2912.35400
45	ENVUSE MIN	0.75000	-2365.64400	-8.48330	-2935.75500
45	ENVUSE MIN	1.00000	-2377.72400	0.00000	-2967.34700
46	ENVUSE MAX	0.00000	0.00000	241.29168	0.00000
46	ENVUSE MAX	0.25000	0.00000	300.01880	0.00000
46	ENVUSE MAX	0.50000	0.00000	359.51250	0.00000
46	ENVUSE MAX	0.75000	0.00000	419.77279	0.00000
46	ENVUSE MAX	1.00000	0.00000	480.79967	0.00000
46	ENVUSE MIN	0.00000	-2377.72400	0.00000	-2967.34700
46	ENVUSE MIN	0.25000	-2389.79400	0.00000	-3007.19900
46	ENVUSE MIN	0.50000	-2401.86400	0.00000	-3055.44400
46	ENVUSE MIN	0.75000	-2413.93400	0.00000	-3112.19300
46	ENVUSE MIN	1.00000	-2426.00400	0.00000	-3177.55300
47	ENVUSE MAX	0.00000	0.00000	480.79967	0.00000
47	ENVUSE MAX	0.25000	0.00000	499.05099	0.00000
47	ENVUSE MAX	0.50000	0.00000	517.36969	0.00000
47	ENVUSE MAX	0.75000	0.00000	535.75577	0.00000
47	ENVUSE MAX	1.00000	0.00000	554.20923	0.00000
47	ENVUSE MIN	0.00000	-2426.00400	0.00000	-3177.55300
47	ENVUSE MIN	0.25000	-2429.58500	0.00000	-3198.61400
47	ENVUSE MIN	0.50000	-2433.16500	0.00000	-3220.44600
47	ENVUSE MIN	0.75000	-2436.74600	0.00000	-3243.05100
47	ENVUSE MIN	1.00000	-2440.32700	0.00000	-3266.43200
48	ENVUSE MAX	0.00000	0.00000	554.20923	0.00000
48	ENVUSE MAX	0.13281	0.00000	577.57750	0.00000
48	ENVUSE MAX	0.26563	0.00000	601.05302	0.00000
48	ENVUSE MAX	0.39844	0.00000	624.63578	0.00000
48	ENVUSE MAX	0.53125	0.00000	648.32579	0.00000
48	ENVUSE MIN	0.00000	-2440.32700	0.00000	-3266.43200
48	ENVUSE MIN	0.13281	-2444.84200	0.00000	-3297.02800
48	ENVUSE MIN	0.26563	-2449.35800	0.00000	-3328.87000
48	ENVUSE MIN	0.39844	-2453.87400	0.00000	-3361.96100
48	ENVUSE MIN	0.53125	-2458.38900	0.00000	-3408.22000

19. OUTPUT DATA (기능수행)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.52941	0.00000	0.00000	130.55481
1	ENVEQ MAX	0.64706	0.00000	0.00000	158.42291
1	ENVEQ MAX	0.76471	0.00000	0.00000	191.98965
1	ENVEQ MAX	0.88235	0.00000	0.00000	255.82685
1	ENVEQ MAX	1.00000	0.00000	0.00000	322.48504
1	ENVEQ MIN	0.52941	-169.01251	-836.79901	-388.24319
1	ENVEQ MIN	0.64706	-168.79121	-841.59901	-304.57197
1	ENVEQ MIN	0.76471	-168.56991	-846.39901	-241.33657
1	ENVEQ MIN	0.88235	-168.34861	-851.19901	-194.26547
1	ENVEQ MIN	1.00000	-168.12731	-855.99901	-147.87753
2	ENVEQ MAX	0.00000	0.00000	0.00000	322.48504
2	ENVEQ MAX	0.25000	0.00000	0.00000	352.47004
2	ENVEQ MAX	0.50000	0.00000	0.00000	382.55116
2	ENVEQ MAX	0.75000	0.00000	0.00000	412.72840
2	ENVEQ MAX	1.00000	0.00000	0.00000	443.55146
2	ENVEQ MIN	0.00000	-168.12731	-855.99897	-147.87754
2	ENVEQ MIN	0.25000	-168.02828	-858.14697	-127.03038
2	ENVEQ MIN	0.50000	-167.92925	-860.29497	-106.11112
2	ENVEQ MIN	0.75000	-167.83021	-862.44297	-85.11977
2	ENVEQ MIN	1.00000	-167.73118	-864.59097	-64.05633
3	ENVEQ MAX	0.00000	0.00000	0.00000	443.55146
3	ENVEQ MAX	0.25000	0.00000	0.00000	483.10803
3	ENVEQ MAX	0.50000	0.00000	0.00000	525.84112
3	ENVEQ MAX	0.75000	0.00000	0.00000	571.75073
3	ENVEQ MAX	1.00000	0.00000	0.00000	620.83686
3	ENVEQ MIN	0.00000	-155.43626	-291.15784	-64.05634
3	ENVEQ MIN	0.25000	-154.86697	-303.50584	-16.45401
3	ENVEQ MIN	0.50000	-154.29768	-315.85384	0.00000
3	ENVEQ MIN	0.75000	-153.72838	-328.20184	0.00000
3	ENVEQ MIN	1.00000	-153.15909	-340.54984	0.00000
4	ENVEQ MAX	0.00000	0.00000	86.96290	620.83686
4	ENVEQ MAX	0.25000	0.00000	74.61490	600.27813
4	ENVEQ MAX	0.50000	0.00000	62.26690	582.89592
4	ENVEQ MAX	0.75000	0.00000	49.91890	568.69024
4	ENVEQ MAX	1.00000	0.00000	39.90821	557.66107
4	ENVEQ MIN	0.00000	-142.19231	-31.98790	0.00000
4	ENVEQ MIN	0.25000	-141.62302	-41.24890	0.00000
4	ENVEQ MIN	0.50000	-141.05372	-50.50990	0.00000
4	ENVEQ MIN	0.75000	-140.48443	-59.87155	0.00000
4	ENVEQ MIN	1.00000	-139.91513	-72.21955	0.00000
5	ENVEQ MAX	0.00000	0.00000	147.29460	557.66107
5	ENVEQ MAX	0.25000	0.00000	134.93460	521.32417
5	ENVEQ MAX	0.50000	0.00000	122.57460	488.16997
5	ENVEQ MAX	0.75000	0.00000	110.21460	458.19847
5	ENVEQ MAX	1.00000	0.00000	97.85460	431.40967
5	ENVEQ MIN	0.00000	-130.16250	0.00000	0.00000
5	ENVEQ MIN	0.25000	-129.59266	0.00000	0.00000
5	ENVEQ MIN	0.50000	-129.02281	0.00000	0.00000
5	ENVEQ MIN	0.75000	-128.45296	0.00000	0.00000
5	ENVEQ MIN	1.00000	-127.88311	-1.50903	0.00000
6	ENVEQ MAX	0.00000	0.00000	108.94043	431.40967
6	ENVEQ MAX	0.25000	0.00000	96.59243	405.22828
6	ENVEQ MAX	0.50000	0.00000	84.24443	382.22341
6	ENVEQ MAX	0.75000	0.00000	71.89643	362.39506
6	ENVEQ MAX	1.00000	0.00000	59.54843	345.74323
6	ENVEQ MIN	0.00000	-119.24215	0.00000	0.00000
6	ENVEQ MIN	0.25000	-118.67285	0.00000	0.00000
6	ENVEQ MIN	0.50000	-118.10356	0.00000	0.00000
6	ENVEQ MIN	0.75000	-117.53427	0.00000	0.00000
6	ENVEQ MIN	1.00000	-116.96497	0.00000	0.00000
7	ENVEQ MAX	0.00000	0.00000	59.54843	345.74323
7	ENVEQ MAX	0.25000	0.00000	47.20043	332.25728
7	ENVEQ MAX	0.50000	0.00000	34.85243	321.94785
7	ENVEQ MAX	0.75000	0.00000	22.50443	314.81495
7	ENVEQ MAX	1.00000	0.00000	10.15643	310.85856
7	ENVEQ MIN	0.00000	-109.34060	0.00000	0.00000
7	ENVEQ MIN	0.25000	-108.77131	0.00000	0.00000
7	ENVEQ MIN	0.50000	-108.20201	0.00000	0.00000
7	ENVEQ MIN	0.75000	-107.63272	-0.23708	0.00000
7	ENVEQ MIN	1.00000	-107.06343	-10.18110	0.00000
8	ENVEQ MAX	0.00000	0.00000	10.17923	310.85856
8	ENVEQ MAX	0.25000	0.00000	0.23552	314.81023
8	ENVEQ MAX	0.50000	0.00000	0.00000	321.94359
8	ENVEQ MAX	0.75000	0.00000	0.00000	332.25347
8	ENVEQ MAX	1.00000	0.00000	0.00000	345.73988
8	ENVEQ MIN	0.00000	-107.05992	-10.15832	0.00000
8	ENVEQ MIN	0.25000	-107.62921	-22.50632	0.00000
8	ENVEQ MIN	0.50000	-108.19851	-34.85432	0.00000
8	ENVEQ MIN	0.75000	-108.76780	-47.20232	0.00000
8	ENVEQ MIN	1.00000	-109.33710	-59.55032	0.00000
9	ENVEQ MAX	0.00000	0.00000	0.00000	345.73988
9	ENVEQ MAX	0.25000	0.00000	0.00000	362.39216
9	ENVEQ MAX	0.50000	0.00000	0.00000	382.22096
9	ENVEQ MAX	0.75000	0.00000	0.00000	405.22629
9	ENVEQ MAX	1.00000	0.00000	0.00000	431.40813
9	ENVEQ MIN	0.00000	-116.96033	-59.55032	0.00000
9	ENVEQ MIN	0.25000	-117.52962	-71.89832	0.00000
9	ENVEQ MIN	0.50000	-118.09892	-84.24632	0.00000
9	ENVEQ MIN	0.75000	-118.66821	-96.59432	0.00000
9	ENVEQ MIN	1.00000	-119.23750	-108.94232	0.00000
10	ENVEQ MAX	0.00000	0.00000	1.50904	431.40813
10	ENVEQ MAX	0.25000	0.00000	0.00000	458.16481
10	ENVEQ MAX	0.50000	0.00000	0.00000	488.09801
10	ENVEQ MAX	0.75000	0.00000	0.00000	521.20773
10	ENVEQ MAX	1.00000	0.00000	0.00000	557.49397
10	ENVEQ MIN	0.00000	-127.87729	-97.83684	0.00000
10	ENVEQ MIN	0.25000	-128.44659	-110.18484	0.00000
10	ENVEQ MIN	0.50000	-129.01588	-122.53284	0.00000
10	ENVEQ MIN	0.75000	-129.58518	-134.88084	0.00000
10	ENVEQ MIN	1.00000	-130.15447	-147.22884	0.00000
11	ENVEQ MAX	0.00000	0.00000	72.20008	557.49397
11	ENVEQ MAX	0.25000	0.00000	59.84008	568.54384
11	ENVEQ MAX	0.50000	0.00000	50.47642	582.77642
11	ENVEQ MAX	0.75000	0.00000	41.20642	600.19169
11	ENVEQ MAX	1.00000	0.00000	31.93642	620.78967
11	ENVEQ MIN	0.00000	-139.90479	-39.92980	0.00000
11	ENVEQ MIN	0.25000	-140.47463	-49.96231	0.00000
11	ENVEQ MIN	0.50000	-141.04448	-62.32231	0.00000
11	ENVEQ MIN	0.75000	-141.61433	-74.68231	0.00000
11	ENVEQ MIN	1.00000	-142.18418	-87.04231	0.00000
12	ENVEQ MAX	0.00000	0.00000	340.48974	620.78967
12	ENVEQ MAX	0.25000	0.00000	328.14174	571.71655
12	ENVEQ MAX	0.50000	0.00000	315.79374	525.81995
12	ENVEQ MAX	0.75000	0.00000	303.44574	483.09988
12	ENVEQ MAX	1.00000	0.00000	291.09774	443.55633
12	ENVEQ MIN	0.00000	-153.14974	0.00000	0.00000
12	ENVEQ MIN	0.25000	-153.71903	0.00000	0.00000
12	ENVEQ MIN	0.50000	-154.28832	0.00000	0.00000
12	ENVEQ MIN	0.75000	-154.85762	0.00000	-16.46624
12	ENVEQ MIN	1.00000	-155.42691	0.00000	-64.06008
13	ENVEQ MAX	0.00000	0.00000	864.55423	443.55633
13	ENVEQ MAX	0.25000	0.00000	862.40623	412.73454
13	ENVEQ MAX	0.50000	0.00000	860.25823	382.55863
13	ENVEQ MAX	0.75000	0.00000	858.11023	352.47885
13	ENVEQ MAX	1.00000	0.00000	855.96223	322.49519
13	ENVEQ MIN	0.00000	-167.72053	0.00000	-64.06007
13	ENVEQ MIN	0.25000	-167.81957	0.00000	-85.12260
13	ENVEQ MIN	0.50000	-167.91860	0.00000	-106.11303
13	ENVEQ MIN	0.75000	-168.01763	0.00000	-127.03138
13	ENVEQ MIN	1.00000	-168.11666	0.00000	-147.87763
14	ENVEQ MAX	0.00000	0.00000	855.96228	322.49519
14	ENVEQ MAX	0.11765	0.00000	851.16228	255.83999
14	ENVEQ MAX	0.23529	0.00000	846.36228	192.00200
14	ENVEQ MAX	0.35294	0.00000	841.56228	158.43056
14	ENVEQ MAX	0.47059	0.00000	836.76228	130.56391
14	ENVEQ MIN	0.00000	-168.11666	0.00000	-147.87762
14	ENVEQ MIN	0.11765	-168.33796	0.00000	-194.26345
14	ENVEQ MIN	0.23529	-168.55926	0.00000	-241.32994
14	ENVEQ MIN	0.35294	-168.78056	0.00000	-304.55621
14	ENVEQ MIN	0.47059	-169.00186	0.00000	-388.22376
15	ENVEQ MAX	0.46875	0.00000	3.09997	9.50038
15	ENVEQ MAX	0.60156	0.00000	0.00000	9.37755
15	ENVEQ MAX	0.73438	0.00000	0.00000	9.73510
15	ENVEQ MAX	0.86719	0.00000	0.00000	10.67400
15	ENVEQ MAX	1.00000	0.00000	0.00000	12.29520
15	ENVEQ MIN	0.46875	-1898.12500	-161.43404	-696.81919
15	ENVEQ MIN	0.60156	-1891.05000	-156.85660	-680.05573
15	ENVEQ MIN	0.73438	-1883.97600	-151.32898	-663.82911
15	ENVEQ MIN	0.86719	-1876.90200	-144.85117	-648.24027
15	ENVEQ MIN	1.00000	-1869.82800	-137.42318	-633.39018
16	ENVEQ MAX	0.00000	0.00000	0.00000	12.29520
16	ENVEQ MAX	0.25000	0.00000	0.00000	14.11886
16	ENVEQ MAX	0.50000	0.00000	0.00000	16.48387
16	ENVEQ MAX	0.75000	0.00000	0.00000	19.43913
16	ENVEQ MAX	1.00000	0.00000	0.00000	23.03350
16	ENVEQ MIN	0.00000	-1869.82800	-137.42316	-633.39018
16	ENVEQ MIN	0.25000	-1864.21900	-130.86638	-622.20664
16	ENVEQ MIN	0.50000	-1858.60900	-123.72942	-611.59995
16	ENVEQ MIN	0.75000	-1853.00000	-116.01226	-601.61899
16	ENVEQ MIN	1.00000	-1847.39100	-107.71492	-592.31264
17	ENVEQ MAX	0.00000	0.00000	430.57260	23.03356
17	ENVEQ MAX	0.25000	0.00000	405.32117	0.00000
17	ENVEQ MAX	0.50000	0.00000	383.20197	0.00000
17	ENVEQ MAX	0.75000	0.00000	364.21501	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	0.00000	348.36028	0.00000
17	ENVEQ MIN	0.00000	-2326.40200	-4.41905	-592.31264
17	ENVEQ MIN	0.25000	-2307.49300	0.00000	-647.43793
17	ENVEQ MIN	0.50000	-2288.58500	0.00000	-711.23172
17	ENVEQ MIN	0.75000	-2269.67600	0.00000	-781.85947
17	ENVEQ MIN	1.00000	-2250.76700	0.00000	-857.83802
18	ENVEQ MAX	0.00000	0.00000	630.30563	0.00000
18	ENVEQ MAX	0.25000	0.00000	615.10994	0.00000
18	ENVEQ MAX	0.50000	0.00000	598.12526	0.00000
18	ENVEQ MAX	0.75000	0.00000	579.35158	0.00000
18	ENVEQ MAX	1.00000	0.00000	558.84837	0.00000
18	ENVEQ MIN	0.00000	-2388.68900	0.00000	-857.83802
18	ENVEQ MIN	0.25000	-2369.76400	0.00000	-981.96989
18	ENVEQ MIN	0.50000	-2350.83900	0.00000	-1111.07900
18	ENVEQ MIN	0.75000	-2331.91300	0.00000	-1245.67500
18	ENVEQ MIN	1.00000	-2312.98800	0.00000	-1386.26500
19	ENVEQ MAX	0.00000	0.00000	950.85293	0.00000
19	ENVEQ MAX	0.25000	0.00000	928.50118	0.00000
19	ENVEQ MAX	0.50000	0.00000	904.54688	0.00000
19	ENVEQ MAX	0.75000	0.00000	879.32748	0.00000
19	ENVEQ MAX	1.00000	0.00000	852.31893	0.00000
19	ENVEQ MIN	0.00000	-2460.09800	0.00000	-1386.26500
19	ENVEQ MIN	0.25000	-2444.65200	0.00000	-1585.72400
19	ENVEQ MIN	0.50000	-2434.58400	0.00000	-1815.32100
19	ENVEQ MIN	0.75000	-2424.51600	0.00000	-2068.74200
19	ENVEQ MIN	1.00000	-2414.44800	0.00000	-2314.53900
20	ENVEQ MAX	0.00000	0.00000	1288.44600	0.00000
20	ENVEQ MAX	0.25000	0.00000	1263.92800	0.00000
20	ENVEQ MAX	0.50000	0.00000	1238.12900	0.00000
20	ENVEQ MAX	0.75000	0.00000	1211.05000	0.00000
20	ENVEQ MAX	1.00000	0.00000	1182.69200	0.00000
20	ENVEQ MIN	0.00000	-2574.51400	0.00000	-2314.53900
20	ENVEQ MIN	0.25000	-2565.89800	0.00000	-2624.81700
20	ENVEQ MIN	0.50000	-2557.28200	0.00000	-2928.82700
20	ENVEQ MIN	0.75000	-2548.66600	0.00000	-3226.25800
20	ENVEQ MIN	1.00000	-2540.05000	0.00000	-3516.79800
21	ENVEQ MAX	0.00000	0.00000	1182.69200	0.00000
21	ENVEQ MAX	0.25000	0.00000	1177.81500	0.00000
21	ENVEQ MAX	0.50000	0.00000	1172.90000	0.00000
21	ENVEQ MAX	0.75000	0.00000	1167.94800	0.00000
21	ENVEQ MAX	1.00000	0.00000	1162.95700	0.00000
21	ENVEQ MIN	0.00000	-2540.05000	0.00000	-3516.79800
21	ENVEQ MIN	0.25000	-2538.58200	0.00000	-3564.77400
21	ENVEQ MIN	0.50000	-2537.06400	0.00000	-3612.54700
21	ENVEQ MIN	0.75000	-2535.49500	0.00000	-3660.11500
21	ENVEQ MIN	1.00000	-2533.87700	0.00000	-3707.47500
22	ENVEQ MAX	0.00000	0.00000	1523.33900	0.00000
22	ENVEQ MAX	0.25000	0.00000	1512.90800	0.00000
22	ENVEQ MAX	0.50000	0.00000	1502.33000	0.00000
22	ENVEQ MAX	0.75000	0.00000	1491.60300	0.00000
22	ENVEQ MAX	1.00000	0.00000	1480.72900	0.00000
22	ENVEQ MIN	0.00000	-2703.85400	0.00000	-3707.47500
22	ENVEQ MIN	0.25000	-2700.35100	0.00000	-3835.15400
22	ENVEQ MIN	0.50000	-2696.63500	0.00000	-3961.93100
22	ENVEQ MIN	0.75000	-2692.70600	0.00000	-4087.79200
22	ENVEQ MIN	1.00000	-2688.56500	0.00000	-4212.72500
23	ENVEQ MAX	0.00000	0.00000	1480.72900	0.00000
23	ENVEQ MAX	0.10937	0.00000	1469.27600	0.00000
23	ENVEQ MAX	0.21875	0.00000	1457.65700	0.00000
23	ENVEQ MAX	0.32812	0.00000	1445.87200	0.00000
23	ENVEQ MAX	0.43750	0.00000	1433.92200	0.00000
23	ENVEQ MIN	0.00000	-2688.56500	0.00000	-4212.72500
23	ENVEQ MIN	0.10937	-2684.15300	0.00000	-4341.48200
23	ENVEQ MIN	0.21875	-2679.74100	0.00000	-4469.21100
23	ENVEQ MIN	0.32812	-2675.32900	0.00000	-4595.89700
23	ENVEQ MIN	0.43750	-2670.91800	0.00000	-4721.52500
24	ENVEQ MAX	0.64706	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.73529	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.82353	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.91176	0.00000	0.00000	0.00000
24	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
24	ENVEQ MIN	0.64706	-1491.56400	-2410.41500	-3961.05200
24	ENVEQ MIN	0.73529	-1486.81800	-2377.99300	-3781.48700
24	ENVEQ MIN	0.82353	-1482.07200	-2345.57100	-3604.35300
24	ENVEQ MIN	0.91176	-1477.32700	-2313.15000	-3429.65100
24	ENVEQ MIN	1.00000	-1472.58100	-2280.72800	-3257.38100
25	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
25	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
25	ENVEQ MIN	0.00000	-1472.58100	-2280.72800	-3257.38100
25	ENVEQ MIN	0.25000	-1469.74900	-2261.41300	-3155.75000
25	ENVEQ MIN	0.50000	-1466.91800	-2242.15800	-3054.98300
25	ENVEQ MIN	0.75000	-1464.08600	-2222.96400	-2955.07600
25	ENVEQ MIN	1.00000	-1461.25400	-2203.82900	-2856.02700
26	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
26	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
26	ENVEQ MIN	0.00000	-1490.64200	-2203.75800	-2856.02700
26	ENVEQ MIN	0.25000	-1485.56400	-2169.59500	-2680.54800
26	ENVEQ MIN	0.50000	-1480.48600	-2135.62500	-2507.80200
26	ENVEQ MIN	0.75000	-1475.40800	-2101.84700	-2337.77500
26	ENVEQ MIN	1.00000	-1470.33100	-2068.26300	-2170.45000
27	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
27	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
27	ENVEQ MIN	0.00000	-1470.33100	-2068.26300	-2170.45000
27	ENVEQ MIN	0.25000	-1459.13100	-1994.40300	-1810.90400
27	ENVEQ MIN	0.50000	-1447.93100	-1920.54200	-1464.43200
27	ENVEQ MIN	0.75000	-1436.73100	-1846.68200	-1131.03200
27	ENVEQ MIN	1.00000	-1425.53100	-1772.82200	-814.86861
28	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
28	ENVEQ MAX	0.25000	0.00000	0.00000	130.56178
28	ENVEQ MAX	0.50000	0.00000	0.00000	451.48420
28	ENVEQ MAX	0.75000	0.00000	0.00000	807.50469
28	ENVEQ MAX	1.00000	0.00000	0.00000	1135.85600
28	ENVEQ MIN	0.00000	-1458.20300	-1772.70900	-814.86861
28	ENVEQ MIN	0.25000	-1441.91000	-1665.25700	-379.05354
28	ENVEQ MIN	0.50000	-1425.61600	-1557.80500	-82.12089
28	ENVEQ MIN	0.75000	-1409.32300	-1450.35200	0.00000
28	ENVEQ MIN	1.00000	-1393.02900	-1342.90000	0.00000
29	ENVEQ MAX	0.00000	0.00000	0.00000	1135.85600
29	ENVEQ MAX	0.25000	0.00000	0.00000	1436.22000
29	ENVEQ MAX	0.50000	0.00000	0.00000	1708.96900
29	ENVEQ MAX	0.75000	0.00000	0.00000	1957.52900
29	ENVEQ MAX	1.00000	0.00000	0.00000	2178.50700
29	ENVEQ MIN	0.00000	-1429.00900	-1342.74300	0.00000
29	ENVEQ MIN	0.25000	-1412.73100	-1235.39400	0.00000
29	ENVEQ MIN	0.50000	-1396.45300	-1128.04600	0.00000
29	ENVEQ MIN	0.75000	-1380.17500	-1020.69800	0.00000
29	ENVEQ MIN	1.00000	-1363.89800	-913.35031	0.00000
30	ENVEQ MAX	0.00000	0.00000	0.00000	2178.50700
30	ENVEQ MAX	0.25000	0.00000	0.00000	2371.82000
30	ENVEQ MAX	0.50000	0.00000	0.00000	2537.51700
30	ENVEQ MAX	0.75000	0.00000	0.00000	2675.59800
30	ENVEQ MAX	1.00000	0.00000	0.00000	2786.06500
30	ENVEQ MIN	0.00000	-1403.11400	-913.15298	0.00000
30	ENVEQ MIN	0.25000	-1386.83600	-805.80492	0.00000
30	ENVEQ MIN	0.50000	-1370.55900	-698.45686	0.00000
30	ENVEQ MIN	0.75000	-1354.28100	-591.65638	0.00000
30	ENVEQ MIN	1.00000	-1344.28800	-486.88082	0.00000
31	ENVEQ MAX	0.00000	0.00000	0.00000	2786.06500
31	ENVEQ MAX	0.25000	0.00000	0.00000	2868.85800
31	ENVEQ MAX	0.50000	0.00000	0.00000	2924.03600
31	ENVEQ MAX	0.75000	0.00000	6.32025	2951.59900
31	ENVEQ MAX	1.00000	0.00000	72.72344	2951.54600
31	ENVEQ MIN	0.00000	-1380.39600	-486.65869	0.00000
31	ENVEQ MIN	0.25000	-1364.11800	-381.88314	0.00000
31	ENVEQ MIN	0.50000	-1347.84100	-277.10758	0.00000
31	ENVEQ MIN	0.75000	-1344.52500	-172.33202	0.00000
31	ENVEQ MIN	1.00000	-1360.80300	-67.55646	0.00000
32	ENVEQ MAX	0.00000	0.00000	67.55746	2951.54600
32	ENVEQ MAX	0.25000	0.00000	172.33302	2951.59800
32	ENVEQ MAX	0.50000	0.00000	277.10858	2924.03500
32	ENVEQ MAX	0.75000	0.00000	381.88414	2868.85700
32	ENVEQ MAX	1.00000	0.00000	486.65970	2786.06300
32	ENVEQ MIN	0.00000	-1360.80200	-72.72309	0.00000
32	ENVEQ MIN	0.25000	-1344.52500	-6.31998	0.00000
32	ENVEQ MIN	0.50000	-1347.84100	0.00000	0.00000
32	ENVEQ MIN	0.75000	-1364.11900	0.00000	0.00000
32	ENVEQ MIN	1.00000	-1380.39700	0.00000	0.00000
33	ENVEQ MAX	0.00000	0.00000	486.88182	2786.06300
33	ENVEQ MAX	0.25000	0.00000	591.65738	2675.59700
33	ENVEQ MAX	0.50000	0.00000	698.45787	2537.51500
33	ENVEQ MAX	0.75000	0.00000	805.80593	2371.81700
33	ENVEQ MAX	1.00000	0.00000	913.15399	2178.50500
33	ENVEQ MIN	0.00000	-1344.28700	0.00000	0.00000
33	ENVEQ MIN	0.25000	-1354.28100	0.00000	0.00000
33	ENVEQ MIN	0.50000	-1370.55900	0.00000	0.00000
33	ENVEQ MIN	0.75000	-1386.83600	0.00000	0.00000
33	ENVEQ MIN	1.00000	-1403.11400	0.00000	0.00000
34	ENVEQ MAX	0.00000	0.00000	913.35132	2178.50500
34	ENVEQ MAX	0.25000	0.00000	1020.80400	1957.29800
34	ENVEQ MAX	0.50000	0.00000	1128.25600	1708.46200
34	ENVEQ MAX	0.75000	0.00000	1235.70800	1435.38100
34	ENVEQ MAX	1.00000	0.00000	1343.16100	1134.63100
34	ENVEQ MIN	0.00000	-1363.89700	0.00000	0.00000
34	ENVEQ MIN	0.25000	-1380.19100	0.00000	0.00000
34	ENVEQ MIN	0.50000	-1396.48500	0.00000	0.00000
34	ENVEQ MIN	0.75000	-1412.77800	0.00000	0.00000
34	ENVEQ MIN	1.00000	-1429.07200	0.00000	0.00000
35	ENVEQ MAX	0.00000	0.00000	1343.31800	1134.63100
35	ENVEQ MAX	0.25000	0.00000	1450.66600	806.50445

FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	1558.01400	450.76227
35	ENVEQ MAX	0.75000	0.00000	1665.36200	130.39598
35	ENVEQ MAX	1.00000	0.00000	1772.71000	0.00000
35	ENVEQ MIN	0.00000	-1393.09500	0.00000	0.00000
35	ENVEQ MIN	0.25000	-1409.37300	0.00000	0.00000
35	ENVEQ MIN	0.50000	-1425.65000	0.00000	-82.48622
35	ENVEQ MIN	0.75000	-1441.92800	0.00000	-379.46695
35	ENVEQ MIN	1.00000	-1458.20600	0.00000	-814.87224
36	ENVEQ MAX	0.00000	0.00000	1772.82300	0.00000
36	ENVEQ MAX	0.25000	0.00000	1846.68300	0.00000
36	ENVEQ MAX	0.50000	0.00000	1920.54300	0.00000
36	ENVEQ MAX	0.75000	0.00000	1994.40400	0.00000
36	ENVEQ MAX	1.00000	0.00000	2068.26400	0.00000
36	ENVEQ MIN	0.00000	-1425.53400	0.00000	-814.87224
36	ENVEQ MIN	0.25000	-1436.73300	0.00000	-1131.03600
36	ENVEQ MIN	0.50000	-1447.93300	0.00000	-1464.43600
36	ENVEQ MIN	0.75000	-1459.13300	0.00000	-1810.90900
36	ENVEQ MIN	1.00000	-1470.33300	0.00000	-2170.45500
37	ENVEQ MAX	0.00000	0.00000	2068.26400	0.00000
37	ENVEQ MAX	0.25000	0.00000	2101.84800	0.00000
37	ENVEQ MAX	0.50000	0.00000	2135.62500	0.00000
37	ENVEQ MAX	0.75000	0.00000	2169.59600	0.00000
37	ENVEQ MAX	1.00000	0.00000	2203.75900	0.00000
37	ENVEQ MIN	0.00000	-1470.33300	0.00000	-2170.45500
37	ENVEQ MIN	0.25000	-1475.41100	0.00000	-2337.77900
37	ENVEQ MIN	0.50000	-1480.48900	0.00000	-2507.80600
37	ENVEQ MIN	0.75000	-1485.56700	0.00000	-2680.55200
37	ENVEQ MIN	1.00000	-1490.64500	0.00000	-2856.03200
38	ENVEQ MAX	0.00000	0.00000	2203.83000	0.00000
38	ENVEQ MAX	0.25000	0.00000	2222.96500	0.00000
38	ENVEQ MAX	0.50000	0.00000	2242.15900	0.00000
38	ENVEQ MAX	0.75000	0.00000	2261.41400	0.00000
38	ENVEQ MAX	1.00000	0.00000	2280.72900	0.00000
38	ENVEQ MIN	0.00000	-1461.25700	0.00000	-2856.03200
38	ENVEQ MIN	0.25000	-1464.08800	0.00000	-2955.08100
38	ENVEQ MIN	0.50000	-1466.92000	0.00000	-3054.98800
38	ENVEQ MIN	0.75000	-1469.75100	0.00000	-3155.75500
38	ENVEQ MIN	1.00000	-1472.58300	0.00000	-3257.38500
39	ENVEQ MAX	0.00000	0.00000	2280.72900	0.00000
39	ENVEQ MAX	0.08824	0.00000	2313.15100	0.00000
39	ENVEQ MAX	0.17647	0.00000	2345.57200	0.00000
39	ENVEQ MAX	0.26471	0.00000	2377.99400	0.00000
39	ENVEQ MAX	0.35294	0.00000	2410.41600	0.00000
39	ENVEQ MIN	0.00000	-1472.58300	0.00000	-3257.38500
39	ENVEQ MIN	0.08824	-1477.32900	0.00000	-3429.65600
39	ENVEQ MIN	0.17647	-1482.07500	0.00000	-3604.35800
39	ENVEQ MIN	0.26471	-1486.82000	0.00000	-3781.49200
39	ENVEQ MIN	0.35294	-1491.56600	0.00000	-3961.05700
40	ENVEQ MAX	0.56250	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.67188	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.78125	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.89063	0.00000	0.00000	0.00000
40	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
40	ENVEQ MIN	0.56250	-2670.91900	-1433.92200	-4721.53000
40	ENVEQ MIN	0.67188	-2675.33000	-1445.87300	-4595.90200
40	ENVEQ MIN	0.78125	-2679.74200	-1457.65800	-4469.21600
40	ENVEQ MIN	0.89063	-2684.15400	-1469.27700	-4341.48700
40	ENVEQ MIN	1.00000	-2688.56600	-1480.73000	-4212.73000
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
41	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	-2688.56500	-1480.73000	-4212.73000
41	ENVEQ MIN	0.25000	-2692.70700	-1491.60400	-4087.79600
41	ENVEQ MIN	0.50000	-2696.63600	-1502.33000	-3961.93500
41	ENVEQ MIN	0.75000	-2700.35200	-1512.90900	-3835.15900
41	ENVEQ MIN	1.00000	-2703.85500	-1523.33900	-3707.48000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
42	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	-2533.88000	-1162.95600	-3707.48000
42	ENVEQ MIN	0.25000	-2535.49800	-1167.94700	-3660.11900
42	ENVEQ MIN	0.50000	-2537.06600	-1172.89900	-3612.55200
42	ENVEQ MIN	0.75000	-2538.58400	-1177.81400	-3564.77900
42	ENVEQ MIN	1.00000	-2540.05300	-1182.69100	-3516.80300
43	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
43	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
43	ENVEQ MIN	0.00000	-2540.05300	-1182.69100	-3516.80300
43	ENVEQ MIN	0.25000	-2548.66900	-1211.05000	-3226.26300
43	ENVEQ MIN	0.50000	-2557.28500	-1238.12800	-2928.83200
43	ENVEQ MIN	0.75000	-2565.90000	-1263.92700	-2624.82200
43	ENVEQ MIN	1.00000	-2574.51600	-1288.44500	-2314.54500
44	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
44	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
44	ENVEQ MIN	0.00000	-2414.45200	-852.31580	-2314.54500
44	ENVEQ MIN	0.25000	-2424.52000	-879.32434	-2068.74900
44	ENVEQ MIN	0.50000	-2434.58800	-904.54375	-1815.32900
44	ENVEQ MIN	0.75000	-2444.65600	-928.49804	-1585.73300
44	ENVEQ MIN	1.00000	-2460.10300	-950.84979	-1386.27400
45	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
45	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
45	ENVEQ MIN	0.00000	-2312.99500	-558.84291	-1386.27400
45	ENVEQ MIN	0.25000	-2331.92000	-579.34612	-1245.68600
45	ENVEQ MIN	0.50000	-2350.84600	-598.11980	-1111.09200
45	ENVEQ MIN	0.75000	-2369.77100	-615.10449	-981.98370
45	ENVEQ MIN	1.00000	-2388.69600	-630.30017	-857.85338
46	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
46	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
46	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
46	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
46	ENVEQ MAX	1.00000	0.00000	4.42246	23.02330
46	ENVEQ MIN	0.00000	-2250.77600	-348.35282	-857.85338
46	ENVEQ MIN	0.25000	-2269.68500	-364.20755	-781.87699
46	ENVEQ MIN	0.50000	-2288.59400	-383.19451	-711.25141
46	ENVEQ MIN	0.75000	-2307.50300	-405.31371	-647.45964
46	ENVEQ MIN	1.00000	-2326.41100	-430.56514	-592.33650
47	ENVEQ MAX	0.00000	0.00000	107.72557	23.02324
47	ENVEQ MAX	0.25000	0.00000	116.02291	19.42850
47	ENVEQ MAX	0.50000	0.00000	123.74006	16.47287
47	ENVEQ MAX	0.75000	0.00000	130.87702	14.10748
47	ENVEQ MAX	1.00000	0.00000	137.43380	12.28345
47	ENVEQ MIN	0.00000	-1847.40800	0.00000	-592.33650
47	ENVEQ MIN	0.25000	-1853.01700	0.00000	-601.64375
47	ENVEQ MIN	0.50000	-1858.62600	0.00000	-611.62560
47	ENVEQ MIN	0.75000	-1864.23600	0.00000	-622.23319
47	ENVEQ MIN	1.00000	-1869.84500	0.00000	-633.41762
48	ENVEQ MAX	0.00000	0.00000	137.43382	12.28345
48	ENVEQ MAX	0.13281	0.00000	144.86182	10.66179
48	ENVEQ MAX	0.26563	0.00000	151.33963	9.72242
48	ENVEQ MAX	0.39844	0.00000	156.86725	9.36440
48	ENVEQ MAX	0.53125	0.00000	161.44468	9.48676
48	ENVEQ MIN	0.00000	-1869.84500	0.00000	-633.41762
48	ENVEQ MIN	0.13281	-1876.91900	0.00000	-648.26883
48	ENVEQ MIN	0.26563	-1883.99300	0.00000	-663.85880
48	ENVEQ MIN	0.39844	-1891.06700	0.00000	-680.08655
48	ENVEQ MIN	0.53125	-1898.14100	-3.09556	-696.85113

20. OUTPUT DATA (붕괴방지)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.52941	65.83270	0.00000	85.31166
1	ENVEQ MAX	0.64706	65.97460	0.00000	126.75927
1	ENVEQ MAX	0.76471	66.11650	0.00000	169.37542
1	ENVEQ MAX	0.88235	66.25840	0.00000	212.62651
1	ENVEQ MAX	1.00000	66.40030	0.00000	256.23759
1	ENVEQ MIN	0.52941	-97.38821	-1133.27700	-875.51880
1	ENVEQ MIN	0.64706	-97.53011	-1138.07700	-762.40211
1	ENVEQ MIN	0.76471	-97.67201	-1142.87700	-648.80543
1	ENVEQ MIN	0.88235	-97.81391	-1147.67700	-534.72874
1	ENVEQ MIN	1.00000	-97.95581	-1152.47700	-425.69949
2	ENVEQ MAX	0.00000	66.40031	0.00000	256.23759
2	ENVEQ MAX	0.25000	66.46381	0.00000	275.87015
2	ENVEQ MAX	0.50000	66.52731	0.00000	307.02940
2	ENVEQ MAX	0.75000	66.59081	0.00000	350.63321
2	ENVEQ MAX	1.00000	66.65431	0.00000	394.33314
2	ENVEQ MIN	0.00000	-97.86176	-1152.47700	-425.69949
2	ENVEQ MIN	0.25000	-97.92526	-1154.62500	-389.84721
2	ENVEQ MIN	0.50000	-97.98876	-1156.77300	-359.92334
2	ENVEQ MIN	0.75000	-98.05226	-1158.92100	-332.34120
2	ENVEQ MIN	1.00000	-98.11576	-1161.06900	-304.68696
3	ENVEQ MAX	0.00000	54.22735	0.00000	394.33314
3	ENVEQ MAX	0.25000	54.59239	0.00000	503.55471
3	ENVEQ MAX	0.50000	54.95743	0.00000	616.72057
3	ENVEQ MAX	0.75000	55.32247	0.00000	734.90768
3	ENVEQ MAX	1.00000	55.68750	0.00000	856.27131
3	ENVEQ MIN	0.00000	-84.73272	-597.54133	-304.68696
3	ENVEQ MIN	0.25000	-85.09776	-609.88933	-216.60778
3	ENVEQ MIN	0.50000	-85.46279	-622.23733	-126.19040
3	ENVEQ MIN	0.75000	-85.82783	-634.58533	-35.12107
3	ENVEQ MIN	1.00000	-86.19287	-646.93333	0.00000
4	ENVEQ MAX	0.00000	43.44534	0.00000	856.27131
4	ENVEQ MAX	0.25000	43.81038	0.00000	887.79022
4	ENVEQ MAX	0.50000	44.17542	0.00000	922.48564
4	ENVEQ MAX	0.75000	44.54045	0.00000	960.35759
4	ENVEQ MAX	1.00000	44.90549	0.00000	1001.40600
4	ENVEQ MIN	0.00000	-73.04214	-261.32818	0.00000
4	ENVEQ MIN	0.25000	-73.40718	-273.67618	0.00000
4	ENVEQ MIN	0.50000	-73.77222	-286.02418	0.00000
4	ENVEQ MIN	0.75000	-74.13726	-298.37218	0.00000
4	ENVEQ MIN	1.00000	-74.50229	-310.72018	0.00000
5	ENVEQ MAX	0.00000	32.93702	51.99778	1001.40600
5	ENVEQ MAX	0.25000	33.30242	42.72778	993.39913
5	ENVEQ MAX	0.50000	33.66781	33.45778	988.57490
5	ENVEQ MAX	0.75000	34.03320	24.18778	986.93337
5	ENVEQ MAX	1.00000	34.39859	14.91778	988.47454
5	ENVEQ MIN	0.00000	-61.61382	-75.59147	0.00000
5	ENVEQ MIN	0.25000	-61.97921	-87.95147	0.00000
5	ENVEQ MIN	0.50000	-62.34460	-100.31147	0.00000
5	ENVEQ MIN	0.75000	-62.71000	-112.67147	0.00000
5	ENVEQ MIN	1.00000	-63.07539	-125.03147	0.00000
6	ENVEQ MAX	0.00000	23.12209	84.55311	988.47454
6	ENVEQ MAX	0.25000	23.48713	72.20511	968.51530
6	ENVEQ MAX	0.50000	23.85217	59.85711	951.73258
6	ENVEQ MAX	0.75000	24.21721	47.50911	938.12638
6	ENVEQ MAX	1.00000	24.58224	36.65873	927.69671
6	ENVEQ MIN	0.00000	-50.40641	-22.98892	0.00000
6	ENVEQ MIN	0.25000	-50.77145	-32.24992	0.00000
6	ENVEQ MIN	0.50000	-51.13649	-41.51092	0.00000
6	ENVEQ MIN	0.75000	-51.50153	-50.77192	0.00000
6	ENVEQ MIN	1.00000	-51.86656	-61.90016	0.00000
7	ENVEQ MAX	0.00000	13.38594	73.32266	927.69671
7	ENVEQ MAX	0.25000	13.75098	60.97466	910.72523
7	ENVEQ MAX	0.50000	14.11602	48.62666	896.93027
7	ENVEQ MAX	0.75000	14.48106	36.27866	886.31184
7	ENVEQ MAX	1.00000	14.84609	26.11219	878.86992
7	ENVEQ MIN	0.00000	-39.37606	-14.39280	0.00000
7	ENVEQ MIN	0.25000	-39.74110	-23.65380	0.00000
7	ENVEQ MIN	0.50000	-40.10614	-32.91480	0.00000
7	ENVEQ MIN	0.75000	-40.47118	-42.61807	0.00000
7	ENVEQ MIN	1.00000	-40.83621	-54.96607	0.00000
8	ENVEQ MAX	0.00000	14.84514	54.95414	878.86992
8	ENVEQ MAX	0.25000	14.48010	42.60614	886.31206
8	ENVEQ MAX	0.50000	14.11507	32.90560	896.93357
8	ENVEQ MAX	0.75000	13.75003	23.64460	910.73160
8	ENVEQ MAX	1.00000	13.38499	14.38360	927.70616
8	ENVEQ MIN	0.00000	-40.83670	-26.12094	0.00000
8	ENVEQ MIN	0.25000	-40.47167	-36.29056	0.00000
8	ENVEQ MIN	0.50000	-40.10663	-48.63856	0.00000
8	ENVEQ MIN	0.75000	-39.74159	-60.98656	0.00000
8	ENVEQ MIN	1.00000	-39.37655	-73.33456	0.00000
9	ENVEQ MAX	0.00000	24.58180	61.89053	927.70616
9	ENVEQ MAX	0.25000	24.21676	50.76406	938.13716
9	ENVEQ MAX	0.50000	23.85172	41.50306	951.74468
9	ENVEQ MAX	0.75000	23.48669	32.24206	968.52872
9	ENVEQ MAX	1.00000	23.12165	22.98106	988.48929
9	ENVEQ MIN	0.00000	-51.86691	-36.66218	0.00000
9	ENVEQ MIN	0.25000	-51.50187	-47.51426	0.00000
9	ENVEQ MIN	0.50000	-51.13684	-59.86226	0.00000
9	ENVEQ MIN	0.75000	-50.77180	-72.21026	0.00000
9	ENVEQ MIN	1.00000	-50.40676	-84.55826	0.00000
10	ENVEQ MAX	0.00000	34.39866	125.03412	988.48929
10	ENVEQ MAX	0.25000	34.03362	112.68612	986.94604
10	ENVEQ MAX	0.50000	33.66858	100.33812	988.57932
10	ENVEQ MAX	0.75000	33.30355	87.99012	993.38912
10	ENVEQ MAX	1.00000	32.93851	75.64212	1001.37500
10	ENVEQ MIN	0.00000	-63.07553	-14.91558	0.00000
10	ENVEQ MIN	0.25000	-62.71049	-24.17658	0.00000
10	ENVEQ MIN	0.50000	-62.34545	-33.43758	0.00000
10	ENVEQ MIN	0.75000	-61.98041	-42.69858	0.00000
10	ENVEQ MIN	1.00000	-61.61538	-51.95958	0.00000
11	ENVEQ MAX	0.00000	44.90731	310.66442	1001.37500
11	ENVEQ MAX	0.25000	44.54192	298.30442	960.30165
11	ENVEQ MAX	0.50000	44.17652	285.94442	922.41057
11	ENVEQ MAX	0.75000	43.81113	273.58442	887.70218
11	ENVEQ MAX	1.00000	43.44574	261.22442	856.17649
11	ENVEQ MIN	0.00000	-74.50350	0.00000	0.00000
11	ENVEQ MIN	0.25000	-74.13811	0.00000	0.00000
11	ENVEQ MIN	0.50000	-73.77271	0.00000	0.00000
11	ENVEQ MIN	0.75000	-73.40732	0.00000	0.00000
11	ENVEQ MIN	1.00000	-73.04193	0.00000	0.00000
12	ENVEQ MAX	0.00000	55.68845	646.85670	856.17649
12	ENVEQ MAX	0.25000	55.32341	634.50870	734.83146
12	ENVEQ MAX	0.50000	54.95838	622.16070	616.66295
12	ENVEQ MAX	0.75000	54.59334	609.81270	503.51637
12	ENVEQ MAX	1.00000	54.22830	597.46470	394.31311
12	ENVEQ MIN	0.00000	-86.19264	0.00000	0.00000
12	ENVEQ MIN	0.25000	-85.82760	0.00000	-35.16813
12	ENVEQ MIN	0.50000	-85.46256	0.00000	-126.22743
12	ENVEQ MIN	0.75000	-85.09752	0.00000	-216.63506
12	ENVEQ MIN	1.00000	-84.73248	0.00000	-304.70398
13	ENVEQ MAX	0.00000	66.65581	1161.01600	394.31311
13	ENVEQ MAX	0.25000	66.59230	1158.86800	350.61536
13	ENVEQ MAX	0.50000	66.52880	1156.72000	307.01374
13	ENVEQ MAX	0.75000	66.46530	1154.57200	275.86358
13	ENVEQ MAX	1.00000	66.40180	1152.42400	256.23211
13	ENVEQ MIN	0.00000	-98.11543	0.00000	-304.70398
13	ENVEQ MIN	0.25000	-98.05193	0.00000	-332.35699
13	ENVEQ MIN	0.50000	-97.98843	0.00000	-359.93790
13	ENVEQ MIN	0.75000	-97.92493	0.00000	-389.86356
13	ENVEQ MIN	1.00000	-97.86143	0.00000	-425.71418
14	ENVEQ MAX	0.00000	66.40180	1152.42400	256.23211
14	ENVEQ MAX	0.11765	66.25990	1147.62400	212.62346
14	ENVEQ MAX	0.23529	66.11800	1142.82400	169.37480
14	ENVEQ MAX	0.35294	65.97610	1138.02400	126.76124
14	ENVEQ MAX	0.47059	65.83420	1133.22400	85.31602
14	ENVEQ MIN	0.00000	-97.95548	0.00000	-425.71418
14	ENVEQ MIN	0.11765	-97.81358	0.00000	-534.74094
14	ENVEQ MIN	0.23529	-97.67168	0.00000	-648.81237
14	ENVEQ MIN	0.35294	-97.52978	0.00000	-762.40380
14	ENVEQ MIN	0.47059	-97.38788	0.00000	-875.51523
15	ENVEQ MAX	0.46875	0.00000	132.69921	0.00000
15	ENVEQ MAX	0.60156	0.00000	129.13552	0.00000
15	ENVEQ MAX	0.73438	0.00000	124.82017	0.00000
15	ENVEQ MAX	0.86719	0.00000	119.75317	0.00000
15	ENVEQ MAX	1.00000	0.00000	113.93452	0.00000
15	ENVEQ MIN	0.46875	-2058.79300	-90.43607	-1359.43300
15	ENVEQ MIN	0.60156	-2052.05500	-86.87237	-1354.68300
15	ENVEQ MIN	0.73438	-2045.31800	-82.55703	-1350.40700
15	ENVEQ MIN	0.86719	-2038.58100	-77.49003	-1346.68600
15	ENVEQ MIN	1.00000	-2031.84300	-71.67137	-1343.60000
16	ENVEQ MAX	0.00000	0.00000	113.93458	0.00000
16	ENVEQ MAX	0.25000	0.00000	108.78951	0.00000
16	ENVEQ MAX	0.50000	0.00000	103.17800	0.00000
16	ENVEQ MAX	0.75000	0.00000	97.10007	0.00000
16	ENVEQ MAX	1.00000	0.00000	90.55571	0.00000
16	ENVEQ MIN	0.00000	-2031.84400	-71.75549	-1343.60000
16	ENVEQ MIN	0.25000	-2026.50100	-66.61042	-1341.65800
16	ENVEQ MIN	0.50000	-2021.15900	-60.99892	-1340.34300
16	ENVEQ MIN	0.75000	-2015.81700	-54.92098	-1339.74100
16	ENVEQ MIN	1.00000	-2010.47400	-48.37662	-1339.68900
17	ENVEQ MAX	0.00000	0.00000	514.91414	0.00000
17	ENVEQ MAX	0.25000	0.00000	493.29599	0.00000
17	ENVEQ MAX	0.50000	0.00000	474.77627	0.00000
17	ENVEQ MAX	0.75000	0.00000	458.78218	0.00000

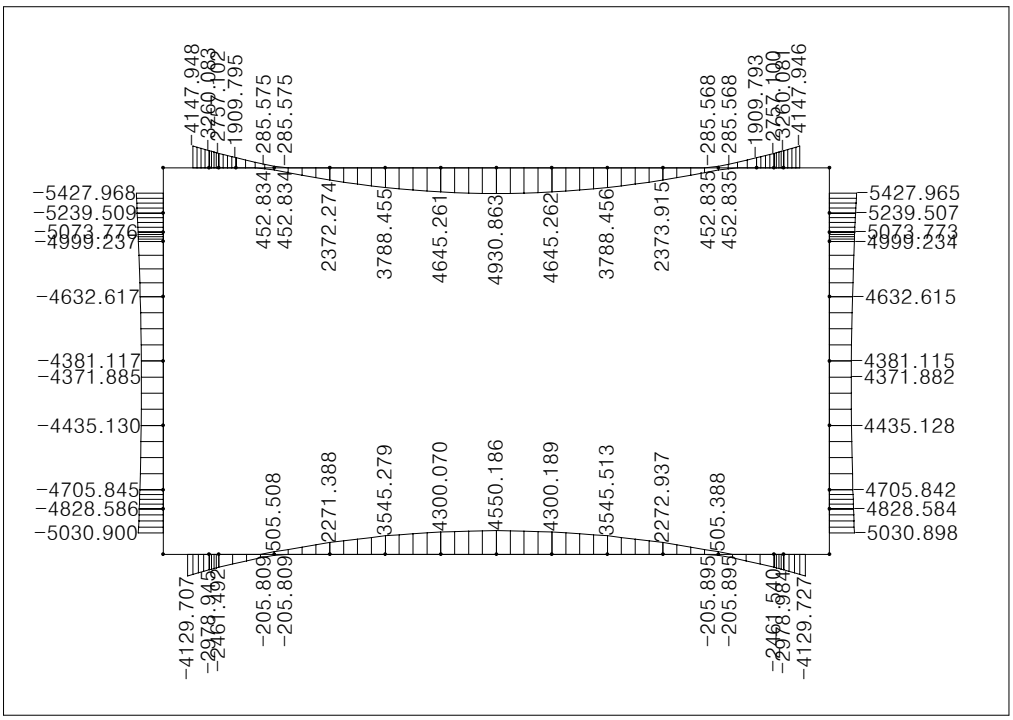
FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	0.00000	445.24510	0.00000
17	ENVEQ MIN	0.00000	-2417.88400	-48.56294	-1339.68900
17	ENVEQ MIN	0.25000	-2399.87500	-26.94478	-1394.28000
17	ENVEQ MIN	0.50000	-2381.86700	-7.78366	-1454.86400
17	ENVEQ MIN	0.75000	-2363.85800	0.00000	-1520.74200
17	ENVEQ MIN	1.00000	-2350.58100	0.00000	-1591.21700
18	ENVEQ MAX	0.00000	0.00000	646.78077	0.00000
18	ENVEQ MAX	0.25000	0.00000	633.74787	0.00000
18	ENVEQ MAX	0.50000	0.00000	619.28797	0.00000
18	ENVEQ MAX	0.75000	0.00000	603.40106	0.00000
18	ENVEQ MAX	1.00000	0.00000	586.08714	0.00000
18	ENVEQ MIN	0.00000	-2472.55200	0.00000	-1591.21700
18	ENVEQ MIN	0.25000	-2461.58300	0.00000	-1690.38800
18	ENVEQ MIN	0.50000	-2450.61300	0.00000	-1793.87000
18	ENVEQ MIN	0.75000	-2439.64400	0.00000	-1902.06900
18	ENVEQ MIN	1.00000	-2428.67500	0.00000	-2015.39100
19	ENVEQ MAX	0.00000	0.00000	847.83589	0.00000
19	ENVEQ MAX	0.25000	0.00000	829.09500	0.00000
19	ENVEQ MAX	0.50000	0.00000	809.46553	0.00000
19	ENVEQ MAX	0.75000	0.00000	788.58139	0.00000
19	ENVEQ MAX	1.00000	0.00000	766.27033	0.00000
19	ENVEQ MIN	0.00000	-2554.38700	0.00000	-2015.39100
19	ENVEQ MIN	0.25000	-2543.41800	0.00000	-2227.00200
19	ENVEQ MIN	0.50000	-2532.44900	0.00000	-2459.84000
19	ENVEQ MIN	0.75000	-2521.48000	0.00000	-2686.74200
19	ENVEQ MIN	1.00000	-2510.51000	0.00000	-2907.30300
20	ENVEQ MAX	0.00000	0.00000	1046.09700	0.00000
20	ENVEQ MAX	0.25000	0.00000	1025.87700	0.00000
20	ENVEQ MAX	0.50000	0.00000	1004.62200	0.00000
20	ENVEQ MAX	0.75000	0.00000	982.33321	0.00000
20	ENVEQ MAX	1.00000	0.00000	959.01031	0.00000
20	ENVEQ MIN	0.00000	-2640.08900	0.00000	-2907.30300
20	ENVEQ MIN	0.25000	-2630.70200	0.00000	-3158.93300
20	ENVEQ MIN	0.50000	-2621.31500	0.00000	-3405.37000
20	ENVEQ MIN	0.75000	-2611.92800	0.00000	-3646.36400
20	ENVEQ MIN	1.00000	-2602.54100	0.00000	-3881.66200
21	ENVEQ MAX	0.00000	0.00000	959.01046	0.00000
21	ENVEQ MAX	0.25000	0.00000	955.00187	0.00000
21	ENVEQ MAX	0.50000	0.00000	950.96358	0.00000
21	ENVEQ MAX	0.75000	0.00000	946.89559	0.00000
21	ENVEQ MAX	1.00000	0.00000	942.79791	0.00000
21	ENVEQ MIN	0.00000	-2602.54100	0.00000	-3881.66200
21	ENVEQ MIN	0.25000	-2600.94400	0.00000	-3920.50500
21	ENVEQ MIN	0.50000	-2599.29600	0.00000	-3959.18000
21	ENVEQ MIN	0.75000	-2597.59900	0.00000	-3997.68600
21	ENVEQ MIN	1.00000	-2595.85200	0.00000	-4036.02100
22	ENVEQ MAX	0.00000	0.00000	1180.22400	0.00000
22	ENVEQ MAX	0.25000	0.00000	1171.66000	0.00000
22	ENVEQ MAX	0.50000	0.00000	1162.97300	0.00000
22	ENVEQ MAX	0.75000	0.00000	1154.16400	0.00000
22	ENVEQ MAX	1.00000	0.00000	1145.23100	0.00000
22	ENVEQ MIN	0.00000	-2729.39800	0.00000	-4036.02100
22	ENVEQ MIN	0.25000	-2725.62800	0.00000	-4134.76900
22	ENVEQ MIN	0.50000	-2721.64500	0.00000	-4232.77200
22	ENVEQ MIN	0.75000	-2717.44900	0.00000	-4330.02000
22	ENVEQ MIN	1.00000	-2713.04000	0.00000	-4426.50400
23	ENVEQ MAX	0.00000	0.00000	1145.23100	0.00000
23	ENVEQ MAX	0.10937	0.00000	1135.82400	0.00000
23	ENVEQ MAX	0.21875	0.00000	1126.28300	0.00000
23	ENVEQ MAX	0.32812	0.00000	1116.60900	0.00000
23	ENVEQ MAX	0.43750	0.00000	1106.80200	0.00000
23	ENVEQ MIN	0.00000	-2713.04100	0.00000	-4426.50400
23	ENVEQ MIN	0.10937	-2708.35100	0.00000	-4525.88800
23	ENVEQ MIN	0.21875	-2703.66200	0.00000	-4624.42400
23	ENVEQ MIN	0.32812	-2698.97300	0.00000	-4722.10000
23	ENVEQ MIN	0.43750	-2694.28400	0.00000	-4818.90500
24	ENVEQ MAX	0.64706	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.73529	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.82353	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.91176	0.00000	0.00000	0.00000
24	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
24	ENVEQ MIN	0.64706	-1180.90600	-2432.35800	-3901.79600
24	ENVEQ MIN	0.73529	-1176.84000	-2399.93600	-3720.58500
24	ENVEQ MIN	0.82353	-1172.77500	-2367.51500	-3541.80500
24	ENVEQ MIN	0.91176	-1168.70900	-2335.09300	-3365.45800
24	ENVEQ MIN	1.00000	-1164.64400	-2302.67100	-3191.54100
25	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
25	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
25	ENVEQ MIN	0.00000	-1164.64400	-2302.67200	-3191.54100
25	ENVEQ MIN	0.25000	-1162.21800	-2283.35700	-3088.92900
25	ENVEQ MIN	0.50000	-1159.79200	-2264.10200	-2987.18000
25	ENVEQ MIN	0.75000	-1157.36700	-2244.90700	-2886.29100
25	ENVEQ MIN	1.00000	-1154.94100	-2225.77300	-2786.26000
26	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
26	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
26	ENVEQ MIN	0.00000	-1182.48100	-2225.71700	-2786.26000
26	ENVEQ MIN	0.25000	-1178.13100	-2191.55400	-2609.01800
26	ENVEQ MIN	0.50000	-1173.78100	-2157.58300	-2434.51000
26	ENVEQ MIN	0.75000	-1169.43100	-2123.80600	-2262.72100
26	ENVEQ MIN	1.00000	-1165.08100	-2090.22200	-2093.63400
27	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.75000	0.00000	0.00000	9.68390
27	ENVEQ MAX	1.00000	0.00000	0.00000	133.43625
27	ENVEQ MIN	0.00000	-1165.08100	-2090.22300	-2093.63400
27	ENVEQ MIN	0.25000	-1155.48700	-2016.36200	-1730.20200
27	ENVEQ MIN	0.50000	-1145.89200	-1942.50200	-1379.84200
27	ENVEQ MIN	0.75000	-1136.29800	-1868.64100	-1047.22400
27	ENVEQ MIN	1.00000	-1126.70300	-1794.78100	-727.91931
28	ENVEQ MAX	0.00000	0.00000	0.00000	133.43625
28	ENVEQ MAX	0.25000	0.00000	0.00000	339.71864
28	ENVEQ MAX	0.50000	0.00000	0.00000	717.34071
28	ENVEQ MAX	0.75000	0.00000	0.00000	1067.34700
28	ENVEQ MAX	1.00000	0.00000	0.00000	1389.68300
28	ENVEQ MIN	0.00000	-1155.25900	-1794.70400	-727.91931
28	ENVEQ MIN	0.25000	-1141.30100	-1687.25200	-298.43810
28	ENVEQ MIN	0.50000	-1127.34300	-1579.79900	-91.52485
28	ENVEQ MIN	0.75000	-1113.38500	-1472.34700	0.00000
28	ENVEQ MIN	1.00000	-1099.42700	-1364.89400	0.00000
29	ENVEQ MAX	0.00000	0.00000	0.00000	1389.68300
29	ENVEQ MAX	0.25000	0.00000	0.00000	1684.05300
29	ENVEQ MAX	0.50000	0.00000	0.00000	1950.80800
29	ENVEQ MAX	0.75000	0.00000	0.00000	2193.35900
29	ENVEQ MAX	1.00000	0.00000	0.00000	2408.55000
29	ENVEQ MIN	0.00000	-1129.00500	-1364.79500	0.00000
29	ENVEQ MIN	0.25000	-1115.06000	-1257.44700	0.00000
29	ENVEQ MIN	0.50000	-1101.11600	-1150.09900	0.00000
29	ENVEQ MIN	0.75000	-1087.17100	-1042.75100	0.00000
29	ENVEQ MIN	1.00000	-1073.22700	-935.40251	0.00000
30	ENVEQ MAX	0.00000	0.00000	0.00000	2408.55000
30	ENVEQ MAX	0.25000	0.00000	0.00000	2596.09600
30	ENVEQ MAX	0.50000	0.00000	0.00000	2756.02600
30	ENVEQ MAX	0.75000	0.00000	0.00000	2888.34000
30	ENVEQ MAX	1.00000	0.00000	0.00000	2993.04000
30	ENVEQ MIN	0.00000	-1103.80200	-935.28292	0.00000
30	ENVEQ MIN	0.25000	-1089.85700	-827.93486	0.00000
30	ENVEQ MIN	0.50000	-1075.91300	-720.58680	0.00000
30	ENVEQ MIN	0.75000	-1061.96800	-614.70414	0.00000
30	ENVEQ MIN	1.00000	-1048.02400	-509.92858	0.00000
31	ENVEQ MAX	0.00000	0.00000	0.00000	2993.04000
31	ENVEQ MAX	0.25000	0.00000	0.00000	3070.09000
31	ENVEQ MAX	0.50000	0.00000	0.00000	3119.52400
31	ENVEQ MAX	0.75000	0.00000	30.17775	3141.34400
31	ENVEQ MAX	1.00000	0.00000	94.64316	3135.54800
31	ENVEQ MIN	0.00000	-1079.57300	-509.79702	0.00000
31	ENVEQ MIN	0.25000	-1065.62800	-405.02146	0.00000
31	ENVEQ MIN	0.50000	-1051.68400	-300.24591	0.00000
31	ENVEQ MIN	0.75000	-1042.35100	-195.47035	0.00000
31	ENVEQ MIN	1.00000	-1056.29500	-91.40601	0.00000
32	ENVEQ MAX	0.00000	0.00000	91.40834	3135.54800
32	ENVEQ MAX	0.25000	0.00000	195.47369	3141.34200
32	ENVEQ MAX	0.50000	0.00000	300.24925	3119.52200
32	ENVEQ MAX	0.75000	0.00000	405.02480	3070.08700
32	ENVEQ MAX	1.00000	0.00000	509.80036	2993.03600
32	ENVEQ MIN	0.00000	-1056.29600	-94.64029	0.00000
32	ENVEQ MIN	0.25000	-1042.35100	-30.17628	0.00000
32	ENVEQ MIN	0.50000	-1051.68300	0.00000	0.00000
32	ENVEQ MIN	0.75000	-1065.62800	0.00000	0.00000
32	ENVEQ MIN	1.00000	-1079.57200	0.00000	0.00000
33	ENVEQ MAX	0.00000	0.00000	509.93192	2993.03600
33	ENVEQ MAX	0.25000	0.00000	614.70748	2888.33600
33	ENVEQ MAX	0.50000	0.00000	720.59017	2756.02000
33	ENVEQ MAX	0.75000	0.00000	827.93823	2596.08900
33	ENVEQ MAX	1.00000	0.00000	935.28629	2408.54300
33	ENVEQ MIN	0.00000	-1048.02300	0.00000	0.00000
33	ENVEQ MIN	0.25000	-1061.96800	0.00000	0.00000
33	ENVEQ MIN	0.50000	-1075.91200	0.00000	0.00000
33	ENVEQ MIN	0.75000	-1089.85700	0.00000	0.00000
33	ENVEQ MIN	1.00000	-1103.80100	0.00000	0.00000
34	ENVEQ MAX	0.00000	0.00000	935.40588	2408.54300
34	ENVEQ MAX	0.25000	0.00000	1042.85800	2193.12800
34	ENVEQ MAX	0.50000	0.00000	1150.31100	1950.30700
34	ENVEQ MAX	0.75000	0.00000	1257.76300	1683.22500
34	ENVEQ MAX	1.00000	0.00000	1365.21500	1388.47500
34	ENVEQ MIN	0.00000	-1073.22700	0.00000	0.00000
34	ENVEQ MIN	0.25000	-1087.18500	0.00000	0.00000
34	ENVEQ MIN	0.50000	-1101.14300	0.00000	0.00000
34	ENVEQ MIN	0.75000	-1115.10100	0.00000	0.00000
34	ENVEQ MIN	1.00000	-1129.05900	0.00000	0.00000
35	ENVEQ MAX	0.00000	0.00000	1365.31500	1388.47500
35	ENVEQ MAX	0.25000	0.00000	1472.66300	1066.35600

FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	1580.01100	716.62199
35	ENVEQ MAX	0.75000	0.00000	1687.35900	339.32557
35	ENVEQ MAX	1.00000	0.00000	1794.70700	133.42911
35	ENVEQ MIN	0.00000	-1099.48200	0.00000	0.00000
35	ENVEQ MIN	0.25000	-1113.42700	0.00000	0.00000
35	ENVEQ MIN	0.50000	-1127.37100	0.00000	-91.90678
35	ENVEQ MIN	0.75000	-1141.31600	0.00000	-298.71062
35	ENVEQ MIN	1.00000	-1155.26000	0.00000	-727.93266
36	ENVEQ MAX	0.00000	0.00000	1794.78400	133.42911
36	ENVEQ MAX	0.25000	0.00000	1868.64500	9.67688
36	ENVEQ MAX	0.50000	0.00000	1942.50500	0.00000
36	ENVEQ MAX	0.75000	0.00000	2016.36600	0.00000
36	ENVEQ MAX	1.00000	0.00000	2090.22600	0.00000
36	ENVEQ MIN	0.00000	-1126.70400	0.00000	-727.93266
36	ENVEQ MIN	0.25000	-1136.29800	0.00000	-1047.23800
36	ENVEQ MIN	0.50000	-1145.89300	0.00000	-1379.85700
36	ENVEQ MIN	0.75000	-1155.48700	0.00000	-1730.21700
36	ENVEQ MIN	1.00000	-1165.08200	0.00000	-2093.65000
37	ENVEQ MAX	0.00000	0.00000	2090.22500	0.00000
37	ENVEQ MAX	0.25000	0.00000	2123.80900	0.00000
37	ENVEQ MAX	0.50000	0.00000	2157.58700	0.00000
37	ENVEQ MAX	0.75000	0.00000	2191.55700	0.00000
37	ENVEQ MAX	1.00000	0.00000	2225.72000	0.00000
37	ENVEQ MIN	0.00000	-1165.08200	0.00000	-2093.65000
37	ENVEQ MIN	0.25000	-1169.43200	0.00000	-2262.73700
37	ENVEQ MIN	0.50000	-1173.78200	0.00000	-2434.52700
37	ENVEQ MIN	0.75000	-1178.13200	0.00000	-2609.03500
37	ENVEQ MIN	1.00000	-1182.48200	0.00000	-2786.27700
38	ENVEQ MAX	0.00000	0.00000	2225.77600	0.00000
38	ENVEQ MAX	0.25000	0.00000	2244.91100	0.00000
38	ENVEQ MAX	0.50000	0.00000	2264.10500	0.00000
38	ENVEQ MAX	0.75000	0.00000	2283.36000	0.00000
38	ENVEQ MAX	1.00000	0.00000	2302.67500	0.00000
38	ENVEQ MIN	0.00000	-1154.94200	0.00000	-2786.27700
38	ENVEQ MIN	0.25000	-1157.36700	0.00000	-2886.30800
38	ENVEQ MIN	0.50000	-1159.79300	0.00000	-2987.19700
38	ENVEQ MIN	0.75000	-1162.21900	0.00000	-3088.94700
38	ENVEQ MIN	1.00000	-1164.64500	0.00000	-3191.55900
39	ENVEQ MAX	0.00000	0.00000	2302.67400	0.00000
39	ENVEQ MAX	0.08824	0.00000	2335.09600	0.00000
39	ENVEQ MAX	0.17647	0.00000	2367.51800	0.00000
39	ENVEQ MAX	0.26471	0.00000	2399.94000	0.00000
39	ENVEQ MAX	0.35294	0.00000	2432.36200	0.00000
39	ENVEQ MIN	0.00000	-1164.64500	0.00000	-3191.55900
39	ENVEQ MIN	0.08824	-1168.71000	0.00000	-3365.47500
39	ENVEQ MIN	0.17647	-1172.77600	0.00000	-3541.82300
39	ENVEQ MIN	0.26471	-1176.84100	0.00000	-3720.60300
39	ENVEQ MIN	0.35294	-1180.90700	0.00000	-3901.81400
40	ENVEQ MAX	0.56250	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.67188	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.78125	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.89063	0.00000	0.00000	0.00000
40	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
40	ENVEQ MIN	0.56250	-2694.28700	-1106.80300	-4818.92500
40	ENVEQ MIN	0.67188	-2698.97700	-1116.61000	-4722.12000
40	ENVEQ MIN	0.78125	-2703.66600	-1126.28400	-4624.44400
40	ENVEQ MIN	0.89063	-2708.35500	-1135.82500	-4525.90700
40	ENVEQ MIN	1.00000	-2713.04400	-1145.23200	-4426.52300
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
41	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	-2713.04300	-1145.23200	-4426.52300
41	ENVEQ MIN	0.25000	-2717.45200	-1154.16500	-4330.04000
41	ENVEQ MIN	0.50000	-2721.64800	-1162.97400	-4232.79100
41	ENVEQ MIN	0.75000	-2725.63100	-1171.66100	-4134.78800
41	ENVEQ MIN	1.00000	-2729.40100	-1180.22500	-4036.04000
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
42	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	-2595.85800	-942.79843	-4036.04000
42	ENVEQ MIN	0.25000	-2597.60500	-946.89612	-3997.70500
42	ENVEQ MIN	0.50000	-2599.30200	-950.96410	-3959.19900
42	ENVEQ MIN	0.75000	-2600.95000	-955.00239	-3920.52400
42	ENVEQ MIN	1.00000	-2602.54700	-959.01098	-3881.68100
43	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
43	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
43	ENVEQ MIN	0.00000	-2602.54700	-959.01083	-3881.68100
43	ENVEQ MIN	0.25000	-2611.93400	-982.33373	-3646.38300
43	ENVEQ MIN	0.50000	-2621.32100	-1004.62300	-3405.38900
43	ENVEQ MIN	0.75000	-2630.70800	-1025.87700	-3158.95100
43	ENVEQ MIN	1.00000	-2640.09500	-1046.09800	-2907.32100
44	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
44	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
44	ENVEQ MIN	0.00000	-2510.51900	-766.26967	-2907.32100
44	ENVEQ MIN	0.25000	-2521.48800	-788.58074	-2686.76000
44	ENVEQ MIN	0.50000	-2532.45700	-809.46487	-2459.85800
44	ENVEQ MIN	0.75000	-2543.42700	-829.09434	-2227.02100
44	ENVEQ MIN	1.00000	-2554.39600	-847.83523	-2015.40900
45	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
45	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
45	ENVEQ MIN	0.00000	-2428.68600	-586.08512	-2015.40900
45	ENVEQ MIN	0.25000	-2439.65600	-603.39904	-1902.08800
45	ENVEQ MIN	0.50000	-2450.62500	-619.28595	-1793.88900
45	ENVEQ MIN	0.75000	-2461.59400	-633.74585	-1690.40700
45	ENVEQ MIN	1.00000	-2472.56300	-646.77875	-1591.23700
46	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
46	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
46	ENVEQ MAX	0.50000	0.00000	7.78425	0.00000
46	ENVEQ MAX	0.75000	0.00000	26.94537	0.00000
46	ENVEQ MAX	1.00000	0.00000	48.56352	0.00000
46	ENVEQ MIN	0.00000	-2350.59500	-445.24195	-1591.23700
46	ENVEQ MIN	0.25000	-2363.87300	-458.77902	-1520.76300
46	ENVEQ MIN	0.50000	-2381.88200	-474.77312	-1454.88500
46	ENVEQ MIN	0.75000	-2399.89000	-493.29289	-1394.30200
46	ENVEQ MIN	1.00000	-2417.89800	-514.91104	-1339.71100
47	ENVEQ MAX	0.00000	0.00000	48.37706	0.00000
47	ENVEQ MAX	0.25000	0.00000	54.92143	0.00000
47	ENVEQ MAX	0.50000	0.00000	60.99936	0.00000
47	ENVEQ MAX	0.75000	0.00000	66.61086	0.00000
47	ENVEQ MAX	1.00000	0.00000	71.75593	0.00000
47	ENVEQ MIN	0.00000	-2010.50000	-90.55095	-1339.71100
47	ENVEQ MIN	0.25000	-2015.84200	-97.09531	-1339.76400
47	ENVEQ MIN	0.50000	-2021.18500	-103.17324	-1340.36600
47	ENVEQ MIN	0.75000	-2026.52700	-108.78474	-1341.68100
47	ENVEQ MIN	1.00000	-2031.86900	-113.92982	-1343.62500
48	ENVEQ MAX	0.00000	0.00000	71.67182	0.00000
48	ENVEQ MAX	0.13281	0.00000	77.49047	0.00000
48	ENVEQ MAX	0.26563	0.00000	82.55747	0.00000
48	ENVEQ MAX	0.39844	0.00000	86.87282	0.00000
48	ENVEQ MAX	0.53125	0.00000	90.43651	0.00000
48	ENVEQ MIN	0.00000	-2031.86900	-113.92976	-1343.62500
48	ENVEQ MIN	0.13281	-2038.60600	-119.74841	-1346.71100
48	ENVEQ MIN	0.26563	-2045.34400	-124.81541	-1350.43200
48	ENVEQ MIN	0.39844	-2052.08100	-129.13076	-1354.70800
48	ENVEQ MIN	0.53125	-2058.81800	-132.69445	-1359.45900

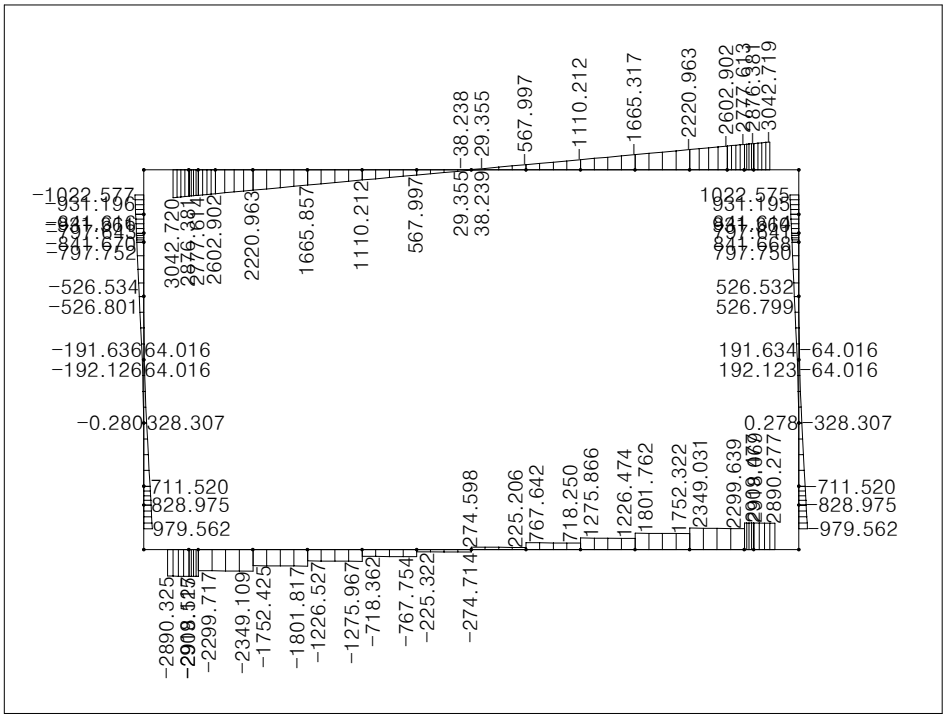
21. 단면력정리

21.1 상시

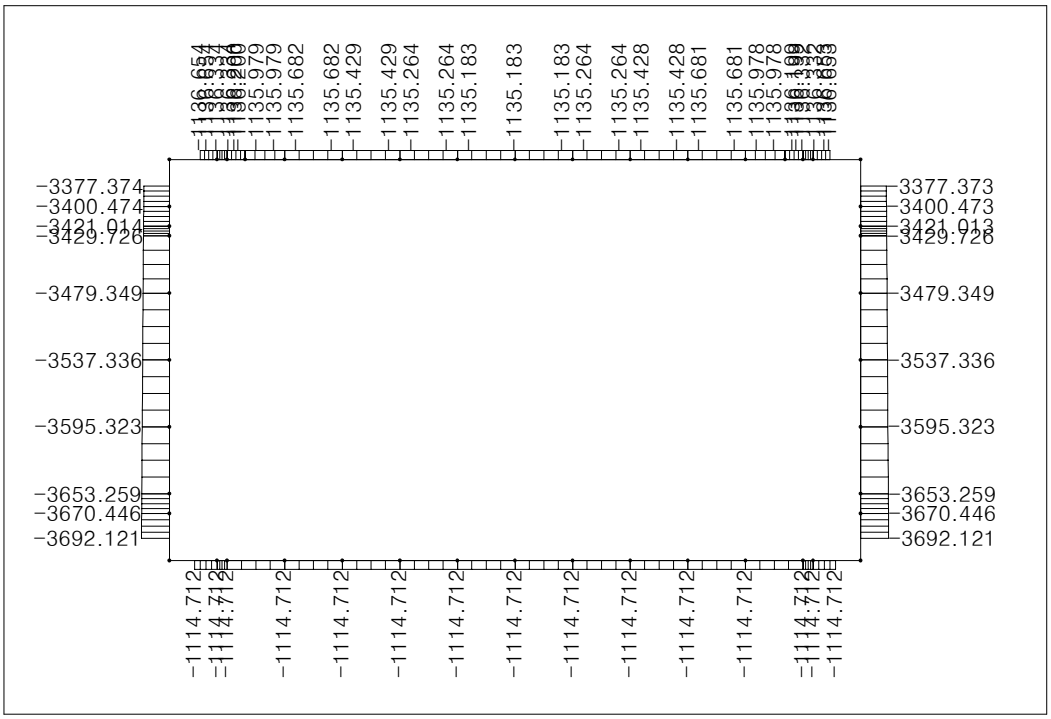
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



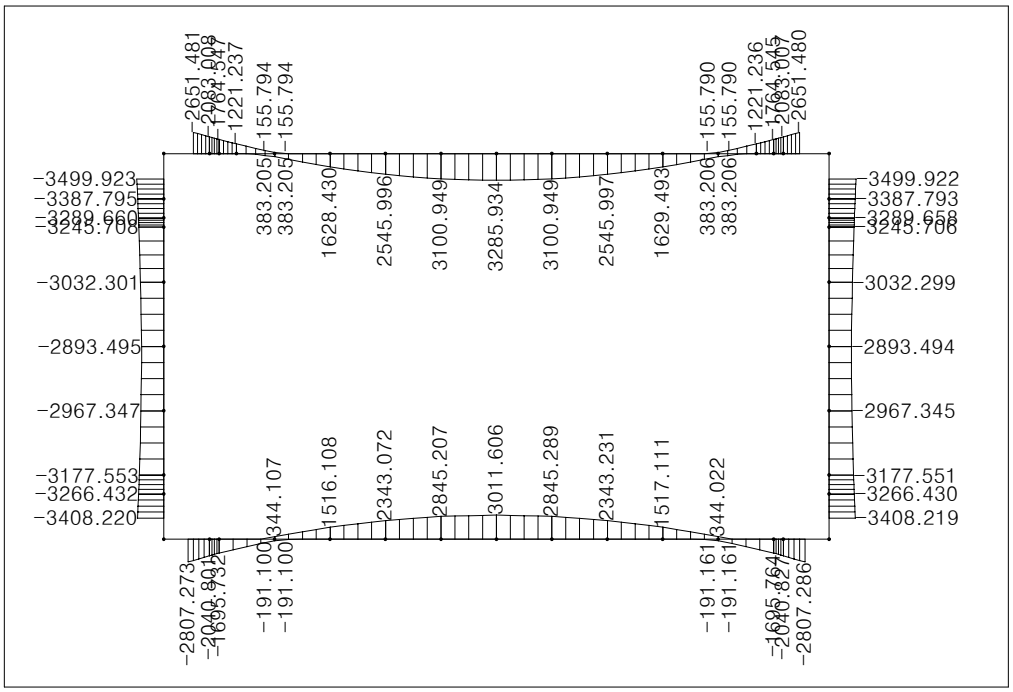
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

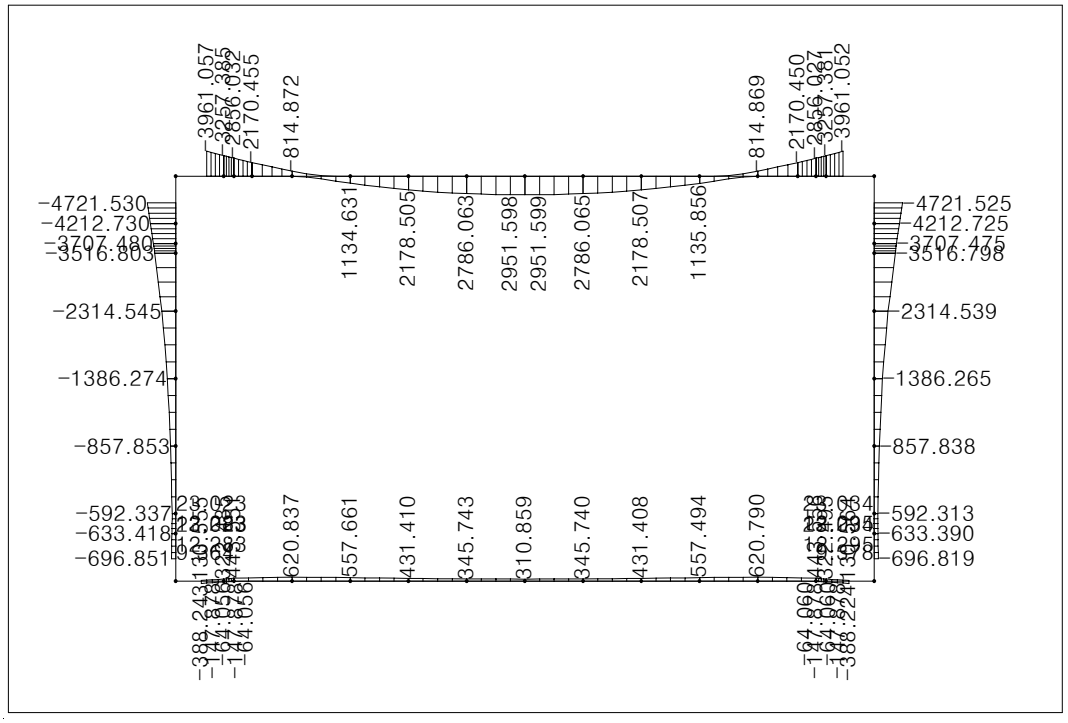


5) 단면력 정리

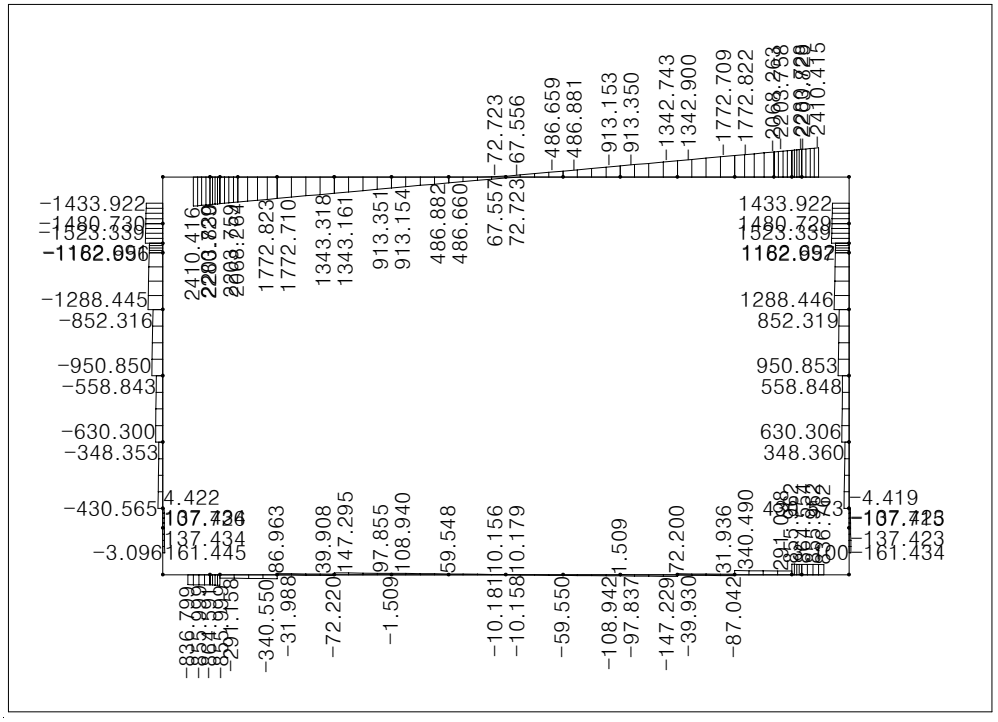
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	3260.08	2063.65	1136.33	2083.01	1000.00	1766.67	
		중앙부	2	4930.86	38.24	1135.18	3285.93	1000.00	1600.00	
		우측	3	3260.08	2063.49	1136.33	2083.01	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	2978.95	1766.42	1114.71	2040.80	1000.00	1600.00	
		측구부	5	924.97	2890.33	1114.71	633.14	1000.00	1600.00	
		중앙부	6	4550.19	274.71	1114.71	3011.61	1000.00	1600.00	
		우측	7	2978.98	1766.33	1114.71	2040.83	1000.00	1600.00	
좌측 벽체	1 층	상부	8	5239.51	490.27	3400.47	3387.80	1000.00	1866.67	
		하부	9	4828.59	286.93	3670.45	3266.43	1000.00	1700.00	
우측 벽체	1 층	상부	10	5239.51	490.27	3400.47	3387.79	1000.00	1855.33	
		하부	11	4828.58	286.93	3670.45	3266.43	1000.00	1700.00	

21.2 지진시(기능수행)

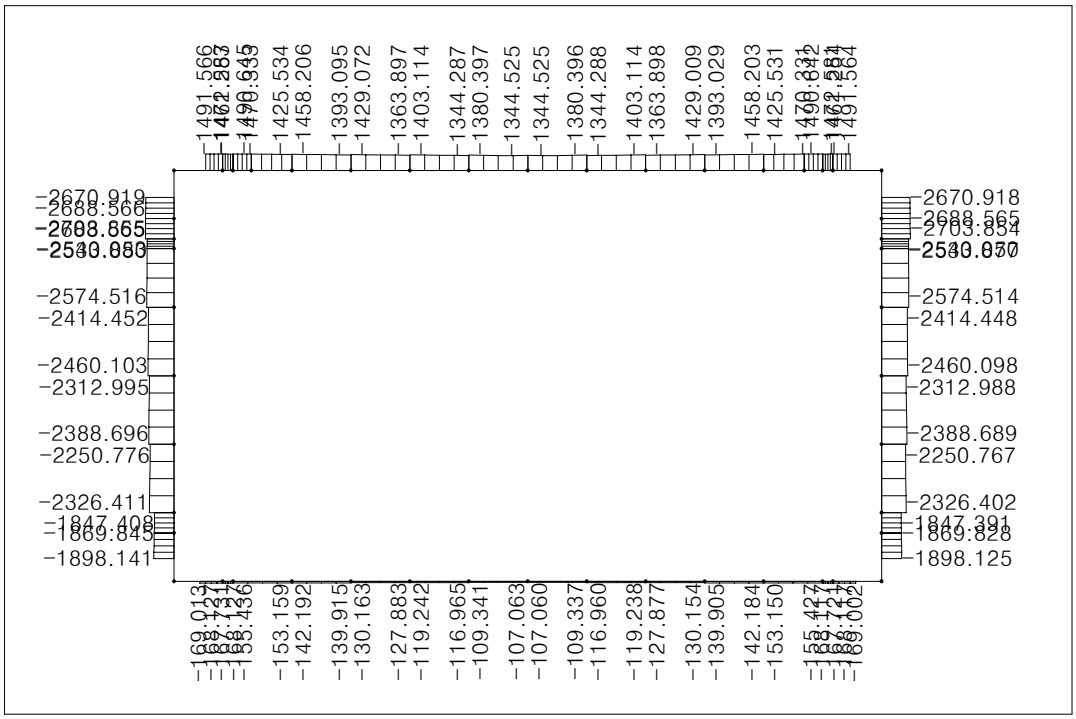
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

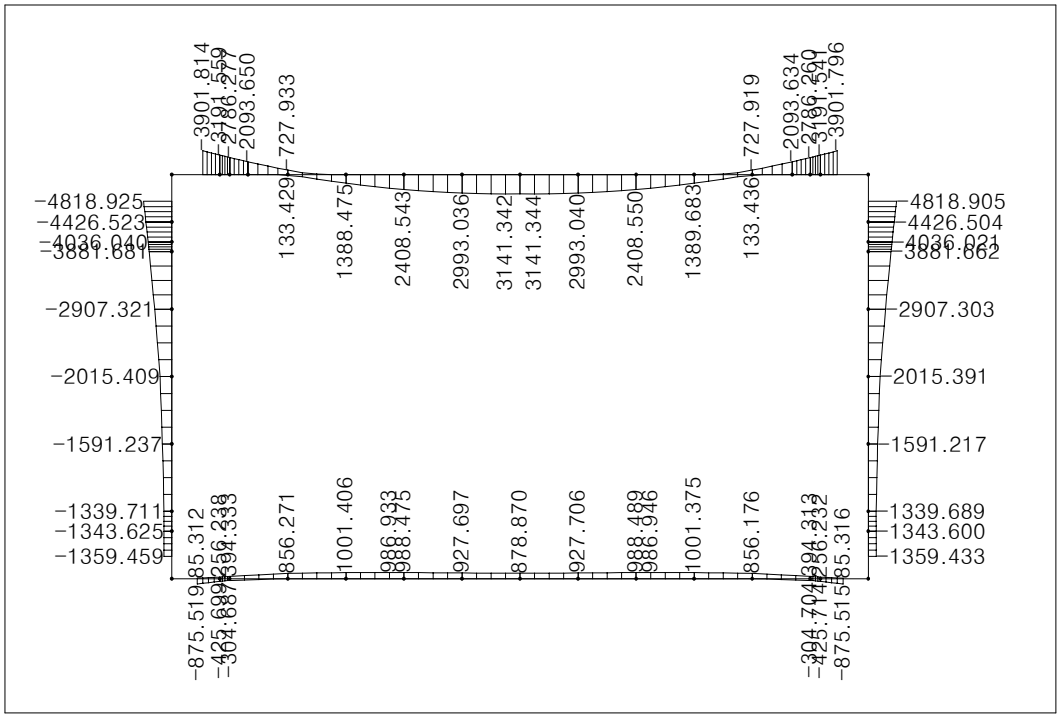


4) 단면력 정리

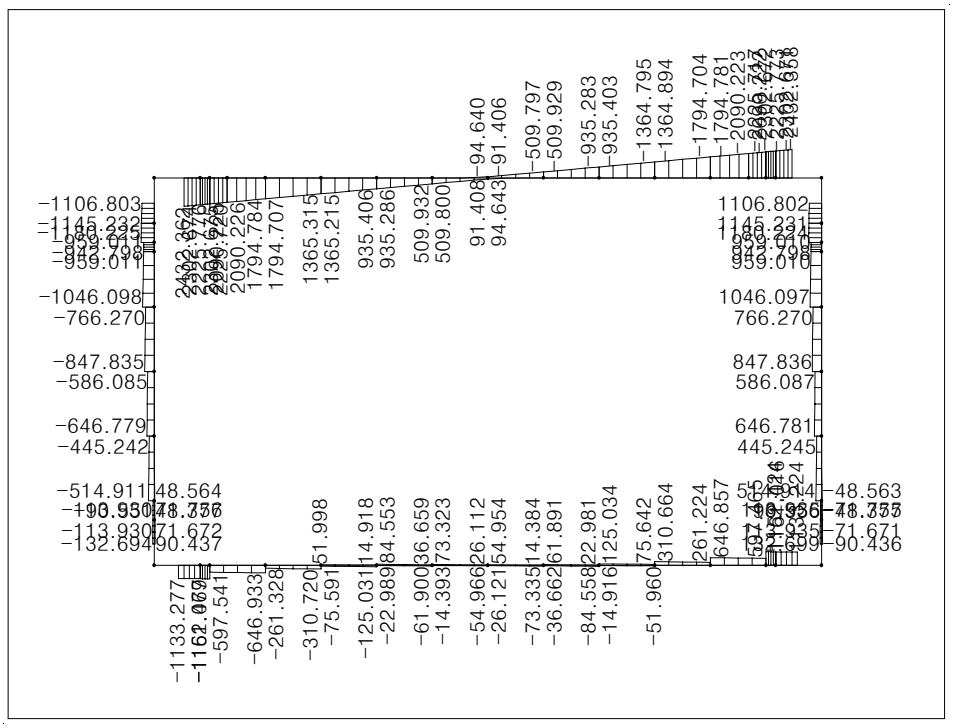
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	3257.39	1651.02	1472.58	1000.00	1766.67	
		중앙부	2	2951.55	72.72	1360.80	1000.00	1600.00	
		우측	3	3257.38	1650.90	1472.58	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	147.88	72.97	168.13	1000.00	1600.00	
		측구부	5	600.28	836.80	169.01	1000.00	1600.00	
		중앙부	6	310.86	10.18	107.06	1000.00	1600.00	
		우측	7	147.88	73.03	168.12	1000.00	1600.00	
좌측 벽체	1 층	상부	8	4212.73	864.36	2688.57	1000.00	1866.67	
		하부	9	633.42	623.53	1869.85	1000.00	1700.00	
우측 벽체	1 층	상부	10	4212.73	864.36	2688.57	1000.00	1855.33	
		하부	11	633.39	623.53	1869.83	1000.00	1700.00	

21.3 지진시(붕괴방지)

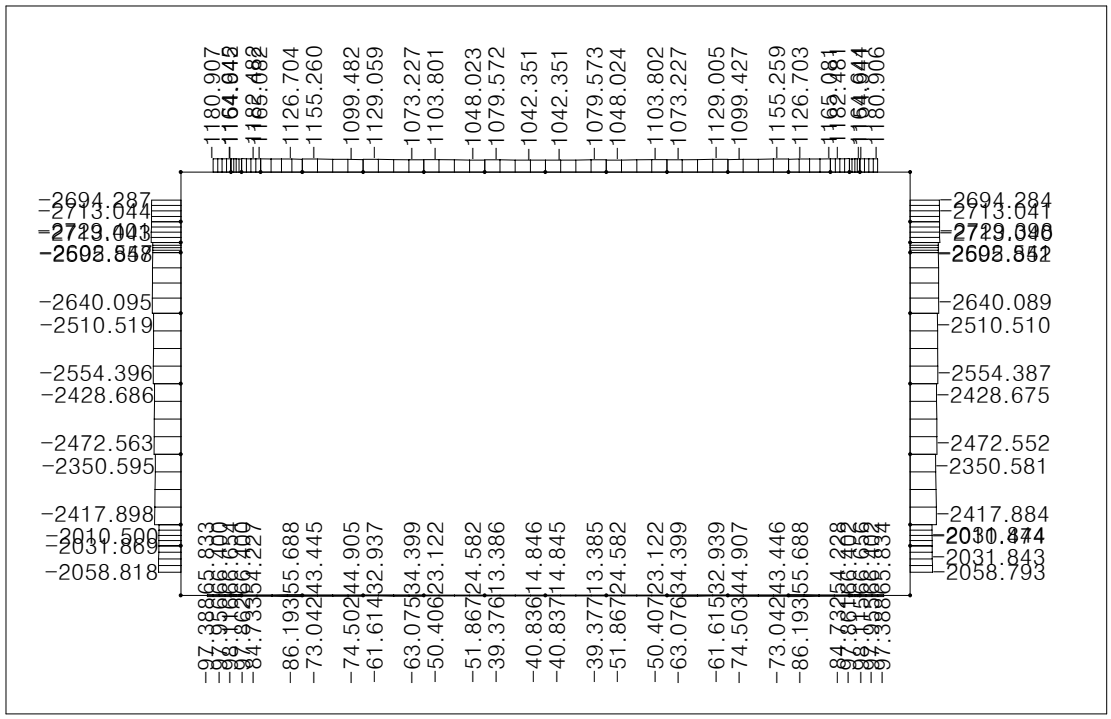
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	3191.56	1673.02	1164.65	1000.00	1766.67	
		중앙부	2	3135.55	94.64	1056.30	1000.00	1600.00	
		우측	3	3191.54	1672.90	1164.64	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	425.70	275.33	97.86	1000.00	1600.00	
		측구부	5	887.79	1133.28	97.39	1000.00	1600.00	
		중앙부	6	878.87	54.97	40.84	1000.00	1600.00	
		우측	6	425.71	275.24	97.86	1000.00	1600.00	
좌측 벽체	1 층	상부	7	4426.52	776.22	2713.04	1000.00	1866.67	
		하부	8	1343.63	640.97	2031.87	1000.00	1700.00	
우측 벽체	1 층	상부	9	4426.50	776.22	2713.04	1000.00	1855.33	
		하부	10	1343.60	640.97	2031.84	1000.00	1700.00	

21.4 단면력 비교

1) 극한모멘트

(kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-3260.08	-	-3191.56	-3257.39	-3260.08	
		중앙부	2	4930.86	-	3135.55	2951.55	4930.86	
		우측	3	-3260.08	-	-3191.54	-3257.38	-3260.08	
하부 슬래브	1 경간	좌측	4	-2978.95	-	-425.70	-147.88	-2978.95	
		측구부	5	924.97	-	887.79	600.28	924.97	
		중앙부	6	4550.19	-	878.87	310.86	4550.19	
		우측	7	-2978.98	-	-425.71	-147.88	-2978.98	
좌측 벽체	1 층	상부	8	-5239.51	-	-4426.52	-4212.73	-5239.51	
		하부	9	-4828.59	-	-1343.63	-633.42	-4828.59	
우측 벽체	1 층	상부	10	-5239.51	-	-4426.50	-4212.73	-5239.51	
		하부	11	-4828.58	-	-1343.60	-633.39	-4828.58	

2) 전단력

(kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	2063.65	-	1673.02	1651.02	2063.65	
		중앙부	2	38.24	-	94.64	72.72	94.64	
		우측	3	-2063.49	-	-1672.90	-1650.90	-2063.49	
하부 슬래브	1 경간	좌측	4	-1766.42	-	-275.33	72.97	-1766.42	
		측구부	5	-2890.33	-	-1133.28	-836.80	-2890.33	
		중앙부	6	-274.71	-	-54.97	-10.18	-274.71	
		우측	7	1766.33	-	275.24	-73.03	1766.33	
좌측 벽체	1 층	상부	8	-490.27	-	-776.22	-864.36	-864.36	
		하부	9	286.93	-	-640.97	-623.53	-640.97	
우측 벽체	1 층	상부	10	490.27	-	776.22	864.36	864.36	
		하부	11	-286.93	-	640.97	623.53	640.97	

3) 축력

(kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-1136.33	-	-1164.65	-1472.58	-1472.58	
		중앙부	2	-1135.18	-	-1056.30	-1360.80	-1360.80	
		우측	3	-1136.33	-	-1164.64	-1472.58	-1472.58	
하부 슬래브	1 경간	좌측	4	-1114.71	-	-97.86	-168.13	-1114.71	
		측구부	5	-1114.71	-	-97.39	-169.01	-1114.71	
		중앙부	6	-1114.71	-	-40.84	-107.06	-1114.71	
		우측	7	-1114.71	-	-97.86	-168.12	-1114.71	
좌측 벽체	1 층	상부	8	-3400.47	-	-2713.04	-2688.57	-3400.47	
		하부	9	-3670.45	-	-2031.87	-1869.85	-3670.45	
우측 벽체	1 층	상부	10	-3400.47	-	-2713.04	-2688.57	-3400.47	
		하부	11	-3670.45	-	-2031.84	-1869.83	-3670.45	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-2083.01	-	-	-	-2083.01	
		중앙부	2	3285.93	-	-	-	3285.93	
		우측	3	-2083.01	-	-	-	-2083.01	
하부 슬래브	1 경간	좌측	4	-2040.80	-	-	-	-2040.80	
		측구부	5	633.14	-	-	-	633.14	
		중앙부	6	3011.61	-	-	-	3011.61	
		우측	7	-2040.83	-	-	-	-2040.83	
좌측 벽체	1 층	상부	8	-3387.80	-	-	-	-3387.80	
		하부	9	-3266.43	-	-	-	-3266.43	
우측 벽체	1 층	상부	10	-3387.79	-	-	-	-3387.79	
		하부	11	-3266.43	-	-	-	-3266.43	

22. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1617	3260.08	5336.67	6133.83	H29 - 8.0EA + H29 - 8.0EA	#######	1.64
		중앙부	2	1000	1475	4930.86	5373.38	#######	H32 - 8.0EA + H29 - 8.0EA	#######	1.09
		우측	3	1000	1617	3260.08	5336.67	6133.82	H29 - 8.0EA + H29 - 8.0EA	#######	1.64
하부슬래브	1경간	좌측	4	1000	1455	2978.95	5295.23	6254.83	H32 - 8.0EA + H29 - 8.0EA	#######	1.78
		측구부	5	1000	1182	924.97	2727.03	2342.62	H29 - 8.0EA + H25 - 4.0EA	7166.00	2.95
		중앙부	6	1000	1475	4550.19	5373.38	9617.83	H32 - 8.0EA + H29 - 8.0EA	#######	1.18
		우측	7	1000	1455	2978.98	5295.23	6254.91	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.78
좌측벽체	1층	상부	8	1000	1717	5239.51	5686.14	9428.13	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.09
		하부	9	1000	1555	4828.59	5685.99	9653.44	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.18
우측벽체	1층	상부	10	1000	1705	5239.51	5646.53	9497.49	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.08
		하부	11	1000	1555	4828.58	5685.99	9653.43	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.18

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	941.8	2063.6	2093.68	2.00	386.84	H16	150	397.20	O.K
		중앙부	2	958.2	94.6	1544.21	2.00	-	H16	300	397.20	O.K
		우측	3	941.8	2063.5	2093.68	2.00	386.79	H16	150	397.20	O.K
하부슬래브	1경간	좌측	4	945.2	1766.4	2101.31	2.00	282.14	H16	150	397.20	O.K
		중앙부	6	958.2	274.7	1544.21	2.00	-	H16	300	397.20	O.K
		우측	7	945.2	1766.3	2101.31	2.00	282.11	H16	150	397.20	O.K
좌측벽체	1층	상부	8	1006.8	864.4	1622.41	2.00	-	H16	300	397.20	O.K
		중앙부	8	1052.2	950.9	1695.68	2.00	-	H16	300	397.20	O.K
		하부	9	1010.2	641.0	1627.94	2.00	-	H16	300	397.20	O.K
우측벽체	1층	상부	10	1006.8	864.4	1622.41	2.00	-	H16	300	397.20	O.K
		중앙부	10	1052.2	950.9	1695.68	2.00	-	H16	300	397.20	O.K
		하부	11	1010.2	641.0	1627.94	2.00	-	H16	300	397.20	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1616.67	100.00	3260.08	2063.65

* 강도감소계수(Φ) 산정

T = As x fy = 10278.400 x 400.00 = 4111360.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 179.144 mm, c = 179.144 / β1 = 179.144 / 0.85 = 210.758 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 210.758) / 210.758 = 0.02072

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 6133.829 \text{ mm}^2$$

* 사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm), [사용률 = 1.676]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00636

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 179.144 mm

ΦMn = 0.85 x 10278.400 x 400 x (1616.67 - a/2) = 5336.670 kN.m

≥ Mu (= 3260.083 kN.m) ∴ O.K [안전률 1.637]

* 전단에 대한 검토 (d = 1450.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1450.00 = 941.803 kN

< Vu (= 2063.645 kN) , 전단보강 필요.

Av_req = (2063.645-941.803) x 150.00 / (400x1450.00xΦ) x 1000 = 386.842 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1450.00 / 150.00 x 1000 = 1535.840 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1450.00 / 1000 = 5022.947 kN ≥ 1535.840 kN ∴ O.K

ΦVn = 0.75 x (1255.737 + 1535.840) = 2093.683 kN ≥ 2063.645 kN ∴ O.K

▣ TITLE : 상부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1475.28	80.00	4930.86	94.64

* 강도감소계수(Φ) 산정

T = As x fy = 11492.800 x 400.00 = 4597120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 200.310 mm, c = 200.310 / β1 = 200.310 / 0.85 = 235.659 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 235.659) / 235.659 = 0.01635

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 10478.992 \text{ mm}^2$$

* 사용철근량 = 11492.8 mm² (철근도심 : 124.7 mm), [사용률 = 1.097]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00779

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 200.310 mm

ΦMn = 0.85 x 11492.800 x 400 x (1475.28 - a/2) = 5373.385 kN.m

≥ Mu (= 4930.863 kN.m) ∴ O.K [안전률 1.090]

* 전단에 대한 검토 (d = 1475.28 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1475.28 = 958.225 kN

≥ Vu (= 94.643 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1616.67	100.00	3260.08	2063.49

* 강도감소계수(Φ) 산정

T = As x fy = 10278.400 x 400.00 = 4111360.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 179.144 mm, c = 179.144 / β1 = 179.144 / 0.85 = 210.758 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 210.758) / 210.758 = 0.02072

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 6133.825 \text{ mm}^2$$

* 사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm), [사용률 = 1.676]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00636

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 179.144 mm

ΦMn = 0.85 x 10278.400 x 400 x (1616.67 - a/2) = 5336.670 kN.m

≥ Mu (= 3260.081 kN.m) ∴ O.K [안전률 1.637]

* 전단에 대한 검토 (d = 1450.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1450.00 = 941.803 kN

< Vu (= 2063.491 kN) , 전단보강 필요.

Av_req = (2063.491-941.803) x 150.00 / (400x1450.00xΦ) x 1000 = 386.789 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1450.00 / 150.00 x 1000 = 1535.840 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1450.00 / 1000 = 5022.947 kN ≥ 1535.840 kN ∴ O.K

ΦVn = 0.75 x (1255.737 + 1535.840) = 2093.683 kN ≥ 2063.491 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1455.28	100.00	2978.95	1766.42

* 강도감소계수(Φ) 산정

T = As x fy = 11492.800 x 400.00 = 4597120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 200.310 mm, c = 200.310 / β1 = 200.310 / 0.85 = 235.659 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1500.00 - 235.659) / 235.659 = 0.01610

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 6254.825 \text{ mm}^2$$

* 사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm), [사용률 = 1.837]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00790

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 200.310 mm

ΦMn = 0.85 x 11492.800 x 400 x (1455.28 - a/2) = 5295.234 kN.m

≥ Mu (= 2978.945 kN.m) ∴ O.K [안전률 1.778]

* 전단에 대한 검토 (d = 1455.28 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1455.28 = 945.234 kN

< Vu (= 1766.423 kN) , 전단보강 필요.

Av_req = (1766.423-945.234) x 150.00 / (400x1455.28xΦ) x 1000 = 282.140 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1455.28 / 150.00 x 1000 = 1541.436 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1455.28 / 1000 = 5041.249 kN ≥ 1541.436 kN ∴ O.K

ΦVn = 0.75 x (1260.312 + 1541.436) = 2101.311 kN ≥ 1766.423 kN ∴ O.K

▣ TITLE : 하부슬래브 추가

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1290.00	1181.72	80.00	924.97	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 7166.000 x 400.00 = 2866400.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 124.898 mm, c = 124.898 / β1 = 124.898 / 0.85 = 146.938 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1210.00 - 146.938) / 146.938 = 0.02170

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2342.625 \text{ mm}^2$$

* 사용철근량 = 7166.0 mm² (철근도심 : 108.3 mm), [사용률 = 3.059]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 4.0 EA (= 2026.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00606

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 124.898 mm

ΦMn = 0.85 x 7166.000 x 400 x (1181.72 - a/2) = 2727.028 kN.m

≥ Mu (= 924.968 kN.m) ∴ O.K [안전률 2.948]

▣ TITLE : 하부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1475.28	80.00	4550.19	274.71

* 강도감소계수(Φ) 산정

T = As x fy = 11492.800 x 400.00 = 4597120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 200.310 mm, c = 200.310 / β1 = 200.310 / 0.85 = 235.659 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 235.659) / 235.659 = 0.01635

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 9617.829 \text{ mm}^2$$

* 사용철근량 = 11492.8 mm² (철근도심 : 124.7 mm), [사용률 = 1.195]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00779

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 200.310 mm

ΦMn = 0.85 x 11492.800 x 400 x (1475.28 - a/2) = 5373.385 kN.m

≥ Mu (= 4550.186 kN.m) ∴ O.K [안전률 1.181]

* 전단에 대한 검토 (d = 1475.28 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1475.28 = 958.225 kN

≥ Vu (= 274.714 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 추가

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1500.00	1391.72	80.00	503.52	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 7166.000 x 400.00 = 2866400.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 124.898 mm, c = 124.898 / β1 = 124.898 / 0.85 = 146.938 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1420.00 - 146.938) / 146.938 = 0.02599

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1071.290 \text{ mm}^2$$

* 사용철근량 = 7166.0 mm² (철근도심 : 108.3 mm), [사용률 = 6.689]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 4.0 EA (= 2026.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00515

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 124.898 mm

ΦMn = 0.85 x 7166.000 x 400 x (1391.72 - a/2) = 3238.681 kN.m

≥ Mu (= 503.516 kN.m) ∴ O.K [안전률 6.432]

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1455.28	100.00	2978.98	1766.33

* 강도감소계수(Φ) 산정

T = As x fy = 11492.800 x 400.00 = 4597120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 200.310 mm, c = 200.310 / β1 = 200.310 / 0.85 = 235.659 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1500.00 - 235.659) / 235.659 = 0.01610

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 6254.910 \text{ mm}^2$$

* 사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm), [사용률 = 1.837]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00790

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 200.310 mm

ΦMn = 0.85 x 11492.800 x 400 x (1455.28 - a/2) = 5295.234 kN.m

≥ Mu (= 2978.984 kN.m) ∴ O.K [안전률 1.778]

* 전단에 대한 검토 (d = 1455.28 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1455.28 = 945.234 kN

< Vu (= 1766.333 kN) , 전단보강 필요.

Av_req = (1766.333-945.234) x 150.00 / (400x1455.28xΦ) x 1000 = 282.110 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1455.28 / 150.00 x 1000 = 1541.436 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1455.28 / 1000 = 5041.249 kN ≥ 1541.436 kN ∴ O.K

ΦVn = 0.75 x (1260.312 + 1541.436) = 2101.311 kN ≥ 1766.333 kN ∴ O.K

▣ TITLE : 좌측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1866.67	1716.67	100.00	5239.51	864.36

* 강도감소계수(Φ) 산정

T = As x fy = 10278.400 x 400.00 = 4111360.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 179.144 mm, c = 179.144 / β1 = 179.144 / 0.85 = 210.758 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1766.67 - 210.758) / 210.758 = 0.02215

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \;,\; As = 9428.131 \text{ mm}^2$$

* 사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm), [사용률 = 1.090]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00599

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 179.144 mm

ΦMn = 0.85 x 10278.400 x 400 x (1716.67 - a/2) = 5686.136 kN.m

≥ Mu (= 5239.509 kN.m) ∴ O.K [안전률 1.085]

* 전단에 대한 검토 (d = 1550.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1550.00 = 1006.755 kN

≥ Vu (= 864.355 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1700.00	1555.28	100.00	4828.59	640.97

* 강도감소계수(Φ) 산정

T = As x fy = 11492.800 x 400.00 = 4597120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 200.310 mm, c = 200.310 / β1 = 200.310 / 0.85 = 235.659 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1600.00 - 235.659) / 235.659 = 0.01737

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 9653.435 \text{ mm}^2$$

* 사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm), [사용률 = 1.191]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00739

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 200.310 mm

ΦMn = 0.85 x 11492.800 x 400 x (1555.28 - a/2) = 5685.989 kN.m

≥ Mu (= 4828.586 kN.m) ∴ O.K [안전률 1.178]

* 전단에 대한 검토 (d = 1555.28 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1555.28 = 1010.186 kN

≥ Vu (= 640.969 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1855.33	1705.33	100.00	5239.51	864.36

* 강도감소계수(Φ) 산정

T = As x fy = 10278.400 x 400.00 = 4111360.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 179.144 mm, c = 179.144 / β1 = 179.144 / 0.85 = 210.758 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1755.33 - 210.758) / 210.758 = 0.02199

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 9497.493 \text{ mm}^2$$

* 사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm), [사용률 = 1.082]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00603

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 179.144 mm

ΦMn = 0.85 x 10278.400 x 400 x (1705.33 - a/2) = 5646.530 kN.m

≥ Mu (= 5239.507 kN.m) ∴ O.K [안전률 1.078]

* 전단에 대한 검토 (d = 1550.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1550.00 = 1006.755 kN

≥ Vu (= 864.358 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1700.00	1555.28	100.00	4828.58	640.97

* 강도감소계수(Φ) 산정

T = As x fy = 11492.800 x 400.00 = 4597120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 200.310 mm, c = 200.310 / β1 = 200.310 / 0.85 = 235.659 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1600.00 - 235.659) / 235.659 = 0.01737

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 9653.431 \text{ mm}^2$$

* 사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm), [사용률 = 1.191]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00739

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 200.310 mm

ΦMn = 0.85 x 11492.800 x 400 x (1555.28 - a/2) = 5685.989 kN.m

≥ Mu (= 4828.584 kN.m) ∴ O.K [안전률 1.178]

* 전단에 대한 검토 (d = 1555.28 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1555.28 = 1010.186 kN

≥ Vu (= 640.971 kN) , 전단보강 불필요.

23. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 10278.400 × 0.20 = 2055.68 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2055.680 ∴ O.K

2) 상부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 11492.800 × 0.20 = 2298.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2298.560 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 10278.400 × 0.20 = 2055.68 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2055.680 ∴ O.K

4) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 11492.800 × 0.20 = 2298.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2298.560 ∴ O.K

5) 하부슬래브 : 측구부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1290 × 0.0020 = 2580.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 7166.000 × 0.20 = 1433.20 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ < 1433.200 ∴ N.G

6) 하부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 3.3EA = 3308.676 ㎟ ≥ 1800.000 ∴ O.K
H16 - 13.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 11492.800 × 0.20 = 2298.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2298.560 ∴ O.K

7) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 5296.662 ㎟ ≥ 1800.000 ∴ O.K
H16 - 6.7EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 11492.800 × 0.20 = 2298.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2298.560 ∴ O.K

8) 좌측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 10278.400 × 0.20 = 2055.68 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2055.680 ∴ O.K

9) 좌측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 11492.800 × 0.20 = 2298.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2298.560 ∴ O.K

10) 우측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 10278.400 × 0.20 = 2055.68 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2055.680 ∴ O.K

11) 우측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

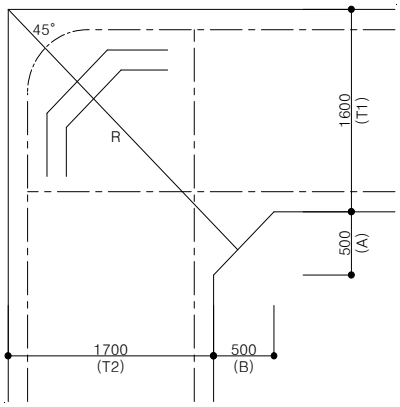
② Req's As = 사용 주철근량 × 20%

= 11492.800 × 0.20 = 2298.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2298.560 ∴ O.K

24. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 3499.923 kN.m
- 절점부 휨모멘트 : Mo = 3499.923 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 2687.006 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 5139.200 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 3499.92 \times 10^6}{2687.006^2 \times 1000} = 2.424 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 3499.92 \times 10^6}{2687.006 \times 180} = 14472.628 \text{ mm}$$

Asb = 5139.200 mm²

Req'd As = As - Asb

= 14472.628 mm² - 5139.200 mm²

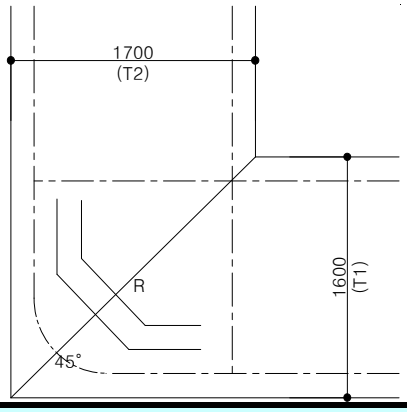
= 9333.428 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H32 - 4EA

∴ Total As = 9530.400 mm² > Req'd As (= 9333.428 mm²) ----------> O.K !!!

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 3408.220 kN.m
- 절점부 휨모멘트 : Mo = 3408.220 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 2334.524$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 5746.400 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 3408.22 \times 10^6}{2334.524^2 \times 1000} = 3.127 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 3408.22 \times 10^6}{2334.524 \times 180} = 16221.345 \text{ mm}$$

Asb = 5746.400 mm²

Req'd As = As - Asb

= 16221.345 mm² - 5746.400 mm²

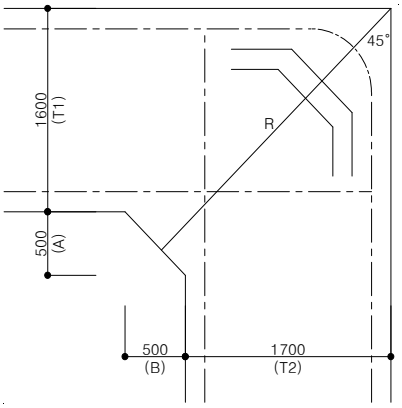
= 10474.945 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H29 - 8EA

∴ Total As = 11492.800 mm² > Req'd As (= 10474.945 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 3499.922 kN.m
- 절점부 휨모멘트 : Mo = 3499.922 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$= 2687.006$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 5139.200 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 3499.92 \times 10^6}{2687.006^2 \times 1000} = 2.424 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 3499.92 \times 10^6}{2687.006 \times 180} = 14472.624 \text{ mm}$$

Asb = 5139.200 mm²

Req'd As = As - Asb

= 14472.624 mm² - 5139.200 mm²

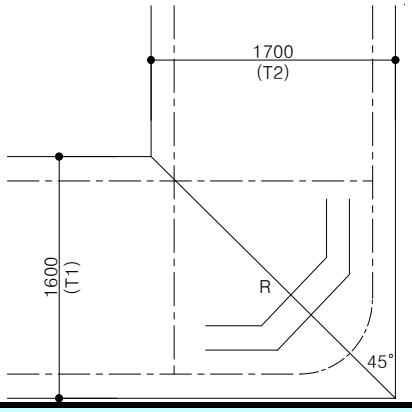
= 9333.424 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H32 - 4EA

∴ Total As = 9530.400 mm² > Req'd As (= 9333.424 mm²) ----------> O.K !!!

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 3408.219 kN.m
- 절점부 휨모멘트 : Mo = 3408.219 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 2334.524$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 5746.400 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 3408.22 \times 10^6}{2334.524^2 \times 1000} = 3.127 \text{ MPa} > 0.13\sqrt{fck}\ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 3408.22 \times 10^6}{2334.524 \times 180} = 16221.340 \text{ mm}$$

Asb = 5746.400 mm²

Req'd As = As - Asb

= 16221.340 mm² - 5746.400 mm²

= 10474.940 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H29 - 8EA

∴ Total As = 11492.800 mm² > Req'd As (= 10474.940 mm²) ----------> O.K !!!

25. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 ㎜)

구분	부재 위치			유효높이 (㎜)	인장사용철근량	철근 간격(㎜)	최대 간격 (㎜)	검토 결과	S.F
상부슬래브	1경간	좌측	1	1617	H29 - 8.0EA + H29 - 8.0EA	125	360.615	O.K	2.885
		중앙부	2	1475	H32 - 8.0EA + H29 - 8.0EA	125	208.392	O.K	1.667
		우측	3	1617	H29 - 8.0EA + H29 - 8.0EA	125	360.615	O.K	2.885
하부슬래브	1경간	좌측	4	1455	H32 - 8.0EA + H29 - 8.0EA	125	374.770	O.K	2.998
		측구부	5	1182	H29 - 8.0EA + H25 - 4.0EA	125	771.843	O.K	6.175
		중앙부	6	1475	H32 - 8.0EA + H29 - 8.0EA	125	241.949	O.K	1.936
		우측	7	1455	H32 - 8.0EA + H29 - 8.0EA	125	374.762	O.K	2.998
좌측벽체	1층	상부	8	1717	H29 - 8.0EA + H29 - 8.0EA	125	162.137	O.K	1.297
		하부	9	1555	H32 - 8.0EA + H29 - 8.0EA	125	181.570	O.K	1.453
우측벽체	1층	상부	10	1705	H29 - 8.0EA + H29 - 8.0EA	125	159.559	O.K	1.276
		하부	11	1555	H32 - 8.0EA + H29 - 8.0EA	125	181.570	O.K	1.453

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 2083.008 x 1000000 / [10278.400 x (1616.667 - 415.710/3)]
= 137.108 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10278.400/1000.0 + 7x10278.400/1000.0 x √[(1 + 2x1000.0x1616.7/(7x10278.400)]
= 415.710 mm

사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 137.11) - 2.5 x 85.50 = 360.62 mm
300 x (Kcr / fs) = 300 x (210 / 137.11) = 459.49 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 360.62 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 360.62 mm) ∴ O.K

2) 상부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 3285.934 x 1000000 / [11492.800 x (1475.283 - 413.356/3)]
= 213.767 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1475.3/(7x11492.800)]
= 413.356 mm

사용철근량 = 11492.8 mm² (철근도심 : 124.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 213.77) - 2.5 x 64.00 = 208.39 mm
300 x (Kcr / fs) = 300 x (210 / 213.77) = 294.71 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 208.39 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 208.39 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 2083.007 x 1000000 / [10278.400 x (1616.667 - 415.710/3)]
= 137.108 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10278.400/1000.0 + 7x10278.400/1000.0 x √[(1 + 2x1000.0x1616.7/(7x10278.400)]
= 415.710 mm

사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 137.11) - 2.5 x 85.50 = 360.62 mm
300 x (Kcr / fs) = 300 x (210 / 137.11) = 459.49 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 360.62 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 360.62 mm) ∴ O.K

4) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 2040.801 x 1000000 / [11492.800 x (1455.283 - 410.087/3)]
= 134.668 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1455.3/(7x11492.800)]
= 410.087 mm

사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 134.67) - 2.5 x 84.00 = 374.77 mm
300 x (Kcr / fs) = 300 x (210 / 134.67) = 467.82 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 374.77 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 374.77 mm) ∴ O.K

5) 하부슬래브 측구부

① 응력 산정

fs = M / [As x (d - χ/3)] = 633.137 x 1000000 / [7166.000 x (1181.716 - 297.790/3)]
= 81.623 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7166.000/1000.0 + 7x7166.000/1000.0 x √[(1 + 2x1000.0x1181.7/(7x7166.000)]
= 297.790 mm

사용철근량 = 7166.0 mm² (철근도심 : 108.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 4.0 EA (= 2026.8 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 81.62) - 2.5 x 65.50 = 801.05 mm
300 x (Kcr / fs) = 300 x (210 / 81.62) = 771.84 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 771.84 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 771.84 mm) ∴ O.K

6) 하부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 3011.606 x 1000000 / [11492.800 x (1475.283 - 413.356/3)]
= 195.920 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1475.3/(7x11492.800)]
= 413.356 mm

사용철근량 = 11492.8 mm² (철근도심 : 124.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 195.92) - 2.5 x 64.00 = 241.95 mm
300 x (Kcr / fs) = 300 x (210 / 195.92) = 321.56 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 241.95 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 241.95 mm) ∴ O.K

7) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 2040.827 x 1000000 / [11492.800 x (1455.283 - 410.087/3)]
= 134.670 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1455.3/(7x11492.800)]
= 410.087 mm

사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 134.67) - 2.5 x 84.00 = 374.76 mm
300 x (Kcr / fs) = 300 x (210 / 134.67) = 467.81 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 374.76 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 374.76 mm) ∴ O.K

8) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 3387.795 x 1000000 / [10278.400 x (1716.667 - 430.247/3)]
= 209.505 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10278.400/1000.0 + 7x10278.400/1000.0 x √[(1 + 2x1000.0x1716.7/(7x10278.400)]
= 430.247 mm

사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 209.50) - 2.5 x 85.50 = 162.14 mm
300 x (Kcr / fs) = 300 x (210 / 209.50) = 300.71 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 162.14 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 162.14 mm) ∴ O.K

9) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 3266.432 x 1000000 / [11492.800 x (1555.283 - 426.222/3)]
= 201.114 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1555.3/(7x11492.800)]
= 426.222 mm

사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 201.11) - 2.5 x 84.00 = 181.57 mm
300 x (Kcr / fs) = 300 x (210 / 201.11) = 313.26 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 181.57 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 181.57 mm) ∴ O.K

10) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 3387.793 x 1000000 / [10278.400 x (1705.333 - 428.621/3)]
= 210.951 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10278.400/1000.0 + 7x10278.400/1000.0 x √[(1 + 2x1000.0x1705.3/(7x10278.400)]
= 428.621 mm

사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 210.95) - 2.5 x 85.50 = 159.56 mm
300 x (Kcr / fs) = 300 x (210 / 210.95) = 298.65 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 159.56 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 159.56 mm) ∴ O.K

11) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 3266.430 x 1000000 / [11492.800 x (1555.283 - 426.222/3)]
= 201.113 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1555.3/(7x11492.800)]
= 426.222 mm

사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 201.11) - 2.5 x 84.00 = 181.57 mm
300 x (Kcr / fs) = 300 x (210 / 201.11) = 313.26 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 181.57 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 181.57 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 12.350 m
- fy = 400 MPa
- 부재두께(T) = 1.60 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28
T = 12.350 / 28
T = 0.441 m < 1.600 m ----------> O.K

26. 기초 지지력 검토

(1) 하중산정

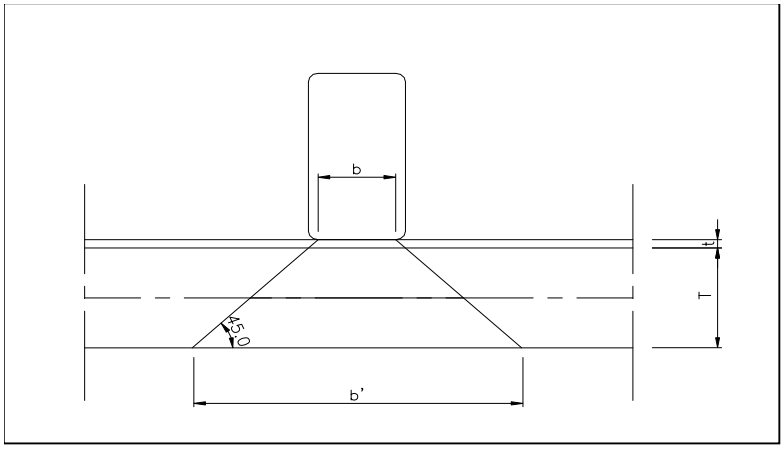
1) 고정하중

- 구체자중 = 1573.950 / 14.050 = 112.025 kN/m²
- 상부연직하중 = 299.409 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.08 × 23.00 = 1.840 kN/m²

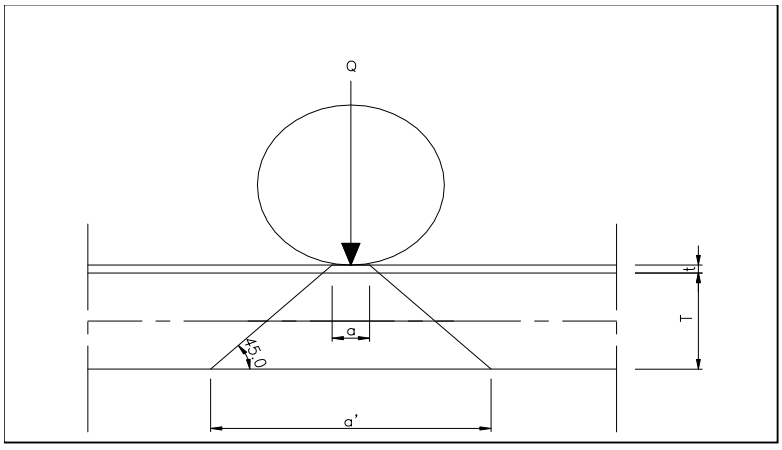
2) 활하중

- 도로 노면 활하중 = 10.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중



t = 80 mm (암거내부 포장두께)
T = 1600 mm (하부 슬래브 두께)
b' = 0.500 + 2 × (1.600 + 0.080) × cot 45°
= 3.860 m



a' = 0.200 + 2 × (1.600 + 0.080) × cot 45°
= 3.560 m

Qz = 96.0 / (3.860 × 3.560)= 6.986 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 112.02 + 299.41 + 10.00 + 1.84 + 6.99

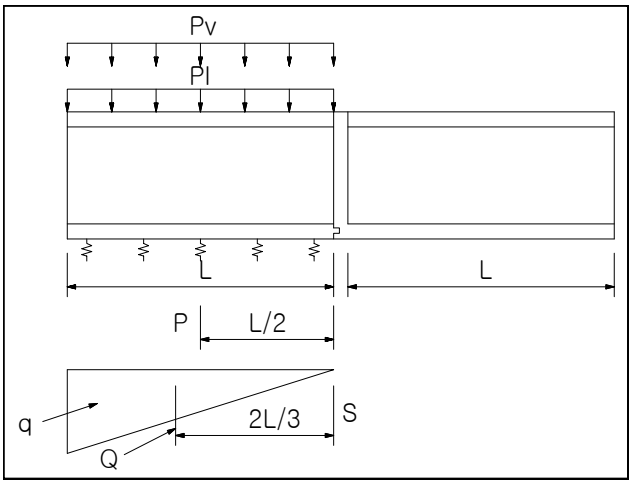
= 430.260 kN/m²

2) 지반의 허용연직지지력 : 지반조사보고서 참고

Qa' = 700.000 kN/m² > Qmax = 430.260 kN/m² ..... O.K !!!

27. 신축이음부 검토

※ 가정 : BOX-TYPE 종방향의 강성 EI는 무한대로 하고, 저면은 스프링 받침으로 한다



$P = \sum Pl + \sum Pv \qquad Q = \sum q$

$P - S - Q = 0$

$P \times L/2 - Q \times 2/3 \times L = 0$

윗식에서

$S = -1/4 \times P$

Pv = B × H × γt

= 14.05 x 15.647 x 19.0

= 4176.97 kN/m

Po = 2 × T1 / 3.0 ÷ 2 × 96 / 3 = 64.0 kN/m

Pl = 2 × Po × (1 + i) = 2 × 64.0 × (1 + 0.2) = 153.6 kN/m

P = (Pv+Pl) × L = (4176.97 + 153.6)x 40.0 = 173136.1 kN

S = P / 4 = 173136 / 4 = 43284.0 kN

(∴ τa = 80 MPa)

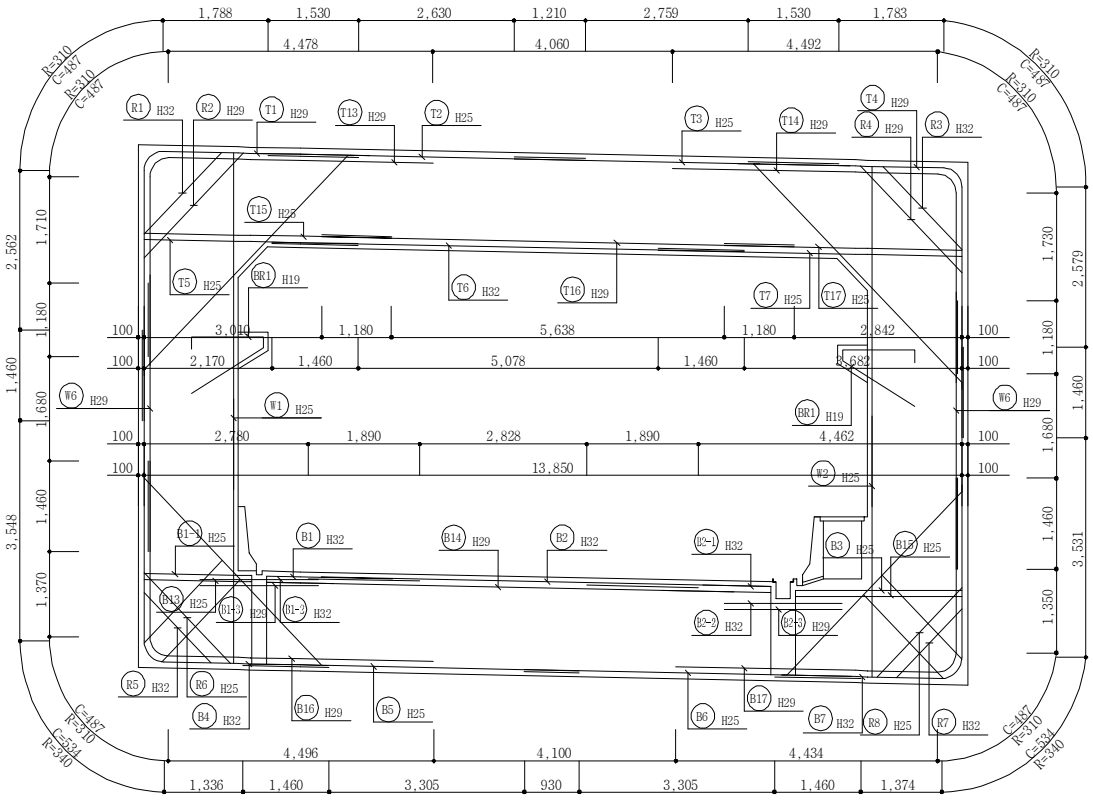
☞ 소요철근량 Areq = S / τa = 43284.0 x 1000 / 80 = 541,050 mm²

☞ 사용철근량 As = D32- 768 EA = 794.2 x 768 = 609,946 mm²

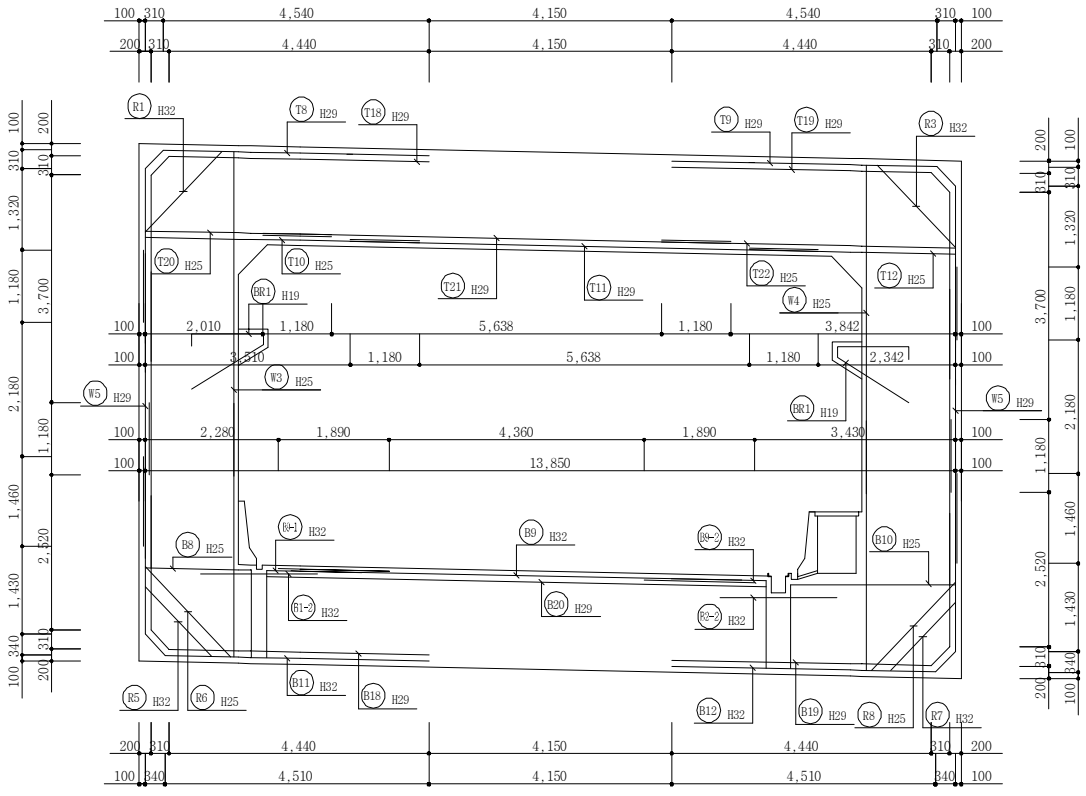
609,946 mm² > 541,050 ……O.K

28. 주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



1.22 B8(STA.0+780.0)

- 램 프 -

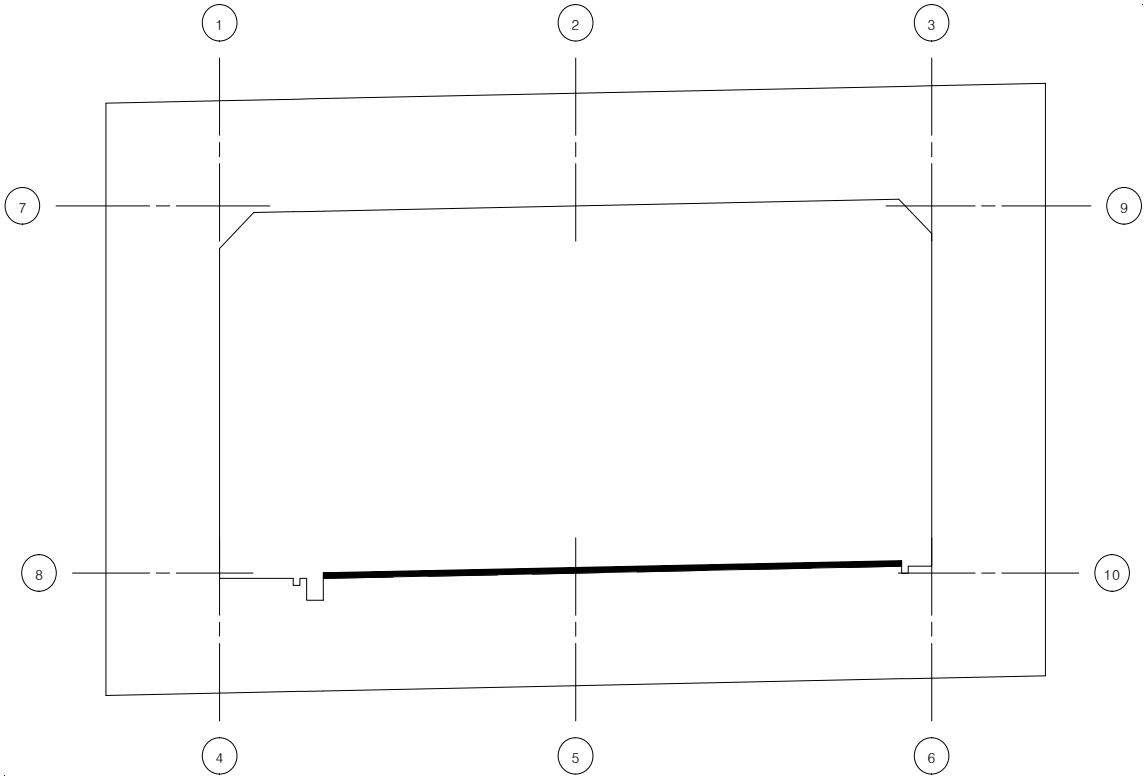
지하차도 구조계산서

▣ STA. 0K+739.000 (BLOCK2 : 단면 B-B)
▣ 토 피(FH) = 13.19 m ▣ 선 형 = ∞
▣ 지반 조건 : 토사
▣ 구조형식 : 지중 1 련
(내공 : 10.65M × 5.22M, 사각 : 90°)

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. INPUT DATA(상시)
16. INPUT DATA(기능수행)
17. INPUT DATA(붕괴방지)
18. OUTPUT DATA(상시)
19. OUTPUT DATA(기능수행)
20. OUTPUT DATA(붕괴방지)
21. 단면력정리
22. 단면검토 및 철근량 산정
23. 수평철근 검토
24. 절점부 검토
25. 사용성 검토
26. STM-우각부
27. 기초 지지력 검토
28. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qa(kN)	비 고
직접기초	383.557	700.000	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	2895.494	5653.125	1.952	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1623	2995.95	4821.04	5599.03	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.61
		중앙부	2	1000	1470	4326.48	4824.12	9153.09	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.12
		우측	3	1000	1623	2995.93	4821.04	5598.97	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.61
하부슬래브	1경간	좌측	4	1000	1471	2597.30	4227.54	5362.79	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.63
		추가1	5	1000	1177	951.78	2323.02	2422.51	H25 - 8.0EA + H25 - 4.0EA	6080.40	2.44
		중앙부	6	1000	1476	3839.00	4362.62	8031.18	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.14
		우측	7	1000	1471	2597.34	4227.54	5362.87	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.63
좌측벽체	1층	상부	8	1000	1723	4540.06	5133.59	8082.34	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.13
		하부	9	1000	1571	4178.66	4530.93	8194.60	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.08
우측벽체	1층	상부	10	1000	1711	4540.06	5098.17	8140.68	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.12
		하부	11	1000	1571	4178.65	4530.93	8194.58	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.08

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부슬래브	1경간	좌측	1	1800.0	3972.0	O.K	1838.6	2647.3	O.K
		중앙부	2	1800.0	3310.7	O.K	2055.7	2647.3	O.K
		우측	3	1800.0	3972.0	O.K	1838.6	2647.3	O.K
하부슬래브	1경간	좌측	4	1800.0	3972.0	O.K	1784.6	2647.3	O.K
		중앙부	5	1800.0	3308.7	O.K	1838.6	2647.3	O.K
		우측	6	1800.0	5296.7	O.K	1784.6	2647.3	O.K
좌측벽체	1층	상부	7	1800.0	2865.0	O.K	1838.6	1911.0	O.K
		하부	8	1800.0	2865.0	O.K	1784.6	1911.0	O.K
우측벽체	1층	상부	9	1800.0	2865.0	O.K	1838.6	1911.0	O.K
		하부	10	1800.0	2865.0	O.K	1784.6	1911.0	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부 슬래브	1 경간	좌측	1	945.6	1791.5	2102.21	2.00	290.51	H16	150	397.20	O.K
		중앙부	2	954.8	139.4	1538.68	2.00	-	H16	300	397.20	O.K
		우측	3	945.6	1791.4	2102.21	2.00	290.46	H16	150	397.20	O.K
하부 슬래브	1 경간	좌측	4	955.6	1499.9	1701.18	2.00	185.01	H13	150	253.40	O.K
		중앙부	6	958.6	233.7	1332.62	2.00	-	H13	300	253.40	O.K
		우측	7	955.6	1499.9	1701.18	2.00	184.98	H13	150	253.40	O.K
좌측 벽체	1 층	상부	8	1010.6	707.9	1404.86	2.00	-	H13	300	253.40	O.K
		중앙부	8	1052.2	793.2	1462.73	2.00	-	H13	300	253.40	O.K
		하부	9	1020.5	562.9	1418.67	2.00	-	H13	300	253.40	O.K
우측 벽체	1 층	상부	10	1010.6	707.9	1404.86	2.00	-	H13	300	253.40	O.K
		중앙부	10	1052.2	793.2	1462.73	2.00	-	H13	300	253.40	O.K
		하부	11	1020.5	562.9	1418.67	2.00	-	H13	300	253.40	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1 경간	좌측	1	1623	H29 - 8.0EA + H25 - 8.0EA	125	384.541	O.K	3.076
		중앙부	2	1470	H29 - 8.0EA + H29 - 8.0EA	125	211.412	O.K	1.691
		우측	3	1623	H29 - 8.0EA + H25 - 8.0EA	125	384.542	O.K	3.076
하부슬래브	1 경간	좌측	4	1471	H32 - 8.0EA + H29 - 4.0EA	125	318.185	O.K	2.545
		측구부	5	1177	H25 - 8.0EA + H25 - 4.0EA	125	743.973	O.K	5.952
		중앙부	6	1476	H29 - 8.0EA + H25 - 8.0EA	125	220.661	O.K	1.765
		우측	7	1471	H32 - 8.0EA + H29 - 4.0EA	125	318.178	O.K	2.545
좌측벽체	1 층	상부	8	1723	H29 - 8.0EA + H25 - 8.0EA	125	178.294	O.K	1.426
		하부	9	1571	H32 - 8.0EA + H29 - 4.0EA	125	146.924	O.K	1.175
우측벽체	1 층	상부	10	1711	H29 - 8.0EA + H25 - 8.0EA	125	175.619	O.K	1.405
		하부	11	1571	H32 - 8.0EA + H29 - 4.0EA	125	146.924	O.K	1.175

2. 설 계 조 건

1) 구조형식

- 지중 1 련 지하차도 (내공 : 10.65M × 5.22M, 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (ω_c) = 25.00 kN/m³
- Mortar (γ_{mot}) = 21.50 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sd
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 10.000 kN/m² (∵ 토피 : 13.188 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

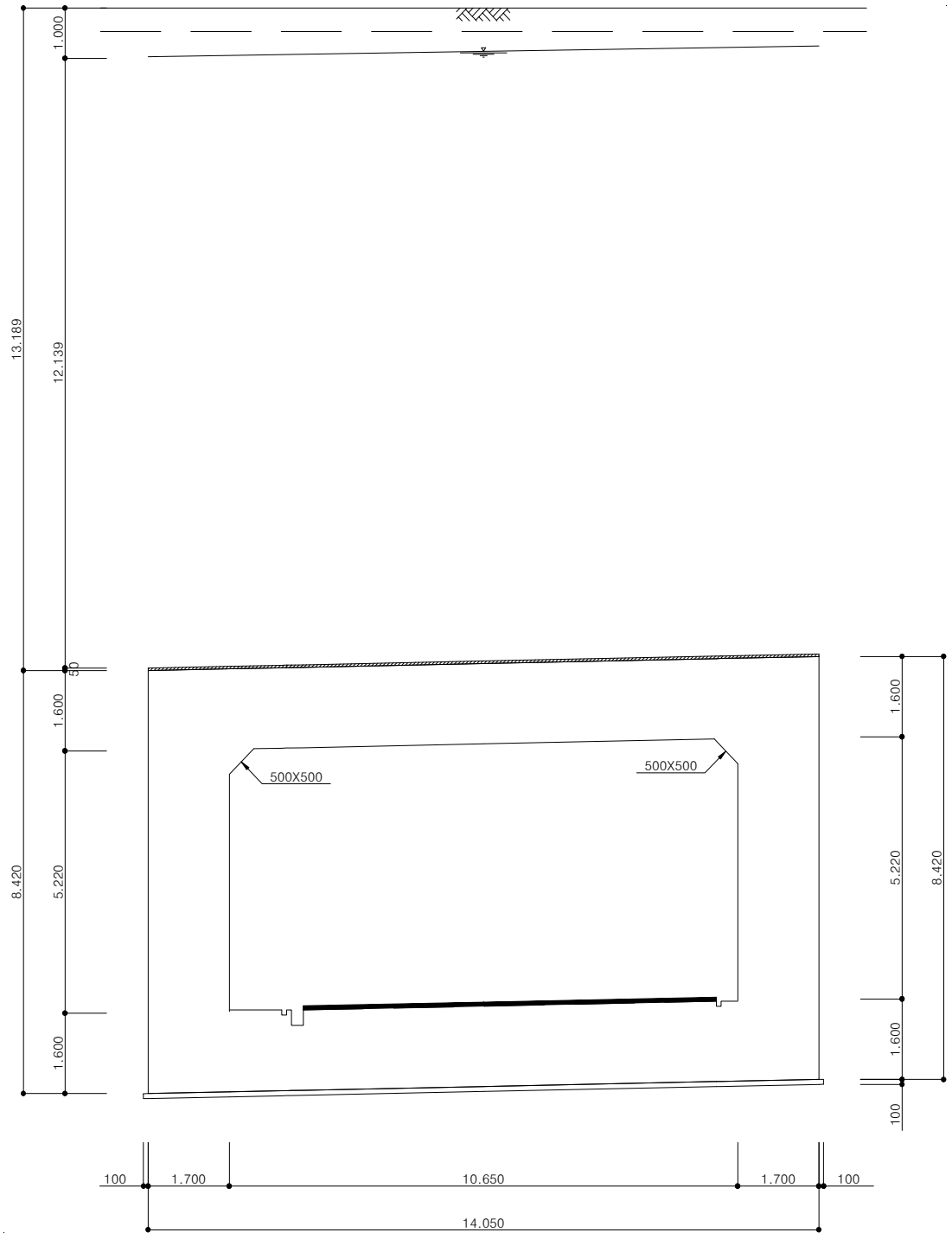
10) 사용프로그램 : SAP2000

11) 참고문헌

- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정

1) 단 면 가 정


1.000
13.189
12.139
50
1.600
8.420
5.220
1.600
500X500
500X500
1.600
5.220
8.420
1.600
100
100
1.700
10.650
1.700
100
14.050

4. 부 력 검 토

4.1 시공중 부력검토 (지하수위:G.L -9.6m) -상부슬래브 폐합전

: 부력에 대한 안전률 Fs = 1.10 (R/B)

1) 구체자중

- 하부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
		∴ Σ	=	1005.700	kN/m

2) 상재 하중

∴ Σ = 0.000 kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 0.000^2 \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$

$= 0.500 \times (2 \times 0.000 \times 0.000 \times 19.000 + 0.000^2 \times 10.000) \times \tan(30.0 \times 2/3)$

$= 0.000$ kN/m

∴ Σ = 0.000 + 0.000 = 0.000 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반편,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)

$= 14.050 \times 20.608 \times 10.000$

$= 2895.494$ kN/m

6) 안정검토

$R = 1005.700 + 0.000 + 0.000 = 1005.700$ kN/m

$Fs = R / U$

$= 1005.700 / 2895.494$

$\geq 1.100 \Rightarrow H \leq 0.316$ m

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 0.316m이하로 유지.

4.2 완공후 부력검토 (지하수위:G.L -9.6m)

: 부력에 대한 안전률 Fs = 1.20 (R/B)
부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려
(최소토피 H = 13.188 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 하부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 2EA × 25.0	=	6.250	kN/m
		∴ Σ	=	1573.950	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 14.050 × 23.0	=	161.575	kN/m
- 흙의 자중(지하수위 이상	:	9.100 × 14.050 × 19.0	=	2429.245	kN/m
- 흙의 자중(지하수위 이하	:	3.539 × 14.050 × 10.0	=	497.230	kN/m
- 지하수 자중	:	3.539 × 14.050 × 10.0	=	497.230	kN/m
- 방수 Mortal	:	0.050 × 14.050 × 21.5	=	15.104	kN/m
		∴ Σ	=	3600.383	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$
$= 0.500 \times 19.000 \times 9.600^2 \times \tan(30.0 \times 2/3)$
$= 318.663$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$
$= 0.500 \times (2 \times 9.600 \times 3.539 \times 19.000 + 3.539^2 \times 10.000) \times \tan(30.0 \times 2/3)$
$= 257.741$ kN/m

∴ Σ = 318.663 + 257.741 = 576.404 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반편,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)
$= 14.050 \times 12.008 \times 10.000$
$= 1687.124$ kN/m

6) 안정검토

$R = 1573.950 + 3600.383 + 576.404 = 5750.737$ kN/m
$Fs = R / U$
$= 5750.737 / 1687.124$
$= 3.409 > 1.200$ ∴O.K

4.3 완공후 부력검토 (극한수위:G.L -1.0m)

: 부력에 대한 안전률 Fs = 1.05 (R/B)
부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려
(최소토피 H = 13.188 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 하부슬래브	:	14.050 × 1.600 × 25.0	=	562.000	kN/m
- 좌측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 우측외벽	:	1.700 × 5.220 × 25.0	=	221.850	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 2EA × 25.0	=	6.250	kN/m
		∴ Σ	=	1573.950	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 14.050 × 23.0	=	161.575	kN/m
- 흙의 자중(지하수위 이상	:	0.500 × 14.050 × 19.0	=	133.475	kN/m
- 흙의 자중(지하수위 이하	:	12.139 × 14.050 × 10.0	=	1705.459	kN/m
- 지하수 자중	:	12.139 × 14.050 × 10.0	=	1705.459	kN/m
- 방수 Mortal	:	0.050 × 14.050 × 21.5	=	15.104	kN/m
		∴ Σ	=	3721.072	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$
$= 0.500 \times 19.000 \times 1.000^2 \times \tan(30.0 \times 2/3)$
$= 3.458$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$
$= 0.500 \times (2 \times 1.000 \times 12.188 \times 19.000 + 12.188^2 \times 10.000) \times \tan(30.0 \times 2/3)$
$= 354.645$ kN/m

∴ Σ = 3.458 + 354.645 = 358.103 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반편,p.170)]

5) 부력

$U = B \times hs \times \gamma w$ (여기서,hs=구조물높이+토피고-지하수위)
$= 14.050 \times 20.608 \times 10.000$
$= 2895.494$ kN/m

6) 안정검토

$R = 1573.950 + 3721.072 + 358.103 = 5653.125$ kN/m
$Fs = R / U$
$= 5653.125 / 2895.494$
$= 1.952 > 1.050$ ∴O.K

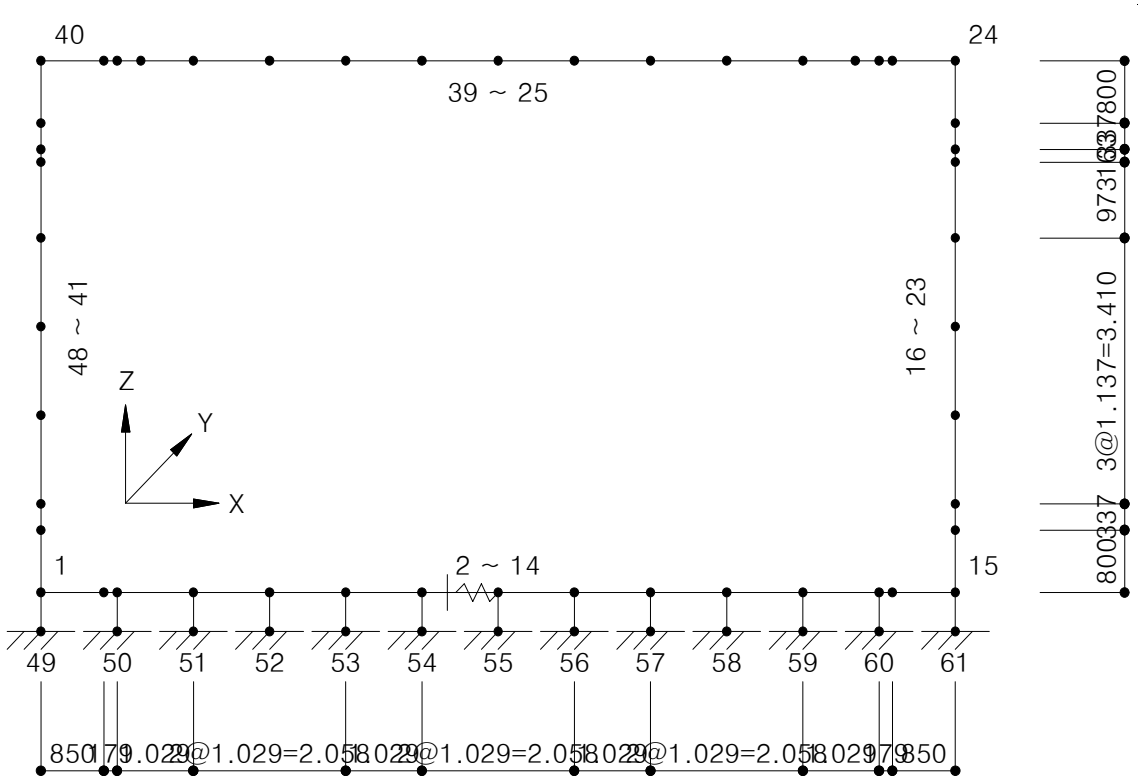
5. 해석모델 및 단면제원 (상시)

1) Modeling

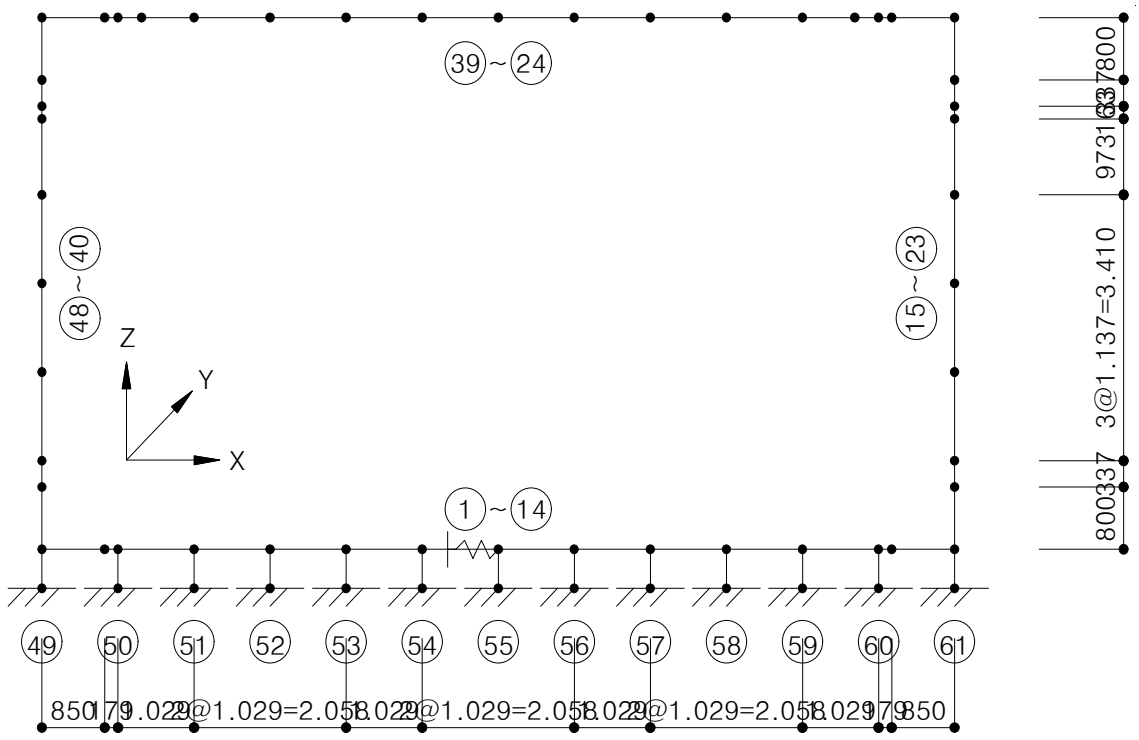
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.600 × 1.000	= 1.600	0.34133	1~14,27~36
2	1.700 × 1.000	= 1.700	0.40942	15~20,43~48
4	2.200 × 1.000	= 2.200	0.88733	23,40
5	2.100 × 1.000	= 2.100	0.77175	24,39

NO	A (m²)		I (m⁴)	절 점
3	1.863 × 1.000	= 1.863	0.53913	22,42
6	1.921 × 1.000	= 1.921	0.59059	26,38

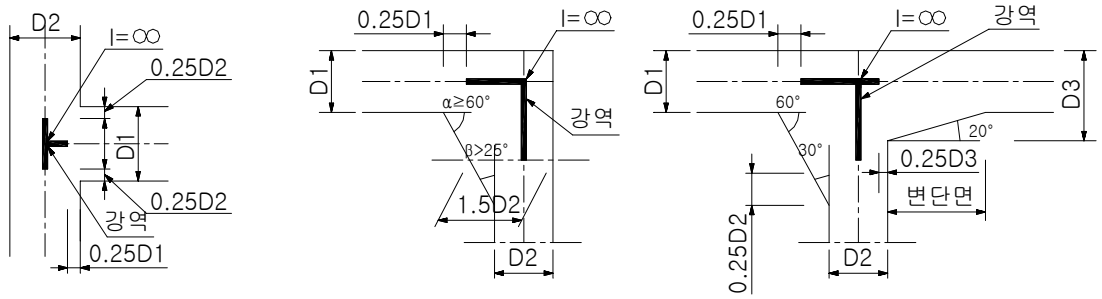
NO	Section(Tapper)	부 재
7	SEC 2 ~ 3	21
8	SEC 3 ~ 4	22
9	SEC 5 ~ 6	25
10	SEC 6 ~ 1	26
11	SEC 1 ~ 6	37
12	SEC 6 ~ 5	38
13	SEC 4 ~ 3	41
14	SEC 3 ~ 2	42

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	32	6.175	7.320
2	0.850	0.500	33	5.146	7.320
3	1.029	0.500	34	4.117	7.320
4	2.058	0.500	35	3.087	7.320
5	3.087	0.500	36	2.058	7.320
6	4.117	0.500	37	1.350	7.320
7	5.146	0.500	38	1.029	7.320
8	6.175	0.500	39	0.850	7.320
9	7.204	0.500	40	0.000	7.320
10	8.233	0.500	41	0.000	6.520
11	9.262	0.500	42	0.000	6.183
12	10.292	0.500	43	0.000	6.020
13	11.321	0.500	44	0.000	5.047
14	11.500	0.500	45	0.000	3.910
15	12.350	0.500	46	0.000	2.773
16	12.350	1.300	47	0.000	1.637
17	12.350	1.637	48	0.000	1.300
18	12.350	2.773	49	0.000	0.000
19	12.350	3.910	50	1.029	0.000
20	12.350	5.047	51	2.058	0.000
21	12.350	6.020	52	3.087	0.000
22	12.350	6.183	53	4.117	0.000
23	12.350	6.520	54	5.146	0.000
24	12.350	7.320	55	6.175	0.000
25	11.500	7.320	56	7.204	0.000
26	11.321	7.320	57	8.233	0.000
27	11.000	7.320	58	9.262	0.000
28	10.292	7.320	59	10.292	0.000
29	9.262	7.320	60	11.321	0.000
30	8.233	7.320	61	12.350	0.000
31	7.204	7.320			

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 40 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(2) 40 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(3) 24 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(4) 24 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

(7) 15 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(8) 15 지점 - 슬래브 벽체 연결부

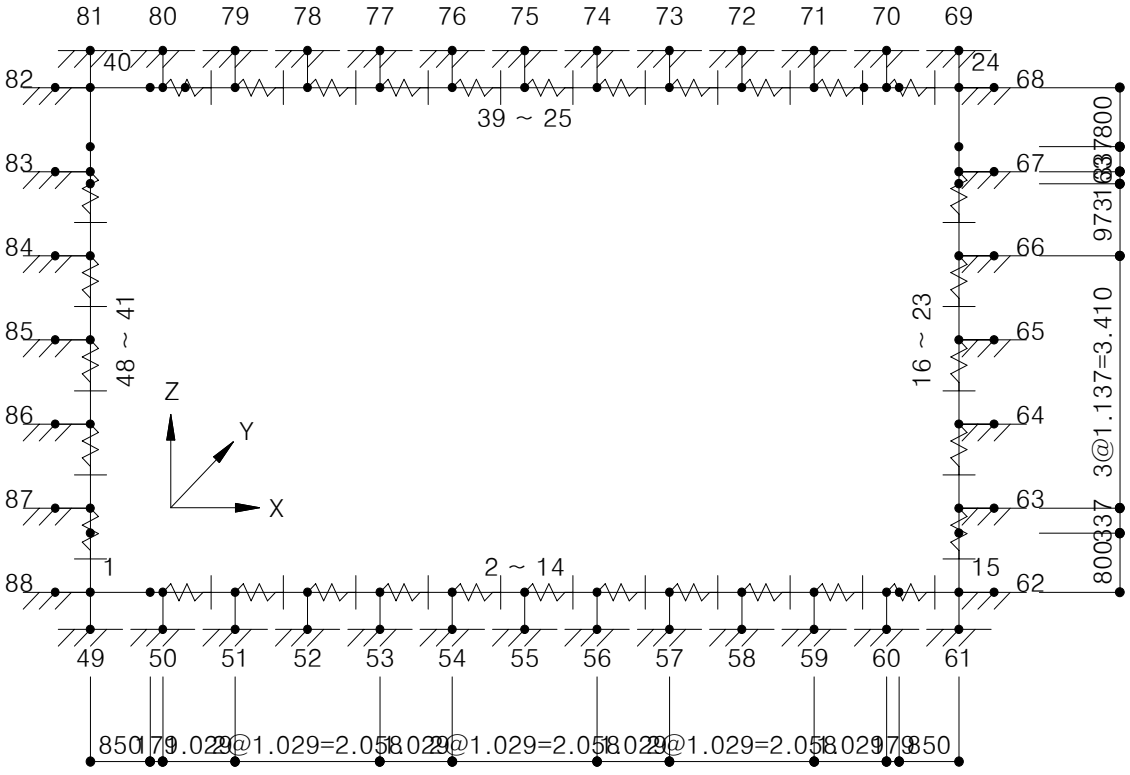
D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

6. 해석모델 및 단면제원 (지진시)

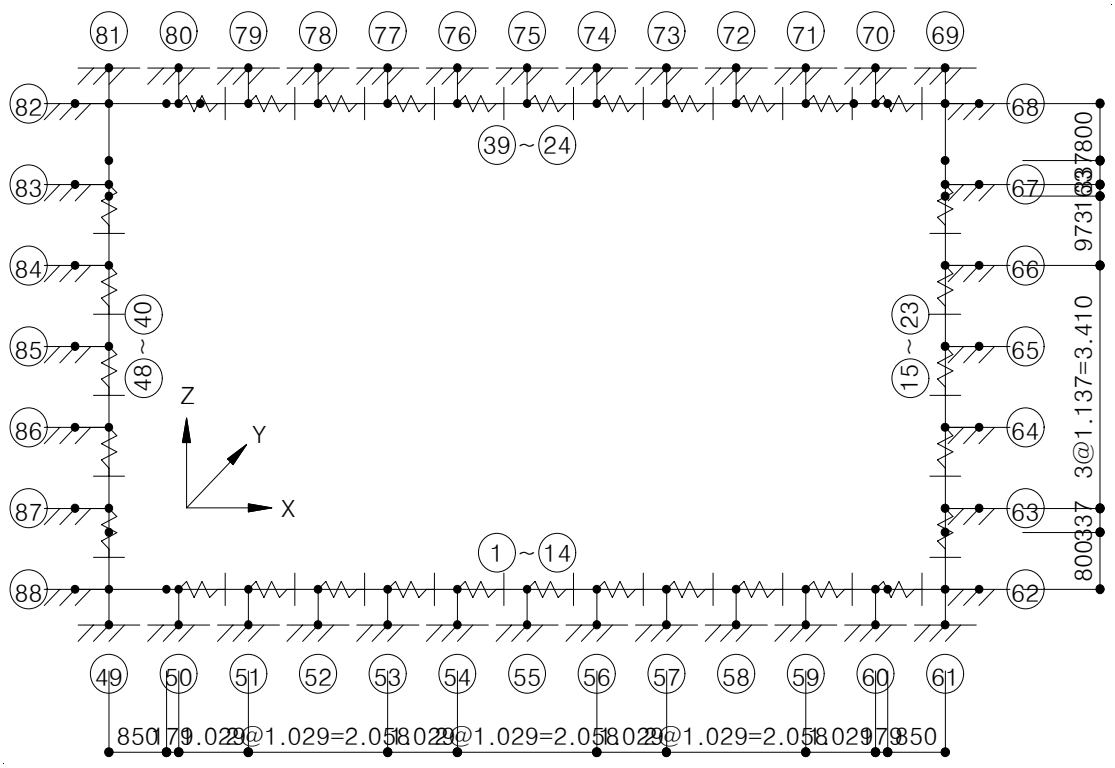
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.600 × 1.000	= 1.600	0.34133	1~14,27~36
2	1.700 × 1.000	= 1.700	0.40942	15~20,43~48
4	2.200 × 1.000	= 2.200	0.88733	23,40
5	2.100 × 1.000	= 2.100	0.77175	24,39

NO	A (m²)		I (m⁴)	절 점
3	1.863 × 1.000	= 1.863	0.53913	22,42
6	1.921 × 1.000	= 1.921	0.59059	26,38

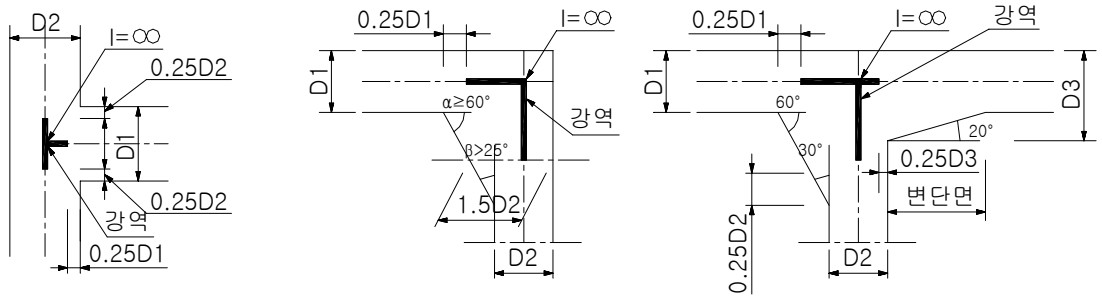
NO	Section(Tapper)	부 재
7	SEC 2 ~ 3	21
8	SEC 3 ~ 4	22
9	SEC 5 ~ 6	25
10	SEC 6 ~ 1	26
11	SEC 1 ~ 6	37
12	SEC 6 ~ 5	38
13	SEC 4 ~ 3	41
14	SEC 3 ~ 2	42

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.500	0.500	45	0.500	3.910
2	1.350	0.500	46	0.500	2.773
3	1.529	0.500	47	0.500	1.637
4	2.558	0.500	48	0.500	1.300
5	3.587	0.500	49	0.500	0.000
6	4.617	0.500	50	1.529	0.000
7	5.646	0.500	51	2.558	0.000
8	6.675	0.500	52	3.587	0.000
9	7.704	0.500	53	4.617	0.000
10	8.733	0.500	54	5.646	0.000
11	9.762	0.500	55	6.675	0.000
12	10.792	0.500	56	7.704	0.000
13	11.821	0.500	57	8.733	0.000
14	12.000	0.500	58	9.762	0.000
15	12.850	0.500	59	10.792	0.000
16	12.850	1.300	60	11.821	0.000
17	12.850	1.637	61	12.850	0.000
18	12.850	2.773	62	13.350	0.500
19	12.850	3.910	63	13.350	1.637
20	12.850	5.047	64	13.350	2.773
21	12.850	6.020	65	13.350	3.910
22	12.850	6.183	66	13.350	5.047
23	12.850	6.520	67	13.350	6.183
24	12.850	7.320	68	13.350	7.320
25	12.000	7.320	69	12.850	7.820
26	11.821	7.320	70	11.821	7.820
27	11.500	7.320	71	10.792	7.820
28	10.792	7.320	72	9.762	7.820
29	9.762	7.320	73	8.733	7.820
30	8.733	7.320	74	7.704	7.820
31	7.704	7.320	75	6.675	7.820
32	6.675	7.320	76	5.646	7.820
33	5.646	7.320	77	4.617	7.820
34	4.617	7.320	78	3.587	7.820
35	3.587	7.320	79	2.558	7.820
36	2.558	7.320	80	1.529	7.820
37	1.850	7.320	81	0.500	7.820
38	1.529	7.320	82	0.000	7.320
39	1.350	7.320	83	0.000	6.183
40	0.500	7.320	84	0.000	5.047
41	0.500	6.520	85	0.000	3.910
42	0.500	6.183	86	0.000	2.773
43	0.500	6.020	87	0.000	1.637
44	0.500	5.047	88	0.000	0.500

8) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 40 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(2) 40 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(3) 24 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(4) 24 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

(7) 15 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 mm

(8) 15 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 2800 x N = 2800 x 50 = 140000.000 kN/m²

Bv = √(B × B) = √(14.050 × 14.050) = 14.05 m (L > B)

Kvo = 1 / 0.3 × 1 × 140000 = 466670.00 kN/m³

Kv = 466670.000 × (14.050 / 0.3) $^{-3 / 4}$ = 26067.15 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 35571 kN/m	1,15
Kv2	Kv x (1.029/2 + 1.029/2) = 26828 kN/m	3~13
Kh	1E10 kN/m (무한강성)	8

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 풍화암 (EL. : 9.900 ~ -11.500, N=50)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 0.8 × Vo = 0.8 × 631.0 = 504.8 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 504.8^2 = 519517.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 519517.0 = 1506599.3 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.5 × Vo = 0.5 × 631.0 = 315.5 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 315.5^2 = 202936.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.45) × 202936.0 = 588514.4 kN/m^2

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제8토층 ,풍화암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 1506599.3 = 5021997.67 kN/m^3

Kv = 5021997.670 × (14.050 / 0.3)$^{-3/4}$ = 280517.66 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 280517.660 = 93505.89 kN/m^3

(2) 하부슬래브 : 제8토층 , 풍화암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 1506599.3 = 5021997.67 kN/m^3

Kv = 5021997.670 × (14.050 / 0.3)$^{-3/4}$ = 280517.66 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 280517.660 = 93505.89 kN/m^3

(3) 측벽 : 제8토층 , 풍화암

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 1506599.3 = 5021997.67 kN/m^3

Kh = 5021997.670 × (8.420 / 0.3)$^{-3/4}$ = 411844.60 kN/m^3

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 411844.600 = 137281.53 kN/m^3

(4) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 288700 kN/m	26,28~36,38
Ksb1	Ksb x (1.029/2 + 1.029/2) = 96233 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.137/2 + 1.137/2) = 468131 kN/m	17~20,22,42,44~47
Kss1	Kss x (1.137/2 + 1.137/2) = 156044 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 288700 kN/m	3~13
Ksb1	Ksb x (1.029/2 + 1.029/2) = 96233 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 382790 kN/m	1,15
Ksb1	Kh x (1.137/2 + 1.600/2) = 563541 kN/m	
Kv2	Kv x (1.029/2 + 1.700/2) = 382790 kN/m	24,40
Ksb2	Kh x (1.137/2 + 1.600/2) = 563541 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제8토층 ,풍화암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 588514.4 = 1961714.67 kN/m³

Kv = 1961714.670 × (14.050 / 0.3)$^{-3/4}$ = 109577.03 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 109577.030 = 36525.68 kN/m³

(2) 하부슬래브 : 제8토층 , 풍화암

① 연직방향 지반반력계수

Bv = √(B × B) = √(14.050 × 14.050) = 14.050 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 588514.4 = 1961714.67 kN/m³

Kv = 1961714.670 × (14.050 / 0.3)$^{-3/4}$ = 109577.03 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 109577.030 = 36525.68 kN/m³

(3) 측벽 : 제8토층 , 풍화암

① 수평방향 지반반력계수

Bv = √(H × H) = √(8.420 × 8.420) = 8.420 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 588514.4 = 1961714.67 kN/m³

Kh = 1961714.670 × (8.420 / 0.3)$^{-3/4}$ = 160876.54 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 160876.540 = 53625.51 kN/m³

(4) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 112773 kN/m	26,28~36,38
Ksb1	Ksb x (1.029/2 + 1.029/2) = 37591 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.137/2 + 1.137/2) = 182864 kN/m	17~20,22,42,44~47
Kss1	Kss x (1.137/2 + 1.137/2) = 60955 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 112773 kN/m	3~13
Ksb1	Ksb x (1.029/2 + 1.029/2) = 37591 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 149527 kN/m	1,15
Ksb1	Kh x (1.137/2 + 1.600/2) = 220133 kN/m	
Kv2	Kv x (1.029/2 + 1.700/2) = 149527 kN/m	24,40
Ksb2	Kh x (1.137/2 + 1.600/2) = 220133 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

	성능기준 / 재현주기	기 능 수 행	붕 괴 방 지
설계지진	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.16 = 0.091
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.16 = 0.224

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500 kN/m²
- 토 사	: 12.638 × 19.00	=	240.131 kN/m²
- 방 수	: 0.050 × 21.50	=	1.075 kN/m²
	∴ Total Wd1	=	252.706 kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500 kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00	=	9.500 kN/m²
- 흙(지하수위 이하)	: 12.138 × 10.00	=	121.385 kN/m²
- 방수	: 0.050 × 21.50	=	1.075 kN/m²
	∴ Total Wd2	=	143.460 kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

토피고(D,m)	도로면의 활하중 (kN/m²)	토피고(D,m)	도로면의 활하중 (kN/m²)
1.0	39.0	1.5	25.0
2.0	18.0	2.5	14.0
3.0	11.0	3.5	10.0
4.0	10.0	5.0	10.0
6.0	10.0	7.0	10.0
8.0	10.0	9.0	10.0
10.0	10.0		

주) 중간토피에 대한 것은 그 상위의 것을 취한다.

① 상부 슬래브에 작용하는 하중 (WI1) - 토피 4m 이상

- WI1 = 10.000 kN/m²

② 측벽에 작용하는 하중 (WI2)

- WI2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 13.489 × 19.000) × 0.500 = 133.891 kN/m²
Wh2 = 133.891 + 0.800 × 19.000 × 0.500 = 141.491 kN/m²
Wh3 = 141.491 + 0.337 × 19.000 × 0.500 = 144.690 kN/m²
Wh4 = 144.690 + 0.163 × 19.000 × 0.500 = 146.241 kN/m²
Wh5 = 146.241 + 0.973 × 19.000 × 0.500 = 155.487 kN/m²
Wh6 = 155.487 + 1.137 × 19.000 × 0.500 = 166.286 kN/m²
Wh7 = 166.286 + 1.137 × 19.000 × 0.500 = 177.085 kN/m²
Wh8 = 177.085 + 1.137 × 19.000 × 0.500 = 187.882 kN/m²
Wh9 = 187.882 + 0.337 × 19.000 × 0.500 = 191.081 kN/m²
Wh10 = 191.081 + 0.800 × 19.000 × 0.500 = 198.681 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 12.989 × 10.00 = 75.443 kN/m²
Wh2 = 75.443 + 0.800 × 10.000 × 0.500 = 79.443 kN/m²
Wh3 = 79.443 + 0.337 × 10.000 × 0.500 = 81.126 kN/m²
Wh4 = 81.126 + 0.163 × 10.000 × 0.500 = 81.943 kN/m²
Wh5 = 81.943 + 0.973 × 10.000 × 0.500 = 86.810 kN/m²
Wh6 = 86.810 + 1.137 × 10.000 × 0.500 = 92.493 kN/m²
Wh7 = 92.493 + 1.137 × 10.000 × 0.500 = 98.176 kN/m²
Wh8 = 98.176 + 1.137 × 10.000 × 0.500 = 103.860 kN/m²
Wh9 = 103.860 + 0.337 × 10.000 × 0.500 = 105.543 kN/m²
Wh10 = 105.543 + 0.800 × 10.000 × 0.500 = 109.543 kN/m²

6) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

7) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 15 \times 10^{-5}$
- 온도선팽창 계수 $\alpha = 1.0 \times 10^{-5}$
- $\Delta T = -\frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
실트질 자갈	2.638	156.000	156.000	20.000	0.068	0.068
점토	2.600	156.000	156.000	20.000	0.067	0.067
점토 섞인 모래(SC	1.600	156.000	156.000	20.000	0.041	0.041
점토 섞인 실트(ML	2.000	156.000	156.000	20.000	0.051	0.051
모래(SP)	2.000	289.000	289.000	20.000	0.028	0.028
와 자갈 섞인 호	0.600	289.000	289.000	20.000	0.008	0.008
모래(SP)	1.100	289.000	289.000	20.000	0.015	0.015
풍화암	8.700	631.000	631.000	20.000	0.055	0.055
연암	8.762	1216.000	1216.000	20.000	0.029	0.029
계					0.362	0.362

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.362 = 0.453	1.25 Tg' = 1.25 × 0.362 = 0.453

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575
To(sec)	To = 0.2 × Ts = 0.2 × 0.575 = 0.115	To = 0.2 × Ts = 0.2 × 0.575 = 0.115

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $$C_d = \frac{1.5}{40h+1} + 0.5$$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa) - 붕괴방지수준시(재현주기 1000년적용)

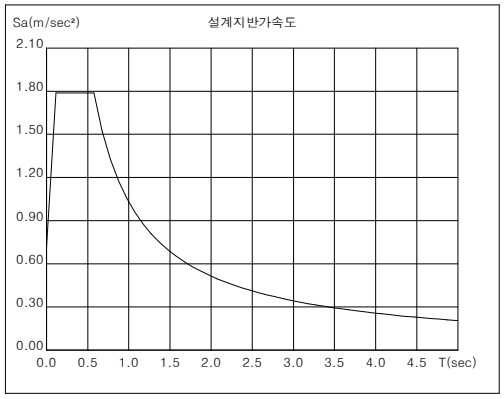
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 1.789 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 3.664 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg

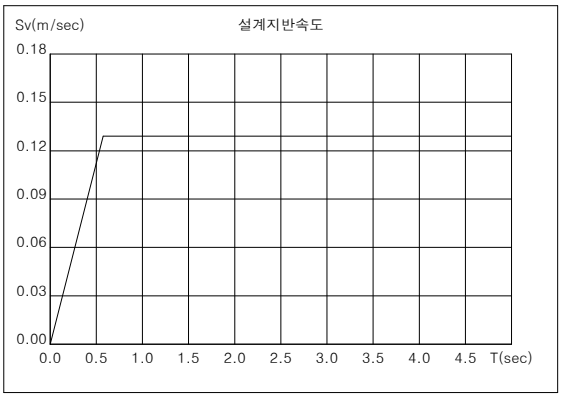
5) 속도 응답스펙트럼(Sv) - 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.453 / 2π × 1.789 = 0.129 m/s	Sv = Tg/2π × Sa = 0.453 / 2π × 3.664 = 0.264 m/s

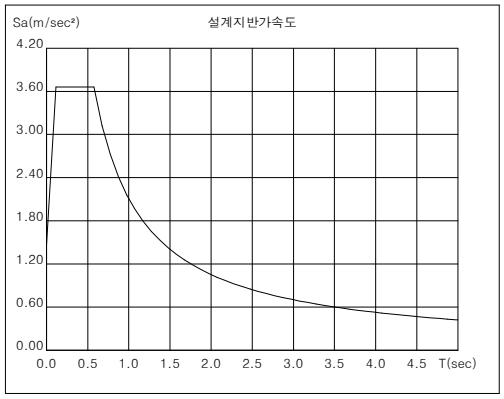
6) 설계응답 응답스펙트럼

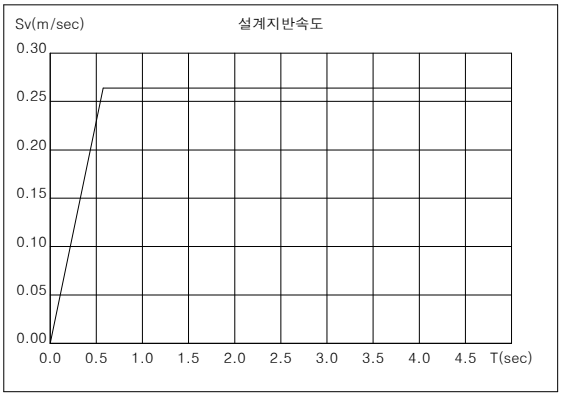
(1) 기능수행수준





(2) 붕괴방지수준





7) 층별 변위값 정리

- 제 1층의 두께(H1) = 12.538 m
- 제 2층의 두께(H2) = 17.462 m
- 제 1층의 습윤단위 체적중량(γ1) = 20.000 kN/m³
- 제 2층의 습윤단위 체적중량(γ2) = 20.000 kN/m³
- 제 1층의 평균전단파속도(Vsod1) = 195.249 m/sec
- 제 2층의 평균전단파속도(Vsod2) = 924.539 m/sec
- 제 1층과 제2층의 임피던스비(α)

  (γ1×Vsod1) / (γ2×Vsod2) = (20.000 × 195.249) / (20.000 × 924.539)

  = 0.211
- 지반의 설계 고유 진동수(Wo)

  (1+α)×cos[Wo×(H1/Vsod1 + H2/Vsod2)] + (1-α)×cos[Wo×(H1/Vsod1 - H2/Vsod2)] = 0

  (1 + 0.211) × cos[Wo × (12.538 / 195.249 + 17.462 / 924.539)] +

  (1 - 0.211) × cos[Wo × (12.538 / 195.249 - 17.462 / 924.539)] = 0

  에서 시행착오법으로 산정, Wo = 22.946
- 각 층별 변위 계산식
  - 제1층 변위 계산식

    $Uh1 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times x1/Vsod1)$

  - 제2층 변위 계산식

    $Uh2 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times H1/Vsod1) \times$

    $[\cos(Wo \times x2/Vsod2) - \sin(Wo \times x2/Vsod2) / \tan(Wo \times H2/Vsod2)]$

8) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 1.450 m
- 하부슬래브 EL. = 20.808 m
- 기반암 심도(H) = 30.000 m

Po = Ksb,top × (U(Zu) - U(Zb))

기능수행수준	붕괴방지수준
Po = 93505.890 × (0.001060 - 0.000620) = 41.143 kN/m²	Po = 36525.680 × (0.002170 - 0.001268) = 32.946 kN/m²

9) 측벽 지반변위 하중

P(z) = Kh × (Uh(z) - Uh(b))

(1) 기능수행수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
1.450	411844.600	0.001060	0.000440	181.212
14.788	411844.600	0.001010	0.000390	160.619
15.125	411844.600	0.000989	0.000369	151.971
15.288	411844.600	0.000978	0.000358	147.440
16.261	411844.600	0.000916	0.000296	121.906
17.398	411844.600	0.000843	0.000223	91.841
18.535	411844.600	0.000769	0.000149	61.365
19.671	411844.600	0.000695	0.000075	30.888
20.008	411844.600	0.000672	0.000052	21.416
20.808	411844.600	0.000620	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
13.988	160876.540	0.002170	0.000902	145.111
14.788	160876.540	0.002067	0.000799	128.540
15.125	160876.540	0.002023	0.000755	121.462
15.288	160876.540	0.002002	0.000734	118.083
16.261	160876.540	0.001875	0.000607	97.652
17.398	160876.540	0.001725	0.000457	73.521
18.535	160876.540	0.001574	0.000306	49.228
19.671	160876.540	0.001422	0.000154	24.775
20.008	160876.540	0.001376	0.000108	17.375
20.808	160876.540	0.001268	0.000000	0.000

10) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

구분	기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
Vu	519517.000 × 0.000062 = 32.210	202936.000 × 0.000127 = 25.770
Vb	1929337.000 × 0.000066 = 127.340	753647.000 × 0.000135 = 101.740
Vs	(32.210 + 127.340) / 2 = 79.780	(25.770 + 101.740) / 2 = 63.750

11) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fu = 1.600×25.000×0.091×(1 - 0.015×1.450) = 2.876	fu = 1.600×25.000×0.224×(1 - 0.015×1.450) = 7.080

② 하부슬래브

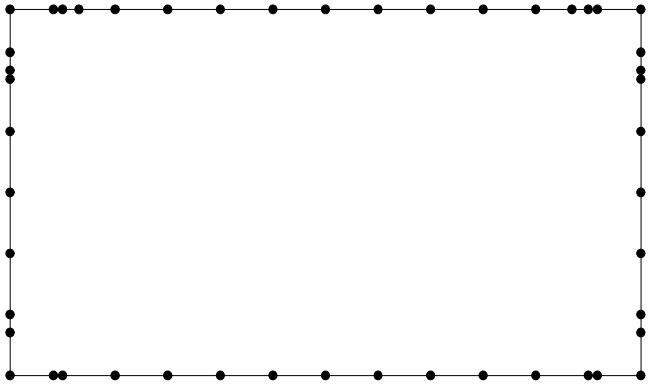
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fb = 1.600×25.000×0.091×(1 - 0.015×20.808) = 2.504	fb = 1.600×25.000×0.224×(1 - 0.015×20.808) = 6.163

③ 측벽

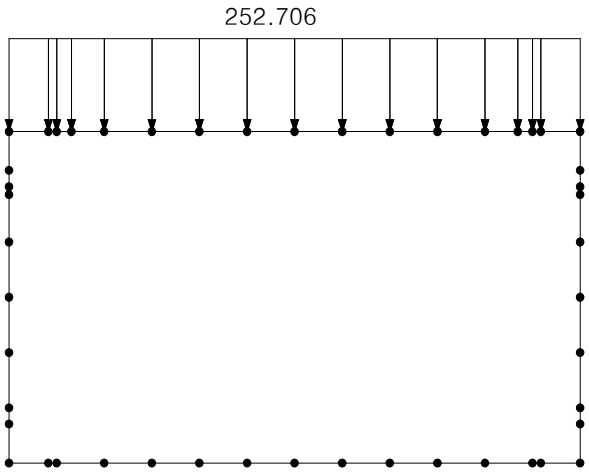
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
f1 = 1.700×25.000×0.091×(1-0.015×13.988) = 3.056	f1 = 1.700×25.000×0.224×(1-0.015×13.988) = 7.523
f2 = 1.700×25.000×0.091×(1-0.015×14.788) = 3.010	f2 = 1.700×25.000×0.224×(1-0.015×14.788) = 7.408
f3 = 1.700×25.000×0.091×(1-0.015×15.125) = 2.990	f3 = 1.700×25.000×0.224×(1-0.015×15.125) = 7.360
f4 = 1.700×25.000×0.091×(1-0.015×15.288) = 2.981	f4 = 1.700×25.000×0.224×(1-0.015×15.288) = 7.337
f5 = 1.700×25.000×0.091×(1-0.015×16.261) = 2.924	f5 = 1.700×25.000×0.224×(1-0.015×16.261) = 7.198
f6 = 1.700×25.000×0.091×(1-0.015×17.398) = 2.858	f6 = 1.700×25.000×0.224×(1-0.015×17.398) = 7.036
f7 = 1.700×25.000×0.091×(1-0.015×18.535) = 2.792	f7 = 1.700×25.000×0.224×(1-0.015×18.535) = 6.873
f8 = 1.700×25.000×0.091×(1-0.015×19.671) = 2.726	f8 = 1.700×25.000×0.224×(1-0.015×19.671) = 6.711
f9 = 1.700×25.000×0.091×(1-0.015×20.008) = 2.707	f9 = 1.700×25.000×0.224×(1-0.015×20.008) = 6.663
f10 = 1.700×25.000×0.091×(1-0.015×20.808) = 2.660	f10 = 1.700×25.000×0.224×(1-0.015×20.808) = 6.549

11. 하 중 재 하 (상시)

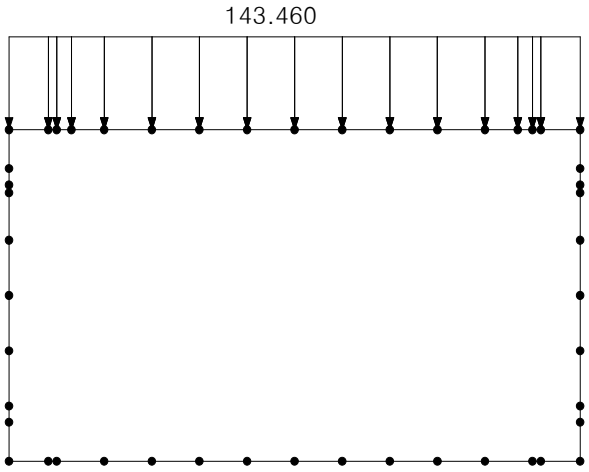
1) CASE1 - 구체자중(SW)



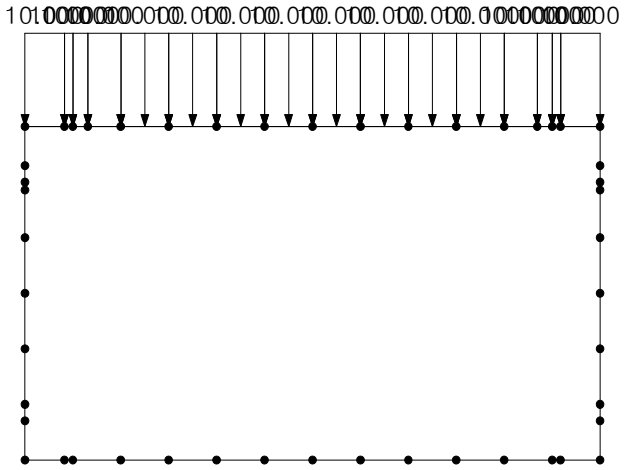
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



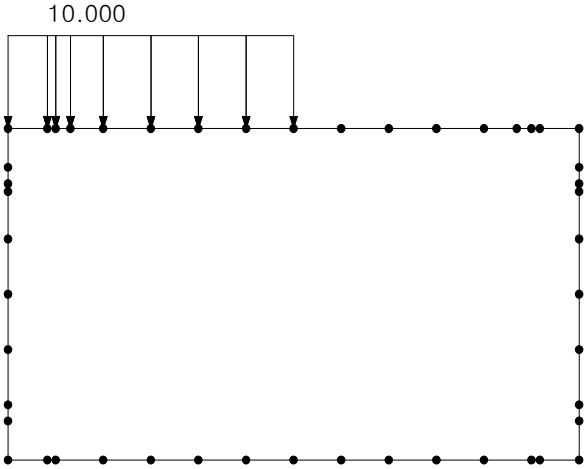
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



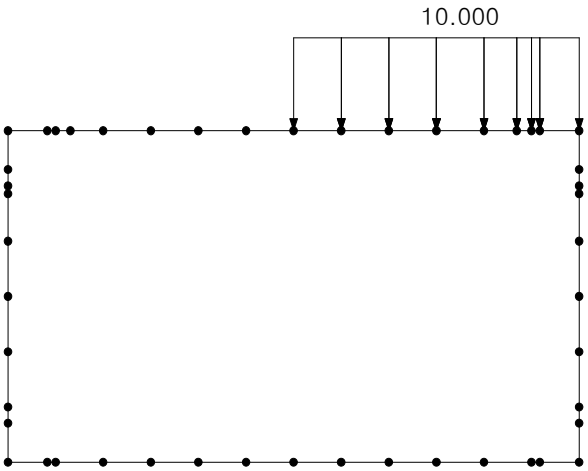
4) CASE4 - 만재활하중(LIVEFU)



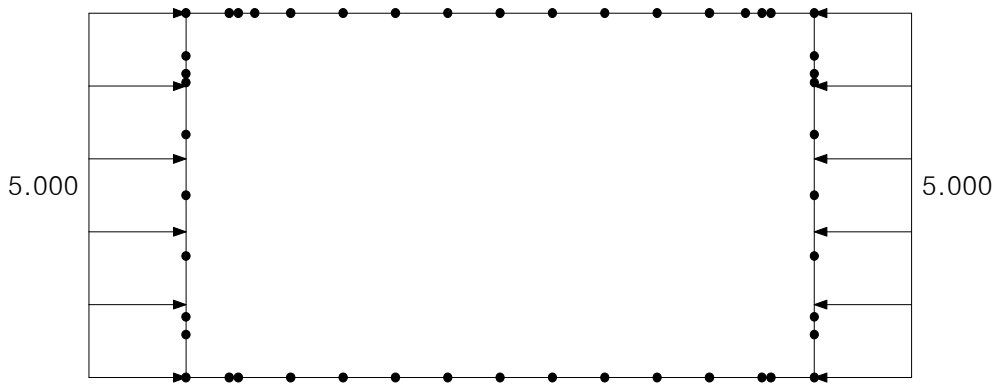
5) CASE5 - 편재활하중(좌측)(LIVELE)



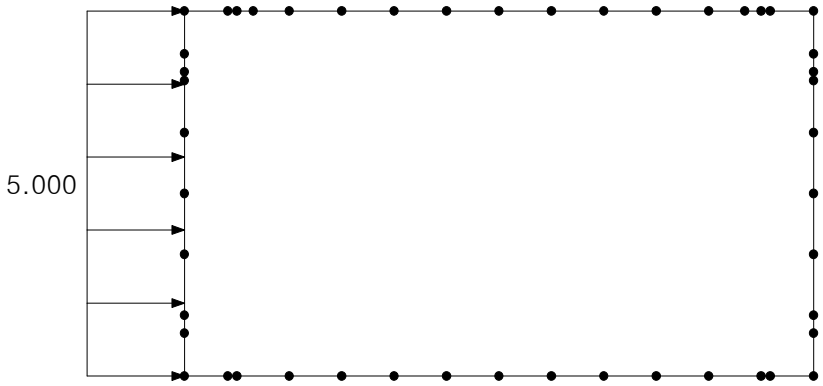
6) CASE6 - 편재활하중(우측)(LIVERI)



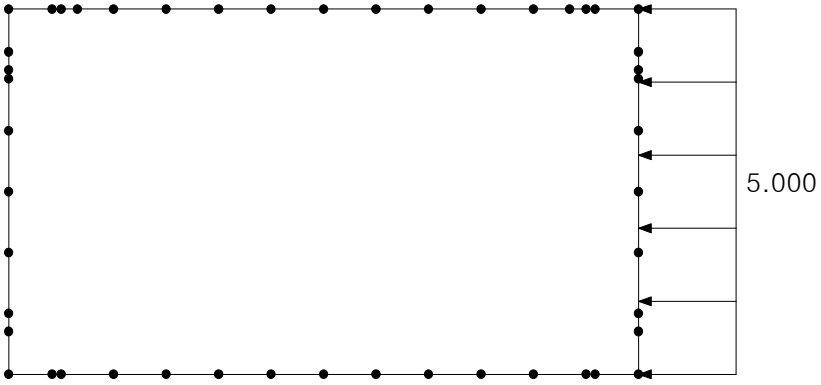
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



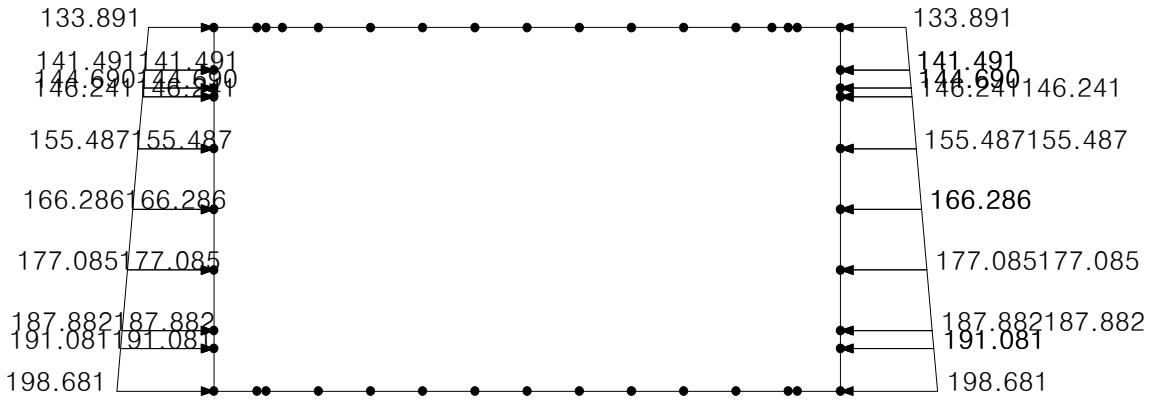
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



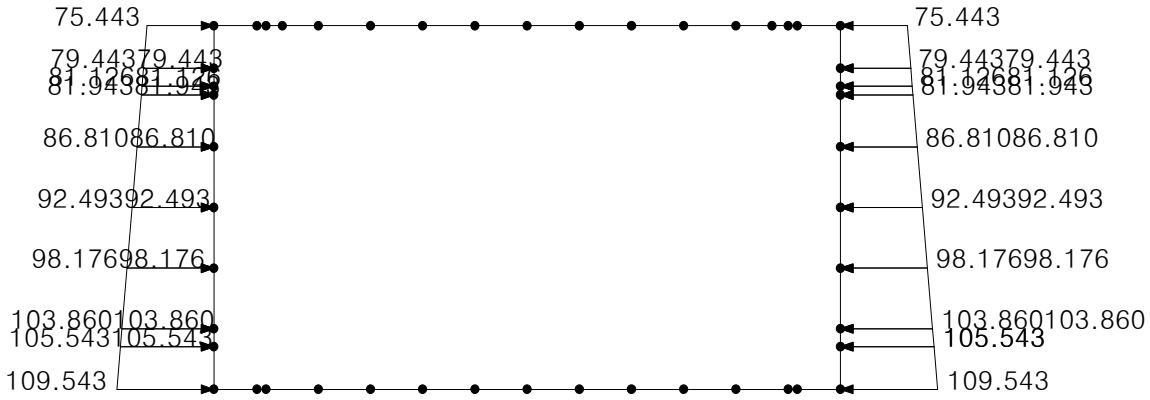
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



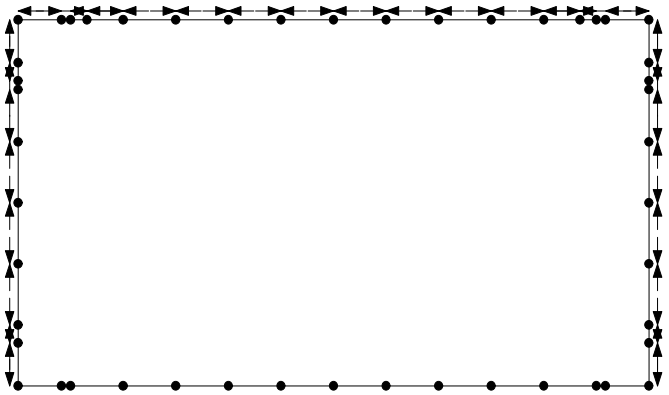
10) CASE10 - 양토압 : 지하수無(SOILB)



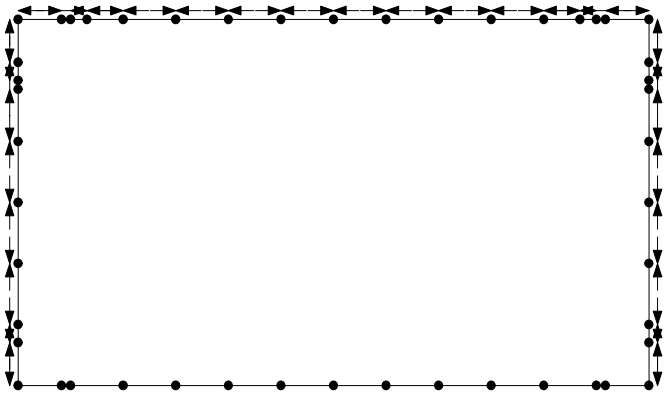
11) CASE11 - 양토압 : 지하수有(SOILBW)



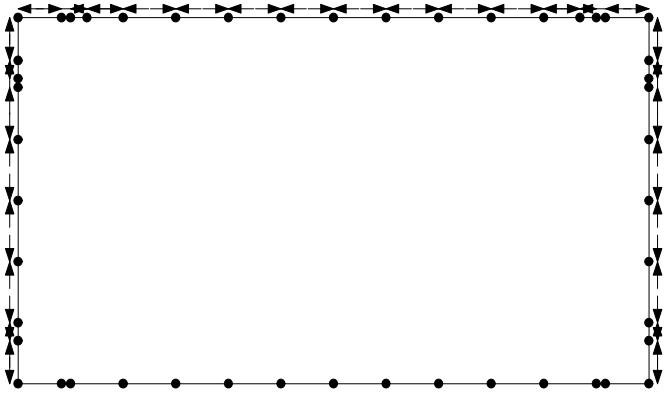
12) CASE12 - 온도변화(+) +10° C(TEMPPLUS)



13) CASE13 - 온도변화(-) -10° C(TEMPMINU)

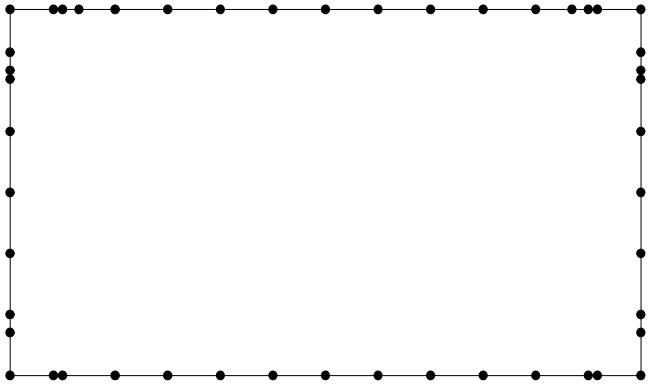


14) CASE14 - 건조수축 -15° C(SHRINK)

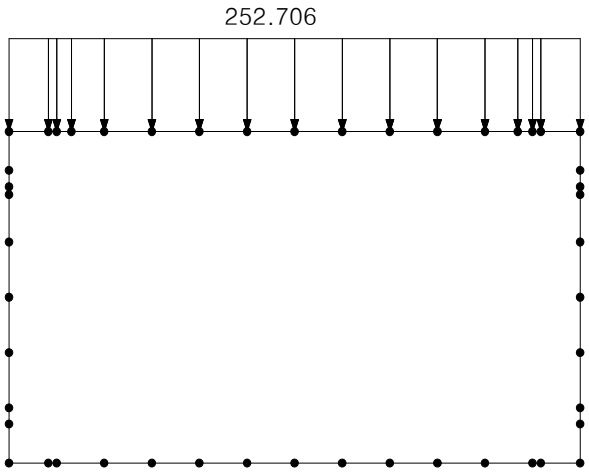


12. 하중 재하 (기능수행)

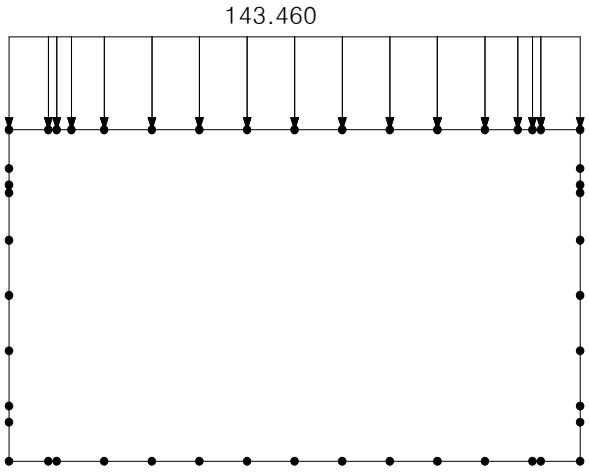
1) CASE1 - 구체자중(SW)



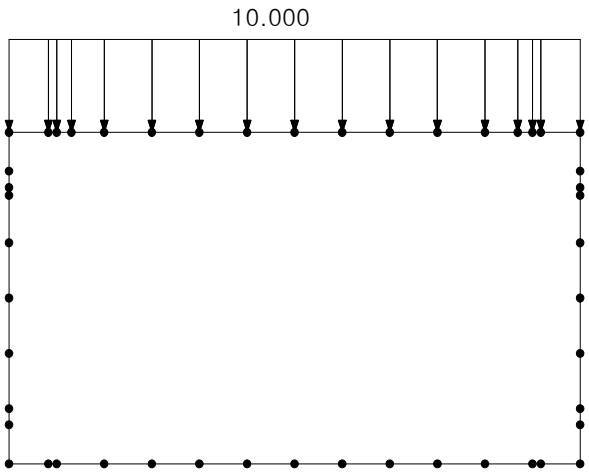
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



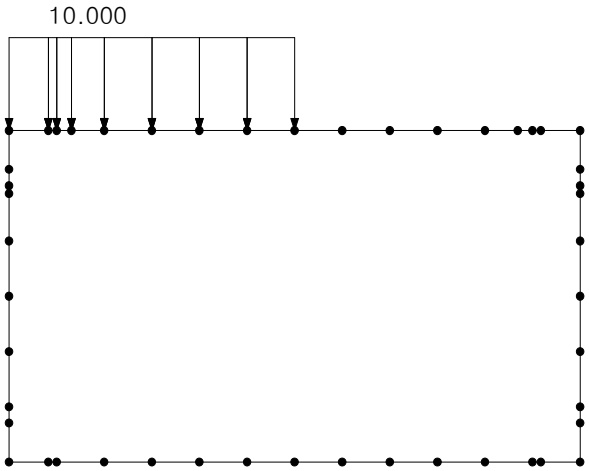
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



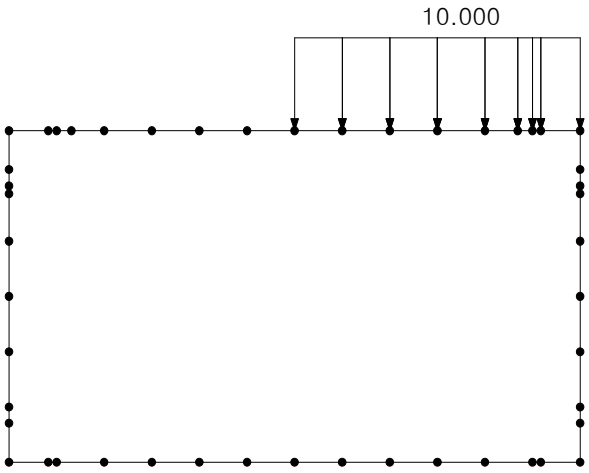
4) CASE4 - 지진시 만재활하중(LIVEFUE)



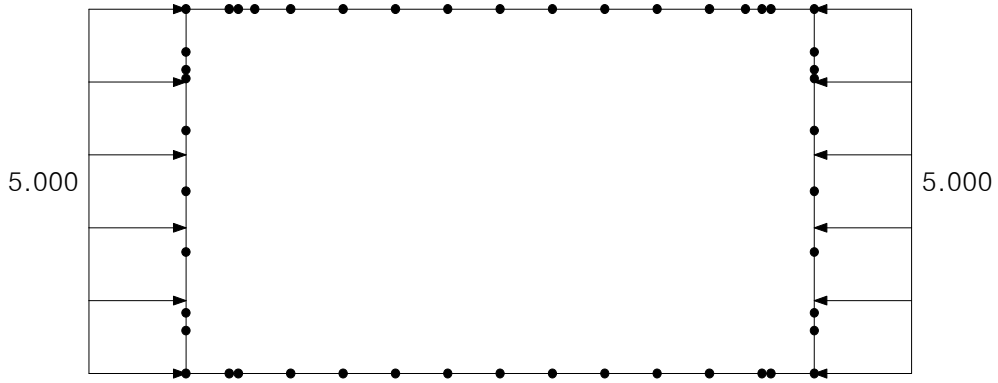
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



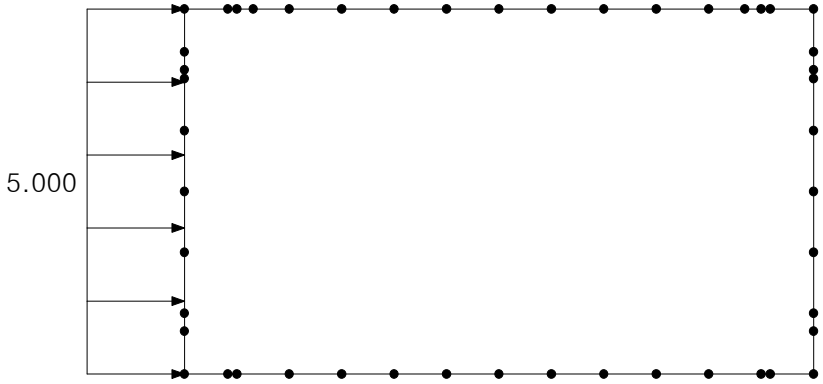
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



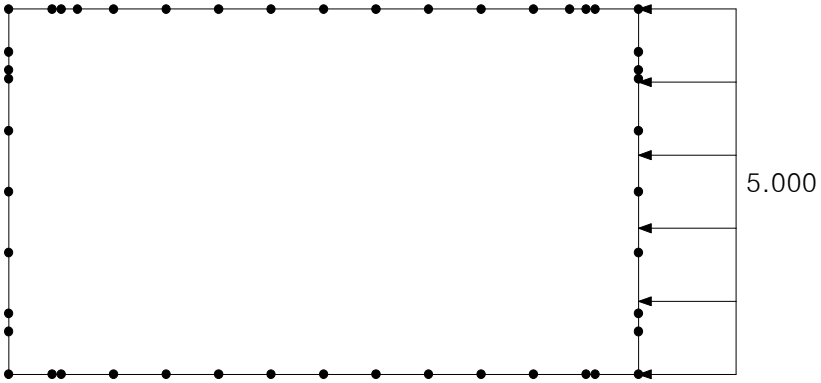
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)

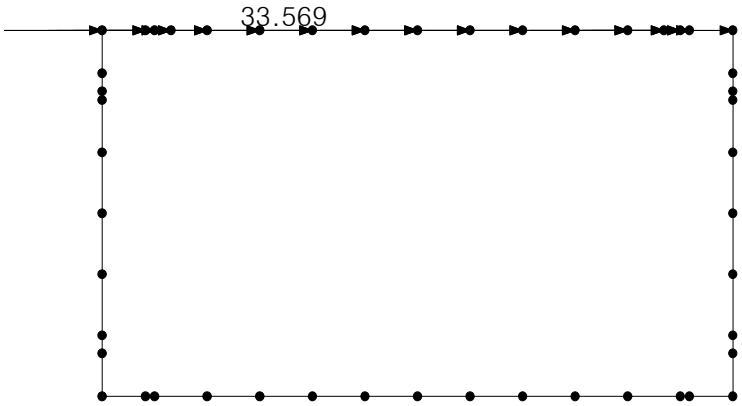


9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)

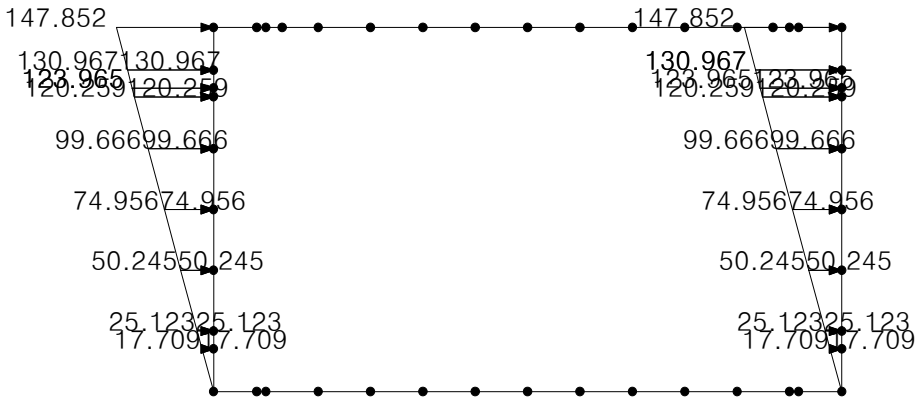


- 지진재하방향(좌측에서 우측으로)

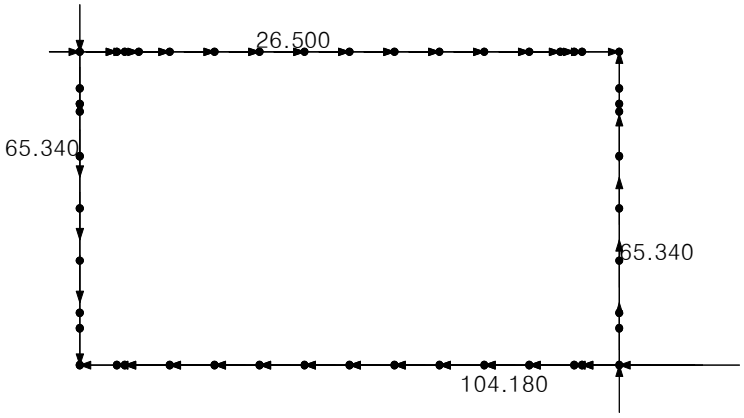
10) CASE10 - 슬래브 지반변위(기능수행)(FUNSLAB)



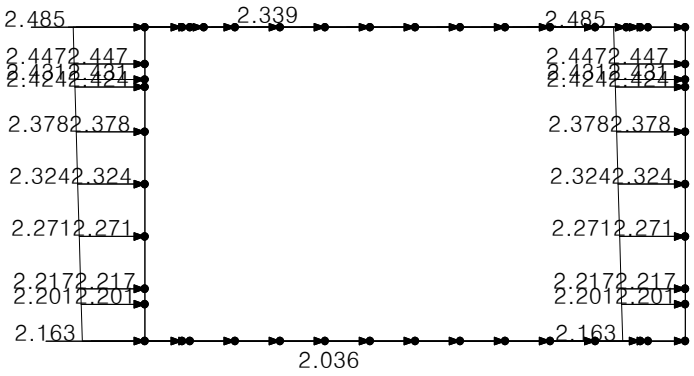
11) CASE11 - 벽체 지반변위(기능수행)(FUNWALL)



12) CASE12 - 주면전단력(기능수행)(FUNMS)

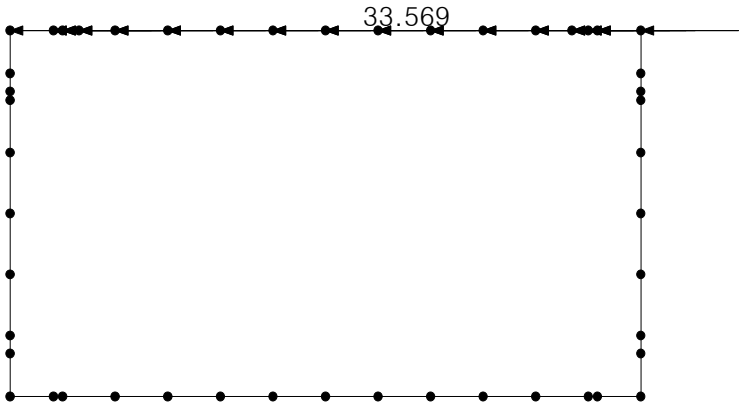


13) CASE13 - 구체 관성력(기능수행)(FUNINER)

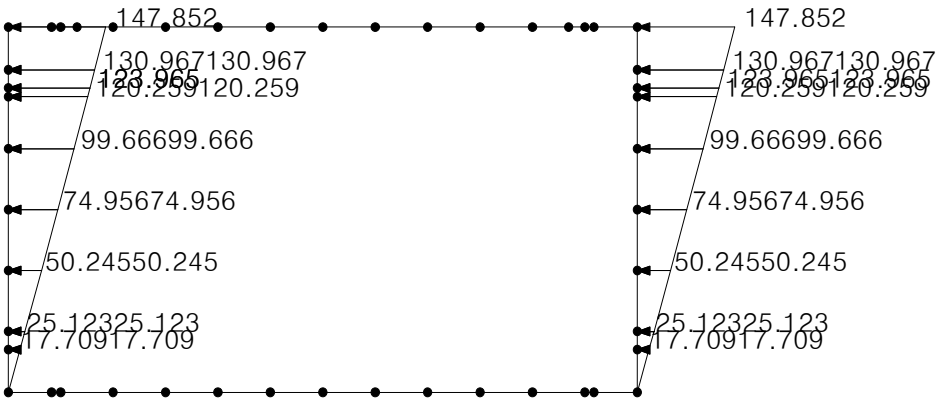


- 지진재하방향(우측에서 좌측으로)

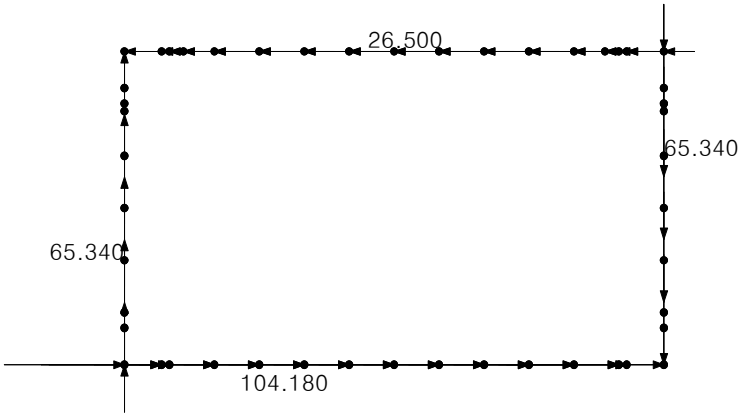
14) CASE14 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



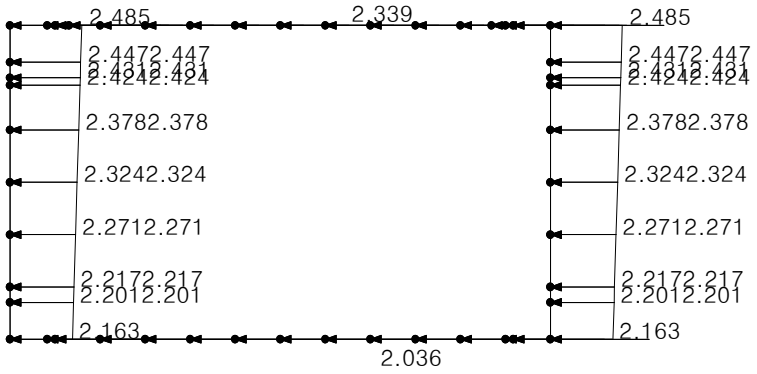
15) CASE15 - 벽체 지반변위(기능수행)2(FUNWALL2)



16) CASE16 - 주면전단력(기능수행)2(FUNMS2)

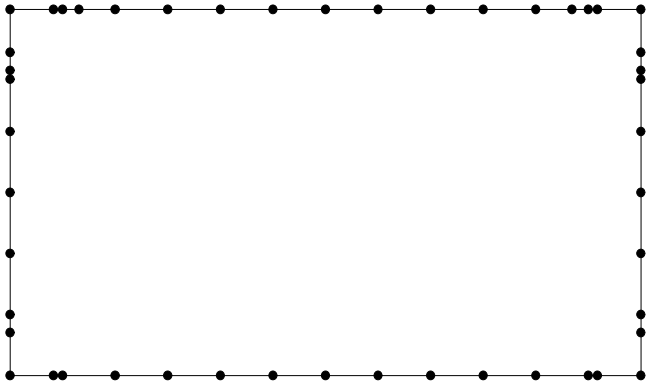


17) CASE17 - 구체 관성력(기능수행)2(FUNINER2)

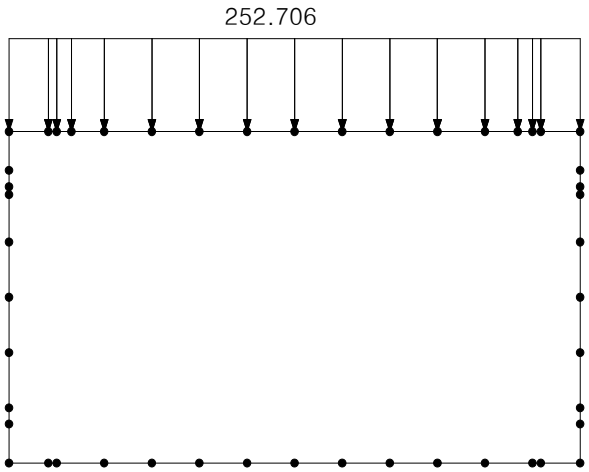


13. 하중 재하 (붕괴방지)

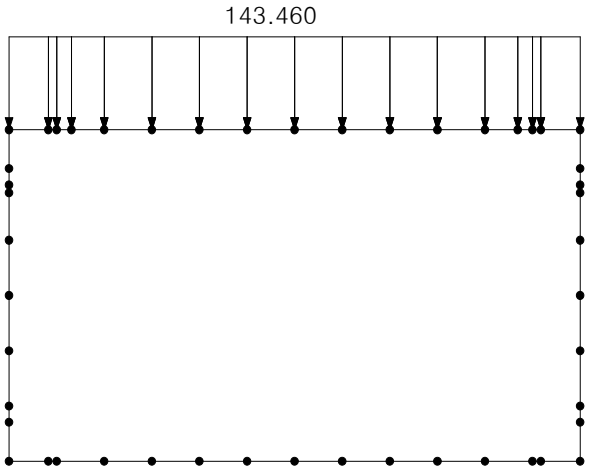
1) CASE1 - 구체자중(SW)



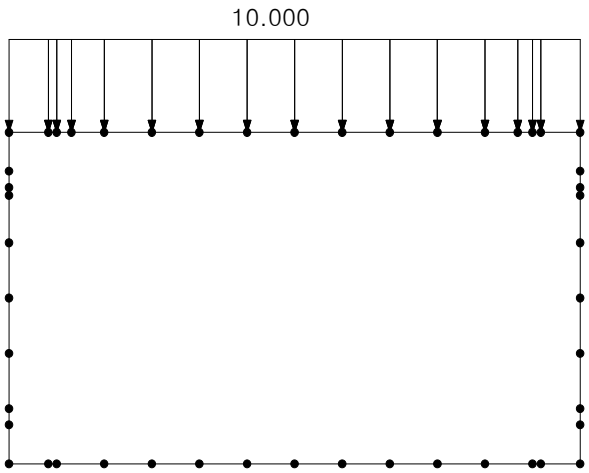
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



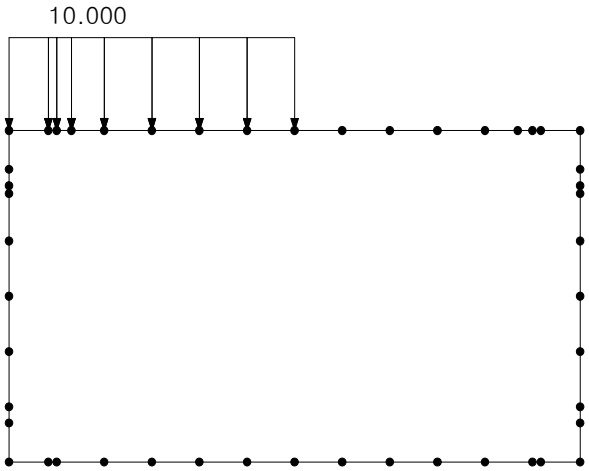
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



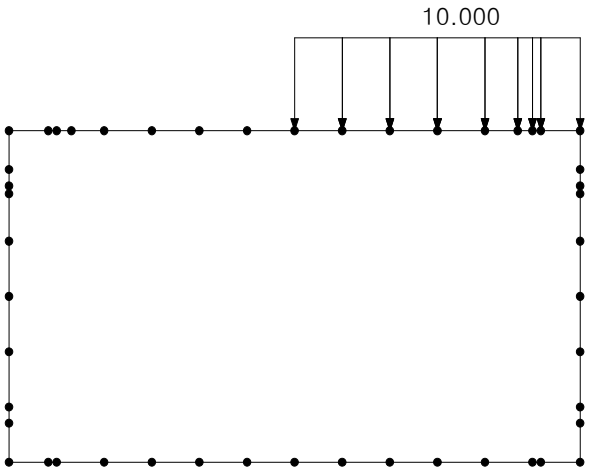
4) CASE4 - 지진시 만재활하중(LIVEFUE)



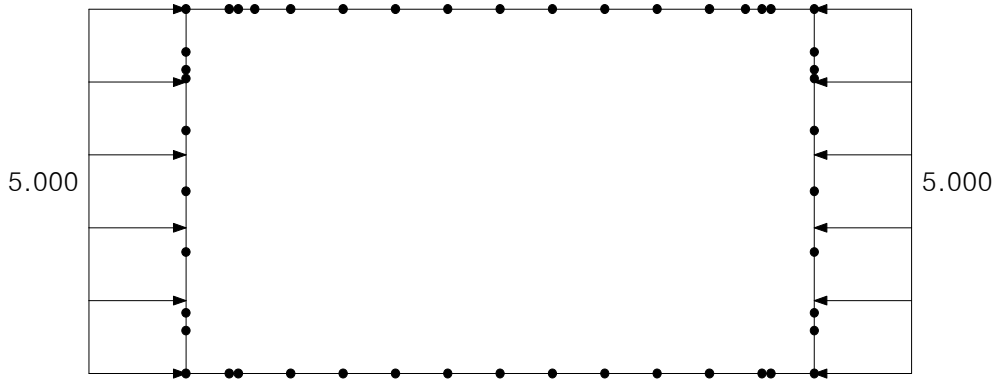
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



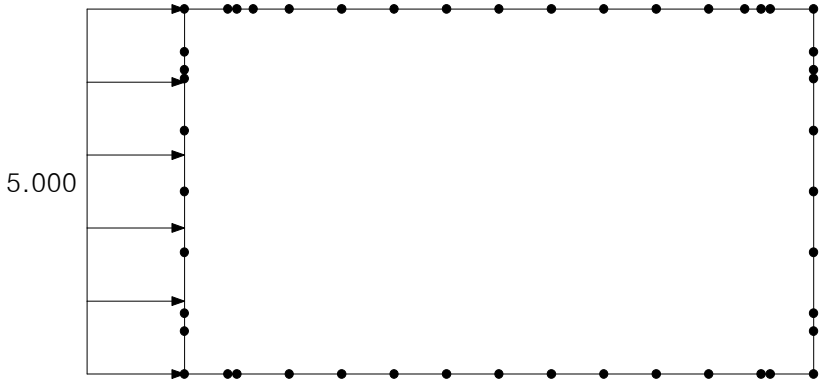
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



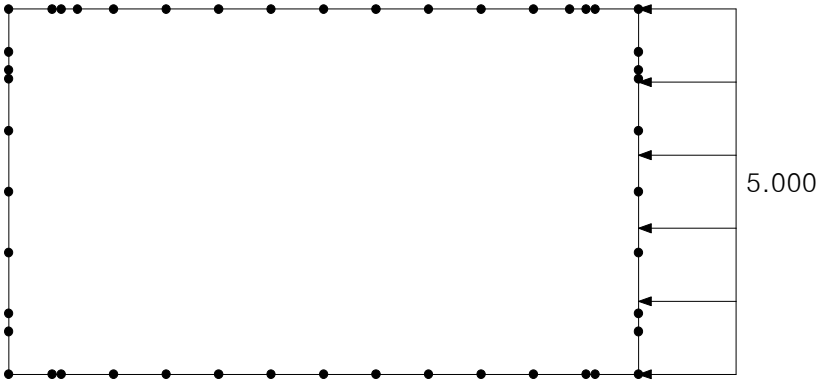
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)

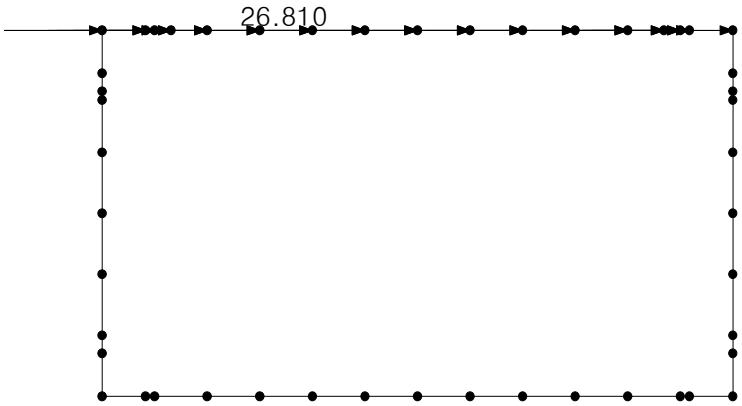


9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)

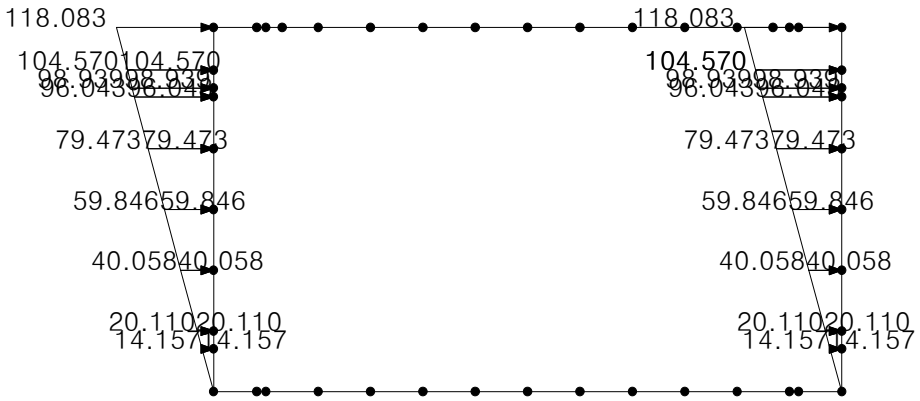


- 지진재하방향(좌측에서 우측으로)

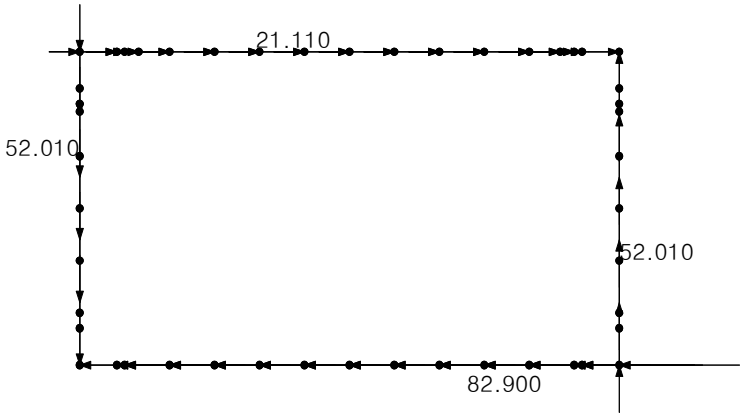
10) CASE10 - 슬래브 지반변위(붕괴방지)(COLSLAB)



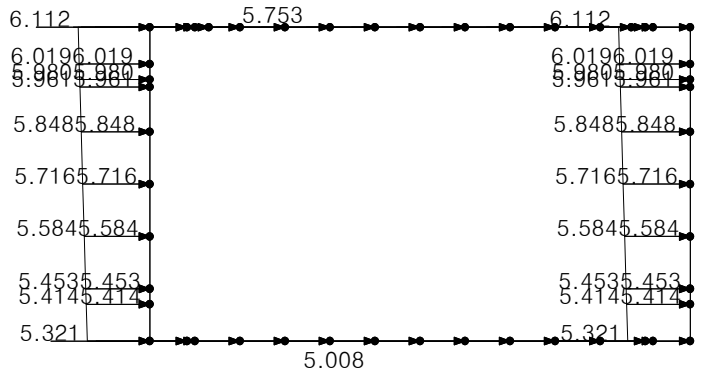
11) CASE11 - 벽체 지반변위(붕괴방지)(COLWALL)



12) CASE12 - 주면전단력(붕괴방지)(COLMS)

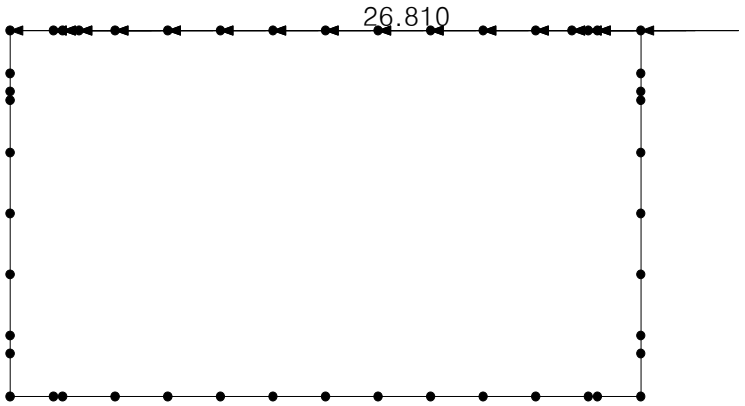


13) CASE13 - 구체 관성력(붕괴방지)(COLINER)

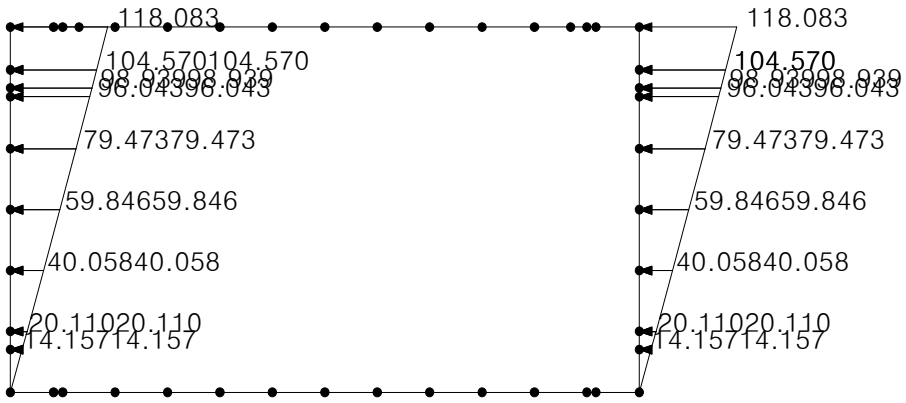


- 지진재하방향(우측에서 좌측으로)

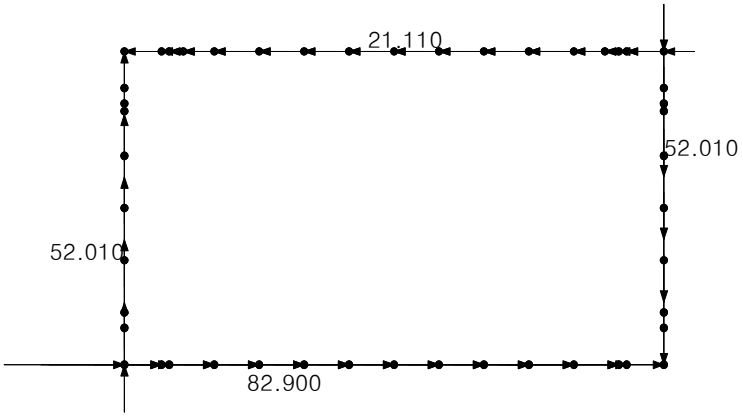
14) CASE14 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



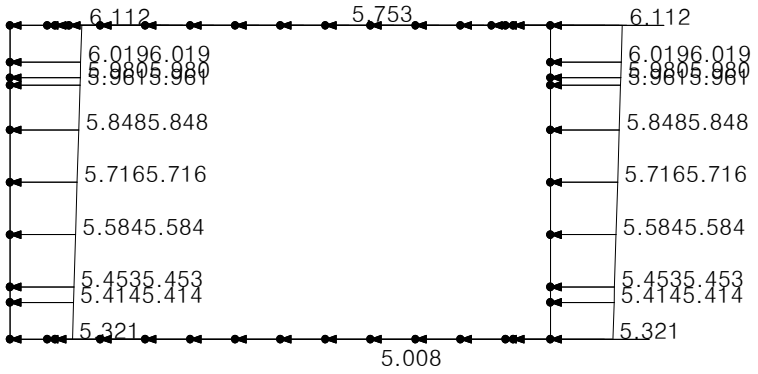
15) CASE15 - 벽체 지반변위(붕괴방지)2(COLWALL2)



16) CASE16 - 주면전단력(붕괴방지)2(COLMS2)



17) CASE17 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 1.000, h = 13.188 m

1) 계수하중

구 분	D	Hv	L	Hh	T	지하수 고려
LC1	1.200	1.600	1.600	1.600	1.200	
LC2	1.200	1.600	1.600	0.800	1.200	
LC3	0.900	1.600		1.600		
LC4	0.900	1.600		0.800		
LC5	1.200	1.600	1.600	1.600	1.200	●
LC6	1.200	1.600	1.600	0.800	1.200	●
LC7	0.900	1.600		1.600		●
LC8	0.900	1.600		0.800		●

2) 사용하중

구 분	D	Hv	L	Hh	T	지하수 고려
LC1	1.000	1.000	1.000	1.000	1.000	
LC2	1.000	1.000	1.000	0.500	1.000	
LC3	1.000	1.000		1.000		
LC4	1.000	1.000		0.500		
LC5	1.000	1.000	1.000	1.000	1.000	●
LC6	1.000	1.000	1.000	0.500	1.000	●
LC7	1.000	1.000		1.000		●
LC8	1.000	1.000		0.500		●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	E	지하수 고려
LC1	1.200	1.200	1.000	1.000		1.000	
LC2	1.200	1.200	1.000	0.500		1.000	
LC3	0.900	0.900		1.000		1.000	
LC4	0.900	0.900		0.500		1.000	
LC5	1.200	1.200	1.000	1.000		1.000	●
LC6	1.200	1.200	1.000	0.500		1.000	●
LC7	0.900	0.900		1.000		1.000	●
LC8	0.900	0.900		0.500		1.000	●

4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	E	지하수 고려
LC1	1.200	1.200	1.000	1.000		1.000	
LC2	1.200	1.200	1.000	0.500		1.000	
LC3	0.900	0.900		1.000		1.000	
LC4	0.900	0.900		0.500		1.000	
LC5	1.200	1.200	1.000	1.000		1.000	●
LC6	1.200	1.200	1.000	0.500		1.000	●
LC7	0.900	0.900		1.000		1.000	●
LC8	0.900	0.900		0.500		1.000	●

15. INPUT DATA (상시)

```
; ACulvert SAP2000 데이터파일 : 평상시
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.000 Y=     0.000 Z=     0.500
  2    X=     0.850 Y=     0.000 Z=     0.500
  3    X=     1.029 Y=     0.000 Z=     0.500
  4    X=     2.058 Y=     0.000 Z=     0.500
  5    X=     3.087 Y=     0.000 Z=     0.500
  6    X=     4.117 Y=     0.000 Z=     0.500
  7    X=     5.146 Y=     0.000 Z=     0.500
  8    X=     6.175 Y=     0.000 Z=     0.500
  9    X=     7.204 Y=     0.000 Z=     0.500
  10   X=     8.233 Y=     0.000 Z=     0.500
  11   X=     9.262 Y=     0.000 Z=     0.500
  12   X=    10.292 Y=     0.000 Z=     0.500
  13   X=    11.321 Y=     0.000 Z=     0.500
  14   X=    11.500 Y=     0.000 Z=     0.500
  15   X=    12.350 Y=     0.000 Z=     0.500
  16   X=    12.350 Y=     0.000 Z=     1.300
  17   X=    12.350 Y=     0.000 Z=     1.637
  18   X=    12.350 Y=     0.000 Z=     2.773
  19   X=    12.350 Y=     0.000 Z=     3.910
  20   X=    12.350 Y=     0.000 Z=     5.047
  21   X=    12.350 Y=     0.000 Z=     6.020
  22   X=    12.350 Y=     0.000 Z=     6.183
  23   X=    12.350 Y=     0.000 Z=     6.520
  24   X=    12.350 Y=     0.000 Z=     7.320
  25   X=    11.500 Y=     0.000 Z=     7.320
  26   X=    11.321 Y=     0.000 Z=     7.320
  27   X=    11.000 Y=     0.000 Z=     7.320
  28   X=    10.292 Y=     0.000 Z=     7.320
  29   X=     9.262 Y=     0.000 Z=     7.320
  30   X=     8.233 Y=     0.000 Z=     7.320
  31   X=     7.204 Y=     0.000 Z=     7.320
  32   X=     6.175 Y=     0.000 Z=     7.320
  33   X=     5.146 Y=     0.000 Z=     7.320
  34   X=     4.117 Y=     0.000 Z=     7.320
  35   X=     3.087 Y=     0.000 Z=     7.320
  36   X=     2.058 Y=     0.000 Z=     7.320
  37   X=     1.350 Y=     0.000 Z=     7.320
  38   X=     1.029 Y=     0.000 Z=     7.320
  39   X=     0.850 Y=     0.000 Z=     7.320
  40   X=     0.000 Y=     0.000 Z=     7.320
  41   X=     0.000 Y=     0.000 Z=     6.520
  42   X=     0.000 Y=     0.000 Z=     6.183
  43   X=     0.000 Y=     0.000 Z=     6.020
  44   X=     0.000 Y=     0.000 Z=     5.047
  45   X=     0.000 Y=     0.000 Z=     3.910
  46   X=     0.000 Y=     0.000 Z=     2.773
  47   X=     0.000 Y=     0.000 Z=     1.637
  48   X=     0.000 Y=     0.000 Z=     1.300
  49   X=     0.000 Y=     0.000 Z=     0.000
  50   X=     1.029 Y=     0.000 Z=     0.000
  51   X=     2.058 Y=     0.000 Z=     0.000
  52   X=     3.087 Y=     0.000 Z=     0.000
  53   X=     4.117 Y=     0.000 Z=     0.000
  54   X=     5.146 Y=     0.000 Z=     0.000
  55   X=     6.175 Y=     0.000 Z=     0.000
  56   X=     7.204 Y=     0.000 Z=     0.000
  57   X=     8.233 Y=     0.000 Z=     0.000
  58   X=     9.262 Y=     0.000 Z=     0.000
  59   X=    10.292 Y=     0.000 Z=     0.000
  60   X=    11.321 Y=     0.000 Z=     0.000
  61   X=    12.350 Y=     0.000 Z=     0.000
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=8 UX=1e+010
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=35570.8 CE=0.99999 K=35570.8 OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
       DOF=U1 KE=26827.5 CE=0.99999 K=26827.5 OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-252.706, -252.706
      ADD=25 RD=0,1 UZ=-252.706, -252.706
      ADD=26 RD=0,1 UZ=-252.706, -252.706
      ADD=27 RD=0,1 UZ=-252.706, -252.706
```

```
      ADD=28 RD=0,1 UZ=-252.706, -252.706
      ADD=29 RD=0,1 UZ=-252.706, -252.706
      ADD=30 RD=0,1 UZ=-252.706, -252.706
      ADD=31 RD=0,1 UZ=-252.706, -252.706
      ADD=32 RD=0,1 UZ=-252.706, -252.706
      ADD=33 RD=0,1 UZ=-252.706, -252.706
      ADD=34 RD=0,1 UZ=-252.706, -252.706
      ADD=35 RD=0,1 UZ=-252.706, -252.706
      ADD=36 RD=0,1 UZ=-252.706, -252.706
      ADD=37 RD=0,1 UZ=-252.706, -252.706
      ADD=38 RD=0,1 UZ=-252.706, -252.706
      ADD=39 RD=0,1 UZ=-252.706, -252.706
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-143.46, -143.46
      ADD=25 RD=0,1 UZ=-143.46, -143.46
      ADD=26 RD=0,1 UZ=-143.46, -143.46
      ADD=27 RD=0,1 UZ=-143.46, -143.46
      ADD=28 RD=0,1 UZ=-143.46, -143.46
      ADD=29 RD=0,1 UZ=-143.46, -143.46
      ADD=30 RD=0,1 UZ=-143.46, -143.46
      ADD=31 RD=0,1 UZ=-143.46, -143.46
      ADD=32 RD=0,1 UZ=-143.46, -143.46
      ADD=33 RD=0,1 UZ=-143.46, -143.46
      ADD=34 RD=0,1 UZ=-143.46, -143.46
      ADD=35 RD=0,1 UZ=-143.46, -143.46
      ADD=36 RD=0,1 UZ=-143.46, -143.46
      ADD=37 RD=0,1 UZ=-143.46, -143.46
      ADD=38 RD=0,1 UZ=-143.46, -143.46
      ADD=39 RD=0,1 UZ=-143.46, -143.46
NAME=LIVEFU  ; 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELE  ; 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERI  ; 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUH  ; 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEH  ; 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIH  ; 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=SOILB  ; 양토압 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=133.891, 141.491
      ADD=41 RD=0,1 UX=141.491, 144.69
      ADD=42 RD=0,1 UX=144.69, 146.241
      ADD=43 RD=0,1 UX=146.241, 155.487
      ADD=44 RD=0,1 UX=155.487, 166.286
      ADD=45 RD=0,1 UX=166.286, 177.085
      ADD=46 RD=0,1 UX=177.085, 187.882
      ADD=47 RD=0,1 UX=187.882, 191.081
      ADD=48 RD=0,1 UX=191.081, 198.681
      ADD=15 RD=0,1 UX=-198.681, -191.081
      ADD=16 RD=0,1 UX=-191.081, -187.882
      ADD=17 RD=0,1 UX=-187.882, -177.085
      ADD=18 RD=0,1 UX=-177.085, -166.286
      ADD=19 RD=0,1 UX=-166.286, -155.487
      ADD=20 RD=0,1 UX=-155.487, -146.241
      ADD=21 RD=0,1 UX=-146.241, -144.69
      ADD=22 RD=0,1 UX=-144.69, -141.491
      ADD=23 RD=0,1 UX=-141.491, -133.891
NAME=SOILBW  ; 양토압 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=75.443, 79.443
      ADD=41 RD=0,1 UX=79.443, 81.126
      ADD=42 RD=0,1 UX=81.126, 81.943
      ADD=43 RD=0,1 UX=81.943, 86.81
      ADD=44 RD=0,1 UX=86.81, 92.493
      ADD=45 RD=0,1 UX=92.493, 98.176
      ADD=46 RD=0,1 UX=98.176, 103.86
      ADD=47 RD=0,1 UX=103.86, 105.543
      ADD=48 RD=0,1 UX=105.543, 109.543
      ADD=15 RD=0,1 UX=-109.543, -105.543
      ADD=16 RD=0,1 UX=-105.543, -103.86
      ADD=17 RD=0,1 UX=-103.86, -98.176
      ADD=18 RD=0,1 UX=-98.176, -92.493
      ADD=19 RD=0,1 UX=-92.493, -86.81
      ADD=20 RD=0,1 UX=-86.81, -81.943
      ADD=21 RD=0,1 UX=-81.943, -81.126
      ADD=22 RD=0,1 UX=-81.126, -79.443
      ADD=23 RD=0,1 UX=-79.443, -75.443
NAME=TEMPPLUS  ; 온도변화(+)
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=10
      ADD=16 T=10
      ADD=17 T=10
      ADD=18 T=10
      ADD=19 T=10
      ADD=20 T=10
      ADD=21 T=10
      ADD=22 T=10
      ADD=23 T=10
      ADD=24 T=10
      ADD=25 T=10
      ADD=26 T=10
      ADD=27 T=10
      ADD=28 T=10
      ADD=29 T=10
      ADD=30 T=10
      ADD=31 T=10
      ADD=32 T=10
      ADD=33 T=10
      ADD=34 T=10
      ADD=35 T=10
      ADD=36 T=10
      ADD=37 T=10
      ADD=38 T=10
      ADD=39 T=10
      ADD=40 T=10
      ADD=41 T=10
      ADD=42 T=10
```

```
      ADD=43 T=10
      ADD=44 T=10
      ADD=45 T=10
      ADD=46 T=10
      ADD=47 T=10
      ADD=48 T=10
NAME=TEMPMINU  ; 온도변화(-)
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=-10
      ADD=16 T=-10
      ADD=17 T=-10
      ADD=18 T=-10
      ADD=19 T=-10
      ADD=20 T=-10
      ADD=21 T=-10
      ADD=22 T=-10
      ADD=23 T=-10
      ADD=24 T=-10
      ADD=25 T=-10
      ADD=26 T=-10
      ADD=27 T=-10
      ADD=28 T=-10
      ADD=29 T=-10
      ADD=30 T=-10
      ADD=31 T=-10
      ADD=32 T=-10
      ADD=33 T=-10
      ADD=34 T=-10
      ADD=35 T=-10
      ADD=36 T=-10
      ADD=37 T=-10
      ADD=38 T=-10
      ADD=39 T=-10
      ADD=40 T=-10
      ADD=41 T=-10
      ADD=42 T=-10
      ADD=43 T=-10
      ADD=44 T=-10
      ADD=45 T=-10
      ADD=46 T=-10
      ADD=47 T=-10
      ADD=48 T=-10
NAME=SHRINK  ; 건조수축
   TYPE=Temperature ELEM=FRAME
      ADD=15 T=-15
      ADD=16 T=-15
      ADD=17 T=-15
      ADD=18 T=-15
      ADD=19 T=-15
      ADD=20 T=-15
      ADD=21 T=-15
      ADD=22 T=-15
      ADD=23 T=-15
      ADD=24 T=-15
      ADD=25 T=-15
      ADD=26 T=-15
      ADD=27 T=-15
      ADD=28 T=-15
      ADD=29 T=-15
      ADD=30 T=-15
      ADD=31 T=-15
      ADD=32 T=-15
      ADD=33 T=-15
      ADD=34 T=-15
      ADD=35 T=-15
      ADD=36 T=-15
      ADD=37 T=-15
      ADD=38 T=-15
      ADD=39 T=-15
      ADD=40 T=-15
      ADD=41 T=-15
      ADD=42 T=-15
      ADD=43 T=-15
      ADD=44 T=-15
      ADD=45 T=-15
      ADD=46 T=-15
      ADD=47 T=-15
      ADD=48 T=-15
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFU
      LOAD=LIVELE
      LOAD=LIVERI
      LOAD=LIVEFUH
      LOAD=LIVELEH
      LOAD=LIVERIH
      LOAD=SOILB
      LOAD=SOILBW
      LOAD=TEMPPLUS
      LOAD=TEMPMINU
      LOAD=SHRINK
      NLLINK=*
HISTORY
   NAME=UL01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
      LOAD= LIVERIH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
      LOAD= LIVERIH     SF=1.600   AT=1
      LOAD= SOILB       SF=1.600   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVEFU      SF=1.600   AT=1
      LOAD= LIVEFUH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPPLUS    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVELE      SF=1.600   AT=1
      LOAD= LIVELEH     SF=0.800   AT=1
      LOAD= SOILB       SF=0.800   AT=1
      LOAD= TEMPMINU    SF=1.200   AT=1
      LOAD= SHRINK      SF=1.200   AT=1
   NAME=UL11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW          SF=1.200   AT=1
      LOAD= PAVE        SF=1.600   AT=1
      LOAD= LIVERI      SF=1.600   AT=1
```

```
    LOAD= LIVERIH       SF=0.800   AT=1
    LOAD= SOILB         SF=0.800   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVE          SF=1.600   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=0.800   AT=1
    LOAD= SOILB         SF=0.800   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=0.900   AT=1
    LOAD= PAVE          SF=1.600   AT=1
    LOAD= SOILB         SF=1.600   AT=1
NAME=UL14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=0.900   AT=1
    LOAD= PAVE          SF=1.600   AT=1
    LOAD= SOILB         SF=0.800   AT=1
NAME=UL15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVEFU        SF=1.600   AT=1
    LOAD= LIVEFUH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVEFU        SF=1.600   AT=1
    LOAD= LIVEFUH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVELE        SF=1.600   AT=1
    LOAD= LIVELEH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVELE        SF=1.600   AT=1
    LOAD= LIVELEH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVEFU        SF=1.600   AT=1
    LOAD= LIVEFUH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVEFU        SF=1.600   AT=1
    LOAD= LIVEFUH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVELE        SF=1.600   AT=1
    LOAD= LIVELEH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVELE        SF=1.600   AT=1
    LOAD= LIVELEH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPPLUS      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.200   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= LIVERI        SF=1.600   AT=1
    LOAD= LIVERIH       SF=0.800   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
    LOAD= TEMPMINU      SF=1.200   AT=1
    LOAD= SHRINK        SF=1.200   AT=1
NAME=UL27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=0.900   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= SOILBW        SF=1.600   AT=1
NAME=UL28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=0.900   AT=1
    LOAD= PAVEW         SF=1.600   AT=1
    LOAD= SOILBW        SF=0.800   AT=1
NAME=SV01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVELE        SF=1.000   AT=1
    LOAD= LIVELEH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVERI        SF=1.000   AT=1
    LOAD= LIVERIH       SF=1.000   AT=1
    LOAD= SOILB         SF=1.000   AT=1
    LOAD= TEMPMINU      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
NAME=SV07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
    LOAD= SW            SF=1.000   AT=1
    LOAD= PAVE          SF=1.000   AT=1
    LOAD= LIVEFU        SF=1.000   AT=1
    LOAD= LIVEFUH       SF=0.500   AT=1
    LOAD= SOILB         SF=0.500   AT=1
    LOAD= TEMPPLUS      SF=1.000   AT=1
    LOAD= SHRINK        SF=1.000   AT=1
```

```
NAME=SV08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILB           SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= SOILB           SF=1.000   AT=1
NAME=SV14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVE            SF=1.000   AT=1
   LOAD= SOILB           SF=0.500   AT=1
NAME=SV15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVEFU          SF=1.000   AT=1
   LOAD= LIVEFUH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVELE          SF=1.000   AT=1
   LOAD= LIVELEH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPPLUS        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= LIVERI          SF=1.000   AT=1
   LOAD= LIVERIH         SF=0.500   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
   LOAD= TEMPMINU        SF=1.000   AT=1
   LOAD= SHRINK          SF=1.000   AT=1
NAME=SV27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= SOILBW          SF=1.000   AT=1
NAME=SV28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW              SF=1.000   AT=1
   LOAD= PAVEW           SF=1.000   AT=1
   LOAD= SOILBW          SF=0.500   AT=1
COMBO
  NAME=ENVUSE  TYPE=ENVE
    HIST=SV01 SF=1
    HIST=SV02 SF=1
    HIST=SV03 SF=1
    HIST=SV04 SF=1
    HIST=SV05 SF=1
    HIST=SV06 SF=1
    HIST=SV07 SF=1
    HIST=SV08 SF=1
    HIST=SV09 SF=1
    HIST=SV10 SF=1
    HIST=SV11 SF=1
    HIST=SV12 SF=1
    HIST=SV13 SF=1
    HIST=SV14 SF=1
    HIST=SV15 SF=1
    HIST=SV16 SF=1
    HIST=SV17 SF=1
    HIST=SV18 SF=1
    HIST=SV19 SF=1
    HIST=SV20 SF=1
    HIST=SV21 SF=1
    HIST=SV22 SF=1
    HIST=SV23 SF=1
    HIST=SV24 SF=1
    HIST=SV25 SF=1
    HIST=SV26 SF=1
```

```
      HIST=SV27 SF=1
      HIST=SV28 SF=1
   NAME=ENVULT  TYPE=ENVE
      HIST=UL01 SF=1
      HIST=UL02 SF=1
      HIST=UL03 SF=1
      HIST=UL04 SF=1
      HIST=UL05 SF=1
      HIST=UL06 SF=1
      HIST=UL07 SF=1
      HIST=UL08 SF=1
      HIST=UL09 SF=1
      HIST=UL10 SF=1
      HIST=UL11 SF=1
      HIST=UL12 SF=1
      HIST=UL13 SF=1
      HIST=UL14 SF=1
      HIST=UL15 SF=1
      HIST=UL16 SF=1
      HIST=UL17 SF=1
      HIST=UL18 SF=1
      HIST=UL19 SF=1
      HIST=UL20 SF=1
      HIST=UL21 SF=1
      HIST=UL22 SF=1
      HIST=UL23 SF=1
      HIST=UL24 SF=1
      HIST=UL25 SF=1
      HIST=UL26 SF=1
      HIST=UL27 SF=1
      HIST=UL28 SF=1
OUTPUT
   ELEM=JOINT   TYPE=REAC,DISP,APP      LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
   ELEM=FRAME   TYPE=FORCE              LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=*
```

16. INPUT DATA (기능수행)

```
; ACulvert SAP2000 데이터파일 : 내진(기능)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     1.350 Y=     0.000 Z=     0.500
  3    X=     1.529 Y=     0.000 Z=     0.500
  4    X=     2.558 Y=     0.000 Z=     0.500
  5    X=     3.587 Y=     0.000 Z=     0.500
  6    X=     4.617 Y=     0.000 Z=     0.500
  7    X=     5.646 Y=     0.000 Z=     0.500
  8    X=     6.675 Y=     0.000 Z=     0.500
  9    X=     7.704 Y=     0.000 Z=     0.500
  10   X=     8.733 Y=     0.000 Z=     0.500
  11   X=     9.762 Y=     0.000 Z=     0.500
  12   X=    10.792 Y=     0.000 Z=     0.500
  13   X=    11.821 Y=     0.000 Z=     0.500
  14   X=    12.000 Y=     0.000 Z=     0.500
  15   X=    12.850 Y=     0.000 Z=     0.500
  16   X=    12.850 Y=     0.000 Z=     1.300
  17   X=    12.850 Y=     0.000 Z=     1.637
  18   X=    12.850 Y=     0.000 Z=     2.773
  19   X=    12.850 Y=     0.000 Z=     3.910
  20   X=    12.850 Y=     0.000 Z=     5.047
  21   X=    12.850 Y=     0.000 Z=     6.020
  22   X=    12.850 Y=     0.000 Z=     6.183
  23   X=    12.850 Y=     0.000 Z=     6.520
  24   X=    12.850 Y=     0.000 Z=     7.320
  25   X=    12.000 Y=     0.000 Z=     7.320
  26   X=    11.821 Y=     0.000 Z=     7.320
  27   X=    11.500 Y=     0.000 Z=     7.320
  28   X=    10.792 Y=     0.000 Z=     7.320
  29   X=     9.762 Y=     0.000 Z=     7.320
  30   X=     8.733 Y=     0.000 Z=     7.320
  31   X=     7.704 Y=     0.000 Z=     7.320
  32   X=     6.675 Y=     0.000 Z=     7.320
  33   X=     5.646 Y=     0.000 Z=     7.320
  34   X=     4.617 Y=     0.000 Z=     7.320
  35   X=     3.587 Y=     0.000 Z=     7.320
  36   X=     2.558 Y=     0.000 Z=     7.320
  37   X=     1.850 Y=     0.000 Z=     7.320
  38   X=     1.529 Y=     0.000 Z=     7.320
  39   X=     1.350 Y=     0.000 Z=     7.320
  40   X=     0.500 Y=     0.000 Z=     7.320
  41   X=     0.500 Y=     0.000 Z=     6.520
  42   X=     0.500 Y=     0.000 Z=     6.183
  43   X=     0.500 Y=     0.000 Z=     6.020
  44   X=     0.500 Y=     0.000 Z=     5.047
  45   X=     0.500 Y=     0.000 Z=     3.910
  46   X=     0.500 Y=     0.000 Z=     2.773
  47   X=     0.500 Y=     0.000 Z=     1.637
  48   X=     0.500 Y=     0.000 Z=     1.300
  49   X=     0.500 Y=     0.000 Z=     0.000
  50   X=     1.529 Y=     0.000 Z=     0.000
  51   X=     2.558 Y=     0.000 Z=     0.000
  52   X=     3.587 Y=     0.000 Z=     0.000
  53   X=     4.617 Y=     0.000 Z=     0.000
  54   X=     5.646 Y=     0.000 Z=     0.000
  55   X=     6.675 Y=     0.000 Z=     0.000
  56   X=     7.704 Y=     0.000 Z=     0.000
  57   X=     8.733 Y=     0.000 Z=     0.000
  58   X=     9.762 Y=     0.000 Z=     0.000
  59   X=    10.792 Y=     0.000 Z=     0.000
  60   X=    11.821 Y=     0.000 Z=     0.000
  61   X=    12.850 Y=     0.000 Z=     0.000
  62   X=    13.350 Y=     0.000 Z=     0.500
  63   X=    13.350 Y=     0.000 Z=     1.637
  64   X=    13.350 Y=     0.000 Z=     2.773
  65   X=    13.350 Y=     0.000 Z=     3.910
  66   X=    13.350 Y=     0.000 Z=     5.047
  67   X=    13.350 Y=     0.000 Z=     6.183
  68   X=    13.350 Y=     0.000 Z=     7.320
  69   X=    12.850 Y=     0.000 Z=     7.820
  70   X=    11.821 Y=     0.000 Z=     7.820
  71   X=    10.792 Y=     0.000 Z=     7.820
  72   X=     9.762 Y=     0.000 Z=     7.820
  73   X=     8.733 Y=     0.000 Z=     7.820
  74   X=     7.704 Y=     0.000 Z=     7.820
  75   X=     6.675 Y=     0.000 Z=     7.820
  76   X=     5.646 Y=     0.000 Z=     7.820
  77   X=     4.617 Y=     0.000 Z=     7.820
  78   X=     3.587 Y=     0.000 Z=     7.820
  79   X=     2.558 Y=     0.000 Z=     7.820
  80   X=     1.529 Y=     0.000 Z=     7.820
  81   X=     0.500 Y=     0.000 Z=     7.820
  82   X=     0.000 Y=     0.000 Z=     7.320
  83   X=     0.000 Y=     0.000 Z=     6.183
  84   X=     0.000 Y=     0.000 Z=     5.047
  85   X=     0.000 Y=     0.000 Z=     3.910
  86   X=     0.000 Y=     0.000 Z=     2.773
  87   X=     0.000 Y=     0.000 Z=     1.637
  88   X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=62 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=63 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=64 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=65 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=66 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=67 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=68 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=69 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=70 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=71 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=72 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=96233.5
  ADD=4 UX=96233.5
  ADD=5 UX=96233.5
  ADD=6 UX=96233.5
  ADD=7 UX=96233.5
  ADD=8 UX=96233.5
  ADD=9 UX=96233.5
  ADD=10 UX=96233.5
  ADD=11 UX=96233.5
  ADD=12 UX=96233.5
  ADD=13 UX=96233.5
  ADD=17 UZ=156044
  ADD=18 UZ=156044
  ADD=19 UZ=156044
  ADD=20 UZ=156044
  ADD=22 UZ=156044
  ADD=26 UX=96233.5
  ADD=28 UX=96233.5
  ADD=29 UX=96233.5
  ADD=30 UX=96233.5
  ADD=31 UX=96233.5
  ADD=32 UX=96233.5
  ADD=33 UX=96233.5
  ADD=34 UX=96233.5
  ADD=35 UX=96233.5
  ADD=36 UX=96233.5
  ADD=38 UX=96233.5
  ADD=42 UZ=156044
  ADD=44 UZ=156044
  ADD=45 UZ=156044
  ADD=46 UZ=156044
  ADD=47 UZ=156044
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=382790. CE=0.99999 K=382790. OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=288700. CE=0.99999 K=288700. OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
```

```
        DOF=U1 KE=563541. CE=0.99999 K=563541. OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=468131. CE=0.99999 K=468131. OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
    14 J=15,62 NLP=3 ANG=0
    15 J=17,63 NLP=4 ANG=0
    16 J=18,64 NLP=4 ANG=0
    17 J=19,65 NLP=4 ANG=0
    18 J=20,66 NLP=4 ANG=0
    19 J=22,67 NLP=4 ANG=0
    20 J=24,68 NLP=3 ANG=0
    21 J=24,69 NLP=1 ANG=0
    22 J=26,70 NLP=2 ANG=0
    23 J=28,71 NLP=2 ANG=0
    24 J=29,72 NLP=2 ANG=0
    25 J=30,73 NLP=2 ANG=0
    26 J=31,74 NLP=2 ANG=0
    27 J=32,75 NLP=2 ANG=0
    28 J=33,76 NLP=2 ANG=0
    29 J=34,77 NLP=2 ANG=0
    30 J=35,78 NLP=2 ANG=0
    31 J=36,79 NLP=2 ANG=0
    32 J=38,80 NLP=2 ANG=0
    33 J=40,81 NLP=1 ANG=0
    34 J=40,82 NLP=3 ANG=0
    35 J=42,83 NLP=4 ANG=0
    36 J=44,84 NLP=4 ANG=0
    37 J=45,85 NLP=4 ANG=0
    38 J=46,86 NLP=4 ANG=0
    39 J=47,87 NLP=4 ANG=0
    40 J= 1,88 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-252.706, -252.706
      ADD=25 RD=0,1 UZ=-252.706, -252.706
      ADD=26 RD=0,1 UZ=-252.706, -252.706
      ADD=27 RD=0,1 UZ=-252.706, -252.706
      ADD=28 RD=0,1 UZ=-252.706, -252.706
      ADD=29 RD=0,1 UZ=-252.706, -252.706
      ADD=30 RD=0,1 UZ=-252.706, -252.706
      ADD=31 RD=0,1 UZ=-252.706, -252.706
      ADD=32 RD=0,1 UZ=-252.706, -252.706
      ADD=33 RD=0,1 UZ=-252.706, -252.706
      ADD=34 RD=0,1 UZ=-252.706, -252.706
      ADD=35 RD=0,1 UZ=-252.706, -252.706
      ADD=36 RD=0,1 UZ=-252.706, -252.706
      ADD=37 RD=0,1 UZ=-252.706, -252.706
      ADD=38 RD=0,1 UZ=-252.706, -252.706
      ADD=39 RD=0,1 UZ=-252.706, -252.706
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-143.46, -143.46
      ADD=25 RD=0,1 UZ=-143.46, -143.46
      ADD=26 RD=0,1 UZ=-143.46, -143.46
      ADD=27 RD=0,1 UZ=-143.46, -143.46
      ADD=28 RD=0,1 UZ=-143.46, -143.46
      ADD=29 RD=0,1 UZ=-143.46, -143.46
      ADD=30 RD=0,1 UZ=-143.46, -143.46
      ADD=31 RD=0,1 UZ=-143.46, -143.46
      ADD=32 RD=0,1 UZ=-143.46, -143.46
      ADD=33 RD=0,1 UZ=-143.46, -143.46
      ADD=34 RD=0,1 UZ=-143.46, -143.46
      ADD=35 RD=0,1 UZ=-143.46, -143.46
      ADD=36 RD=0,1 UZ=-143.46, -143.46
      ADD=37 RD=0,1 UZ=-143.46, -143.46
      ADD=38 RD=0,1 UZ=-143.46, -143.46
      ADD=39 RD=0,1 UZ=-143.46, -143.46
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
```

```
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=FUNSLAB  ; 슬래브 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=33.569, 33.569
      ADD=25 RD=0,1 UX=33.569, 33.569
      ADD=26 RD=0,1 UX=33.569, 33.569
      ADD=27 RD=0,1 UX=33.569, 33.569
      ADD=28 RD=0,1 UX=33.569, 33.569
      ADD=29 RD=0,1 UX=33.569, 33.569
      ADD=30 RD=0,1 UX=33.569, 33.569
      ADD=31 RD=0,1 UX=33.569, 33.569
      ADD=32 RD=0,1 UX=33.569, 33.569
      ADD=33 RD=0,1 UX=33.569, 33.569
      ADD=34 RD=0,1 UX=33.569, 33.569
      ADD=35 RD=0,1 UX=33.569, 33.569
      ADD=36 RD=0,1 UX=33.569, 33.569
      ADD=37 RD=0,1 UX=33.569, 33.569
      ADD=38 RD=0,1 UX=33.569, 33.569
      ADD=39 RD=0,1 UX=33.569, 33.569
NAME=FUNWALL  ; 벽체 지반변위(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=147.852, 130.967
      ADD=41 RD=0,1 UX=130.967, 123.965
      ADD=42 RD=0,1 UX=123.965, 120.259
      ADD=43 RD=0,1 UX=120.259, 99.666
      ADD=44 RD=0,1 UX=99.666, 74.956
      ADD=45 RD=0,1 UX=74.956, 50.245
      ADD=46 RD=0,1 UX=50.245, 25.123
      ADD=47 RD=0,1 UX=25.123, 17.709
      ADD=48 RD=0,1 UX=17.709, 0
      ADD=15 RD=0,1 UX=0, 17.709
      ADD=16 RD=0,1 UX=17.709, 25.123
      ADD=17 RD=0,1 UX=25.123, 50.245
      ADD=18 RD=0,1 UX=50.245, 74.956
      ADD=19 RD=0,1 UX=74.956, 99.666
      ADD=20 RD=0,1 UX=99.666, 120.259
      ADD=21 RD=0,1 UX=120.259, 123.965
      ADD=22 RD=0,1 UX=123.965, 130.967
      ADD=23 RD=0,1 UX=130.967, 147.852
NAME=FUNMS  ; 주면전단력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=26.5, 26.5
      ADD=25 RD=0,1 UX=26.5, 26.5
      ADD=26 RD=0,1 UX=26.5, 26.5
      ADD=27 RD=0,1 UX=26.5, 26.5
      ADD=28 RD=0,1 UX=26.5, 26.5
      ADD=29 RD=0,1 UX=26.5, 26.5
      ADD=30 RD=0,1 UX=26.5, 26.5
      ADD=31 RD=0,1 UX=26.5, 26.5
      ADD=32 RD=0,1 UX=26.5, 26.5
      ADD=33 RD=0,1 UX=26.5, 26.5
      ADD=34 RD=0,1 UX=26.5, 26.5
      ADD=35 RD=0,1 UX=26.5, 26.5
      ADD=36 RD=0,1 UX=26.5, 26.5
      ADD=37 RD=0,1 UX=26.5, 26.5
      ADD=38 RD=0,1 UX=26.5, 26.5
      ADD=39 RD=0,1 UX=26.5, 26.5
      ADD=40 RD=0,1 UZ=-65.34, -65.34
      ADD=41 RD=0,1 UZ=-65.34, -65.34
      ADD=42 RD=0,1 UZ=-65.34, -65.34
      ADD=43 RD=0,1 UZ=-65.34, -65.34
      ADD=44 RD=0,1 UZ=-65.34, -65.34
      ADD=45 RD=0,1 UZ=-65.34, -65.34
      ADD=46 RD=0,1 UZ=-65.34, -65.34
      ADD=47 RD=0,1 UZ=-65.34, -65.34
      ADD=48 RD=0,1 UZ=-65.34, -65.34
      ADD=15 RD=0,1 UZ=65.34, 65.34
      ADD=16 RD=0,1 UZ=65.34, 65.34
      ADD=17 RD=0,1 UZ=65.34, 65.34
      ADD=18 RD=0,1 UZ=65.34, 65.34
      ADD=19 RD=0,1 UZ=65.34, 65.34
      ADD=20 RD=0,1 UZ=65.34, 65.34
      ADD=21 RD=0,1 UZ=65.34, 65.34
      ADD=22 RD=0,1 UZ=65.34, 65.34
      ADD=23 RD=0,1 UZ=65.34, 65.34
      ADD=1 RD=0,1 UX=-104.18, -104.18
      ADD=2 RD=0,1 UX=-104.18, -104.18
      ADD=3 RD=0,1 UX=-104.18, -104.18
      ADD=4 RD=0,1 UX=-104.18, -104.18
      ADD=5 RD=0,1 UX=-104.18, -104.18
      ADD=6 RD=0,1 UX=-104.18, -104.18
      ADD=7 RD=0,1 UX=-104.18, -104.18
      ADD=8 RD=0,1 UX=-104.18, -104.18
      ADD=9 RD=0,1 UX=-104.18, -104.18
      ADD=10 RD=0,1 UX=-104.18, -104.18
      ADD=11 RD=0,1 UX=-104.18, -104.18
      ADD=12 RD=0,1 UX=-104.18, -104.18
      ADD=13 RD=0,1 UX=-104.18, -104.18
      ADD=14 RD=0,1 UX=-104.18, -104.18
NAME=FUNINER  ; 구체 관성력(기능수행)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=2.339, 2.339
      ADD=25 RD=0,1 UX=2.339, 2.339
      ADD=26 RD=0,1 UX=2.339, 2.339
      ADD=27 RD=0,1 UX=2.339, 2.339
      ADD=28 RD=0,1 UX=2.339, 2.339
      ADD=29 RD=0,1 UX=2.339, 2.339
      ADD=30 RD=0,1 UX=2.339, 2.339
      ADD=31 RD=0,1 UX=2.339, 2.339
      ADD=32 RD=0,1 UX=2.339, 2.339
      ADD=33 RD=0,1 UX=2.339, 2.339
      ADD=34 RD=0,1 UX=2.339, 2.339
      ADD=35 RD=0,1 UX=2.339, 2.339
      ADD=36 RD=0,1 UX=2.339, 2.339
      ADD=37 RD=0,1 UX=2.339, 2.339
      ADD=38 RD=0,1 UX=2.339, 2.339
      ADD=39 RD=0,1 UX=2.339, 2.339
      ADD=40 RD=0,1 UX=2.485, 2.447
      ADD=41 RD=0,1 UX=2.447, 2.431
      ADD=42 RD=0,1 UX=2.431, 2.424
      ADD=43 RD=0,1 UX=2.424, 2.378
      ADD=44 RD=0,1 UX=2.378, 2.324
      ADD=45 RD=0,1 UX=2.324, 2.271
      ADD=46 RD=0,1 UX=2.271, 2.217
      ADD=47 RD=0,1 UX=2.217, 2.201
      ADD=48 RD=0,1 UX=2.201, 2.163
      ADD=15 RD=0,1 UX=2.163, 2.201
      ADD=16 RD=0,1 UX=2.201, 2.217
      ADD=17 RD=0,1 UX=2.217, 2.271
      ADD=18 RD=0,1 UX=2.271, 2.324
      ADD=19 RD=0,1 UX=2.324, 2.378
      ADD=20 RD=0,1 UX=2.378, 2.424
      ADD=21 RD=0,1 UX=2.424, 2.431
      ADD=22 RD=0,1 UX=2.431, 2.447
      ADD=23 RD=0,1 UX=2.447, 2.485
      ADD=1 RD=0,1 UX=2.036, 2.036
      ADD=2 RD=0,1 UX=2.036, 2.036
      ADD=3 RD=0,1 UX=2.036, 2.036
      ADD=4 RD=0,1 UX=2.036, 2.036
      ADD=5 RD=0,1 UX=2.036, 2.036
      ADD=6 RD=0,1 UX=2.036, 2.036
      ADD=7 RD=0,1 UX=2.036, 2.036
      ADD=8 RD=0,1 UX=2.036, 2.036
      ADD=9 RD=0,1 UX=2.036, 2.036
      ADD=10 RD=0,1 UX=2.036, 2.036
```

```
      ADD=11 RD=0,1 UX=2.036, 2.036
      ADD=12 RD=0,1 UX=2.036, 2.036
      ADD=13 RD=0,1 UX=2.036, 2.036
      ADD=14 RD=0,1 UX=2.036, 2.036
NAME=FUNSLAB2  ; 슬래브 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-33.569, -33.569
      ADD=25 RD=0,1 UX=-33.569, -33.569
      ADD=26 RD=0,1 UX=-33.569, -33.569
      ADD=27 RD=0,1 UX=-33.569, -33.569
      ADD=28 RD=0,1 UX=-33.569, -33.569
      ADD=29 RD=0,1 UX=-33.569, -33.569
      ADD=30 RD=0,1 UX=-33.569, -33.569
      ADD=31 RD=0,1 UX=-33.569, -33.569
      ADD=32 RD=0,1 UX=-33.569, -33.569
      ADD=33 RD=0,1 UX=-33.569, -33.569
      ADD=34 RD=0,1 UX=-33.569, -33.569
      ADD=35 RD=0,1 UX=-33.569, -33.569
      ADD=36 RD=0,1 UX=-33.569, -33.569
      ADD=37 RD=0,1 UX=-33.569, -33.569
      ADD=38 RD=0,1 UX=-33.569, -33.569
      ADD=39 RD=0,1 UX=-33.569, -33.569
NAME=FUNWALL2  ; 벽체 지반변위(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=-147.852, -130.967
      ADD=41 RD=0,1 UX=-130.967, -123.965
      ADD=42 RD=0,1 UX=-123.965, -120.259
      ADD=43 RD=0,1 UX=-120.259, -99.666
      ADD=44 RD=0,1 UX=-99.666, -74.956
      ADD=45 RD=0,1 UX=-74.956, -50.245
      ADD=46 RD=0,1 UX=-50.245, -25.123
      ADD=47 RD=0,1 UX=-25.123, -17.709
      ADD=48 RD=0,1 UX=-17.709, -0
      ADD=15 RD=0,1 UX=-0, -17.709
      ADD=16 RD=0,1 UX=-17.709, -25.123
      ADD=17 RD=0,1 UX=-25.123, -50.245
      ADD=18 RD=0,1 UX=-50.245, -74.956
      ADD=19 RD=0,1 UX=-74.956, -99.666
      ADD=20 RD=0,1 UX=-99.666, -120.259
      ADD=21 RD=0,1 UX=-120.259, -123.965
      ADD=22 RD=0,1 UX=-123.965, -130.967
      ADD=23 RD=0,1 UX=-130.967, -147.852
NAME=FUNMS2  ; 주면전단력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-26.5, -26.5
      ADD=25 RD=0,1 UX=-26.5, -26.5
      ADD=26 RD=0,1 UX=-26.5, -26.5
      ADD=27 RD=0,1 UX=-26.5, -26.5
      ADD=28 RD=0,1 UX=-26.5, -26.5
      ADD=29 RD=0,1 UX=-26.5, -26.5
      ADD=30 RD=0,1 UX=-26.5, -26.5
      ADD=31 RD=0,1 UX=-26.5, -26.5
      ADD=32 RD=0,1 UX=-26.5, -26.5
      ADD=33 RD=0,1 UX=-26.5, -26.5
      ADD=34 RD=0,1 UX=-26.5, -26.5
      ADD=35 RD=0,1 UX=-26.5, -26.5
      ADD=36 RD=0,1 UX=-26.5, -26.5
      ADD=37 RD=0,1 UX=-26.5, -26.5
      ADD=38 RD=0,1 UX=-26.5, -26.5
      ADD=39 RD=0,1 UX=-26.5, -26.5
      ADD=40 RD=0,1 UZ=65.34, 65.34
      ADD=41 RD=0,1 UZ=65.34, 65.34
      ADD=42 RD=0,1 UZ=65.34, 65.34
      ADD=43 RD=0,1 UZ=65.34, 65.34
      ADD=44 RD=0,1 UZ=65.34, 65.34
      ADD=45 RD=0,1 UZ=65.34, 65.34
      ADD=46 RD=0,1 UZ=65.34, 65.34
      ADD=47 RD=0,1 UZ=65.34, 65.34
      ADD=48 RD=0,1 UZ=65.34, 65.34
      ADD=15 RD=0,1 UZ=-65.34, -65.34
      ADD=16 RD=0,1 UZ=-65.34, -65.34
      ADD=17 RD=0,1 UZ=-65.34, -65.34
      ADD=18 RD=0,1 UZ=-65.34, -65.34
      ADD=19 RD=0,1 UZ=-65.34, -65.34
      ADD=20 RD=0,1 UZ=-65.34, -65.34
      ADD=21 RD=0,1 UZ=-65.34, -65.34
      ADD=22 RD=0,1 UZ=-65.34, -65.34
      ADD=23 RD=0,1 UZ=-65.34, -65.34
      ADD=1 RD=0,1 UX=104.18, 104.18
      ADD=2 RD=0,1 UX=104.18, 104.18
      ADD=3 RD=0,1 UX=104.18, 104.18
      ADD=4 RD=0,1 UX=104.18, 104.18
      ADD=5 RD=0,1 UX=104.18, 104.18
      ADD=6 RD=0,1 UX=104.18, 104.18
      ADD=7 RD=0,1 UX=104.18, 104.18
      ADD=8 RD=0,1 UX=104.18, 104.18
      ADD=9 RD=0,1 UX=104.18, 104.18
      ADD=10 RD=0,1 UX=104.18, 104.18
      ADD=11 RD=0,1 UX=104.18, 104.18
      ADD=12 RD=0,1 UX=104.18, 104.18
      ADD=13 RD=0,1 UX=104.18, 104.18
      ADD=14 RD=0,1 UX=104.18, 104.18
NAME=FUNINER2  ; 구체 관성력(기능수행)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-2.339, -2.339
      ADD=25 RD=0,1 UX=-2.339, -2.339
      ADD=26 RD=0,1 UX=-2.339, -2.339
      ADD=27 RD=0,1 UX=-2.339, -2.339
      ADD=28 RD=0,1 UX=-2.339, -2.339
      ADD=29 RD=0,1 UX=-2.339, -2.339
      ADD=30 RD=0,1 UX=-2.339, -2.339
      ADD=31 RD=0,1 UX=-2.339, -2.339
      ADD=32 RD=0,1 UX=-2.339, -2.339
      ADD=33 RD=0,1 UX=-2.339, -2.339
      ADD=34 RD=0,1 UX=-2.339, -2.339
      ADD=35 RD=0,1 UX=-2.339, -2.339
      ADD=36 RD=0,1 UX=-2.339, -2.339
      ADD=37 RD=0,1 UX=-2.339, -2.339
      ADD=38 RD=0,1 UX=-2.339, -2.339
      ADD=39 RD=0,1 UX=-2.339, -2.339
      ADD=40 RD=0,1 UX=-2.485, -2.447
      ADD=41 RD=0,1 UX=-2.447, -2.431
      ADD=42 RD=0,1 UX=-2.431, -2.424
      ADD=43 RD=0,1 UX=-2.424, -2.378
      ADD=44 RD=0,1 UX=-2.378, -2.324
      ADD=45 RD=0,1 UX=-2.324, -2.271
      ADD=46 RD=0,1 UX=-2.271, -2.217
      ADD=47 RD=0,1 UX=-2.217, -2.201
      ADD=48 RD=0,1 UX=-2.201, -2.163
      ADD=15 RD=0,1 UX=-2.163, -2.201
      ADD=16 RD=0,1 UX=-2.201, -2.217
      ADD=17 RD=0,1 UX=-2.217, -2.271
      ADD=18 RD=0,1 UX=-2.271, -2.324
      ADD=19 RD=0,1 UX=-2.324, -2.378
      ADD=20 RD=0,1 UX=-2.378, -2.424
      ADD=21 RD=0,1 UX=-2.424, -2.431
      ADD=22 RD=0,1 UX=-2.431, -2.447
      ADD=23 RD=0,1 UX=-2.447, -2.485
      ADD=1 RD=0,1 UX=-2.036, -2.036
      ADD=2 RD=0,1 UX=-2.036, -2.036
      ADD=3 RD=0,1 UX=-2.036, -2.036
      ADD=4 RD=0,1 UX=-2.036, -2.036
      ADD=5 RD=0,1 UX=-2.036, -2.036
      ADD=6 RD=0,1 UX=-2.036, -2.036
      ADD=7 RD=0,1 UX=-2.036, -2.036
      ADD=8 RD=0,1 UX=-2.036, -2.036
      ADD=9 RD=0,1 UX=-2.036, -2.036
      ADD=10 RD=0,1 UX=-2.036, -2.036
      ADD=11 RD=0,1 UX=-2.036, -2.036
      ADD=12 RD=0,1 UX=-2.036, -2.036
      ADD=13 RD=0,1 UX=-2.036, -2.036
      ADD=14 RD=0,1 UX=-2.036, -2.036
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=FUNSLAB
      LOAD=FUNWALL
      LOAD=FUNMS
      LOAD=FUNINER
      LOAD=FUNSLAB2
      LOAD=FUNWALL2
      LOAD=FUNMS2
      LOAD=FUNINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= FUNSLAB       SF=1.000   AT=1
      LOAD= FUNWALL       SF=1.000   AT=1
      LOAD= FUNMS         SF=1.000   AT=1
      LOAD= FUNINER       SF=1.000   AT=1
    NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= FUNSLAB2      SF=1.000   AT=1
      LOAD= FUNWALL2      SF=1.000   AT=1
      LOAD= FUNMS2        SF=1.000   AT=1
```

```
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
   LOAD= FUNMS         SF=1.000   AT=1
   LOAD= FUNINER       SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= FUNSLAB2      SF=1.000   AT=1
   LOAD= FUNWALL2      SF=1.000   AT=1
   LOAD= FUNMS2        SF=1.000   AT=1
   LOAD= FUNINER2      SF=1.000   AT=1
NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= FUNSLAB       SF=1.000   AT=1
   LOAD= FUNWALL       SF=1.000   AT=1
```

```
      LOAD= FUNMS          SF=1.000   AT=1                                HIST=UE14 SF=1
      LOAD= FUNINER        SF=1.000   AT=1                                HIST=UE15 SF=1
   NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     HIST=UE16 SF=1
      LOAD= SW             SF=1.200   AT=1                                HIST=UE17 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                HIST=UE18 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                HIST=UE19 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                HIST=UE20 SF=1
      LOAD= FUNSLAB2       SF=1.000   AT=1                                HIST=UE21 SF=1
      LOAD= FUNWALL2       SF=1.000   AT=1                                HIST=UE22 SF=1
      LOAD= FUNMS2         SF=1.000   AT=1                                HIST=UE23 SF=1
      LOAD= FUNINER2       SF=1.000   AT=1                                HIST=UE24 SF=1
   NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     HIST=UE25 SF=1
      LOAD= SW             SF=1.200   AT=1                                HIST=UE26 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                HIST=UE27 SF=1
      LOAD= LIVELEE        SF=1.000   AT=1                                HIST=UE28 SF=1
      LOAD= LIVELEHE       SF=0.500   AT=1                                HIST=UE29 SF=1
      LOAD= FUNSLAB        SF=1.000   AT=1                                HIST=UE30 SF=1
      LOAD= FUNWALL        SF=1.000   AT=1                                HIST=UE31 SF=1
      LOAD= FUNMS          SF=1.000   AT=1                                HIST=UE32 SF=1
      LOAD= FUNINER        SF=1.000   AT=1                          OUTPUT
   NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     ELEM=JOINT   TYPE=REAC,DISP,APP     LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= SW             SF=1.200   AT=1                                ELEM=FRAME   TYPE=FORCE             LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVELEE        SF=1.000   AT=1
      LOAD= LIVELEHE       SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB        SF=1.000   AT=1
      LOAD= FUNWALL        SF=1.000   AT=1
      LOAD= FUNMS          SF=1.000   AT=1
      LOAD= FUNINER        SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= FUNSLAB2       SF=1.000   AT=1
      LOAD= FUNWALL2       SF=1.000   AT=1
      LOAD= FUNMS2         SF=1.000   AT=1
      LOAD= FUNINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
      HIST=UE06 SF=1
      HIST=UE07 SF=1
      HIST=UE08 SF=1
      HIST=UE09 SF=1
      HIST=UE10 SF=1
      HIST=UE11 SF=1
      HIST=UE12 SF=1
      HIST=UE13 SF=1
```

17. INPUT DATA (붕괴방지)

```
; ACulvert SAP2000 데이터파일 : 내진(붕괴)
;
SYSTEM
   DOF=UX,UZ,RY LENGTH=m FORCE=kN
JOINT
  1    X=     0.500 Y=     0.000 Z=     0.500
  2    X=     1.350 Y=     0.000 Z=     0.500
  3    X=     1.529 Y=     0.000 Z=     0.500
  4    X=     2.558 Y=     0.000 Z=     0.500
  5    X=     3.587 Y=     0.000 Z=     0.500
  6    X=     4.617 Y=     0.000 Z=     0.500
  7    X=     5.646 Y=     0.000 Z=     0.500
  8    X=     6.675 Y=     0.000 Z=     0.500
  9    X=     7.704 Y=     0.000 Z=     0.500
  10   X=     8.733 Y=     0.000 Z=     0.500
  11   X=     9.762 Y=     0.000 Z=     0.500
  12   X=    10.792 Y=     0.000 Z=     0.500
  13   X=    11.821 Y=     0.000 Z=     0.500
  14   X=    12.000 Y=     0.000 Z=     0.500
  15   X=    12.850 Y=     0.000 Z=     0.500
  16   X=    12.850 Y=     0.000 Z=     1.300
  17   X=    12.850 Y=     0.000 Z=     1.637
  18   X=    12.850 Y=     0.000 Z=     2.773
  19   X=    12.850 Y=     0.000 Z=     3.910
  20   X=    12.850 Y=     0.000 Z=     5.047
  21   X=    12.850 Y=     0.000 Z=     6.020
  22   X=    12.850 Y=     0.000 Z=     6.183
  23   X=    12.850 Y=     0.000 Z=     6.520
  24   X=    12.850 Y=     0.000 Z=     7.320
  25   X=    12.000 Y=     0.000 Z=     7.320
  26   X=    11.821 Y=     0.000 Z=     7.320
  27   X=    11.500 Y=     0.000 Z=     7.320
  28   X=    10.792 Y=     0.000 Z=     7.320
  29   X=     9.762 Y=     0.000 Z=     7.320
  30   X=     8.733 Y=     0.000 Z=     7.320
  31   X=     7.704 Y=     0.000 Z=     7.320
  32   X=     6.675 Y=     0.000 Z=     7.320
  33   X=     5.646 Y=     0.000 Z=     7.320
  34   X=     4.617 Y=     0.000 Z=     7.320
  35   X=     3.587 Y=     0.000 Z=     7.320
  36   X=     2.558 Y=     0.000 Z=     7.320
  37   X=     1.850 Y=     0.000 Z=     7.320
  38   X=     1.529 Y=     0.000 Z=     7.320
  39   X=     1.350 Y=     0.000 Z=     7.320
  40   X=     0.500 Y=     0.000 Z=     7.320
  41   X=     0.500 Y=     0.000 Z=     6.520
  42   X=     0.500 Y=     0.000 Z=     6.183
  43   X=     0.500 Y=     0.000 Z=     6.020
  44   X=     0.500 Y=     0.000 Z=     5.047
  45   X=     0.500 Y=     0.000 Z=     3.910
  46   X=     0.500 Y=     0.000 Z=     2.773
  47   X=     0.500 Y=     0.000 Z=     1.637
  48   X=     0.500 Y=     0.000 Z=     1.300
  49   X=     0.500 Y=     0.000 Z=     0.000
  50   X=     1.529 Y=     0.000 Z=     0.000
  51   X=     2.558 Y=     0.000 Z=     0.000
  52   X=     3.587 Y=     0.000 Z=     0.000
  53   X=     4.617 Y=     0.000 Z=     0.000
  54   X=     5.646 Y=     0.000 Z=     0.000
  55   X=     6.675 Y=     0.000 Z=     0.000
  56   X=     7.704 Y=     0.000 Z=     0.000
  57   X=     8.733 Y=     0.000 Z=     0.000
  58   X=     9.762 Y=     0.000 Z=     0.000
  59   X=    10.792 Y=     0.000 Z=     0.000
  60   X=    11.821 Y=     0.000 Z=     0.000
  61   X=    12.850 Y=     0.000 Z=     0.000
  62   X=    13.350 Y=     0.000 Z=     0.500
  63   X=    13.350 Y=     0.000 Z=     1.637
  64   X=    13.350 Y=     0.000 Z=     2.773
  65   X=    13.350 Y=     0.000 Z=     3.910
  66   X=    13.350 Y=     0.000 Z=     5.047
  67   X=    13.350 Y=     0.000 Z=     6.183
  68   X=    13.350 Y=     0.000 Z=     7.320
  69   X=    12.850 Y=     0.000 Z=     7.820
  70   X=    11.821 Y=     0.000 Z=     7.820
  71   X=    10.792 Y=     0.000 Z=     7.820
  72   X=     9.762 Y=     0.000 Z=     7.820
  73   X=     8.733 Y=     0.000 Z=     7.820
  74   X=     7.704 Y=     0.000 Z=     7.820
  75   X=     6.675 Y=     0.000 Z=     7.820
  76   X=     5.646 Y=     0.000 Z=     7.820
  77   X=     4.617 Y=     0.000 Z=     7.820
  78   X=     3.587 Y=     0.000 Z=     7.820
  79   X=     2.558 Y=     0.000 Z=     7.820
  80   X=     1.529 Y=     0.000 Z=     7.820
  81   X=     0.500 Y=     0.000 Z=     7.820
  82   X=     0.000 Y=     0.000 Z=     7.320
  83   X=     0.000 Y=     0.000 Z=     6.183
  84   X=     0.000 Y=     0.000 Z=     5.047
  85   X=     0.000 Y=     0.000 Z=     3.910
  86   X=     0.000 Y=     0.000 Z=     2.773
  87   X=     0.000 Y=     0.000 Z=     1.637
  88   X=     0.000 Y=     0.000 Z=     0.500
RESTRAINT
  ADD=49 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=50 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=51 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=52 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=53 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=54 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=55 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=56 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=57 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=58 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=59 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=60 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=61 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=62 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=63 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=64 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=65 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=66 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=67 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=68 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=69 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=70 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=71 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=72 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=73 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=74 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=75 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=76 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=77 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=78 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=79 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=80 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=81 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=82 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=83 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=84 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=85 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=86 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=87 DOF=UX,UY,UZ,RX,RY,RZ
  ADD=88 DOF=UX,UY,UZ,RX,RY,RZ
SPRING
  ADD=3 UX=37591.1
  ADD=4 UX=37591.1
  ADD=5 UX=37591.1
  ADD=6 UX=37591.1
  ADD=7 UX=37591.1
  ADD=8 UX=37591.1
  ADD=9 UX=37591.1
  ADD=10 UX=37591.1
  ADD=11 UX=37591.1
  ADD=12 UX=37591.1
  ADD=13 UX=37591.1
  ADD=17 UZ=60954.5
  ADD=18 UZ=60954.5
  ADD=19 UZ=60954.5
  ADD=20 UZ=60954.5
  ADD=22 UZ=60954.5
  ADD=26 UX=37591.1
  ADD=28 UX=37591.1
  ADD=29 UX=37591.1
  ADD=30 UX=37591.1
  ADD=31 UX=37591.1
  ADD=32 UX=37591.1
  ADD=33 UX=37591.1
  ADD=34 UX=37591.1
  ADD=35 UX=37591.1
  ADD=36 UX=37591.1
  ADD=38 UX=37591.1
  ADD=42 UZ=60954.5
  ADD=44 UZ=60954.5
  ADD=45 UZ=60954.5
  ADD=46 UZ=60954.5
  ADD=47 UZ=60954.5
MATERIAL
  Name=1 M=2.54946 W=25
    E=2.6702e+007 U=0.167 A=9.99e-006
NLPROP
  NAME=1 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=149527. CE=0.99999 K=149527. OPEN=0
  NAME=2 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=112773. CE=0.99999 K=112773. OPEN=0
  NAME=3 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
```

```
        DOF=U1 KE=220133. CE=0.99999 K=220133. OPEN=0
  NAME=4 TYPE=Gap M=1e-005 MR1=1e-005 MR2=1e-005 MR3=1e-005
        DOF=U1 KE=182864. CE=0.99999 K=182864. OPEN=0
FRAME SECTION
  Name=1  TYPE=PRISM Mat=1  SH=R T=1.6,1
  Name=2  TYPE=PRISM Mat=1  SH=R T=1.7,1
  Name=3  TYPE=PRISM Mat=1  SH=R T=1.86333,1
  Name=4  TYPE=PRISM Mat=1  SH=R T=2.2,1
  Name=5  TYPE=PRISM Mat=1  SH=R T=2.1,1
  Name=6  TYPE=PRISM Mat=1  SH=R T=1.92083,1
  Name=7  TYPE=NONPR SEC=2,3 EIVAR=1,1
  Name=8  TYPE=NONPR SEC=3,4 EIVAR=1,1
  Name=9  TYPE=NONPR SEC=5,6 EIVAR=1,1
  Name=10  TYPE=NONPR SEC=6,1 EIVAR=1,1
  Name=11  TYPE=NONPR SEC=1,6 EIVAR=1,1
  Name=12  TYPE=NONPR SEC=6,5 EIVAR=1,1
  Name=13  TYPE=NONPR SEC=4,3 EIVAR=1,1
  Name=14  TYPE=NONPR SEC=3,2 EIVAR=1,1
FRAME
     1 J=  1,   2 SEC= 1 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
     2 J=  2,   3 SEC= 1 NSEG= 4 ANG=180
     3 J=  3,   4 SEC= 1 NSEG= 4 ANG=180
     4 J=  4,   5 SEC= 1 NSEG= 4 ANG=180
     5 J=  5,   6 SEC= 1 NSEG= 4 ANG=180
     6 J=  6,   7 SEC= 1 NSEG= 4 ANG=180
     7 J=  7,   8 SEC= 1 NSEG= 4 ANG=180
     8 J=  8,   9 SEC= 1 NSEG= 4 ANG=180
     9 J=  9,  10 SEC= 1 NSEG= 4 ANG=180
    10 J= 10,  11 SEC= 1 NSEG= 4 ANG=180
    11 J= 11,  12 SEC= 1 NSEG= 4 ANG=180
    12 J= 12,  13 SEC= 1 NSEG= 4 ANG=180
    13 J= 13,  14 SEC= 1 NSEG= 4 ANG=180
    14 J= 14,  15 SEC= 1 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=180
    15 J= 15,  16 SEC= 2 IOFF=0.375 JOFF=0 RIGID=1 NSEG=4 ANG=0
    16 J= 16,  17 SEC= 2 NSEG= 4 ANG=0
    17 J= 17,  18 SEC= 2 NSEG= 4 ANG=0
    18 J= 18,  19 SEC= 2 NSEG= 4 ANG=0
    19 J= 19,  20 SEC= 2 NSEG= 4 ANG=0
    20 J= 20,  21 SEC= 2 NSEG= 4 ANG=0
    21 J= 21,  22 SEC= 7 NSEG= 4 ANG=0
    22 J= 22,  23 SEC= 8 NSEG= 4 ANG=0
    23 J= 23,  24 SEC= 4 IOFF=0 JOFF=0.45 RIGID=1 NSEG=4 ANG=0
    24 J= 24,  25 SEC= 5 IOFF=0.55 JOFF=0 RIGID=1 NSEG=4 ANG=0
    25 J= 25,  26 SEC= 9 NSEG= 4 ANG=0
    26 J= 26,  27 SEC=10 NSEG= 4 ANG=0
    27 J= 27,  28 SEC= 1 NSEG= 4 ANG=0
    28 J= 28,  29 SEC= 1 NSEG= 4 ANG=0
    29 J= 29,  30 SEC= 1 NSEG= 4 ANG=0
    30 J= 30,  31 SEC= 1 NSEG= 4 ANG=0
    31 J= 31,  32 SEC= 1 NSEG= 4 ANG=0
    32 J= 32,  33 SEC= 1 NSEG= 4 ANG=0
    33 J= 33,  34 SEC= 1 NSEG= 4 ANG=0
    34 J= 34,  35 SEC= 1 NSEG= 4 ANG=0
    35 J= 35,  36 SEC= 1 NSEG= 4 ANG=0
    36 J= 36,  37 SEC= 1 NSEG= 4 ANG=0
    37 J= 37,  38 SEC=11 NSEG= 4 ANG=0
    38 J= 38,  39 SEC=12 NSEG= 4 ANG=0
    39 J= 39,  40 SEC= 5 IOFF=0 JOFF=0.55 RIGID=1 NSEG=4 ANG=0
    40 J= 40,  41 SEC= 4 IOFF=0.45 JOFF=0 RIGID=1 NSEG=4 ANG=180
    41 J= 41,  42 SEC=13 NSEG= 4 ANG=180
    42 J= 42,  43 SEC=14 NSEG= 4 ANG=180
    43 J= 43,  44 SEC= 2 NSEG= 4 ANG=180
    44 J= 44,  45 SEC= 2 NSEG= 4 ANG=180
    45 J= 45,  46 SEC= 2 NSEG= 4 ANG=180
    46 J= 46,  47 SEC= 2 NSEG= 4 ANG=180
    47 J= 47,  48 SEC= 2 NSEG= 4 ANG=180
    48 J= 48,   1 SEC= 2 IOFF=0 JOFF=0.375 RIGID=1 NSEG=4 ANG=180
NLLINK
     1 J= 1,49 NLP=1 ANG=0
     2 J= 3,50 NLP=2 ANG=0
     3 J= 4,51 NLP=2 ANG=0
     4 J= 5,52 NLP=2 ANG=0
     5 J= 6,53 NLP=2 ANG=0
     6 J= 7,54 NLP=2 ANG=0
     7 J= 8,55 NLP=2 ANG=0
     8 J= 9,56 NLP=2 ANG=0
     9 J=10,57 NLP=2 ANG=0
    10 J=11,58 NLP=2 ANG=0
    11 J=12,59 NLP=2 ANG=0
    12 J=13,60 NLP=2 ANG=0
    13 J=15,61 NLP=1 ANG=0
    14 J=15,62 NLP=3 ANG=0
    15 J=17,63 NLP=4 ANG=0
    16 J=18,64 NLP=4 ANG=0
    17 J=19,65 NLP=4 ANG=0
    18 J=20,66 NLP=4 ANG=0
    19 J=22,67 NLP=4 ANG=0
    20 J=24,68 NLP=3 ANG=0
    21 J=24,69 NLP=1 ANG=0
    22 J=26,70 NLP=2 ANG=0
    23 J=28,71 NLP=2 ANG=0
    24 J=29,72 NLP=2 ANG=0
    25 J=30,73 NLP=2 ANG=0
    26 J=31,74 NLP=2 ANG=0
    27 J=32,75 NLP=2 ANG=0
    28 J=33,76 NLP=2 ANG=0
    29 J=34,77 NLP=2 ANG=0
    30 J=35,78 NLP=2 ANG=0
    31 J=36,79 NLP=2 ANG=0
    32 J=38,80 NLP=2 ANG=0
    33 J=40,81 NLP=1 ANG=0
    34 J=40,82 NLP=3 ANG=0
    35 J=42,83 NLP=4 ANG=0
    36 J=44,84 NLP=4 ANG=0
    37 J=45,85 NLP=4 ANG=0
    38 J=46,86 NLP=4 ANG=0
    39 J=47,87 NLP=4 ANG=0
    40 J= 1,88 NLP=3 ANG=0
LOAD
NAME=SW SW=1  ; 구체자중
NAME=PAVE  ; 상부고정하중 : 지하수無
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-252.706, -252.706
      ADD=25 RD=0,1 UZ=-252.706, -252.706
      ADD=26 RD=0,1 UZ=-252.706, -252.706
      ADD=27 RD=0,1 UZ=-252.706, -252.706
      ADD=28 RD=0,1 UZ=-252.706, -252.706
      ADD=29 RD=0,1 UZ=-252.706, -252.706
      ADD=30 RD=0,1 UZ=-252.706, -252.706
      ADD=31 RD=0,1 UZ=-252.706, -252.706
      ADD=32 RD=0,1 UZ=-252.706, -252.706
      ADD=33 RD=0,1 UZ=-252.706, -252.706
      ADD=34 RD=0,1 UZ=-252.706, -252.706
      ADD=35 RD=0,1 UZ=-252.706, -252.706
      ADD=36 RD=0,1 UZ=-252.706, -252.706
      ADD=37 RD=0,1 UZ=-252.706, -252.706
      ADD=38 RD=0,1 UZ=-252.706, -252.706
      ADD=39 RD=0,1 UZ=-252.706, -252.706
NAME=PAVEW  ; 상부고정하중 : 지하수有
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-143.46, -143.46
      ADD=25 RD=0,1 UZ=-143.46, -143.46
      ADD=26 RD=0,1 UZ=-143.46, -143.46
      ADD=27 RD=0,1 UZ=-143.46, -143.46
      ADD=28 RD=0,1 UZ=-143.46, -143.46
      ADD=29 RD=0,1 UZ=-143.46, -143.46
      ADD=30 RD=0,1 UZ=-143.46, -143.46
      ADD=31 RD=0,1 UZ=-143.46, -143.46
      ADD=32 RD=0,1 UZ=-143.46, -143.46
      ADD=33 RD=0,1 UZ=-143.46, -143.46
      ADD=34 RD=0,1 UZ=-143.46, -143.46
      ADD=35 RD=0,1 UZ=-143.46, -143.46
      ADD=36 RD=0,1 UZ=-143.46, -143.46
      ADD=37 RD=0,1 UZ=-143.46, -143.46
      ADD=38 RD=0,1 UZ=-143.46, -143.46
      ADD=39 RD=0,1 UZ=-143.46, -143.46
NAME=LIVEFUE  ; 지진시 만재활하중
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVELEE  ; 지진시 편재활하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=32 RD=0,1 UZ=-10, -10
      ADD=33 RD=0,1 UZ=-10, -10
      ADD=34 RD=0,1 UZ=-10, -10
      ADD=35 RD=0,1 UZ=-10, -10
      ADD=36 RD=0,1 UZ=-10, -10
      ADD=37 RD=0,1 UZ=-10, -10
      ADD=38 RD=0,1 UZ=-10, -10
      ADD=39 RD=0,1 UZ=-10, -10
NAME=LIVERIE  ; 지진시 편재활하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UZ=-10, -10
      ADD=25 RD=0,1 UZ=-10, -10
      ADD=26 RD=0,1 UZ=-10, -10
      ADD=27 RD=0,1 UZ=-10, -10
```

```
      ADD=28 RD=0,1 UZ=-10, -10
      ADD=29 RD=0,1 UZ=-10, -10
      ADD=30 RD=0,1 UZ=-10, -10
      ADD=31 RD=0,1 UZ=-10, -10
NAME=LIVEFUHE  ; 지진시 만재활하중에 의한 수평하중
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=LIVELEHE  ; 지진시 편재활하중에 의한 수평하중(좌측)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=5, 5
      ADD=41 RD=0,1 UX=5, 5
      ADD=42 RD=0,1 UX=5, 5
      ADD=43 RD=0,1 UX=5, 5
      ADD=44 RD=0,1 UX=5, 5
      ADD=45 RD=0,1 UX=5, 5
      ADD=46 RD=0,1 UX=5, 5
      ADD=47 RD=0,1 UX=5, 5
      ADD=48 RD=0,1 UX=5, 5
NAME=LIVERIHE  ; 지진시 편재활하중에 의한 수평하중(우측)
   TYPE=DISTRIBUTED SPAN
      ADD=15 RD=0,1 UX=-5, -5
      ADD=16 RD=0,1 UX=-5, -5
      ADD=17 RD=0,1 UX=-5, -5
      ADD=18 RD=0,1 UX=-5, -5
      ADD=19 RD=0,1 UX=-5, -5
      ADD=20 RD=0,1 UX=-5, -5
      ADD=21 RD=0,1 UX=-5, -5
      ADD=22 RD=0,1 UX=-5, -5
      ADD=23 RD=0,1 UX=-5, -5
NAME=COLSLAB  ; 슬래브 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=26.81, 26.81
      ADD=25 RD=0,1 UX=26.81, 26.81
      ADD=26 RD=0,1 UX=26.81, 26.81
      ADD=27 RD=0,1 UX=26.81, 26.81
      ADD=28 RD=0,1 UX=26.81, 26.81
      ADD=29 RD=0,1 UX=26.81, 26.81
      ADD=30 RD=0,1 UX=26.81, 26.81
      ADD=31 RD=0,1 UX=26.81, 26.81
      ADD=32 RD=0,1 UX=26.81, 26.81
      ADD=33 RD=0,1 UX=26.81, 26.81
      ADD=34 RD=0,1 UX=26.81, 26.81
      ADD=35 RD=0,1 UX=26.81, 26.81
      ADD=36 RD=0,1 UX=26.81, 26.81
      ADD=37 RD=0,1 UX=26.81, 26.81
      ADD=38 RD=0,1 UX=26.81, 26.81
      ADD=39 RD=0,1 UX=26.81, 26.81
NAME=COLWALL  ; 벽체 지반변위(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=118.083, 104.57
      ADD=41 RD=0,1 UX=104.57, 98.939
      ADD=42 RD=0,1 UX=98.939, 96.043
      ADD=43 RD=0,1 UX=96.043, 79.473
      ADD=44 RD=0,1 UX=79.473, 59.846
      ADD=45 RD=0,1 UX=59.846, 40.058
      ADD=46 RD=0,1 UX=40.058, 20.11
      ADD=47 RD=0,1 UX=20.11, 14.157
      ADD=48 RD=0,1 UX=14.157, 0
      ADD=15 RD=0,1 UX=0, 14.157
      ADD=16 RD=0,1 UX=14.157, 20.11
      ADD=17 RD=0,1 UX=20.11, 40.058
      ADD=18 RD=0,1 UX=40.058, 59.846
      ADD=19 RD=0,1 UX=59.846, 79.473
      ADD=20 RD=0,1 UX=79.473, 96.043
      ADD=21 RD=0,1 UX=96.043, 98.939
      ADD=22 RD=0,1 UX=98.939, 104.57
      ADD=23 RD=0,1 UX=104.57, 118.083
NAME=COLMS  ; 주면전단력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=21.11, 21.11
      ADD=25 RD=0,1 UX=21.11, 21.11
      ADD=26 RD=0,1 UX=21.11, 21.11
      ADD=27 RD=0,1 UX=21.11, 21.11
      ADD=28 RD=0,1 UX=21.11, 21.11
      ADD=29 RD=0,1 UX=21.11, 21.11
      ADD=30 RD=0,1 UX=21.11, 21.11
      ADD=31 RD=0,1 UX=21.11, 21.11
      ADD=32 RD=0,1 UX=21.11, 21.11
      ADD=33 RD=0,1 UX=21.11, 21.11
      ADD=34 RD=0,1 UX=21.11, 21.11
      ADD=35 RD=0,1 UX=21.11, 21.11
      ADD=36 RD=0,1 UX=21.11, 21.11
      ADD=37 RD=0,1 UX=21.11, 21.11
      ADD=38 RD=0,1 UX=21.11, 21.11
      ADD=39 RD=0,1 UX=21.11, 21.11
      ADD=40 RD=0,1 UZ=-52.01, -52.01
      ADD=41 RD=0,1 UZ=-52.01, -52.01
      ADD=42 RD=0,1 UZ=-52.01, -52.01
      ADD=43 RD=0,1 UZ=-52.01, -52.01
      ADD=44 RD=0,1 UZ=-52.01, -52.01
      ADD=45 RD=0,1 UZ=-52.01, -52.01
      ADD=46 RD=0,1 UZ=-52.01, -52.01
      ADD=47 RD=0,1 UZ=-52.01, -52.01
      ADD=48 RD=0,1 UZ=-52.01, -52.01
      ADD=15 RD=0,1 UZ=52.01, 52.01
      ADD=16 RD=0,1 UZ=52.01, 52.01
      ADD=17 RD=0,1 UZ=52.01, 52.01
      ADD=18 RD=0,1 UZ=52.01, 52.01
      ADD=19 RD=0,1 UZ=52.01, 52.01
      ADD=20 RD=0,1 UZ=52.01, 52.01
      ADD=21 RD=0,1 UZ=52.01, 52.01
      ADD=22 RD=0,1 UZ=52.01, 52.01
      ADD=23 RD=0,1 UZ=52.01, 52.01
      ADD=1 RD=0,1 UX=-82.9, -82.9
      ADD=2 RD=0,1 UX=-82.9, -82.9
      ADD=3 RD=0,1 UX=-82.9, -82.9
      ADD=4 RD=0,1 UX=-82.9, -82.9
      ADD=5 RD=0,1 UX=-82.9, -82.9
      ADD=6 RD=0,1 UX=-82.9, -82.9
      ADD=7 RD=0,1 UX=-82.9, -82.9
      ADD=8 RD=0,1 UX=-82.9, -82.9
      ADD=9 RD=0,1 UX=-82.9, -82.9
      ADD=10 RD=0,1 UX=-82.9, -82.9
      ADD=11 RD=0,1 UX=-82.9, -82.9
      ADD=12 RD=0,1 UX=-82.9, -82.9
      ADD=13 RD=0,1 UX=-82.9, -82.9
      ADD=14 RD=0,1 UX=-82.9, -82.9
NAME=COLINER  ; 구체 관성력(붕괴방지)
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=5.753, 5.753
      ADD=25 RD=0,1 UX=5.753, 5.753
      ADD=26 RD=0,1 UX=5.753, 5.753
      ADD=27 RD=0,1 UX=5.753, 5.753
      ADD=28 RD=0,1 UX=5.753, 5.753
      ADD=29 RD=0,1 UX=5.753, 5.753
      ADD=30 RD=0,1 UX=5.753, 5.753
      ADD=31 RD=0,1 UX=5.753, 5.753
      ADD=32 RD=0,1 UX=5.753, 5.753
      ADD=33 RD=0,1 UX=5.753, 5.753
      ADD=34 RD=0,1 UX=5.753, 5.753
      ADD=35 RD=0,1 UX=5.753, 5.753
      ADD=36 RD=0,1 UX=5.753, 5.753
      ADD=37 RD=0,1 UX=5.753, 5.753
      ADD=38 RD=0,1 UX=5.753, 5.753
      ADD=39 RD=0,1 UX=5.753, 5.753
      ADD=40 RD=0,1 UX=6.112, 6.019
      ADD=41 RD=0,1 UX=6.019, 5.98
      ADD=42 RD=0,1 UX=5.98, 5.961
      ADD=43 RD=0,1 UX=5.961, 5.848
      ADD=44 RD=0,1 UX=5.848, 5.716
      ADD=45 RD=0,1 UX=5.716, 5.584
      ADD=46 RD=0,1 UX=5.584, 5.453
      ADD=47 RD=0,1 UX=5.453, 5.414
      ADD=48 RD=0,1 UX=5.414, 5.321
      ADD=15 RD=0,1 UX=5.321, 5.414
      ADD=16 RD=0,1 UX=5.414, 5.453
      ADD=17 RD=0,1 UX=5.453, 5.584
      ADD=18 RD=0,1 UX=5.584, 5.716
      ADD=19 RD=0,1 UX=5.716, 5.848
      ADD=20 RD=0,1 UX=5.848, 5.961
      ADD=21 RD=0,1 UX=5.961, 5.98
      ADD=22 RD=0,1 UX=5.98, 6.019
      ADD=23 RD=0,1 UX=6.019, 6.112
      ADD=1 RD=0,1 UX=5.008, 5.008
      ADD=2 RD=0,1 UX=5.008, 5.008
      ADD=3 RD=0,1 UX=5.008, 5.008
      ADD=4 RD=0,1 UX=5.008, 5.008
      ADD=5 RD=0,1 UX=5.008, 5.008
      ADD=6 RD=0,1 UX=5.008, 5.008
      ADD=7 RD=0,1 UX=5.008, 5.008
      ADD=8 RD=0,1 UX=5.008, 5.008
      ADD=9 RD=0,1 UX=5.008, 5.008
      ADD=10 RD=0,1 UX=5.008, 5.008
```

```
      ADD=11 RD=0,1 UX=5.008, 5.008
      ADD=12 RD=0,1 UX=5.008, 5.008
      ADD=13 RD=0,1 UX=5.008, 5.008
      ADD=14 RD=0,1 UX=5.008, 5.008
NAME=COLSLAB2  ; 슬래브 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-26.81, -26.81
      ADD=25 RD=0,1 UX=-26.81, -26.81
      ADD=26 RD=0,1 UX=-26.81, -26.81
      ADD=27 RD=0,1 UX=-26.81, -26.81
      ADD=28 RD=0,1 UX=-26.81, -26.81
      ADD=29 RD=0,1 UX=-26.81, -26.81
      ADD=30 RD=0,1 UX=-26.81, -26.81
      ADD=31 RD=0,1 UX=-26.81, -26.81
      ADD=32 RD=0,1 UX=-26.81, -26.81
      ADD=33 RD=0,1 UX=-26.81, -26.81
      ADD=34 RD=0,1 UX=-26.81, -26.81
      ADD=35 RD=0,1 UX=-26.81, -26.81
      ADD=36 RD=0,1 UX=-26.81, -26.81
      ADD=37 RD=0,1 UX=-26.81, -26.81
      ADD=38 RD=0,1 UX=-26.81, -26.81
      ADD=39 RD=0,1 UX=-26.81, -26.81
NAME=COLWALL2  ; 벽체 지반변위(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=40 RD=0,1 UX=-118.083, -104.57
      ADD=41 RD=0,1 UX=-104.57, -98.939
      ADD=42 RD=0,1 UX=-98.939, -96.043
      ADD=43 RD=0,1 UX=-96.043, -79.473
      ADD=44 RD=0,1 UX=-79.473, -59.846
      ADD=45 RD=0,1 UX=-59.846, -40.058
      ADD=46 RD=0,1 UX=-40.058, -20.11
      ADD=47 RD=0,1 UX=-20.11, -14.157
      ADD=48 RD=0,1 UX=-14.157, -0
      ADD=15 RD=0,1 UX=-0, -14.157
      ADD=16 RD=0,1 UX=-14.157, -20.11
      ADD=17 RD=0,1 UX=-20.11, -40.058
      ADD=18 RD=0,1 UX=-40.058, -59.846
      ADD=19 RD=0,1 UX=-59.846, -79.473
      ADD=20 RD=0,1 UX=-79.473, -96.043
      ADD=21 RD=0,1 UX=-96.043, -98.939
      ADD=22 RD=0,1 UX=-98.939, -104.57
      ADD=23 RD=0,1 UX=-104.57, -118.083
NAME=COLMS2  ; 주면전단력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-21.11, -21.11
      ADD=25 RD=0,1 UX=-21.11, -21.11
      ADD=26 RD=0,1 UX=-21.11, -21.11
      ADD=27 RD=0,1 UX=-21.11, -21.11
      ADD=28 RD=0,1 UX=-21.11, -21.11
      ADD=29 RD=0,1 UX=-21.11, -21.11
      ADD=30 RD=0,1 UX=-21.11, -21.11
      ADD=31 RD=0,1 UX=-21.11, -21.11
      ADD=32 RD=0,1 UX=-21.11, -21.11
      ADD=33 RD=0,1 UX=-21.11, -21.11
      ADD=34 RD=0,1 UX=-21.11, -21.11
      ADD=35 RD=0,1 UX=-21.11, -21.11
      ADD=36 RD=0,1 UX=-21.11, -21.11
      ADD=37 RD=0,1 UX=-21.11, -21.11
      ADD=38 RD=0,1 UX=-21.11, -21.11
      ADD=39 RD=0,1 UX=-21.11, -21.11
      ADD=40 RD=0,1 UZ=52.01, 52.01
      ADD=41 RD=0,1 UZ=52.01, 52.01
      ADD=42 RD=0,1 UZ=52.01, 52.01
      ADD=43 RD=0,1 UZ=52.01, 52.01
      ADD=44 RD=0,1 UZ=52.01, 52.01
      ADD=45 RD=0,1 UZ=52.01, 52.01
      ADD=46 RD=0,1 UZ=52.01, 52.01
      ADD=47 RD=0,1 UZ=52.01, 52.01
      ADD=48 RD=0,1 UZ=52.01, 52.01
      ADD=15 RD=0,1 UZ=-52.01, -52.01
      ADD=16 RD=0,1 UZ=-52.01, -52.01
      ADD=17 RD=0,1 UZ=-52.01, -52.01
      ADD=18 RD=0,1 UZ=-52.01, -52.01
      ADD=19 RD=0,1 UZ=-52.01, -52.01
      ADD=20 RD=0,1 UZ=-52.01, -52.01
      ADD=21 RD=0,1 UZ=-52.01, -52.01
      ADD=22 RD=0,1 UZ=-52.01, -52.01
      ADD=23 RD=0,1 UZ=-52.01, -52.01
      ADD=1 RD=0,1 UX=82.9, 82.9
      ADD=2 RD=0,1 UX=82.9, 82.9
      ADD=3 RD=0,1 UX=82.9, 82.9
      ADD=4 RD=0,1 UX=82.9, 82.9
      ADD=5 RD=0,1 UX=82.9, 82.9
      ADD=6 RD=0,1 UX=82.9, 82.9
      ADD=7 RD=0,1 UX=82.9, 82.9
      ADD=8 RD=0,1 UX=82.9, 82.9
      ADD=9 RD=0,1 UX=82.9, 82.9
      ADD=10 RD=0,1 UX=82.9, 82.9
      ADD=11 RD=0,1 UX=82.9, 82.9
      ADD=12 RD=0,1 UX=82.9, 82.9
      ADD=13 RD=0,1 UX=82.9, 82.9
      ADD=14 RD=0,1 UX=82.9, 82.9
NAME=COLINER2  ; 구체 관성력(붕괴방지)2
   TYPE=DISTRIBUTED SPAN
      ADD=24 RD=0,1 UX=-5.753, -5.753
      ADD=25 RD=0,1 UX=-5.753, -5.753
      ADD=26 RD=0,1 UX=-5.753, -5.753
      ADD=27 RD=0,1 UX=-5.753, -5.753
      ADD=28 RD=0,1 UX=-5.753, -5.753
      ADD=29 RD=0,1 UX=-5.753, -5.753
      ADD=30 RD=0,1 UX=-5.753, -5.753
      ADD=31 RD=0,1 UX=-5.753, -5.753
      ADD=32 RD=0,1 UX=-5.753, -5.753
      ADD=33 RD=0,1 UX=-5.753, -5.753
      ADD=34 RD=0,1 UX=-5.753, -5.753
      ADD=35 RD=0,1 UX=-5.753, -5.753
      ADD=36 RD=0,1 UX=-5.753, -5.753
      ADD=37 RD=0,1 UX=-5.753, -5.753
      ADD=38 RD=0,1 UX=-5.753, -5.753
      ADD=39 RD=0,1 UX=-5.753, -5.753
      ADD=40 RD=0,1 UX=-6.112, -6.019
      ADD=41 RD=0,1 UX=-6.019, -5.98
      ADD=42 RD=0,1 UX=-5.98, -5.961
      ADD=43 RD=0,1 UX=-5.961, -5.848
      ADD=44 RD=0,1 UX=-5.848, -5.716
      ADD=45 RD=0,1 UX=-5.716, -5.584
      ADD=46 RD=0,1 UX=-5.584, -5.453
      ADD=47 RD=0,1 UX=-5.453, -5.414
      ADD=48 RD=0,1 UX=-5.414, -5.321
      ADD=15 RD=0,1 UX=-5.321, -5.414
      ADD=16 RD=0,1 UX=-5.414, -5.453
      ADD=17 RD=0,1 UX=-5.453, -5.584
      ADD=18 RD=0,1 UX=-5.584, -5.716
      ADD=19 RD=0,1 UX=-5.716, -5.848
      ADD=20 RD=0,1 UX=-5.848, -5.961
      ADD=21 RD=0,1 UX=-5.961, -5.98
      ADD=22 RD=0,1 UX=-5.98, -6.019
      ADD=23 RD=0,1 UX=-6.019, -6.112
      ADD=1 RD=0,1 UX=-5.008, -5.008
      ADD=2 RD=0,1 UX=-5.008, -5.008
      ADD=3 RD=0,1 UX=-5.008, -5.008
      ADD=4 RD=0,1 UX=-5.008, -5.008
      ADD=5 RD=0,1 UX=-5.008, -5.008
      ADD=6 RD=0,1 UX=-5.008, -5.008
      ADD=7 RD=0,1 UX=-5.008, -5.008
      ADD=8 RD=0,1 UX=-5.008, -5.008
      ADD=9 RD=0,1 UX=-5.008, -5.008
      ADD=10 RD=0,1 UX=-5.008, -5.008
      ADD=11 RD=0,1 UX=-5.008, -5.008
      ADD=12 RD=0,1 UX=-5.008, -5.008
      ADD=13 RD=0,1 UX=-5.008, -5.008
      ADD=14 RD=0,1 UX=-5.008, -5.008
MODE
   TYPE=RITZ   N=100   TOL=0.00001
      LOAD=SW
      LOAD=PAVE
      LOAD=PAVEW
      LOAD=LIVEFUE
      LOAD=LIVELEE
      LOAD=LIVERIE
      LOAD=LIVEFUHE
      LOAD=LIVELEHE
      LOAD=LIVERIHE
      LOAD=COLSLAB
      LOAD=COLWALL
      LOAD=COLMS
      LOAD=COLINER
      LOAD=COLSLAB2
      LOAD=COLWALL2
      LOAD=COLMS2
      LOAD=COLINER2
      NLLINK=*
HISTORY
    NAME=UE01    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= COLSLAB       SF=1.000   AT=1
      LOAD= COLWALL       SF=1.000   AT=1
      LOAD= COLMS         SF=1.000   AT=1
      LOAD= COLINER       SF=1.000   AT=1
    NAME=UE02    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
      LOAD= SW            SF=1.200   AT=1
      LOAD= PAVE          SF=1.200   AT=1
      LOAD= LIVEFUE       SF=1.000   AT=1
      LOAD= LIVEFUHE      SF=1.000   AT=1
      LOAD= COLSLAB2      SF=1.000   AT=1
      LOAD= COLWALL2      SF=1.000   AT=1
      LOAD= COLMS2        SF=1.000   AT=1
```

```
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE03    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE04    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE05    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE06    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE07    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE08    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE09    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE10    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE11    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE12    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVE          SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=0.500   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE13    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE14    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE15    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE16    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=0.900   AT=1
   LOAD= PAVE          SF=0.900   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE17    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE18    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE19    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE20    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVELEE       SF=1.000   AT=1
   LOAD= LIVELEHE      SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE21    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
   LOAD= COLMS         SF=1.000   AT=1
   LOAD= COLINER       SF=1.000   AT=1
NAME=UE22    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVERIE       SF=1.000   AT=1
   LOAD= LIVERIHE      SF=1.000   AT=1
   LOAD= COLSLAB2      SF=1.000   AT=1
   LOAD= COLWALL2      SF=1.000   AT=1
   LOAD= COLMS2        SF=1.000   AT=1
   LOAD= COLINER2      SF=1.000   AT=1
NAME=UE23    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENV
   LOAD= SW            SF=1.200   AT=1
   LOAD= PAVEW         SF=1.200   AT=1
   LOAD= LIVEFUE       SF=1.000   AT=1
   LOAD= LIVEFUHE      SF=0.500   AT=1
   LOAD= COLSLAB       SF=1.000   AT=1
   LOAD= COLWALL       SF=1.000   AT=1
```

```
      LOAD= COLMS          SF=1.000   AT=1                                  HIST=UE14 SF=1
      LOAD= COLINER        SF=1.000   AT=1                                  HIST=UE15 SF=1
   NAME=UE24    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1      HIST=UE16 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE17 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE18 SF=1
      LOAD= LIVEFUE        SF=1.000   AT=1                                  HIST=UE19 SF=1
      LOAD= LIVEFUHE       SF=0.500   AT=1                                  HIST=UE20 SF=1
      LOAD= COLSLAB2       SF=1.000   AT=1                                  HIST=UE21 SF=1
      LOAD= COLWALL2       SF=1.000   AT=1                                  HIST=UE22 SF=1
      LOAD= COLMS2         SF=1.000   AT=1                                  HIST=UE23 SF=1
      LOAD= COLINER2       SF=1.000   AT=1                                  HIST=UE24 SF=1
   NAME=UE25    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1      HIST=UE25 SF=1
      LOAD= SW             SF=1.200   AT=1                                  HIST=UE26 SF=1
      LOAD= PAVEW          SF=1.200   AT=1                                  HIST=UE27 SF=1
      LOAD= LIVELEE        SF=1.000   AT=1                                  HIST=UE28 SF=1
      LOAD= LIVELEHE       SF=0.500   AT=1                                  HIST=UE29 SF=1
      LOAD= COLSLAB        SF=1.000   AT=1                                  HIST=UE30 SF=1
      LOAD= COLWALL        SF=1.000   AT=1                                  HIST=UE31 SF=1
      LOAD= COLMS          SF=1.000   AT=1                                  HIST=UE32 SF=1
      LOAD= COLINER        SF=1.000   AT=1                              OUTPUT
   NAME=UE26    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1     ELEM=JOINT   TYPE=REAC,DISP,APP     LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= SW             SF=1.200   AT=1                                  ELEM=FRAME   TYPE=FORCE             LOAD=*  COMB=*  HIST=*  SPEC=*  MOVE=
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVELEE        SF=1.000   AT=1
      LOAD= LIVELEHE       SF=0.500   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE27    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE28    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=1.200   AT=1
      LOAD= PAVEW          SF=1.200   AT=1
      LOAD= LIVERIE        SF=1.000   AT=1
      LOAD= LIVERIHE       SF=0.500   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE29    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE30    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
   NAME=UE31    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB        SF=1.000   AT=1
      LOAD= COLWALL        SF=1.000   AT=1
      LOAD= COLMS          SF=1.000   AT=1
      LOAD= COLINER        SF=1.000   AT=1
   NAME=UE32    TYPE=NON    NSTEP=100    DT=1    DAMP=0.99    DTMAX=1    ENVE=Y
      LOAD= SW             SF=0.900   AT=1
      LOAD= PAVEW          SF=0.900   AT=1
      LOAD= COLSLAB2       SF=1.000   AT=1
      LOAD= COLWALL2       SF=1.000   AT=1
      LOAD= COLMS2         SF=1.000   AT=1
      LOAD= COLINER2       SF=1.000   AT=1
COMBO
   NAME=ENVEQ  TYPE=ENVE
      HIST=UE01 SF=1
      HIST=UE02 SF=1
      HIST=UE03 SF=1
      HIST=UE04 SF=1
      HIST=UE05 SF=1
      HIST=UE06 SF=1
      HIST=UE07 SF=1
      HIST=UE08 SF=1
      HIST=UE09 SF=1
      HIST=UE10 SF=1
      HIST=UE11 SF=1
      HIST=UE12 SF=1
      HIST=UE13 SF=1
```

18. OUTPUT DATA (상시)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVULT MAX	0.52941	0.00000	0.00000	0.00000
1	ENVULT MAX	0.64706	0.00000	0.00000	0.00000
1	ENVULT MAX	0.76471	0.00000	0.00000	0.00000
1	ENVULT MAX	0.88235	0.00000	0.00000	0.00000
1	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
1	ENVULT MIN	0.52941	-998.33540	-2511.41400	-3596.80800
1	ENVULT MIN	0.64706	-998.33540	-2516.21400	-3347.65200
1	ENVULT MIN	0.76471	-998.33540	-2521.01400	-3098.01600
1	ENVULT MIN	0.88235	-998.33540	-2525.81400	-2847.90000
1	ENVULT MIN	1.00000	-998.33540	-2530.61400	-2597.30400
2	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
2	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
2	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
2	ENVULT MIN	0.00000	-998.33540	-2530.61400	-2597.30400
2	ENVULT MIN	0.25000	-998.33540	-2532.76200	-2485.00700
2	ENVULT MIN	0.50000	-998.33540	-2534.91000	-2372.61300
2	ENVULT MIN	0.75000	-998.33540	-2537.05800	-2260.12400
2	ENVULT MIN	1.00000	-998.33540	-2539.20600	-2147.53800
3	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
3	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
3	ENVULT MAX	1.00000	0.00000	0.00000	457.04191
3	ENVULT MIN	0.00000	-998.33540	-1972.75500	-2147.53800
3	ENVULT MIN	0.25000	-998.33540	-1985.10300	-1642.85700
3	ENVULT MIN	0.50000	-998.33540	-1997.45100	-1135.00000
3	ENVULT MIN	0.75000	-998.33540	-2009.79900	-623.96584
3	ENVULT MIN	1.00000	-998.33540	-2022.14700	-211.51751
4	ENVULT MAX	0.00000	0.00000	0.00000	457.04191
4	ENVULT MAX	0.25000	0.00000	0.00000	803.82661
4	ENVULT MAX	0.50000	0.00000	0.00000	1175.92000
4	ENVULT MAX	0.75000	0.00000	0.00000	1559.32900
4	ENVULT MAX	1.00000	0.00000	0.00000	1945.91500
4	ENVULT MIN	0.00000	-998.33540	-1485.95000	-211.51751
4	ENVULT MIN	0.25000	-998.33540	-1498.29800	0.00000
4	ENVULT MIN	0.50000	-998.33540	-1510.64600	0.00000
4	ENVULT MIN	0.75000	-998.33540	-1522.99400	0.00000
4	ENVULT MIN	1.00000	-998.33540	-1535.34200	0.00000
5	ENVULT MAX	0.00000	0.00000	0.00000	1945.91500
5	ENVULT MAX	0.25000	0.00000	0.00000	2206.77100
5	ENVULT MAX	0.50000	0.00000	0.00000	2470.81000
5	ENVULT MAX	0.75000	0.00000	0.00000	2738.03100
5	ENVULT MAX	1.00000	0.00000	0.00000	3008.43500
5	ENVULT MIN	0.00000	-998.33540	-1029.00600	0.00000
5	ENVULT MIN	0.25000	-998.33540	-1041.36600	0.00000
5	ENVULT MIN	0.50000	-998.33540	-1053.72600	0.00000
5	ENVULT MIN	0.75000	-998.33540	-1066.08600	0.00000
5	ENVULT MIN	1.00000	-998.33540	-1078.44600	0.00000
6	ENVULT MAX	0.00000	0.00000	0.00000	3008.43500
6	ENVULT MAX	0.25000	0.00000	0.00000	3159.79500
6	ENVULT MAX	0.50000	0.00000	0.00000	3314.33100
6	ENVULT MAX	0.75000	0.00000	0.00000	3472.04400
6	ENVULT MAX	1.00000	0.00000	0.00000	3632.93400
6	ENVULT MIN	0.00000	-998.33540	-596.79297	0.00000
6	ENVULT MIN	0.25000	-998.33540	-609.14097	0.00000
6	ENVULT MIN	0.50000	-998.33540	-621.48897	0.00000
6	ENVULT MIN	0.75000	-998.33540	-633.83697	0.00000
6	ENVULT MIN	1.00000	-998.33540	-646.18497	0.00000
7	ENVULT MAX	0.00000	0.00000	0.00000	3632.93400
7	ENVULT MAX	0.25000	0.00000	0.00000	3679.68500
7	ENVULT MAX	0.50000	0.00000	0.00000	3729.61200
7	ENVULT MAX	0.75000	0.00000	0.00000	3782.71600
7	ENVULT MAX	1.00000	0.00000	0.00000	3838.99700
7	ENVULT MIN	0.00000	-998.33540	-184.34142	0.00000
7	ENVULT MIN	0.25000	-998.33540	-196.68942	0.00000
7	ENVULT MIN	0.50000	-998.33540	-209.03742	0.00000
7	ENVULT MIN	0.75000	-998.33540	-221.38542	0.00000
7	ENVULT MIN	1.00000	-998.33540	-233.73342	0.00000
8	ENVULT MAX	0.00000	0.00000	233.63464	3838.99700
8	ENVULT MAX	0.25000	0.00000	221.28664	3782.74200
8	ENVULT MAX	0.50000	0.00000	208.93864	3729.66300
8	ENVULT MAX	0.75000	0.00000	196.59064	3679.76100
8	ENVULT MAX	1.00000	0.00000	184.24264	3633.03500
8	ENVULT MIN	0.00000	-998.33548	0.00000	0.00000
8	ENVULT MIN	0.25000	-998.33548	0.00000	0.00000
8	ENVULT MIN	0.50000	-998.33548	0.00000	0.00000
8	ENVULT MIN	0.75000	-998.33548	0.00000	0.00000
8	ENVULT MIN	1.00000	-998.33548	0.00000	0.00000
9	ENVULT MAX	0.00000	0.00000	646.08966	3633.03500
9	ENVULT MAX	0.25000	0.00000	633.74166	3472.16900
9	ENVULT MAX	0.50000	0.00000	621.39366	3314.48000
9	ENVULT MAX	0.75000	0.00000	609.04566	3159.96800
9	ENVULT MAX	1.00000	0.00000	596.69766	3008.63200
9	ENVULT MIN	0.00000	-998.33548	0.00000	0.00000
9	ENVULT MIN	0.25000	-998.33548	0.00000	0.00000
9	ENVULT MIN	0.50000	-998.33548	0.00000	0.00000
9	ENVULT MIN	0.75000	-998.33548	0.00000	0.00000
9	ENVULT MIN	1.00000	-998.33548	0.00000	0.00000
10	ENVULT MAX	0.00000	0.00000	1078.36100	3008.63200
10	ENVULT MAX	0.25000	0.00000	1066.01300	2738.51000
10	ENVULT MAX	0.50000	0.00000	1053.66500	2471.56500
10	ENVULT MAX	0.75000	0.00000	1041.31700	2207.79600
10	ENVULT MAX	1.00000	0.00000	1028.96900	1947.20400
10	ENVULT MIN	0.00000	-998.33548	0.00000	0.00000
10	ENVULT MIN	0.25000	-998.33548	0.00000	0.00000
10	ENVULT MIN	0.50000	-998.33548	0.00000	0.00000
10	ENVULT MIN	0.75000	-998.33548	0.00000	0.00000
10	ENVULT MIN	1.00000	-998.33548	0.00000	0.00000
11	ENVULT MAX	0.00000	0.00000	1535.29400	1947.20400
11	ENVULT MAX	0.25000	0.00000	1522.93400	1560.25700
11	ENVULT MAX	0.50000	0.00000	1510.57400	1176.49300
11	ENVULT MAX	0.75000	0.00000	1498.21400	804.03370
11	ENVULT MAX	1.00000	0.00000	1485.85400	456.93364
11	ENVULT MIN	0.00000	-998.33548	0.00000	0.00000
11	ENVULT MIN	0.25000	-998.33548	0.00000	0.00000
11	ENVULT MIN	0.50000	-998.33548	0.00000	0.00000
11	ENVULT MIN	0.75000	-998.33548	0.00000	0.00000
11	ENVULT MIN	1.00000	-998.33548	0.00000	-211.59858
12	ENVULT MAX	0.00000	0.00000	2022.07400	456.93364
12	ENVULT MAX	0.25000	0.00000	2009.72600	0.00000
12	ENVULT MAX	0.50000	0.00000	1997.37800	0.00000
12	ENVULT MAX	0.75000	0.00000	1985.03000	0.00000
12	ENVULT MAX	1.00000	0.00000	1972.68200	0.00000
12	ENVULT MIN	0.00000	-998.33548	0.00000	-211.59858
12	ENVULT MIN	0.25000	-998.33548	0.00000	-624.06469
12	ENVULT MIN	0.50000	-998.33548	0.00000	-1135.08000
12	ENVULT MIN	0.75000	-998.33548	0.00000	-1642.91900
12	ENVULT MIN	1.00000	-998.33548	0.00000	-2147.58100
13	ENVULT MAX	0.00000	0.00000	2539.16000	0.00000
13	ENVULT MAX	0.25000	0.00000	2537.01200	0.00000
13	ENVULT MAX	0.50000	0.00000	2534.86400	0.00000
13	ENVULT MAX	0.75000	0.00000	2532.71600	0.00000
13	ENVULT MAX	1.00000	0.00000	2530.56800	0.00000
13	ENVULT MIN	0.00000	-998.33548	0.00000	-2147.58100
13	ENVULT MIN	0.25000	-998.33548	0.00000	-2260.16500
13	ENVULT MIN	0.50000	-998.33548	0.00000	-2372.65200
13	ENVULT MIN	0.75000	-998.33548	0.00000	-2485.04300
13	ENVULT MIN	1.00000	-998.33548	0.00000	-2597.33900
14	ENVULT MAX	0.00000	0.00000	2530.56800	0.00000
14	ENVULT MAX	0.11765	0.00000	2525.76800	0.00000
14	ENVULT MAX	0.23529	0.00000	2520.96800	0.00000
14	ENVULT MAX	0.35294	0.00000	2516.16800	0.00000
14	ENVULT MAX	0.47059	0.00000	2511.36800	0.00000
14	ENVULT MIN	0.00000	-998.33548	0.00000	-2597.33900
14	ENVULT MIN	0.11765	-998.33548	0.00000	-2847.93000
14	ENVULT MIN	0.23529	-998.33548	0.00000	-3098.04200
14	ENVULT MIN	0.35294	-998.33548	0.00000	-3347.67300
14	ENVULT MIN	0.47059	-998.33548	0.00000	-3596.82500
15	ENVULT MAX	0.46875	0.00000	0.00000	0.00000
15	ENVULT MAX	0.60156	0.00000	0.00000	0.00000
15	ENVULT MAX	0.73438	0.00000	0.00000	0.00000
15	ENVULT MAX	0.86719	0.00000	0.00000	0.00000
15	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
15	ENVULT MIN	0.46875	-3252.88100	-877.19563	-4366.85700
15	ENVULT MIN	0.60156	-3247.46200	-843.26129	-4299.61200
15	ENVULT MIN	0.73438	-3242.04400	-809.49853	-4257.50700
15	ENVULT MIN	0.86719	-3236.62500	-775.90737	-4217.19100
15	ENVULT MIN	1.00000	-3231.20600	-742.48780	-4178.65500
16	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
16	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
16	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
16	ENVULT MIN	0.00000	-3231.20600	-742.48780	-4178.65500
16	ENVULT MIN	0.25000	-3226.90900	-716.10999	-4149.35800
16	ENVULT MIN	0.50000	-3222.61300	-689.83998	-4121.17000
16	ENVULT MIN	0.75000	-3218.31600	-663.67778	-4094.08600
16	ENVULT MIN	1.00000	-3214.01900	-637.62338	-4068.10100
17	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
17	ENVULT MAX	0.75000	0.00000	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVULT MAX	1.00000	0.00000	6.99385	0.00000
17	ENVULT MIN	0.00000	-3214.01900	-637.62338	-4068.10100
17	ENVULT MIN	0.25000	-3199.53500	-550.59107	-3988.55300
17	ENVULT MIN	0.50000	-3185.05100	-464.78530	-3921.27600
17	ENVULT MIN	0.75000	-3170.56700	-380.20606	-3866.09600
17	ENVULT MIN	1.00000	-3156.08300	-296.85337	-3822.84000
18	ENVULT MAX	0.00000	0.00000	7.32316	0.00000
18	ENVULT MAX	0.25000	0.00000	47.28532	0.00000
18	ENVULT MAX	0.50000	0.00000	86.63357	0.00000
18	ENVULT MAX	0.75000	0.00000	125.36789	0.00000
18	ENVULT MAX	1.00000	0.00000	176.66490	0.00000
18	ENVULT MIN	0.00000	-3156.08300	-296.85337	-3822.84000
18	ENVULT MIN	0.25000	-3141.58600	-214.65504	-3791.31000
18	ENVULT MIN	0.50000	-3127.09000	-157.66919	-3771.37500
18	ENVULT MIN	0.75000	-3112.59300	-112.36014	-3762.86100
18	ENVULT MIN	1.00000	-3098.09600	-67.69724	-3765.59300
19	ENVULT MAX	0.00000	0.00000	176.23590	0.00000
19	ENVULT MAX	0.25000	0.00000	251.24885	0.00000
19	ENVULT MAX	0.50000	0.00000	325.03396	0.00000
19	ENVULT MAX	0.75000	0.00000	397.59121	0.00000
19	ENVULT MAX	1.00000	0.00000	468.92063	0.00000
19	ENVULT MIN	0.00000	-3098.09600	-67.69726	-3765.59300
19	ENVULT MIN	0.25000	-3083.59900	-45.47114	-3805.80600
19	ENVULT MIN	0.50000	-3069.10300	-23.78585	-3858.33200
19	ENVULT MIN	0.75000	-3054.60600	-2.42364	-3921.58000
19	ENVULT MIN	1.00000	-3040.10900	0.00000	-3995.37700
20	ENVULT MAX	0.00000	0.00000	468.68837	0.00000
20	ENVULT MAX	0.25000	0.00000	528.75409	0.00000
20	ENVULT MAX	0.50000	0.00000	587.92017	0.00000
20	ENVULT MAX	0.75000	0.00000	646.18663	0.00000
20	ENVULT MAX	1.00000	0.00000	703.55344	0.00000
20	ENVULT MIN	0.00000	-3040.10900	0.00000	-3995.37700
20	ENVULT MIN	0.25000	-3027.70300	0.00000	-4066.77300
20	ENVULT MIN	0.50000	-3015.29800	0.00000	-4145.65600
20	ENVULT MIN	0.75000	-3002.89200	0.00000	-4231.91700
20	ENVULT MIN	1.00000	-2990.48600	0.00000	-4325.44700
21	ENVULT MAX	0.00000	0.00000	703.45984	0.00000
21	ENVULT MAX	0.25000	0.00000	712.98211	0.00000
21	ENVULT MAX	0.50000	0.00000	722.47910	0.00000
21	ENVULT MAX	0.75000	0.00000	731.95081	0.00000
21	ENVULT MAX	1.00000	0.00000	741.39724	0.00000
21	ENVULT MIN	0.00000	-2990.48600	0.00000	-4325.44700
21	ENVULT MIN	0.25000	-2988.38300	0.00000	-4341.81900
21	ENVULT MIN	0.50000	-2986.23000	0.00000	-4358.39100
21	ENVULT MIN	0.75000	-2984.02700	0.00000	-4375.16300
21	ENVULT MIN	1.00000	-2981.77400	0.00000	-4392.13400
22	ENVULT MAX	0.00000	0.00000	741.35086	0.00000
22	ENVULT MAX	0.25000	0.00000	760.80117	0.00000
22	ENVULT MAX	0.50000	0.00000	780.14367	0.00000
22	ENVULT MAX	0.75000	0.00000	799.37837	0.00000
22	ENVULT MAX	1.00000	0.00000	818.50526	0.00000
22	ENVULT MIN	0.00000	-2981.77400	0.00000	-4392.13400
22	ENVULT MIN	0.25000	-2976.95800	0.00000	-4427.85100
22	ENVULT MIN	0.50000	-2971.92900	0.00000	-4464.41500
22	ENVULT MIN	0.75000	-2966.68800	0.00000	-4501.81900
22	ENVULT MIN	1.00000	-2961.23400	0.00000	-4540.05900
23	ENVULT MAX	0.00000	0.00000	818.36428	0.00000
23	ENVULT MAX	0.10937	0.00000	838.11483	0.00000
23	ENVULT MAX	0.21875	0.00000	857.74901	0.00000
23	ENVULT MAX	0.32812	0.00000	877.26681	0.00000
23	ENVULT MAX	0.43750	0.00000	896.66824	0.00000
23	ENVULT MIN	0.00000	-2961.23400	0.00000	-4540.05900
23	ENVULT MIN	0.10937	-2955.45900	0.00000	-4580.65500
23	ENVULT MIN	0.21875	-2949.68400	0.00000	-4622.14300
23	ENVULT MIN	0.32812	-2943.90900	0.00000	-4664.51900
23	ENVULT MIN	0.43750	-2938.13400	0.00000	-4707.83600
24	ENVULT MAX	0.64706	0.00000	0.00000	0.00000
24	ENVULT MAX	0.73529	0.00000	0.00000	0.00000
24	ENVULT MAX	0.82353	0.00000	0.00000	0.00000
24	ENVULT MAX	0.91176	0.00000	0.00000	0.00000
24	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
24	ENVULT MIN	0.64706	-994.02943	-2642.60200	-3602.21800
24	ENVULT MIN	0.73529	-994.02943	-2606.35300	-3405.38200
24	ENVULT MIN	0.82353	-994.02943	-2570.10300	-3211.26500
24	ENVULT MIN	0.91176	-994.02943	-2533.85300	-3019.86700
24	ENVULT MIN	1.00000	-994.02943	-2497.60400	-2831.18700
25	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
25	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
25	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
25	ENVULT MIN	0.00000	-993.75457	-2497.60400	-2831.18700
25	ENVULT MIN	0.25000	-993.75457	-2476.00500	-2719.90300
25	ENVULT MIN	0.50000	-993.75457	-2454.46600	-2609.58400
25	ENVULT MIN	0.75000	-993.75457	-2432.98700	-2500.58500
25	ENVULT MIN	1.00000	-993.75457	-2411.56900	-2394.57500
26	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
26	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
26	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
26	ENVULT MIN	0.00000	-993.63995	-2411.56900	-2394.57500
26	ENVULT MIN	0.25000	-993.63995	-2373.30900	-2206.78500
26	ENVULT MIN	0.50000	-993.63995	-2335.24300	-2021.95300
26	ENVULT MIN	0.75000	-993.63995	-2297.37000	-1840.06600
26	ENVULT MIN	1.00000	-993.63995	-2259.69000	-1661.10700
27	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
27	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
27	ENVULT MAX	0.50000	0.00000	0.00000	24.96008
27	ENVULT MAX	0.75000	0.00000	0.00000	240.04973
27	ENVULT MAX	1.00000	0.00000	0.00000	451.00883
27	ENVULT MIN	0.00000	-993.45097	-2259.69000	-1661.10700
27	ENVULT MIN	0.25000	-993.45097	-2176.79600	-1276.69800
27	ENVULT MIN	0.50000	-993.45097	-2093.90100	-919.51518
27	ENVULT MIN	0.75000	-993.45097	-2011.00700	-577.95047
27	ENVULT MIN	1.00000	-993.45097	-1928.11300	-257.50284
28	ENVULT MAX	0.00000	0.00000	0.00000	451.00884
28	ENVULT MAX	0.25000	0.00000	0.00000	872.15225
28	ENVULT MAX	0.50000	0.00000	0.00000	1315.38800
28	ENVULT MAX	0.75000	0.00000	0.00000	1727.57000
28	ENVULT MAX	1.00000	0.00000	0.00000	2108.69900
28	ENVULT MIN	0.00000	-993.19582	-1928.11300	-257.50284
28	ENVULT MIN	0.25000	-993.19582	-1807.51800	0.00000
28	ENVULT MIN	0.50000	-993.19582	-1686.92300	0.00000
28	ENVULT MIN	0.75000	-993.19582	-1566.32800	0.00000
28	ENVULT MIN	1.00000	-993.19582	-1445.73300	0.00000
29	ENVULT MAX	0.00000	0.00000	0.00000	2108.69900
29	ENVULT MAX	0.25000	0.00000	0.00000	2458.45000
29	ENVULT MAX	0.50000	0.00000	0.00000	2777.20800
29	ENVULT MAX	0.75000	0.00000	0.00000	3071.26800
29	ENVULT MAX	1.00000	0.00000	0.00000	3334.70800
29	ENVULT MIN	0.00000	-992.97857	-1445.73300	0.00000
29	ENVULT MIN	0.25000	-992.97857	-1325.25500	0.00000
29	ENVULT MIN	0.50000	-992.97857	-1204.77800	0.00000
29	ENVULT MIN	0.75000	-992.97857	-1084.30000	0.00000
29	ENVULT MIN	1.00000	-992.97857	-963.82200	0.00000
30	ENVULT MAX	0.00000	0.00000	0.00000	3334.70800
30	ENVULT MAX	0.25000	0.00000	0.00000	3567.15400
30	ENVULT MAX	0.50000	0.00000	0.00000	3768.60800
30	ENVULT MAX	0.75000	0.00000	0.00000	3939.06900
30	ENVULT MAX	1.00000	0.00000	0.00000	4078.53700
30	ENVULT MIN	0.00000	-992.83766	-963.82200	0.00000
30	ENVULT MIN	0.25000	-992.83766	-843.87570	0.00000
30	ENVULT MIN	0.50000	-992.83766	-727.51391	0.00000
30	ENVULT MIN	0.75000	-992.83766	-611.15212	0.00000
30	ENVULT MIN	1.00000	-992.83766	-494.79033	0.00000
31	ENVULT MAX	0.00000	0.00000	0.00000	4078.53700
31	ENVULT MAX	0.25000	0.00000	0.00000	4187.01200
31	ENVULT MAX	0.50000	0.00000	0.00000	4264.49400
31	ENVULT MAX	0.75000	0.00000	0.00000	4310.98400
31	ENVULT MAX	1.00000	0.00000	36.21632	4326.48000
31	ENVULT MIN	0.00000	-992.76830	-494.79033	0.00000
31	ENVULT MIN	0.25000	-992.76830	-378.42854	0.00000
31	ENVULT MIN	0.50000	-992.76830	-262.06675	0.00000
31	ENVULT MIN	0.75000	-992.76830	-145.70496	0.00000
31	ENVULT MIN	1.00000	-992.76830	-29.34330	0.00000
32	ENVULT MAX	0.00000	0.00000	29.34384	4326.48000
32	ENVULT MAX	0.25000	0.00000	145.70563	4310.98300
32	ENVULT MAX	0.50000	0.00000	262.06742	4264.49400
32	ENVULT MAX	0.75000	0.00000	378.42921	4187.01200
32	ENVULT MAX	1.00000	0.00000	494.79100	4078.53600
32	ENVULT MIN	0.00000	-992.76838	-36.21492	0.00000
32	ENVULT MIN	0.25000	-992.76838	0.00000	0.00000
32	ENVULT MIN	0.50000	-992.76838	0.00000	0.00000
32	ENVULT MIN	0.75000	-992.76838	0.00000	0.00000
32	ENVULT MIN	1.00000	-992.76838	0.00000	0.00000
33	ENVULT MAX	0.00000	0.00000	494.79100	4078.53600
33	ENVULT MAX	0.25000	0.00000	611.15279	3939.06800
33	ENVULT MAX	0.50000	0.00000	727.51458	3768.60700
33	ENVULT MAX	0.75000	0.00000	843.87637	3567.15300
33	ENVULT MAX	1.00000	0.00000	963.82270	3334.70600
33	ENVULT MIN	0.00000	-992.83790	0.00000	0.00000
33	ENVULT MIN	0.25000	-992.83790	0.00000	0.00000
33	ENVULT MIN	0.50000	-992.83790	0.00000	0.00000
33	ENVULT MIN	0.75000	-992.83790	0.00000	0.00000
33	ENVULT MIN	1.00000	-992.83790	0.00000	0.00000
34	ENVULT MAX	0.00000	0.00000	963.82270	3334.70600
34	ENVULT MAX	0.25000	0.00000	1084.41800	3070.99500
34	ENVULT MAX	0.50000	0.00000	1205.01200	2776.61700
34	ENVULT MAX	0.75000	0.00000	1325.60700	2457.47300
34	ENVULT MAX	1.00000	0.00000	1446.20200	2107.27700
34	ENVULT MIN	0.00000	-992.97904	0.00000	0.00000
34	ENVULT MIN	0.25000	-992.97904	0.00000	0.00000
34	ENVULT MIN	0.50000	-992.97904	0.00000	0.00000
34	ENVULT MIN	0.75000	-992.97904	0.00000	0.00000
34	ENVULT MIN	1.00000	-992.97904	0.00000	0.00000
35	ENVULT MAX	0.00000	0.00000	1446.20200	2107.27700
35	ENVULT MAX	0.25000	0.00000	1566.68000	1726.41200

FRAME	LOAD	DIST	P	V2	M3
35	ENVULT MAX	0.50000	0.00000	1687.15800	1314.55500
35	ENVULT MAX	0.75000	0.00000	1807.63600	871.70415
35	ENVULT MAX	1.00000	0.00000	1928.11300	451.00708
35	ENVULT MIN	0.00000	-993.19652	0.00000	0.00000
35	ENVULT MIN	0.25000	-993.19652	0.00000	0.00000
35	ENVULT MIN	0.50000	-993.19652	0.00000	0.00000
35	ENVULT MIN	0.75000	-993.19652	0.00000	0.00000
35	ENVULT MIN	1.00000	-993.19652	0.00000	-257.50891
36	ENVULT MAX	0.00000	0.00000	1928.11300	451.00707
36	ENVULT MAX	0.25000	0.00000	2011.00800	240.04553
36	ENVULT MAX	0.50000	0.00000	2093.90200	24.95568
36	ENVULT MAX	0.75000	0.00000	2176.79600	0.00000
36	ENVULT MAX	1.00000	0.00000	2259.69100	0.00000
36	ENVULT MIN	0.00000	-993.45166	0.00000	-257.50891
36	ENVULT MIN	0.25000	-993.45166	0.00000	-577.95338
36	ENVULT MIN	0.50000	-993.45166	0.00000	-919.51821
36	ENVULT MIN	0.75000	-993.45166	0.00000	-1276.70200
36	ENVULT MIN	1.00000	-993.45166	0.00000	-1661.11100
37	ENVULT MAX	0.00000	0.00000	2259.69100	0.00000
37	ENVULT MAX	0.25000	0.00000	2297.37100	0.00000
37	ENVULT MAX	0.50000	0.00000	2335.24400	0.00000
37	ENVULT MAX	0.75000	0.00000	2373.31000	0.00000
37	ENVULT MAX	1.00000	0.00000	2411.56900	0.00000
37	ENVULT MIN	0.00000	-993.64070	0.00000	-1661.11100
37	ENVULT MIN	0.25000	-993.64070	0.00000	-1840.06900
37	ENVULT MIN	0.50000	-993.64070	0.00000	-2021.95700
37	ENVULT MIN	0.75000	-993.64070	0.00000	-2206.78800
37	ENVULT MIN	1.00000	-993.64070	0.00000	-2394.57900
38	ENVULT MAX	0.00000	0.00000	2411.56900	0.00000
38	ENVULT MAX	0.25000	0.00000	2432.98800	0.00000
38	ENVULT MAX	0.50000	0.00000	2454.46600	0.00000
38	ENVULT MAX	0.75000	0.00000	2476.00500	0.00000
38	ENVULT MAX	1.00000	0.00000	2497.60400	0.00000
38	ENVULT MIN	0.00000	-993.75538	0.00000	-2394.57900
38	ENVULT MIN	0.25000	-993.75538	0.00000	-2500.58800
38	ENVULT MIN	0.50000	-993.75538	0.00000	-2609.58800
38	ENVULT MIN	0.75000	-993.75538	0.00000	-2719.90700
38	ENVULT MIN	1.00000	-993.75538	0.00000	-2831.19100
39	ENVULT MAX	0.00000	0.00000	2497.60400	0.00000
39	ENVULT MAX	0.08824	0.00000	2533.85400	0.00000
39	ENVULT MAX	0.17647	0.00000	2570.10400	0.00000
39	ENVULT MAX	0.26471	0.00000	2606.35300	0.00000
39	ENVULT MAX	0.35294	0.00000	2642.60300	0.00000
39	ENVULT MIN	0.00000	-994.03034	0.00000	-2831.19100
39	ENVULT MIN	0.08824	-994.03034	0.00000	-3019.87100
39	ENVULT MIN	0.17647	-994.03034	0.00000	-3211.26900
39	ENVULT MIN	0.26471	-994.03034	0.00000	-3405.38600
39	ENVULT MIN	0.35294	-994.03034	0.00000	-3602.22200
40	ENVULT MAX	0.56250	0.00000	0.00000	0.00000
40	ENVULT MAX	0.67188	0.00000	0.00000	0.00000
40	ENVULT MAX	0.78125	0.00000	0.00000	0.00000
40	ENVULT MAX	0.89063	0.00000	0.00000	0.00000
40	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
40	ENVULT MIN	0.56250	-2938.13400	-896.66933	-4707.84100
40	ENVULT MIN	0.67188	-2943.90900	-877.26790	-4664.52300
40	ENVULT MIN	0.78125	-2949.68400	-857.75010	-4622.14800
40	ENVULT MIN	0.89063	-2955.45900	-838.11592	-4580.66000
40	ENVULT MIN	1.00000	-2961.23400	-818.36537	-4540.06400
41	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
41	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
41	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
41	ENVULT MIN	0.00000	-2961.23400	-818.50645	-4540.06400
41	ENVULT MIN	0.25000	-2966.68900	-799.37956	-4501.82300
41	ENVULT MIN	0.50000	-2971.93000	-780.14486	-4464.41900
41	ENVULT MIN	0.75000	-2976.95900	-760.80236	-4427.85600
41	ENVULT MIN	1.00000	-2981.77500	-741.35205	-4392.13800
42	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
42	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
42	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
42	ENVULT MIN	0.00000	-2981.77500	-741.39846	-4392.13800
42	ENVULT MIN	0.25000	-2984.02700	-731.95203	-4375.16700
42	ENVULT MIN	0.50000	-2986.23100	-722.48032	-4358.39500
42	ENVULT MIN	0.75000	-2988.38400	-712.98333	-4341.82300
42	ENVULT MIN	1.00000	-2990.48700	-703.46106	-4325.45200
43	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.25000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.50000	0.00000	0.00000	0.00000
43	ENVULT MAX	0.75000	0.00000	0.00000	0.00000
43	ENVULT MAX	1.00000	0.00000	0.00000	0.00000
43	ENVULT MIN	0.00000	-2990.48700	-703.55474	-4325.45200
43	ENVULT MIN	0.25000	-3002.89300	-646.18793	-4231.92200
43	ENVULT MIN	0.50000	-3015.29800	-587.92148	-4145.66100
43	ENVULT MIN	0.75000	-3027.70400	-528.75539	-4066.77700
43	ENVULT MIN	1.00000	-3040.11000	-468.68967	-3995.38100
44	ENVULT MAX	0.00000	0.00000	0.00000	0.00000
44	ENVULT MAX	0.25000	0.00000	2.42352	0.00000
44	ENVULT MAX	0.50000	0.00000	23.78573	0.00000
44	ENVULT MAX	0.75000	0.00000	45.47102	0.00000
44	ENVULT MAX	1.00000	0.00000	67.69718	0.00000
44	ENVULT MIN	0.00000	-3040.11000	-468.92204	-3995.38100
44	ENVULT MIN	0.25000	-3054.60700	-397.59263	-3921.58500
44	ENVULT MIN	0.50000	-3069.10300	-325.03537	-3858.33700
44	ENVULT MIN	0.75000	-3083.60000	-251.25027	-3805.81100
44	ENVULT MIN	1.00000	-3098.09700	-176.23732	-3765.59700
45	ENVULT MAX	0.00000	0.00000	67.69716	0.00000
45	ENVULT MAX	0.25000	0.00000	112.36006	0.00000
45	ENVULT MAX	0.50000	0.00000	157.66911	0.00000
45	ENVULT MAX	0.75000	0.00000	214.65496	0.00000
45	ENVULT MAX	1.00000	0.00000	296.85329	0.00000
45	ENVULT MIN	0.00000	-3098.09700	-176.66641	-3765.59700
45	ENVULT MIN	0.25000	-3112.59400	-125.36939	-3762.86500
45	ENVULT MIN	0.50000	-3127.09000	-86.63507	-3771.37900
45	ENVULT MIN	0.75000	-3141.58700	-47.28683	-3791.31400
45	ENVULT MIN	1.00000	-3156.08400	-7.32466	-3822.84400
46	ENVULT MAX	0.00000	0.00000	296.85329	0.00000
46	ENVULT MAX	0.25000	0.00000	380.20598	0.00000
46	ENVULT MAX	0.50000	0.00000	464.78522	0.00000
46	ENVULT MAX	0.75000	0.00000	550.59099	0.00000
46	ENVULT MAX	1.00000	0.00000	637.62330	0.00000
46	ENVULT MIN	0.00000	-3156.08400	-6.99542	-3822.84400
46	ENVULT MIN	0.25000	-3170.56800	0.00000	-3866.10100
46	ENVULT MIN	0.50000	-3185.05200	0.00000	-3921.28000
46	ENVULT MIN	0.75000	-3199.53600	0.00000	-3988.55700
46	ENVULT MIN	1.00000	-3214.02000	0.00000	-4068.10600
47	ENVULT MAX	0.00000	0.00000	637.62330	0.00000
47	ENVULT MAX	0.25000	0.00000	663.67770	0.00000
47	ENVULT MAX	0.50000	0.00000	689.83990	0.00000
47	ENVULT MAX	0.75000	0.00000	716.10991	0.00000
47	ENVULT MAX	1.00000	0.00000	742.48772	0.00000
47	ENVULT MIN	0.00000	-3214.02000	0.00000	-4068.10600
47	ENVULT MIN	0.25000	-3218.31700	0.00000	-4094.09000
47	ENVULT MIN	0.50000	-3222.61300	0.00000	-4121.17400
47	ENVULT MIN	0.75000	-3226.91000	0.00000	-4149.36200
47	ENVULT MIN	1.00000	-3231.20700	0.00000	-4178.66000
48	ENVULT MAX	0.00000	0.00000	742.48772	0.00000
48	ENVULT MAX	0.13281	0.00000	775.90729	0.00000
48	ENVULT MAX	0.26563	0.00000	809.49845	0.00000
48	ENVULT MAX	0.39844	0.00000	843.26121	0.00000
48	ENVULT MAX	0.53125	0.00000	877.19555	0.00000
48	ENVULT MIN	0.00000	-3231.20700	0.00000	-4178.66000
48	ENVULT MIN	0.13281	-3236.62600	0.00000	-4217.19500
48	ENVULT MIN	0.26563	-3242.04400	0.00000	-4257.51100
48	ENVULT MIN	0.39844	-3247.46300	0.00000	-4299.61600
48	ENVULT MIN	0.53125	-3252.88200	0.00000	-4366.86100

2) 사용하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVUSE MAX	0.52941	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.64706	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.76471	0.00000	0.00000	0.00000
1	ENVUSE MAX	0.88235	0.00000	0.00000	0.00000
1	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
1	ENVUSE MIN	0.52941	-660.66196	-1674.41400	-2460.27800
1	ENVUSE MIN	0.64706	-660.66196	-1678.41400	-2294.02800
1	ENVUSE MIN	0.76471	-660.66196	-1682.41400	-2127.37700
1	ENVUSE MIN	0.88235	-660.66196	-1686.41400	-1960.32600
1	ENVUSE MIN	1.00000	-660.66196	-1690.41400	-1792.87600
2	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
2	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
2	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
2	ENVUSE MIN	0.00000	-660.66196	-1690.41400	-1792.87600
2	ENVUSE MIN	0.25000	-660.66196	-1692.20400	-1717.81200
2	ENVUSE MIN	0.50000	-660.66196	-1693.99400	-1642.66900
2	ENVUSE MIN	0.75000	-660.66196	-1695.78400	-1567.44500
2	ENVUSE MIN	1.00000	-660.66196	-1697.57400	-1492.14100
3	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
3	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
3	ENVUSE MAX	1.00000	0.00000	0.00000	315.95190
3	ENVUSE MIN	0.00000	-660.66196	-1312.89300	-1492.14100
3	ENVUSE MIN	0.25000	-660.66196	-1323.18300	-1155.82500
3	ENVUSE MIN	0.50000	-660.66196	-1333.47300	-816.86140
3	ENVUSE MIN	0.75000	-660.66196	-1343.76300	-475.25108
3	ENVUSE MIN	1.00000	-660.66196	-1354.05300	-195.62733
4	ENVUSE MAX	0.00000	0.00000	0.00000	315.95190
4	ENVUSE MAX	0.25000	0.00000	0.00000	558.35264
4	ENVUSE MAX	0.50000	0.00000	0.00000	803.40047
4	ENVUSE MAX	0.75000	0.00000	0.00000	1051.09500
4	ENVUSE MAX	1.00000	0.00000	0.00000	1301.43700
4	ENVUSE MIN	0.00000	-660.66196	-988.74645	-195.62732
4	ENVUSE MIN	0.25000	-660.66196	-999.03645	-29.72292
4	ENVUSE MIN	0.50000	-660.66196	-1009.32600	0.00000
4	ENVUSE MIN	0.75000	-660.66196	-1019.61600	0.00000
4	ENVUSE MIN	1.00000	-660.66196	-1029.90600	0.00000
5	ENVUSE MAX	0.00000	0.00000	0.00000	1301.43700
5	ENVUSE MAX	0.25000	0.00000	0.00000	1468.77000
5	ENVUSE MAX	0.50000	0.00000	0.00000	1638.75400
5	ENVUSE MAX	0.75000	0.00000	0.00000	1811.39100
5	ENVUSE MAX	1.00000	0.00000	0.00000	1989.47400
5	ENVUSE MIN	0.00000	-660.66196	-683.90207	0.00000
5	ENVUSE MIN	0.25000	-660.66196	-694.20207	0.00000
5	ENVUSE MIN	0.50000	-660.66196	-704.50207	0.00000
5	ENVUSE MIN	0.75000	-660.66196	-714.80207	0.00000
5	ENVUSE MIN	1.00000	-660.66196	-725.10207	0.00000
6	ENVUSE MAX	0.00000	0.00000	0.00000	1989.47400
6	ENVUSE MAX	0.25000	0.00000	0.00000	2089.60700
6	ENVUSE MAX	0.50000	0.00000	0.00000	2192.38800
6	ENVUSE MAX	0.75000	0.00000	0.00000	2297.81600
6	ENVUSE MAX	1.00000	0.00000	0.00000	2405.89000
6	ENVUSE MIN	0.00000	-660.66196	-395.12751	0.00000
6	ENVUSE MIN	0.25000	-660.66196	-405.41751	0.00000
6	ENVUSE MIN	0.50000	-660.66196	-415.70751	0.00000
6	ENVUSE MIN	0.75000	-660.66196	-425.99751	0.00000
6	ENVUSE MIN	1.00000	-660.66196	-436.28751	0.00000
7	ENVUSE MAX	0.00000	0.00000	0.00000	2405.89000
7	ENVUSE MAX	0.25000	0.00000	0.00000	2436.27300
7	ENVUSE MAX	0.50000	0.00000	0.00000	2469.30300
7	ENVUSE MAX	0.75000	0.00000	0.00000	2504.98000
7	ENVUSE MAX	1.00000	0.00000	0.00000	2543.30400
7	ENVUSE MIN	0.00000	-660.66196	-119.11298	0.00000
7	ENVUSE MIN	0.25000	-660.66196	-129.40298	0.00000
7	ENVUSE MIN	0.50000	-660.66196	-139.69298	0.00000
7	ENVUSE MIN	0.75000	-660.66196	-149.98298	0.00000
7	ENVUSE MIN	1.00000	-660.66196	-160.27298	0.00000
8	ENVUSE MAX	0.00000	0.00000	160.20513	2543.30400
8	ENVUSE MAX	0.25000	0.00000	149.91513	2504.99700
8	ENVUSE MAX	0.50000	0.00000	139.62513	2469.33700
8	ENVUSE MAX	0.75000	0.00000	129.33513	2436.32500
8	ENVUSE MAX	1.00000	0.00000	119.04513	2405.96000
8	ENVUSE MIN	0.00000	-660.66201	0.00000	0.00000
8	ENVUSE MIN	0.25000	-660.66201	0.00000	0.00000
8	ENVUSE MIN	0.50000	-660.66201	0.00000	0.00000
8	ENVUSE MIN	0.75000	-660.66201	0.00000	0.00000
8	ENVUSE MIN	1.00000	-660.66201	0.00000	0.00000
9	ENVUSE MAX	0.00000	0.00000	436.22208	2405.96000
9	ENVUSE MAX	0.25000	0.00000	425.93208	2297.90100
9	ENVUSE MAX	0.50000	0.00000	415.64208	2192.49000
9	ENVUSE MAX	0.75000	0.00000	405.35208	2089.72600
9	ENVUSE MAX	1.00000	0.00000	395.06208	1989.60800
9	ENVUSE MIN	0.00000	-660.66201	0.00000	0.00000
9	ENVUSE MIN	0.25000	-660.66201	0.00000	0.00000
9	ENVUSE MIN	0.50000	-660.66201	0.00000	0.00000
9	ENVUSE MIN	0.75000	-660.66201	0.00000	0.00000
9	ENVUSE MIN	1.00000	-660.66201	0.00000	0.00000
10	ENVUSE MAX	0.00000	0.00000	725.04342	1989.60800
10	ENVUSE MAX	0.25000	0.00000	714.75342	1811.70500
10	ENVUSE MAX	0.50000	0.00000	704.46342	1639.24600
10	ENVUSE MAX	0.75000	0.00000	694.17342	1469.43400
10	ENVUSE MAX	1.00000	0.00000	683.88342	1302.27000
10	ENVUSE MIN	0.00000	-660.66201	0.00000	0.00000
10	ENVUSE MIN	0.25000	-660.66201	0.00000	0.00000
10	ENVUSE MIN	0.50000	-660.66201	0.00000	0.00000
10	ENVUSE MIN	0.75000	-660.66201	0.00000	0.00000
10	ENVUSE MIN	1.00000	-660.66201	0.00000	0.00000
11	ENVUSE MAX	0.00000	0.00000	1029.88100	1302.27000
11	ENVUSE MAX	0.25000	0.00000	1019.58100	1051.69200
11	ENVUSE MAX	0.50000	0.00000	1009.28100	803.76678
11	ENVUSE MAX	0.75000	0.00000	998.98122	558.49360
11	ENVUSE MAX	1.00000	0.00000	988.68122	315.87267
11	ENVUSE MIN	0.00000	-660.66201	0.00000	0.00000
11	ENVUSE MIN	0.25000	-660.66201	0.00000	0.00000
11	ENVUSE MIN	0.50000	-660.66201	0.00000	0.00000
11	ENVUSE MIN	0.75000	-660.66201	0.00000	-29.62888
11	ENVUSE MIN	1.00000	-660.66201	0.00000	-195.68441
12	ENVUSE MAX	0.00000	0.00000	1354.00300	315.87267
12	ENVUSE MAX	0.25000	0.00000	1343.71300	0.00000
12	ENVUSE MAX	0.50000	0.00000	1333.42300	0.00000
12	ENVUSE MAX	0.75000	0.00000	1323.13300	0.00000
12	ENVUSE MAX	1.00000	0.00000	1312.84300	0.00000
12	ENVUSE MIN	0.00000	-660.66201	0.00000	-195.68442
12	ENVUSE MIN	0.25000	-660.66201	0.00000	-475.31830
12	ENVUSE MIN	0.50000	-660.66201	0.00000	-816.91592
12	ENVUSE MIN	0.75000	-660.66201	0.00000	-1155.86600
12	ENVUSE MIN	1.00000	-660.66201	0.00000	-1492.17000
13	ENVUSE MAX	0.00000	0.00000	1697.54300	0.00000
13	ENVUSE MAX	0.25000	0.00000	1695.75300	0.00000
13	ENVUSE MAX	0.50000	0.00000	1693.96300	0.00000
13	ENVUSE MAX	0.75000	0.00000	1692.17300	0.00000
13	ENVUSE MAX	1.00000	0.00000	1690.38300	0.00000
13	ENVUSE MIN	0.00000	-660.66201	0.00000	-1492.17000
13	ENVUSE MIN	0.25000	-660.66201	0.00000	-1567.47200
13	ENVUSE MIN	0.50000	-660.66201	0.00000	-1642.69500
13	ENVUSE MIN	0.75000	-660.66201	0.00000	-1717.83700
13	ENVUSE MIN	1.00000	-660.66201	0.00000	-1792.90000
14	ENVUSE MAX	0.00000	0.00000	1690.38300	0.00000
14	ENVUSE MAX	0.11765	0.00000	1686.38300	0.00000
14	ENVUSE MAX	0.23529	0.00000	1682.38300	0.00000
14	ENVUSE MAX	0.35294	0.00000	1678.38300	0.00000
14	ENVUSE MAX	0.47059	0.00000	1674.38300	0.00000
14	ENVUSE MIN	0.00000	-660.66201	0.00000	-1792.90000
14	ENVUSE MIN	0.11765	-660.66201	0.00000	-1960.34700
14	ENVUSE MIN	0.23529	-660.66201	0.00000	-2127.39500
14	ENVUSE MIN	0.35294	-660.66201	0.00000	-2294.04200
14	ENVUSE MIN	0.47059	-660.66201	0.00000	-2460.29000
15	ENVUSE MAX	0.46875	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.60156	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.73438	0.00000	0.00000	0.00000
15	ENVUSE MAX	0.86719	0.00000	0.00000	0.00000
15	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
15	ENVUSE MIN	0.46875	-2169.99800	-584.94961	-2973.93400
15	ENVUSE MIN	0.60156	-2165.48200	-563.74064	-2928.00600
15	ENVUSE MIN	0.73438	-2160.96700	-542.63892	-2897.79100
15	ENVUSE MIN	0.86719	-2156.45100	-521.64444	-2868.69400
15	ENVUSE MIN	1.00000	-2151.93500	-500.75721	-2840.71000
16	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
16	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
16	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
16	ENVUSE MIN	0.00000	-2151.93500	-500.75721	-2840.71000
16	ENVUSE MIN	0.25000	-2148.35500	-484.27108	-2819.30700
16	ENVUSE MIN	0.50000	-2144.77400	-467.85232	-2798.59700
16	ENVUSE MIN	0.75000	-2141.19300	-451.50095	-2778.57700
16	ENVUSE MIN	1.00000	-2137.61300	-435.21695	-2759.24500
17	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
17	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
17	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
17	ENVUSE MIN	0.00000	-2137.61300	-435.21695	-2759.24500

FRAME	LOAD	DIST	P	V2	M3
17	ENVUSE MIN	0.25000	-2125.54300	-380.82175	-2699.10300
17	ENVUSE MIN	0.50000	-2113.47300	-327.19315	-2646.63200
17	ENVUSE MIN	0.75000	-2101.40300	-274.33112	-2601.72100
17	ENVUSE MIN	1.00000	-2089.33300	-222.23569	-2564.26200
18	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
18	ENVUSE MAX	0.25000	0.00000	10.80760	0.00000
18	ENVUSE MAX	0.50000	0.00000	35.40025	0.00000
18	ENVUSE MAX	0.75000	0.00000	59.60920	0.00000
18	ENVUSE MAX	1.00000	0.00000	91.66983	0.00000
18	ENVUSE MIN	0.00000	-2089.33300	-222.23569	-2564.26200
18	ENVUSE MIN	0.25000	-2077.25200	-170.86173	-2534.12300
18	ENVUSE MIN	0.50000	-2065.17200	-135.24558	-2511.23200
18	ENVUSE MIN	0.75000	-2053.09100	-106.92742	-2495.47800
18	ENVUSE MIN	1.00000	-2041.01000	-79.01311	-2486.75200
19	ENVUSE MAX	0.00000	0.00000	91.44099	0.00000
19	ENVUSE MAX	0.25000	0.00000	138.32409	0.00000
19	ENVUSE MAX	0.50000	0.00000	184.43978	0.00000
19	ENVUSE MAX	0.75000	0.00000	229.78806	0.00000
19	ENVUSE MAX	1.00000	0.00000	274.36895	0.00000
19	ENVUSE MIN	0.00000	-2041.01000	-79.01312	-2486.75200
19	ENVUSE MIN	0.25000	-2028.93000	-65.12180	-2506.95500
19	ENVUSE MIN	0.50000	-2016.84900	-51.56849	-2535.14800
19	ENVUSE MIN	0.75000	-2004.76800	-38.21711	-2570.04200
19	ENVUSE MIN	1.00000	-1992.68800	-25.06765	-2611.52900
20	ENVUSE MAX	0.00000	0.00000	274.25517	0.00000
20	ENVUSE MAX	0.25000	0.00000	311.79625	0.00000
20	ENVUSE MAX	0.50000	0.00000	348.77505	0.00000
20	ENVUSE MAX	0.75000	0.00000	385.19159	0.00000
20	ENVUSE MAX	1.00000	0.00000	421.04585	0.00000
20	ENVUSE MIN	0.00000	-1992.68800	-26.25335	-2611.52900
20	ENVUSE MIN	0.25000	-1982.35000	-15.16095	-2652.18400
20	ENVUSE MIN	0.50000	-1972.01200	-4.21654	-2697.51900
20	ENVUSE MIN	0.75000	-1961.67300	0.00000	-2747.46600
20	ENVUSE MIN	1.00000	-1951.33500	0.00000	-2801.95500
21	ENVUSE MAX	0.00000	0.00000	420.99871	0.00000
21	ENVUSE MAX	0.25000	0.00000	426.95013	0.00000
21	ENVUSE MAX	0.50000	0.00000	432.88575	0.00000
21	ENVUSE MAX	0.75000	0.00000	438.80557	0.00000
21	ENVUSE MAX	1.00000	0.00000	444.70959	0.00000
21	ENVUSE MIN	0.00000	-1951.33500	0.00000	-2801.95500
21	ENVUSE MIN	0.25000	-1949.58300	0.00000	-2811.52200
21	ENVUSE MIN	0.50000	-1947.78800	0.00000	-2821.21500
21	ENVUSE MIN	0.75000	-1945.95300	0.00000	-2831.03300
21	ENVUSE MIN	1.00000	-1944.07500	0.00000	-2840.97500
22	ENVUSE MAX	0.00000	0.00000	444.68564	0.00000
22	ENVUSE MAX	0.25000	0.00000	456.84208	0.00000
22	ENVUSE MAX	0.50000	0.00000	468.93114	0.00000
22	ENVUSE MAX	0.75000	0.00000	480.95283	0.00000
22	ENVUSE MAX	1.00000	0.00000	492.90713	0.00000
22	ENVUSE MIN	0.00000	-1944.07500	0.00000	-2840.97500
22	ENVUSE MIN	0.25000	-1940.06200	0.00000	-2861.92500
22	ENVUSE MIN	0.50000	-1935.87100	0.00000	-2883.40300
22	ENVUSE MIN	0.75000	-1931.50300	0.00000	-2905.40600
22	ENVUSE MIN	1.00000	-1926.95800	0.00000	-2927.93300
23	ENVUSE MAX	0.00000	0.00000	492.82865	0.00000
23	ENVUSE MAX	0.10937	0.00000	505.17274	0.00000
23	ENVUSE MAX	0.21875	0.00000	517.44411	0.00000
23	ENVUSE MAX	0.32812	0.00000	529.64273	0.00000
23	ENVUSE MAX	0.43750	0.00000	541.76862	0.00000
23	ENVUSE MIN	0.00000	-1926.95800	0.00000	-2927.93300
23	ENVUSE MIN	0.10937	-1922.14600	0.00000	-2951.87800
23	ENVUSE MIN	0.21875	-1917.33300	0.00000	-2976.38100
23	ENVUSE MIN	0.32812	-1912.52100	0.00000	-3001.43900
23	ENVUSE MIN	0.43750	-1907.70800	0.00000	-3027.08600
24	ENVUSE MAX	0.64706	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.73529	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.82353	0.00000	0.00000	0.00000
24	ENVUSE MAX	0.91176	0.00000	0.00000	0.00000
24	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
24	ENVUSE MIN	0.64706	-602.61927	-1709.59500	-2294.86700
24	ENVUSE MIN	0.73529	-602.61927	-1685.95500	-2167.53400
24	ENVUSE MIN	0.82353	-602.61927	-1662.31400	-2041.97400
24	ENVUSE MIN	0.91176	-602.61927	-1638.67400	-1921.12600
24	ENVUSE MIN	1.00000	-602.61927	-1615.03300	-1803.13400
25	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
25	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
25	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
25	ENVUSE MIN	0.00000	-602.44769	-1615.03300	-1803.13400
25	ENVUSE MIN	0.25000	-602.44769	-1600.95300	-1733.54900
25	ENVUSE MIN	0.50000	-602.44769	-1586.92200	-1664.57400
25	ENVUSE MIN	0.75000	-602.44769	-1572.94200	-1596.20500
25	ENVUSE MIN	1.00000	-602.44769	-1559.01200	-1528.44000
26	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
26	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
26	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000

FRAME	LOAD	DIST	P	V2	M3
26	ENVUSE MIN	0.00000	-602.37615	-1559.01200	-1528.44000
26	ENVUSE MIN	0.25000	-602.37615	-1534.15700	-1408.42500
26	ENVUSE MIN	0.50000	-602.37615	-1509.46200	-1290.33400
26	ENVUSE MIN	0.75000	-602.37615	-1484.92900	-1174.15400
26	ENVUSE MIN	1.00000	-602.37615	-1460.55600	-1059.87200
27	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
27	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
27	ENVUSE MAX	0.50000	0.00000	0.00000	101.36147
27	ENVUSE MAX	0.75000	0.00000	0.00000	242.76022
27	ENVUSE MAX	1.00000	0.00000	0.00000	381.60620
27	ENVUSE MIN	0.00000	-602.25822	-1460.55600	-1059.87200
27	ENVUSE MIN	0.25000	-602.25822	-1406.97700	-814.47878
27	ENVUSE MIN	0.50000	-602.25822	-1353.39800	-578.25586
27	ENVUSE MIN	0.75000	-602.25822	-1299.81900	-351.20313
27	ENVUSE MIN	1.00000	-602.25822	-1246.24000	-139.00554
28	ENVUSE MAX	0.00000	0.00000	0.00000	381.60620
28	ENVUSE MAX	0.25000	0.00000	0.00000	655.09058
28	ENVUSE MAX	0.50000	0.00000	0.00000	941.71938
28	ENVUSE MAX	0.75000	0.00000	0.00000	1208.27700
28	ENVUSE MAX	1.00000	0.00000	0.00000	1454.76300
28	ENVUSE MIN	0.00000	-602.09905	-1246.24000	-139.00554
28	ENVUSE MIN	0.25000	-602.09905	-1168.29400	0.00000
28	ENVUSE MIN	0.50000	-602.09905	-1090.34700	0.00000
28	ENVUSE MIN	0.75000	-602.09905	-1012.40000	0.00000
28	ENVUSE MIN	1.00000	-602.09905	-934.45322	0.00000
29	ENVUSE MAX	0.00000	0.00000	0.00000	1454.76300
29	ENVUSE MAX	0.25000	0.00000	0.00000	1680.96800
29	ENVUSE MAX	0.50000	0.00000	0.00000	1887.14000
29	ENVUSE MAX	0.75000	0.00000	0.00000	2077.21500
29	ENVUSE MAX	1.00000	0.00000	0.00000	2247.49000
29	ENVUSE MIN	0.00000	-601.96355	-934.45322	0.00000
29	ENVUSE MIN	0.25000	-601.96355	-856.58210	0.00000
29	ENVUSE MIN	0.50000	-601.96355	-778.71098	0.00000
29	ENVUSE MIN	0.75000	-601.96355	-700.83986	0.00000
29	ENVUSE MIN	1.00000	-601.96355	-622.96874	0.00000
30	ENVUSE MAX	0.00000	0.00000	0.00000	2247.49000
30	ENVUSE MAX	0.25000	0.00000	0.00000	2397.73200
30	ENVUSE MAX	0.50000	0.00000	0.00000	2527.94200
30	ENVUSE MAX	0.75000	0.00000	0.00000	2638.12000
30	ENVUSE MAX	1.00000	0.00000	0.00000	2728.26600
30	ENVUSE MIN	0.00000	-601.87567	-622.96874	0.00000
30	ENVUSE MIN	0.25000	-601.87567	-545.42981	0.00000
30	ENVUSE MIN	0.50000	-601.87567	-470.13119	0.00000
30	ENVUSE MIN	0.75000	-601.87567	-394.83257	0.00000
30	ENVUSE MIN	1.00000	-601.87567	-319.53395	0.00000
31	ENVUSE MAX	0.00000	0.00000	0.00000	2728.26600
31	ENVUSE MAX	0.25000	0.00000	0.00000	2798.37900
31	ENVUSE MAX	0.50000	0.00000	0.00000	2848.46000
31	ENVUSE MAX	0.75000	0.00000	0.00000	2878.50800
31	ENVUSE MAX	1.00000	0.00000	23.06729	2888.52400
31	ENVUSE MIN	0.00000	-601.83242	-319.53395	0.00000
31	ENVUSE MIN	0.25000	-601.83242	-244.23534	0.00000
31	ENVUSE MIN	0.50000	-601.83242	-168.93672	0.00000
31	ENVUSE MIN	0.75000	-601.83242	-93.63810	0.00000
31	ENVUSE MIN	1.00000	-601.83242	-18.33956	0.00000
32	ENVUSE MAX	0.00000	0.00000	18.33991	2888.52400
32	ENVUSE MAX	0.25000	0.00000	93.63853	2878.50800
32	ENVUSE MAX	0.50000	0.00000	168.93715	2848.45900
32	ENVUSE MAX	0.75000	0.00000	244.23577	2798.37800
32	ENVUSE MAX	1.00000	0.00000	319.53439	2728.26500
32	ENVUSE MIN	0.00000	-601.83248	-23.06637	0.00000
32	ENVUSE MIN	0.25000	-601.83248	0.00000	0.00000
32	ENVUSE MIN	0.50000	-601.83248	0.00000	0.00000
32	ENVUSE MIN	0.75000	-601.83248	0.00000	0.00000
32	ENVUSE MIN	1.00000	-601.83248	0.00000	0.00000
33	ENVUSE MAX	0.00000	0.00000	319.53439	2728.26500
33	ENVUSE MAX	0.25000	0.00000	394.83300	2638.12000
33	ENVUSE MAX	0.50000	0.00000	470.13162	2527.94200
33	ENVUSE MAX	0.75000	0.00000	545.43024	2397.73100
33	ENVUSE MAX	1.00000	0.00000	622.96920	2247.48900
33	ENVUSE MIN	0.00000	-601.87585	0.00000	0.00000
33	ENVUSE MIN	0.25000	-601.87585	0.00000	0.00000
33	ENVUSE MIN	0.50000	-601.87585	0.00000	0.00000
33	ENVUSE MIN	0.75000	-601.87585	0.00000	0.00000
33	ENVUSE MIN	1.00000	-601.87585	0.00000	0.00000
34	ENVUSE MAX	0.00000	0.00000	622.96920	2247.48900
34	ENVUSE MAX	0.25000	0.00000	700.91599	2077.03800
34	ENVUSE MAX	0.50000	0.00000	778.86279	1886.75800
34	ENVUSE MAX	0.75000	0.00000	856.80958	1680.33600
34	ENVUSE MAX	1.00000	0.00000	934.75638	1453.84300
34	ENVUSE MIN	0.00000	-601.96388	0.00000	0.00000
34	ENVUSE MIN	0.25000	-601.96388	0.00000	0.00000
34	ENVUSE MIN	0.50000	-601.96388	0.00000	0.00000
34	ENVUSE MIN	0.75000	-601.96388	0.00000	0.00000
34	ENVUSE MIN	1.00000	-601.96388	0.00000	0.00000
35	ENVUSE MAX	0.00000	0.00000	934.75638	1453.84300
35	ENVUSE MAX	0.25000	0.00000	1012.62700	1207.52800
35	ENVUSE MAX	0.50000	0.00000	1090.49900	941.18067
35	ENVUSE MAX	0.75000	0.00000	1168.37000	654.80084

FRAME	LOAD	DIST	P	V2	M3
35	ENVUSE MAX	1.00000	0.00000	1246.24100	381.60507
35	ENVUSE MIN	0.00000	-602.09954	0.00000	0.00000
35	ENVUSE MIN	0.25000	-602.09954	0.00000	0.00000
35	ENVUSE MIN	0.50000	-602.09954	0.00000	0.00000
35	ENVUSE MIN	0.75000	-602.09954	0.00000	0.00000
35	ENVUSE MIN	1.00000	-602.09954	0.00000	-139.00989
36	ENVUSE MAX	0.00000	0.00000	1246.24100	381.60507
36	ENVUSE MAX	0.25000	0.00000	1299.82000	242.75739
36	ENVUSE MAX	0.50000	0.00000	1353.39900	101.35851
36	ENVUSE MAX	0.75000	0.00000	1406.97800	0.00000
36	ENVUSE MAX	1.00000	0.00000	1460.55700	0.00000
36	ENVUSE MIN	0.00000	-602.25873	0.00000	-139.00989
36	ENVUSE MIN	0.25000	-602.25873	0.00000	-351.20516
36	ENVUSE MIN	0.50000	-602.25873	0.00000	-578.25797
36	ENVUSE MIN	0.75000	-602.25873	0.00000	-814.48098
36	ENVUSE MIN	1.00000	-602.25873	0.00000	-1059.87400
37	ENVUSE MAX	0.00000	0.00000	1460.55700	0.00000
37	ENVUSE MAX	0.25000	0.00000	1484.92900	0.00000
37	ENVUSE MAX	0.50000	0.00000	1509.46300	0.00000
37	ENVUSE MAX	0.75000	0.00000	1534.15700	0.00000
37	ENVUSE MAX	1.00000	0.00000	1559.01300	0.00000
37	ENVUSE MIN	0.00000	-602.37671	0.00000	-1059.87400
37	ENVUSE MIN	0.25000	-602.37671	0.00000	-1174.15600
37	ENVUSE MIN	0.50000	-602.37671	0.00000	-1290.33700
37	ENVUSE MIN	0.75000	-602.37671	0.00000	-1408.42800
37	ENVUSE MIN	1.00000	-602.37671	0.00000	-1528.44300
38	ENVUSE MAX	0.00000	0.00000	1559.01300	0.00000
38	ENVUSE MAX	0.25000	0.00000	1572.94300	0.00000
38	ENVUSE MAX	0.50000	0.00000	1586.92300	0.00000
38	ENVUSE MAX	0.75000	0.00000	1600.95300	0.00000
38	ENVUSE MAX	1.00000	0.00000	1615.03400	0.00000
38	ENVUSE MIN	0.00000	-602.44829	0.00000	-1528.44300
38	ENVUSE MIN	0.25000	-602.44829	0.00000	-1596.20700
38	ENVUSE MIN	0.50000	-602.44829	0.00000	-1664.57600
38	ENVUSE MIN	0.75000	-602.44829	0.00000	-1733.55200
38	ENVUSE MIN	1.00000	-602.44829	0.00000	-1803.13600
39	ENVUSE MAX	0.00000	0.00000	1615.03400	0.00000
39	ENVUSE MAX	0.08824	0.00000	1638.67400	0.00000
39	ENVUSE MAX	0.17647	0.00000	1662.31500	0.00000
39	ENVUSE MAX	0.26471	0.00000	1685.95500	0.00000
39	ENVUSE MAX	0.35294	0.00000	1709.59500	0.00000
39	ENVUSE MIN	0.00000	-602.61993	0.00000	-1803.13600
39	ENVUSE MIN	0.08824	-602.61993	0.00000	-1921.12900
39	ENVUSE MIN	0.17647	-602.61993	0.00000	-2041.97700
39	ENVUSE MIN	0.26471	-602.61993	0.00000	-2167.53700
39	ENVUSE MIN	0.35294	-602.61993	0.00000	-2294.87000
40	ENVUSE MAX	0.56250	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.67188	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.78125	0.00000	0.00000	0.00000
40	ENVUSE MAX	0.89063	0.00000	0.00000	0.00000
40	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
40	ENVUSE MIN	0.56250	-1907.70900	-541.76942	-3027.08800
40	ENVUSE MIN	0.67188	-1912.52100	-529.64353	-3001.44200
40	ENVUSE MIN	0.78125	-1917.33400	-517.44490	-2976.38400
40	ENVUSE MIN	0.89063	-1922.14600	-505.17354	-2951.88100
40	ENVUSE MIN	1.00000	-1926.95900	-492.82945	-2927.93600
41	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
41	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
41	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
41	ENVUSE MIN	0.00000	-1926.95900	-492.90801	-2927.93600
41	ENVUSE MIN	0.25000	-1931.50400	-480.95370	-2905.41000
41	ENVUSE MIN	0.50000	-1935.87200	-468.93201	-2883.40600
41	ENVUSE MIN	0.75000	-1940.06200	-456.84295	-2861.92800
41	ENVUSE MIN	1.00000	-1944.07600	-444.68651	-2840.97900
42	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.50000	0.00000	0.00000	0.00000
42	ENVUSE MAX	0.75000	0.00000	0.00000	0.00000
42	ENVUSE MAX	1.00000	0.00000	0.00000	0.00000
42	ENVUSE MIN	0.00000	-1944.07600	-444.71048	-2840.97900
42	ENVUSE MIN	0.25000	-1945.95300	-438.80646	-2831.03600
42	ENVUSE MIN	0.50000	-1947.78900	-432.88664	-2821.21800
42	ENVUSE MIN	0.75000	-1949.58300	-426.95102	-2811.52500
42	ENVUSE MIN	1.00000	-1951.33600	-420.99960	-2801.95800
43	ENVUSE MAX	0.00000	0.00000	0.00000	0.00000
43	ENVUSE MAX	0.25000	0.00000	0.00000	0.00000
43	ENVUSE MAX	0.50000	0.00000	4.21581	0.00000
43	ENVUSE MAX	0.75000	0.00000	15.16022	0.00000
43	ENVUSE MAX	1.00000	0.00000	26.25262	0.00000
43	ENVUSE MIN	0.00000	-1951.33600	-421.04680	-2801.95800
43	ENVUSE MIN	0.25000	-1961.67400	-385.19254	-2747.46900
43	ENVUSE MIN	0.50000	-1972.01200	-348.77601	-2697.52300
43	ENVUSE MIN	0.75000	-1982.35000	-311.79720	-2652.18800
43	ENVUSE MIN	1.00000	-1992.68800	-274.25613	-2611.53200
44	ENVUSE MAX	0.00000	0.00000	25.06758	0.00000
44	ENVUSE MAX	0.25000	0.00000	38.21703	0.00000
44	ENVUSE MAX	0.50000	0.00000	51.56842	0.00000
44	ENVUSE MAX	0.75000	0.00000	65.12172	0.00000
44	ENVUSE MAX	1.00000	0.00000	79.01307	0.00000
44	ENVUSE MIN	0.00000	-1992.68800	-274.36998	-2611.53200
44	ENVUSE MIN	0.25000	-2004.76900	-229.78910	-2570.04500
44	ENVUSE MIN	0.50000	-2016.85000	-184.44081	-2535.15100
44	ENVUSE MIN	0.75000	-2028.93000	-138.32512	-2506.95800
44	ENVUSE MIN	1.00000	-2041.01100	-91.44203	-2486.75500
45	ENVUSE MAX	0.00000	0.00000	79.01306	0.00000
45	ENVUSE MAX	0.25000	0.00000	106.92737	0.00000
45	ENVUSE MAX	0.50000	0.00000	135.24553	0.00000
45	ENVUSE MAX	0.75000	0.00000	170.86168	0.00000
45	ENVUSE MAX	1.00000	0.00000	222.23564	0.00000
45	ENVUSE MIN	0.00000	-2041.01100	-91.67093	-2486.75500
45	ENVUSE MIN	0.25000	-2053.09100	-59.61030	-2495.48000
45	ENVUSE MIN	0.50000	-2065.17200	-35.40135	-2511.23400
45	ENVUSE MIN	0.75000	-2077.25300	-10.80870	-2534.12600
45	ENVUSE MIN	1.00000	-2089.33300	0.00000	-2564.26500
46	ENVUSE MAX	0.00000	0.00000	222.23564	0.00000
46	ENVUSE MAX	0.25000	0.00000	274.33107	0.00000
46	ENVUSE MAX	0.50000	0.00000	327.19310	0.00000
46	ENVUSE MAX	0.75000	0.00000	380.82170	0.00000
46	ENVUSE MAX	1.00000	0.00000	435.21690	0.00000
46	ENVUSE MIN	0.00000	-2089.33300	0.00000	-2564.26500
46	ENVUSE MIN	0.25000	-2101.40300	0.00000	-2601.72400
46	ENVUSE MIN	0.50000	-2113.47300	0.00000	-2646.63400
46	ENVUSE MIN	0.75000	-2125.54300	0.00000	-2699.10600
46	ENVUSE MIN	1.00000	-2137.61300	0.00000	-2759.24700
47	ENVUSE MAX	0.00000	0.00000	435.21690	0.00000
47	ENVUSE MAX	0.25000	0.00000	451.50090	0.00000
47	ENVUSE MAX	0.50000	0.00000	467.85227	0.00000
47	ENVUSE MAX	0.75000	0.00000	484.27103	0.00000
47	ENVUSE MAX	1.00000	0.00000	500.75716	0.00000
47	ENVUSE MIN	0.00000	-2137.61300	0.00000	-2759.24700
47	ENVUSE MIN	0.25000	-2141.19400	0.00000	-2778.58000
47	ENVUSE MIN	0.50000	-2144.77500	0.00000	-2798.59900
47	ENVUSE MIN	0.75000	-2148.35500	0.00000	-2819.30900
47	ENVUSE MIN	1.00000	-2151.93600	0.00000	-2840.71200
48	ENVUSE MAX	0.00000	0.00000	500.75716	0.00000
48	ENVUSE MAX	0.13281	0.00000	521.64439	0.00000
48	ENVUSE MAX	0.26563	0.00000	542.63887	0.00000
48	ENVUSE MAX	0.39844	0.00000	563.74059	0.00000
48	ENVUSE MAX	0.53125	0.00000	584.94956	0.00000
48	ENVUSE MIN	0.00000	-2151.93600	0.00000	-2840.71200
48	ENVUSE MIN	0.13281	-2156.45100	0.00000	-2868.69700
48	ENVUSE MIN	0.26563	-2160.96700	0.00000	-2897.79400
48	ENVUSE MIN	0.39844	-2165.48300	0.00000	-2928.00900
48	ENVUSE MIN	0.53125	-2169.99800	0.00000	-2973.93700

19. OUTPUT DATA (기능수행)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.52941	295.64312	0.00000	371.23080
1	ENVEQ MAX	0.64706	285.42872	0.00000	383.23958
1	ENVEQ MAX	0.76471	275.21432	0.00000	395.60836
1	ENVEQ MAX	0.88235	264.99992	0.00000	408.54152
1	ENVEQ MAX	1.00000	254.78552	0.00000	422.52785
1	ENVEQ MIN	0.52941	-530.48632	-961.03649	-1138.47400
1	ENVEQ MIN	0.64706	-520.27192	-965.83649	-1042.13100
1	ENVEQ MIN	0.76471	-510.05752	-970.63649	-945.30704
1	ENVEQ MIN	0.88235	-499.84312	-975.43649	-848.00339
1	ENVEQ MIN	1.00000	-489.62872	-980.23649	-750.21974
2	ENVEQ MAX	0.00000	254.78552	0.00000	422.52785
2	ENVEQ MAX	0.25000	250.21458	0.00000	428.90333
2	ENVEQ MAX	0.50000	245.64363	0.00000	435.35090
2	ENVEQ MAX	0.75000	241.07269	0.00000	441.87056
2	ENVEQ MAX	1.00000	236.50174	0.00000	448.46232
2	ENVEQ MIN	0.00000	-489.62872	-980.23631	-750.21974
2	ENVEQ MIN	0.25000	-485.05778	-982.38431	-706.30611
2	ENVEQ MIN	0.50000	-480.48683	-984.53231	-662.29635
2	ENVEQ MIN	0.75000	-475.91589	-986.68031	-618.19054
2	ENVEQ MIN	1.00000	-471.34495	-988.82831	-574.15092
3	ENVEQ MAX	0.00000	269.61165	0.00000	448.46232
3	ENVEQ MAX	0.25000	243.33511	0.00000	474.59002
3	ENVEQ MAX	0.50000	217.05856	0.00000	535.69867
3	ENVEQ MAX	0.75000	190.78202	0.00000	602.20216
3	ENVEQ MAX	1.00000	164.50547	0.00000	671.89111
3	ENVEQ MIN	0.00000	-502.13999	-585.53104	-574.15092
3	ENVEQ MIN	0.25000	-475.86344	-597.87904	-453.02938
3	ENVEQ MIN	0.50000	-449.58690	-610.22704	-353.29679
3	ENVEQ MIN	0.75000	-423.31036	-622.57504	-251.92283
3	ENVEQ MIN	1.00000	-397.03381	-634.92304	-149.31668
4	ENVEQ MAX	0.00000	198.11848	39.12661	671.89111
4	ENVEQ MAX	0.25000	171.84194	29.86561	691.74860
4	ENVEQ MAX	0.50000	145.56539	20.60461	714.78261
4	ENVEQ MAX	0.75000	119.28885	11.34361	740.99315
4	ENVEQ MAX	1.00000	93.01231	2.08261	770.38021
4	ENVEQ MIN	0.00000	-428.87091	-326.59593	-149.31668
4	ENVEQ MIN	0.25000	-402.59437	-338.94393	-92.17914
4	ENVEQ MIN	0.50000	-376.31782	-351.29193	-32.65921
4	ENVEQ MIN	0.75000	-350.04128	-363.63993	0.00000
4	ENVEQ MIN	1.00000	-323.76474	-375.98793	0.00000
5	ENVEQ MAX	0.00000	126.98845	54.54400	770.38021
5	ENVEQ MAX	0.25000	100.68637	45.27400	769.33623
5	ENVEQ MAX	0.50000	74.38429	36.00400	771.47496
5	ENVEQ MAX	0.75000	48.08221	26.73400	776.79638
5	ENVEQ MAX	1.00000	21.78013	17.46400	785.30050
5	ENVEQ MIN	0.00000	-356.47407	-157.41080	0.00000
5	ENVEQ MIN	0.25000	-330.17199	-169.77080	0.00000
5	ENVEQ MIN	0.50000	-303.86991	-182.13080	0.00000
5	ENVEQ MIN	0.75000	-277.56783	-194.49080	0.00000
5	ENVEQ MIN	1.00000	-251.26575	-206.85080	0.00000
6	ENVEQ MAX	0.00000	56.34801	54.58599	785.30050
6	ENVEQ MAX	0.25000	30.07147	44.68452	775.87810
6	ENVEQ MAX	0.50000	3.79493	35.42352	769.63221
6	ENVEQ MAX	0.75000	0.00000	26.16252	766.56285
6	ENVEQ MAX	1.00000	0.00000	16.90152	766.67002
6	ENVEQ MIN	0.00000	-284.68008	-61.97444	0.00000
6	ENVEQ MIN	0.25000	-258.40353	-74.32244	0.00000
6	ENVEQ MIN	0.50000	-232.12699	-86.67044	0.00000
6	ENVEQ MIN	0.75000	-205.85045	-99.01844	0.00000
6	ENVEQ MIN	1.00000	-179.57390	-111.36644	0.00000
7	ENVEQ MAX	0.00000	0.00000	57.05186	766.67002
7	ENVEQ MAX	0.25000	0.00000	44.70386	754.49967
7	ENVEQ MAX	0.50000	0.00000	33.03078	745.50585
7	ENVEQ MAX	0.75000	0.00000	23.76978	739.68855
7	ENVEQ MAX	1.00000	0.00000	14.50878	737.04778
7	ENVEQ MIN	0.00000	-213.52626	-23.10526	0.00000
7	ENVEQ MIN	0.25000	-187.24971	-32.36626	0.00000
7	ENVEQ MIN	0.50000	-160.97317	-44.16222	0.00000
7	ENVEQ MIN	0.75000	-134.69662	-56.51022	0.00000
7	ENVEQ MIN	1.00000	-142.74704	-68.85822	0.00000
8	ENVEQ MAX	0.00000	0.00000	68.84474	737.04778
8	ENVEQ MAX	0.25000	0.00000	56.49674	739.68107
8	ENVEQ MAX	0.50000	0.00000	44.14874	745.50156
8	ENVEQ MAX	0.75000	0.00000	32.35604	754.49857
8	ENVEQ MAX	1.00000	0.00000	23.09504	766.67210
8	ENVEQ MIN	0.00000	-142.74554	-14.51683	0.00000
8	ENVEQ MIN	0.25000	-134.69793	-23.77783	0.00000
8	ENVEQ MIN	0.50000	-160.97447	-33.03883	0.00000
8	ENVEQ MIN	0.75000	-187.25102	-44.71481	0.00000
8	ENVEQ MIN	1.00000	-213.52756	-57.06281	0.00000
9	ENVEQ MAX	0.00000	0.00000	111.35417	766.67210
9	ENVEQ MAX	0.25000	0.00000	99.00617	766.56728
9	ENVEQ MAX	0.50000	3.79673	86.65817	769.63898
9	ENVEQ MAX	0.75000	30.07328	74.31017	775.88720
9	ENVEQ MAX	1.00000	56.34982	61.96217	785.31194
9	ENVEQ MIN	0.00000	-179.57501	-16.90751	0.00000
9	ENVEQ MIN	0.25000	-205.85155	-26.16851	0.00000
9	ENVEQ MIN	0.50000	-232.12810	-35.42951	0.00000
9	ENVEQ MIN	0.75000	-258.40464	-44.69051	0.00000
9	ENVEQ MIN	1.00000	-284.68119	-54.59447	0.00000
10	ENVEQ MAX	0.00000	21.78254	206.84320	785.31194
10	ENVEQ MAX	0.25000	48.05908	194.49520	776.81544
10	ENVEQ MAX	0.50000	74.33563	182.14720	771.49547
10	ENVEQ MAX	0.75000	100.61217	169.79920	769.35201
10	ENVEQ MAX	1.00000	126.88871	157.45120	770.38508
10	ENVEQ MIN	0.00000	-251.26666	-17.46742	0.00000
10	ENVEQ MIN	0.25000	-277.54321	-26.72842	0.00000
10	ENVEQ MIN	0.50000	-303.81975	-35.98942	0.00000
10	ENVEQ MIN	0.75000	-330.09629	-45.25042	0.00000
10	ENVEQ MIN	1.00000	-356.37284	-54.51142	0.00000
11	ENVEQ MAX	0.00000	92.91245	375.95883	770.38508
11	ENVEQ MAX	0.25000	119.21453	363.59883	740.97270
11	ENVEQ MAX	0.50000	145.51661	351.23883	714.74302
11	ENVEQ MAX	0.75000	171.81869	338.87883	691.69604
11	ENVEQ MAX	1.00000	198.12077	326.51883	671.83176
11	ENVEQ MIN	0.00000	-323.66251	-2.06877	0.00000
11	ENVEQ MIN	0.25000	-349.96459	-11.33877	0.00000
11	ENVEQ MIN	0.50000	-376.26667	-20.60877	-32.62141
11	ENVEQ MIN	0.75000	-402.56875	-29.87877	-92.19112
11	ENVEQ MIN	1.00000	-428.87083	-39.14877	-149.37381
12	ENVEQ MAX	0.00000	164.50795	634.86091	671.83176
12	ENVEQ MAX	0.25000	190.78449	622.51291	602.15400
12	ENVEQ MAX	0.50000	217.06104	610.16491	535.66251
12	ENVEQ MAX	0.75000	243.33758	597.81691	474.56482
12	ENVEQ MAX	1.00000	269.61412	585.46891	448.45766
12	ENVEQ MIN	0.00000	-397.03347	0.00000	-149.37381
12	ENVEQ MIN	0.25000	-423.31001	0.00000	-251.97071
12	ENVEQ MIN	0.50000	-449.58656	0.00000	-353.33629
12	ENVEQ MIN	0.75000	-475.86310	0.00000	-453.05942
12	ENVEQ MIN	1.00000	-502.13964	0.00000	-574.18097
13	ENVEQ MAX	0.00000	236.50441	988.77974	448.45766
13	ENVEQ MAX	0.25000	241.07536	986.63174	441.86654
13	ENVEQ MAX	0.50000	245.64630	984.48374	435.34751
13	ENVEQ MAX	0.75000	250.21724	982.33574	428.90058
13	ENVEQ MAX	1.00000	254.78819	980.18774	422.52573
13	ENVEQ MIN	0.00000	-471.34434	0.00000	-574.18097
13	ENVEQ MIN	0.25000	-475.91528	0.00000	-618.21849
13	ENVEQ MIN	0.50000	-480.48623	0.00000	-662.32213
13	ENVEQ MIN	0.75000	-485.05717	0.00000	-706.32971
13	ENVEQ MIN	1.00000	-489.62811	0.00000	-750.24117
14	ENVEQ MAX	0.00000	254.78819	980.18793	422.52573
14	ENVEQ MAX	0.11765	265.00259	975.38793	408.54081
14	ENVEQ MAX	0.23529	275.21699	970.58793	395.60910
14	ENVEQ MAX	0.35294	285.43139	965.78793	383.24168
14	ENVEQ MAX	0.47059	295.64579	960.98793	371.23426
14	ENVEQ MIN	0.00000	-489.62811	0.00000	-750.24117
14	ENVEQ MIN	0.11765	-499.84251	0.00000	-848.01997
14	ENVEQ MIN	0.23529	-510.05691	0.00000	-945.31876
14	ENVEQ MIN	0.35294	-520.27131	0.00000	-1042.13800
14	ENVEQ MIN	0.47059	-530.48571	0.00000	-1138.47600
15	ENVEQ MAX	0.46875	0.00000	339.23954	202.32397
15	ENVEQ MAX	0.60156	0.00000	338.00062	168.73045
15	ENVEQ MAX	0.73438	0.00000	336.51127	135.28188
15	ENVEQ MAX	0.86719	0.00000	334.77148	102.00486
15	ENVEQ MAX	1.00000	0.00000	332.78126	68.92599
15	ENVEQ MIN	0.46875	-1531.88000	-398.97891	-1415.86900
15	ENVEQ MIN	0.60156	-1519.51800	-397.20875	-1373.66000
15	ENVEQ MIN	0.73438	-1507.15700	-395.18814	-1331.65200
15	ENVEQ MIN	0.86719	-1494.79600	-392.91711	-1289.87300
15	ENVEQ MIN	1.00000	-1482.43500	-390.39563	-1248.34700
16	ENVEQ MAX	0.00000	0.00000	332.78130	68.92598
16	ENVEQ MAX	0.25000	0.00000	331.02563	42.87431
16	ENVEQ MAX	0.50000	0.00000	329.11348	16.97716
16	ENVEQ MAX	0.75000	0.00000	327.04482	0.00000
16	ENVEQ MAX	1.00000	0.00000	324.81967	0.00000
16	ENVEQ MIN	0.00000	-1482.43500	-390.39563	-1248.34700
16	ENVEQ MIN	0.25000	-1472.63400	-388.21872	-1215.84700
16	ENVEQ MIN	0.50000	-1462.83200	-385.88531	-1183.61200
16	ENVEQ MIN	0.75000	-1453.03000	-383.39541	-1151.56400
16	ENVEQ MIN	1.00000	-1443.22900	-380.74901	-1119.71400
17	ENVEQ MAX	0.00000	0.00000	352.90814	0.00000
17	ENVEQ MAX	0.25000	0.00000	344.24983	0.00000
17	ENVEQ MAX	0.50000	0.00000	333.80402	0.00000
17	ENVEQ MAX	0.75000	0.00000	321.79408	0.00000

FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	0.00000	308.48329	0.00000
17	ENVEQ MIN	0.00000	-1708.44200	-216.16374	-1119.71400
17	ENVEQ MIN	0.25000	-1675.40100	-207.50543	-1078.62200
17	ENVEQ MIN	0.50000	-1642.36100	-197.05963	-1040.44500
17	ENVEQ MIN	0.75000	-1609.32000	-184.82633	-1005.69000
17	ENVEQ MIN	1.00000	-1576.28000	-170.80553	-974.86434
18	ENVEQ MAX	0.00000	0.00000	521.00509	0.00000
18	ENVEQ MAX	0.25000	0.00000	505.90814	0.00000
18	ENVEQ MAX	0.50000	0.00000	489.05141	0.00000
18	ENVEQ MAX	0.75000	0.00000	470.43488	0.00000
18	ENVEQ MAX	1.00000	0.00000	450.54130	0.00000
18	ENVEQ MIN	0.00000	-1847.90600	-48.24394	-974.86434
18	ENVEQ MIN	0.25000	-1814.83700	-32.43637	-1021.26900
18	ENVEQ MIN	0.50000	-1781.76700	-14.86901	-1142.94600
18	ENVEQ MIN	0.75000	-1748.69800	0.00000	-1279.35500
18	ENVEQ MIN	1.00000	-1715.62800	0.00000	-1410.22200
19	ENVEQ MAX	0.00000	0.00000	793.21842	0.00000
19	ENVEQ MAX	0.25000	0.00000	771.08231	0.00000
19	ENVEQ MAX	0.50000	0.00000	747.59824	0.00000
19	ENVEQ MAX	0.75000	0.00000	722.65317	0.00000
19	ENVEQ MAX	1.00000	0.00000	695.94831	0.00000
19	ENVEQ MIN	0.00000	-1994.21900	0.00000	-1410.22200
19	ENVEQ MIN	0.25000	-1961.14900	0.00000	-1632.59000
19	ENVEQ MIN	0.50000	-1928.08000	0.00000	-1848.41500
19	ENVEQ MIN	0.75000	-1895.01000	0.00000	-2057.19800
19	ENVEQ MIN	1.00000	-1861.94000	0.00000	-2258.43900
20	ENVEQ MAX	0.00000	0.00000	1095.71400	0.00000
20	ENVEQ MAX	0.25000	0.00000	1071.48000	0.00000
20	ENVEQ MAX	0.50000	0.00000	1045.99200	0.00000
20	ENVEQ MAX	0.75000	0.00000	1019.24800	0.00000
20	ENVEQ MAX	1.00000	0.00000	991.24918	0.00000
20	ENVEQ MIN	0.00000	-2148.06700	0.00000	-2258.43900
20	ENVEQ MIN	0.25000	-2119.76800	0.00000	-2521.84300
20	ENVEQ MIN	0.50000	-2091.46800	0.00000	-2779.05200
20	ENVEQ MIN	0.75000	-2071.67600	0.00000	-3029.76000
20	ENVEQ MIN	1.00000	-2075.16400	0.00000	-3273.66200
21	ENVEQ MAX	0.00000	0.00000	991.24934	0.00000
21	ENVEQ MAX	0.25000	0.00000	986.43484	0.00000
21	ENVEQ MAX	0.50000	0.00000	981.58252	0.00000
21	ENVEQ MAX	0.75000	0.00000	976.69237	0.00000
21	ENVEQ MAX	1.00000	0.00000	971.76440	0.00000
21	ENVEQ MIN	0.00000	-2075.16500	0.00000	-3273.66200
21	ENVEQ MIN	0.25000	-2075.72400	0.00000	-3313.83400
21	ENVEQ MIN	0.50000	-2076.23400	0.00000	-3353.80500
21	ENVEQ MIN	0.75000	-2076.69300	0.00000	-3393.57300
21	ENVEQ MIN	1.00000	-2077.10300	0.00000	-3433.13700
22	ENVEQ MAX	0.00000	0.00000	1310.85900	0.00000
22	ENVEQ MAX	0.25000	0.00000	1300.55800	0.00000
22	ENVEQ MAX	0.50000	0.00000	1290.10900	0.00000
22	ENVEQ MAX	0.75000	0.00000	1279.51100	0.00000
22	ENVEQ MAX	1.00000	0.00000	1268.76600	0.00000
22	ENVEQ MIN	0.00000	-2333.66600	0.00000	-3433.13700
22	ENVEQ MIN	0.25000	-2334.35500	0.00000	-3542.91500
22	ENVEQ MIN	0.50000	-2334.83100	0.00000	-3651.80200
22	ENVEQ MIN	0.75000	-2335.09500	0.00000	-3759.78300
22	ENVEQ MIN	1.00000	-2335.14500	0.00000	-3866.84900
23	ENVEQ MAX	0.00000	0.00000	1268.76700	0.00000
23	ENVEQ MAX	0.10937	0.00000	1257.44900	0.00000
23	ENVEQ MAX	0.21875	0.00000	1245.97000	0.00000
23	ENVEQ MAX	0.32812	0.00000	1234.32900	0.00000
23	ENVEQ MAX	0.43750	0.00000	1222.52600	0.00000
23	ENVEQ MIN	0.00000	-2335.14600	0.00000	-3866.84900
23	ENVEQ MIN	0.10937	-2335.08800	0.00000	-3977.06000
23	ENVEQ MIN	0.21875	-2335.03000	0.00000	-4086.25500
23	ENVEQ MIN	0.32812	-2334.97300	0.00000	-4194.41900
23	ENVEQ MIN	0.43750	-2334.91500	0.00000	-4301.53800
24	ENVEQ MAX	0.64706	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.73529	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.82353	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.91176	0.00000	0.00000	0.00000
24	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
24	ENVEQ MIN	0.64706	-1288.89300	-2127.58600	-3610.35700
24	ENVEQ MIN	0.73529	-1284.21200	-2099.36700	-3451.84600
24	ENVEQ MIN	0.82353	-1279.53200	-2071.14900	-3295.45200
24	ENVEQ MIN	0.91176	-1274.85100	-2042.93000	-3141.17400
24	ENVEQ MIN	1.00000	-1270.17100	-2014.71100	-2989.01200
25	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
25	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
25	ENVEQ MIN	0.00000	-1270.17000	-2014.71200	-2989.01200
25	ENVEQ MIN	0.25000	-1267.37800	-1997.90500	-2899.23000
25	ENVEQ MIN	0.50000	-1264.58500	-1981.15800	-2810.19900
25	ENVEQ MIN	0.75000	-1261.79200	-1964.47200	-2721.91500
25	ENVEQ MIN	1.00000	-1258.99900	-1947.84500	-2634.37700
26	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
26	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
26	ENVEQ MIN	0.00000	-1289.29400	-1947.74100	-2634.37700
26	ENVEQ MIN	0.25000	-1284.28600	-1918.07500	-2479.26300
26	ENVEQ MIN	0.50000	-1279.27800	-1888.60200	-2326.52100
26	ENVEQ MIN	0.75000	-1274.27000	-1859.32200	-2176.13700
26	ENVEQ MIN	1.00000	-1269.26100	-1830.23600	-2028.09500
27	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.75000	0.00000	0.00000	39.23809
27	ENVEQ MAX	1.00000	0.00000	0.00000	143.04479
27	ENVEQ MIN	0.00000	-1269.26100	-1830.23700	-2028.09500
27	ENVEQ MIN	0.25000	-1258.21500	-1766.29600	-1709.80200
27	ENVEQ MIN	0.50000	-1247.16900	-1702.35500	-1402.82600
27	ENVEQ MIN	0.75000	-1236.12300	-1638.41400	-1107.68100
27	ENVEQ MIN	1.00000	-1225.07600	-1574.47400	-828.37218
28	ENVEQ MAX	0.00000	0.00000	0.00000	143.04481
28	ENVEQ MAX	0.25000	0.00000	0.00000	289.31995
28	ENVEQ MAX	0.50000	0.00000	0.00000	577.79038
28	ENVEQ MAX	0.75000	0.00000	0.00000	875.32718
28	ENVEQ MAX	1.00000	0.00000	0.00000	1148.91100
28	ENVEQ MIN	0.00000	-1258.20300	-1574.32900	-828.37218
28	ENVEQ MIN	0.25000	-1242.13300	-1481.30800	-441.72008
28	ENVEQ MIN	0.50000	-1226.06300	-1388.28600	-195.43566
28	ENVEQ MIN	0.75000	-1209.99300	-1295.26500	-28.03511
28	ENVEQ MIN	1.00000	-1193.92300	-1202.24400	0.00000
29	ENVEQ MAX	0.00000	0.00000	0.00000	1148.91100
29	ENVEQ MAX	0.25000	0.00000	0.00000	1398.26300
29	ENVEQ MAX	0.50000	0.00000	0.00000	1623.70800
29	ENVEQ MAX	0.75000	0.00000	0.00000	1828.35800
29	ENVEQ MAX	1.00000	0.00000	0.00000	2009.54000
29	ENVEQ MIN	0.00000	-1229.89400	-1202.05500	0.00000
29	ENVEQ MIN	0.25000	-1213.83900	-1109.12400	0.00000
29	ENVEQ MIN	0.50000	-1197.78500	-1016.19300	0.00000
29	ENVEQ MIN	0.75000	-1181.73000	-923.26207	0.00000
29	ENVEQ MIN	1.00000	-1165.67600	-830.33123	0.00000
30	ENVEQ MAX	0.00000	0.00000	0.00000	2009.54000
30	ENVEQ MAX	0.25000	0.00000	0.00000	2166.75600
30	ENVEQ MAX	0.50000	0.00000	0.00000	2300.06500
30	ENVEQ MAX	0.75000	0.00000	0.00000	2409.46800
30	ENVEQ MAX	1.00000	0.00000	0.00000	2494.96500
30	ENVEQ MIN	0.00000	-1204.42300	-830.10258	0.00000
30	ENVEQ MIN	0.25000	-1188.36900	-737.17174	0.00000
30	ENVEQ MIN	0.50000	-1172.31400	-644.24090	0.00000
30	ENVEQ MIN	0.75000	-1156.26000	-552.18829	0.00000
30	ENVEQ MIN	1.00000	-1144.11000	-461.82994	0.00000
31	ENVEQ MAX	0.00000	0.00000	0.00000	2494.96500
31	ENVEQ MAX	0.25000	0.00000	0.00000	2556.48900
31	ENVEQ MAX	0.50000	0.00000	2.53418	2594.10700
31	ENVEQ MAX	0.75000	0.00000	45.00976	2607.81900
31	ENVEQ MAX	1.00000	0.00000	104.73122	2597.62400
31	ENVEQ MIN	0.00000	-1181.67000	-461.57777	0.00000
31	ENVEQ MIN	0.25000	-1165.61600	-371.21943	0.00000
31	ENVEQ MIN	0.50000	-1149.56100	-280.86109	0.00000
31	ENVEQ MIN	0.75000	-1145.52600	-190.50274	0.00000
31	ENVEQ MIN	1.00000	-1161.58100	-100.14440	0.00000
32	ENVEQ MAX	0.00000	0.00000	100.14722	2597.62400
32	ENVEQ MAX	0.25000	0.00000	190.50556	2607.81800
32	ENVEQ MAX	0.50000	0.00000	280.86390	2594.10600
32	ENVEQ MAX	0.75000	0.00000	371.22224	2556.48700
32	ENVEQ MAX	1.00000	0.00000	461.58058	2494.96200
32	ENVEQ MIN	0.00000	-1161.58100	-104.72916	0.00000
32	ENVEQ MIN	0.25000	-1145.52700	-45.00864	0.00000
32	ENVEQ MIN	0.50000	-1149.56100	-2.53306	0.00000
32	ENVEQ MIN	0.75000	-1165.61500	0.00000	0.00000
32	ENVEQ MIN	1.00000	-1181.67000	0.00000	0.00000
33	ENVEQ MAX	0.00000	0.00000	461.83276	2494.96200
33	ENVEQ MAX	0.25000	0.00000	552.19110	2409.46400
33	ENVEQ MAX	0.50000	0.00000	644.24374	2300.06000
33	ENVEQ MAX	0.75000	0.00000	737.17459	2166.75000
33	ENVEQ MAX	1.00000	0.00000	830.10543	2009.53300
33	ENVEQ MIN	0.00000	-1144.11000	0.00000	0.00000
33	ENVEQ MIN	0.25000	-1156.25900	0.00000	0.00000
33	ENVEQ MIN	0.50000	-1172.31400	0.00000	0.00000
33	ENVEQ MIN	0.75000	-1188.36800	0.00000	0.00000
33	ENVEQ MIN	1.00000	-1204.42300	0.00000	0.00000
34	ENVEQ MAX	0.00000	0.00000	830.33407	2009.53300
34	ENVEQ MAX	0.25000	0.00000	923.35522	1828.16300
34	ENVEQ MAX	0.50000	0.00000	1016.37600	1623.28600
34	ENVEQ MAX	0.75000	0.00000	1109.39800	1397.56200
34	ENVEQ MAX	1.00000	0.00000	1202.41900	1147.88600
34	ENVEQ MIN	0.00000	-1165.67500	0.00000	0.00000
34	ENVEQ MIN	0.25000	-1181.74600	0.00000	0.00000
34	ENVEQ MIN	0.50000	-1197.81600	0.00000	0.00000
34	ENVEQ MIN	0.75000	-1213.88600	0.00000	0.00000
34	ENVEQ MIN	1.00000	-1229.95600	0.00000	0.00000
35	ENVEQ MAX	0.00000	0.00000	1202.60800	1147.88600
35	ENVEQ MAX	0.25000	0.00000	1295.53900	874.48583

FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	1388.47000	577.17911
35	ENVEQ MAX	0.75000	0.00000	1481.40100	289.11484
35	ENVEQ MAX	1.00000	0.00000	1574.33200	143.03866
35	ENVEQ MIN	0.00000	-1193.98700	0.00000	0.00000
35	ENVEQ MIN	0.25000	-1210.04200	0.00000	-28.50434
35	ENVEQ MIN	0.50000	-1226.09600	0.00000	-195.78104
35	ENVEQ MIN	0.75000	-1242.15100	0.00000	-442.09449
35	ENVEQ MIN	1.00000	-1258.20500	0.00000	-828.38320
36	ENVEQ MAX	0.00000	0.00000	1574.47600	143.03865
36	ENVEQ MAX	0.25000	0.00000	1638.41700	39.23168
36	ENVEQ MAX	0.50000	0.00000	1702.35800	0.00000
36	ENVEQ MAX	0.75000	0.00000	1766.29900	0.00000
36	ENVEQ MAX	1.00000	0.00000	1830.23900	0.00000
36	ENVEQ MIN	0.00000	-1225.07900	0.00000	-828.38320
36	ENVEQ MIN	0.25000	-1236.12500	0.00000	-1107.69200
36	ENVEQ MIN	0.50000	-1247.17100	0.00000	-1402.83800
36	ENVEQ MIN	0.75000	-1258.21700	0.00000	-1709.81400
36	ENVEQ MIN	1.00000	-1269.26400	0.00000	-2028.10800
37	ENVEQ MAX	0.00000	0.00000	1830.23900	0.00000
37	ENVEQ MAX	0.25000	0.00000	1859.32500	0.00000
37	ENVEQ MAX	0.50000	0.00000	1888.60500	0.00000
37	ENVEQ MAX	0.75000	0.00000	1918.07800	0.00000
37	ENVEQ MAX	1.00000	0.00000	1947.74400	0.00000
37	ENVEQ MIN	0.00000	-1269.26400	0.00000	-2028.10800
37	ENVEQ MIN	0.25000	-1274.27200	0.00000	-2176.15000
37	ENVEQ MIN	0.50000	-1279.28000	0.00000	-2326.53500
37	ENVEQ MIN	0.75000	-1284.28800	0.00000	-2479.27700
37	ENVEQ MIN	1.00000	-1289.29700	0.00000	-2634.39200
38	ENVEQ MAX	0.00000	0.00000	1947.84800	0.00000
38	ENVEQ MAX	0.25000	0.00000	1964.47500	0.00000
38	ENVEQ MAX	0.50000	0.00000	1981.16100	0.00000
38	ENVEQ MAX	0.75000	0.00000	1997.90800	0.00000
38	ENVEQ MAX	1.00000	0.00000	2014.71500	0.00000
38	ENVEQ MIN	0.00000	-1259.00200	0.00000	-2634.39200
38	ENVEQ MIN	0.25000	-1261.79500	0.00000	-2721.93000
38	ENVEQ MIN	0.50000	-1264.58700	0.00000	-2810.21300
38	ENVEQ MIN	0.75000	-1267.38000	0.00000	-2899.24400
38	ENVEQ MIN	1.00000	-1270.17300	0.00000	-2989.02700
39	ENVEQ MAX	0.00000	0.00000	2014.71400	0.00000
39	ENVEQ MAX	0.08824	0.00000	2042.93300	0.00000
39	ENVEQ MAX	0.17647	0.00000	2071.15100	0.00000
39	ENVEQ MAX	0.26471	0.00000	2099.37000	0.00000
39	ENVEQ MAX	0.35294	0.00000	2127.58800	0.00000
39	ENVEQ MIN	0.00000	-1270.17300	0.00000	-2989.02700
39	ENVEQ MIN	0.08824	-1274.85400	0.00000	-3141.18800
39	ENVEQ MIN	0.17647	-1279.53400	0.00000	-3295.46600
39	ENVEQ MIN	0.26471	-1284.21500	0.00000	-3451.86100
39	ENVEQ MIN	0.35294	-1288.89500	0.00000	-3610.37200
40	ENVEQ MAX	0.56250	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.67188	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.78125	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.89063	0.00000	0.00000	0.00000
40	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
40	ENVEQ MIN	0.56250	-2334.91800	-1222.52900	-4301.55400
40	ENVEQ MIN	0.67188	-2334.97500	-1234.33200	-4194.43400
40	ENVEQ MIN	0.78125	-2335.03300	-1245.97300	-4086.27000
40	ENVEQ MIN	0.89063	-2335.09100	-1257.45200	-3977.07500
40	ENVEQ MIN	1.00000	-2335.14900	-1268.76900	-3866.86300
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
41	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	-2335.14800	-1268.76900	-3866.86300
41	ENVEQ MIN	0.25000	-2335.09700	-1279.51400	-3759.79800
41	ENVEQ MIN	0.50000	-2334.83400	-1290.11100	-3651.81600
41	ENVEQ MIN	0.75000	-2334.35800	-1300.56100	-3542.92900
41	ENVEQ MIN	1.00000	-2333.66900	-1310.86200	-3433.15100
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
42	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	-2077.11000	-971.76639	-3433.15100
42	ENVEQ MIN	0.25000	-2076.70000	-976.69436	-3393.58700
42	ENVEQ MIN	0.50000	-2076.24000	-981.58451	-3353.81800
42	ENVEQ MIN	0.75000	-2075.73100	-986.43683	-3313.84700
42	ENVEQ MIN	1.00000	-2075.17200	-991.25133	-3273.67500
43	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
43	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
43	ENVEQ MIN	0.00000	-2075.17100	-991.25117	-3273.67500
43	ENVEQ MIN	0.25000	-2071.68300	-1019.25000	-3029.77200
43	ENVEQ MIN	0.50000	-2091.47700	-1045.99400	-2779.06400
43	ENVEQ MIN	0.75000	-2119.77600	-1071.48200	-2521.85500
43	ENVEQ MIN	1.00000	-2148.07600	-1095.71600	-2258.45000
44	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
44	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
44	ENVEQ MIN	0.00000	-1861.95500	-695.94861	-2258.45000
44	ENVEQ MIN	0.25000	-1895.02500	-722.65347	-2057.21000
44	ENVEQ MIN	0.50000	-1928.09400	-747.59854	-1848.42600
44	ENVEQ MIN	0.75000	-1961.16400	-771.08260	-1632.60100
44	ENVEQ MIN	1.00000	-1994.23400	-793.21872	-1410.23300
45	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
45	ENVEQ MAX	0.50000	0.00000	14.86929	0.00000
45	ENVEQ MAX	0.75000	0.00000	32.43665	0.00000
45	ENVEQ MAX	1.00000	0.00000	48.24422	0.00000
45	ENVEQ MIN	0.00000	-1715.64900	-450.53972	-1410.23300
45	ENVEQ MIN	0.25000	-1748.71800	-470.43331	-1279.36600
45	ENVEQ MIN	0.50000	-1781.78800	-489.04983	-1142.95800
45	ENVEQ MIN	0.75000	-1814.85800	-505.90657	-1021.28100
45	ENVEQ MIN	1.00000	-1847.92700	-521.00351	-974.87707
46	ENVEQ MAX	0.00000	0.00000	170.80673	0.00000
46	ENVEQ MAX	0.25000	0.00000	184.82752	0.00000
46	ENVEQ MAX	0.50000	0.00000	197.06082	0.00000
46	ENVEQ MAX	0.75000	0.00000	207.50663	0.00000
46	ENVEQ MAX	1.00000	0.00000	216.16493	0.00000
46	ENVEQ MIN	0.00000	-1576.30600	-308.48022	-974.87707
46	ENVEQ MIN	0.25000	-1609.34700	-321.79102	-1005.70300
46	ENVEQ MIN	0.50000	-1642.38700	-333.80103	-1040.45900
46	ENVEQ MIN	0.75000	-1675.42800	-344.24683	-1078.63700
46	ENVEQ MIN	1.00000	-1708.46900	-352.90514	-1119.73000
47	ENVEQ MAX	0.00000	0.00000	380.75118	0.00000
47	ENVEQ MAX	0.25000	0.00000	383.39758	0.00000
47	ENVEQ MAX	0.50000	0.00000	385.88748	16.96913
47	ENVEQ MAX	0.75000	0.00000	388.22089	42.86615
47	ENVEQ MAX	1.00000	0.00000	390.39781	68.91767
47	ENVEQ MIN	0.00000	-1443.26200	-324.81701	-1119.73000
47	ENVEQ MIN	0.25000	-1453.06300	-327.04216	-1151.58000
47	ENVEQ MIN	0.50000	-1462.86500	-329.11081	-1183.62900
47	ENVEQ MIN	0.75000	-1472.66700	-331.02297	-1215.86400
47	ENVEQ MIN	1.00000	-1482.46800	-332.77863	-1248.36500
48	ENVEQ MAX	0.00000	0.00000	390.39781	68.91768
48	ENVEQ MAX	0.13281	0.00000	392.91928	101.99637
48	ENVEQ MAX	0.26563	0.00000	395.19031	135.27322
48	ENVEQ MAX	0.39844	0.00000	397.21092	168.72162
48	ENVEQ MAX	0.53125	0.00000	398.98109	202.31496
48	ENVEQ MIN	0.00000	-1482.46800	-332.77859	-1248.36500
48	ENVEQ MIN	0.13281	-1494.82900	-334.76881	-1289.89000
48	ENVEQ MIN	0.26563	-1507.19000	-336.50860	-1331.67000
48	ENVEQ MIN	0.39844	-1519.55100	-337.99795	-1373.67900
48	ENVEQ MIN	0.53125	-1531.91300	-339.23687	-1415.88800

20. OUTPUT DATA (붕괴방지)

1) 계수하중

F R A M E E L E M E N T F O R C E S

FRAME	LOAD	DIST	P	V2	M3
1	ENVEQ MAX	0.52941	393.53450	0.00000	328.85233
1	ENVEQ MAX	0.64706	385.74530	0.00000	355.78577
1	ENVEQ MAX	0.76471	377.95610	0.00000	383.07920
1	ENVEQ MAX	0.88235	370.16690	0.00000	410.73264
1	ENVEQ MAX	1.00000	362.37770	0.00000	438.74607
1	ENVEQ MIN	0.52941	-381.84400	-1172.28600	-1630.79000
1	ENVEQ MIN	0.64706	-374.05480	-1177.08600	-1513.32100
1	ENVEQ MIN	0.76471	-366.26560	-1181.88600	-1395.37300
1	ENVEQ MIN	0.88235	-358.47640	-1186.68600	-1276.94400
1	ENVEQ MIN	1.00000	-350.68720	-1191.48600	-1158.03600
2	ENVEQ MAX	0.00000	362.37770	0.00000	438.74606
2	ENVEQ MAX	0.25000	358.89203	0.00000	451.37124
2	ENVEQ MAX	0.50000	355.40637	0.00000	464.06851
2	ENVEQ MAX	0.75000	351.92070	0.00000	477.39504
2	ENVEQ MAX	1.00000	348.43503	0.00000	490.91567
2	ENVEQ MIN	0.00000	-350.68720	-1191.48600	-1158.03600
2	ENVEQ MIN	0.25000	-347.20153	-1193.63400	-1104.66800
2	ENVEQ MIN	0.50000	-343.71587	-1195.78200	-1051.20500
2	ENVEQ MIN	0.75000	-340.23020	-1197.93000	-997.82557
2	ENVEQ MIN	1.00000	-336.74453	-1200.07800	-944.47875
3	ENVEQ MAX	0.00000	362.97796	0.00000	490.91567
3	ENVEQ MAX	0.25000	342.94024	0.00000	529.78674
3	ENVEQ MAX	0.50000	322.90252	0.00000	604.32102
3	ENVEQ MAX	0.75000	302.86481	0.00000	736.92277
3	ENVEQ MAX	1.00000	282.82709	0.00000	875.00060
3	ENVEQ MIN	0.00000	-351.50130	-835.37484	-944.47875
3	ENVEQ MIN	0.25000	-331.46359	-847.72284	-729.36604
3	ENVEQ MIN	0.50000	-311.42587	-860.07084	-553.47742
3	ENVEQ MIN	0.75000	-291.38815	-872.41884	-421.93602
3	ENVEQ MIN	1.00000	-271.35044	-884.76684	-288.01224
4	ENVEQ MAX	0.00000	297.66237	0.00000	875.00060
4	ENVEQ MAX	0.25000	277.62465	0.00000	951.77696
4	ENVEQ MAX	0.50000	257.58694	0.00000	1031.73000
4	ENVEQ MAX	0.75000	237.54922	0.00000	1114.85900
4	ENVEQ MAX	1.00000	217.51150	0.00000	1201.16500
4	ENVEQ MIN	0.00000	-286.38917	-578.22857	-288.01224
4	ENVEQ MIN	0.25000	-266.35145	-590.57657	-199.07065
4	ENVEQ MIN	0.50000	-246.31373	-602.92457	-107.75785
4	ENVEQ MIN	0.75000	-226.27602	-615.27257	-14.06266
4	ENVEQ MIN	1.00000	-206.23830	-627.62057	0.00000
5	ENVEQ MAX	0.00000	232.58000	3.81108	1201.16500
5	ENVEQ MAX	0.25000	212.52281	0.00000	1239.09400
5	ENVEQ MAX	0.50000	192.46562	0.00000	1280.20500
5	ENVEQ MAX	0.75000	172.40843	0.00000	1324.49900
5	ENVEQ MAX	1.00000	152.35124	0.00000	1371.97600
5	ENVEQ MIN	0.00000	-221.50004	-378.69701	0.00000
5	ENVEQ MIN	0.25000	-201.44285	-391.05701	0.00000
5	ENVEQ MIN	0.50000	-181.38566	-403.41701	0.00000
5	ENVEQ MIN	0.75000	-161.32847	-415.77701	0.00000
5	ENVEQ MIN	1.00000	-141.27128	-428.13701	0.00000
6	ENVEQ MAX	0.00000	167.59416	47.65374	1371.97600
6	ENVEQ MAX	0.25000	147.55645	38.39274	1380.59600
6	ENVEQ MAX	0.50000	127.51873	29.13174	1392.39300
6	ENVEQ MAX	0.75000	107.48101	19.87074	1407.36700
6	ENVEQ MAX	1.00000	87.44330	10.60974	1425.51700
6	ENVEQ MIN	0.00000	-156.69741	-228.50122	0.00000
6	ENVEQ MIN	0.25000	-136.65969	-240.84922	0.00000
6	ENVEQ MIN	0.50000	-116.62198	-253.19722	0.00000
6	ENVEQ MIN	0.75000	-96.58426	-265.54522	0.00000
6	ENVEQ MIN	1.00000	-76.54654	-277.89322	0.00000
7	ENVEQ MAX	0.00000	102.80168	87.85923	1425.51700
7	ENVEQ MAX	0.25000	82.76396	78.59823	1409.68100
7	ENVEQ MAX	0.50000	62.72624	69.33723	1397.02200
7	ENVEQ MAX	0.75000	42.68852	60.07623	1387.54000
7	ENVEQ MAX	1.00000	38.06617	50.81523	1381.23300
7	ENVEQ MIN	0.00000	-92.48382	-113.94385	0.00000
7	ENVEQ MIN	0.25000	-72.44611	-126.29185	0.00000
7	ENVEQ MIN	0.50000	-52.40839	-138.63985	0.00000
7	ENVEQ MIN	0.75000	-32.37067	-150.98785	0.00000
7	ENVEQ MIN	1.00000	-28.54738	-163.33585	0.00000
8	ENVEQ MAX	0.00000	38.06598	163.31248	1381.23300
8	ENVEQ MAX	0.25000	42.68840	150.96448	1387.53700
8	ENVEQ MAX	0.50000	62.72612	138.61648	1397.02600
8	ENVEQ MAX	0.75000	82.76383	126.26848	1409.69100
8	ENVEQ MAX	1.00000	102.80155	113.92048	1425.53200
8	ENVEQ MIN	0.00000	-28.54723	-50.82870	0.00000
8	ENVEQ MIN	0.25000	-32.37106	-60.08970	0.00000
8	ENVEQ MIN	0.50000	-52.40878	-69.35070	0.00000
8	ENVEQ MIN	0.75000	-72.44649	-78.61170	0.00000
8	ENVEQ MIN	1.00000	-92.48421	-87.87270	0.00000
9	ENVEQ MAX	0.00000	87.44286	277.87108	1425.53200
9	ENVEQ MAX	0.25000	107.48057	265.52308	1407.38800
9	ENVEQ MAX	0.50000	127.51829	253.17508	1392.42000
9	ENVEQ MAX	0.75000	147.55601	240.82708	1380.62800
9	ENVEQ MAX	1.00000	167.59372	228.47908	1372.01300
9	ENVEQ MIN	0.00000	-76.54725	-10.62188	0.00000
9	ENVEQ MIN	0.25000	-96.58496	-19.88288	0.00000
9	ENVEQ MIN	0.50000	-116.62268	-29.14388	0.00000
9	ENVEQ MIN	0.75000	-136.66040	-38.40488	0.00000
9	ENVEQ MIN	1.00000	-156.69811	-47.66588	0.00000
10	ENVEQ MAX	0.00000	152.35049	428.11807	1372.01300
10	ENVEQ MAX	0.25000	172.38820	415.77007	1324.58500
10	ENVEQ MAX	0.50000	192.42592	403.42207	1280.33400
10	ENVEQ MAX	0.75000	212.46364	391.07407	1239.26000
10	ENVEQ MAX	1.00000	232.50135	378.72607	1201.36200
10	ENVEQ MIN	0.00000	-141.27216	0.00000	0.00000
10	ENVEQ MIN	0.25000	-161.30988	0.00000	0.00000
10	ENVEQ MIN	0.50000	-181.34760	0.00000	0.00000
10	ENVEQ MIN	0.75000	-201.38531	0.00000	0.00000
10	ENVEQ MIN	1.00000	-221.42303	-3.78588	0.00000
11	ENVEQ MAX	0.00000	217.43234	627.60347	1201.36200
11	ENVEQ MAX	0.25000	237.48953	615.24347	1114.97600
11	ENVEQ MAX	0.50000	257.54672	602.88347	1031.77200
11	ENVEQ MAX	0.75000	277.60391	590.52347	951.75168
11	ENVEQ MAX	1.00000	297.66110	578.16347	874.91369
11	ENVEQ MIN	0.00000	-206.16127	0.00000	0.00000
11	ENVEQ MIN	0.25000	-226.21846	0.00000	-13.87242
11	ENVEQ MIN	0.50000	-246.27565	0.00000	-107.65534
11	ENVEQ MIN	0.75000	-266.33284	0.00000	-199.05124
11	ENVEQ MIN	1.00000	-286.39003	0.00000	-288.07310
12	ENVEQ MAX	0.00000	282.82549	884.71133	874.91369
12	ENVEQ MAX	0.25000	302.86320	872.36333	736.84960
12	ENVEQ MAX	0.50000	322.90092	860.01533	604.25998
12	ENVEQ MAX	0.75000	342.93864	847.66733	529.76388
12	ENVEQ MAX	1.00000	362.97636	835.31933	490.89875
12	ENVEQ MIN	0.00000	-271.35147	0.00000	-288.07310
12	ENVEQ MIN	0.25000	-291.38918	0.00000	-421.98905
12	ENVEQ MIN	0.50000	-311.42690	0.00000	-553.52259
12	ENVEQ MIN	0.75000	-331.46462	0.00000	-729.42997
12	ENVEQ MIN	1.00000	-351.50233	0.00000	-944.52847
13	ENVEQ MAX	0.00000	348.43310	1200.03200	490.89875
13	ENVEQ MAX	0.25000	351.91876	1197.88400	477.37898
13	ENVEQ MAX	0.50000	355.40443	1195.73600	464.05394
13	ENVEQ MAX	0.75000	358.89010	1193.58800	451.35749
13	ENVEQ MAX	1.00000	362.37577	1191.44000	438.73313
13	ENVEQ MIN	0.00000	-336.74573	0.00000	-944.52847
13	ENVEQ MIN	0.25000	-340.23140	0.00000	-997.87327
13	ENVEQ MIN	0.50000	-343.71706	0.00000	-1051.25100
13	ENVEQ MIN	0.75000	-347.20273	0.00000	-1104.71200
13	ENVEQ MIN	1.00000	-350.68840	0.00000	-1158.07700
14	ENVEQ MAX	0.00000	362.37577	1191.44100	438.73314
14	ENVEQ MAX	0.11765	370.16497	1186.64100	410.72153
14	ENVEQ MAX	0.23529	377.95417	1181.84100	383.06993
14	ENVEQ MAX	0.35294	385.74337	1177.04100	355.77832
14	ENVEQ MAX	0.47059	393.53257	1172.24100	328.84671
14	ENVEQ MIN	0.00000	-350.68840	0.00000	-1158.07700
14	ENVEQ MIN	0.11765	-358.47760	0.00000	-1276.98100
14	ENVEQ MIN	0.23529	-366.26680	0.00000	-1395.40500
14	ENVEQ MIN	0.35294	-374.05600	0.00000	-1513.35000
14	ENVEQ MIN	0.47059	-381.84520	0.00000	-1630.81400
15	ENVEQ MAX	0.46875	0.00000	425.33566	72.63941
15	ENVEQ MAX	0.60156	0.00000	423.96005	33.38892
15	ENVEQ MAX	0.73438	0.00000	422.38334	0.00000
15	ENVEQ MAX	0.86719	0.00000	420.60555	0.00000
15	ENVEQ MAX	1.00000	0.00000	418.62668	0.00000
15	ENVEQ MIN	0.46875	-1656.35600	-329.23219	-2046.31800
15	ENVEQ MIN	0.60156	-1645.41100	-327.85658	-2016.35500
15	ENVEQ MIN	0.73438	-1634.46700	-326.27987	-1986.60400
15	ENVEQ MIN	0.86719	-1623.52200	-324.50208	-1957.25400
15	ENVEQ MIN	1.00000	-1612.57700	-322.52321	-1928.55900
16	ENVEQ MAX	0.00000	0.00000	418.62678	0.00000
16	ENVEQ MAX	0.25000	0.00000	416.91482	0.00000
16	ENVEQ MAX	0.50000	0.00000	415.07665	0.00000
16	ENVEQ MAX	0.75000	0.00000	413.11228	0.00000
16	ENVEQ MAX	1.00000	0.00000	411.02170	0.00000
16	ENVEQ MIN	0.00000	-1612.57800	-322.52321	-1928.55900
16	ENVEQ MIN	0.25000	-1603.89900	-320.81125	-1905.98200
16	ENVEQ MIN	0.50000	-1595.22100	-318.97308	-1883.57200
16	ENVEQ MIN	0.75000	-1586.54200	-317.00871	-1861.34000
16	ENVEQ MIN	1.00000	-1577.86300	-314.91813	-1839.29700
17	ENVEQ MAX	0.00000	0.00000	459.51793	0.00000
17	ENVEQ MAX	0.25000	0.00000	451.54524	0.00000
17	ENVEQ MAX	0.50000	0.00000	442.14693	0.00000
17	ENVEQ MAX	0.75000	0.00000	431.32302	0.00000

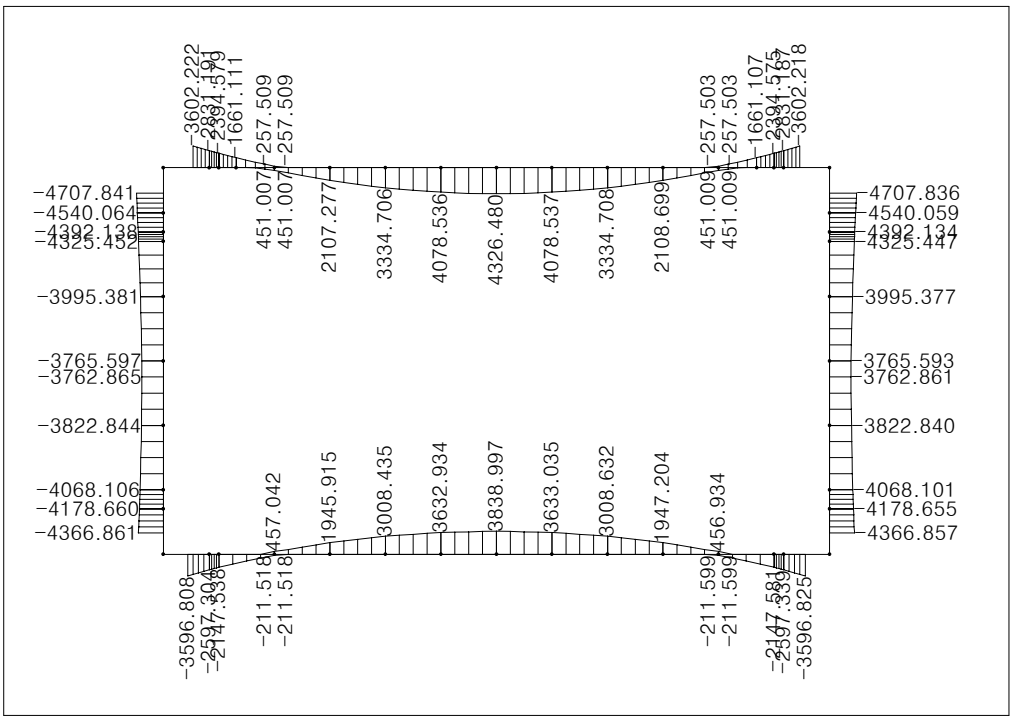
FRAME	LOAD	DIST	P	V2	M3
17	ENVEQ MAX	1.00000	0.00000	419.55482	0.00000
17	ENVEQ MIN	0.00000	-1802.26400	-236.20319	-1839.29700
17	ENVEQ MIN	0.25000	-1773.00900	-228.23049	-1803.01800
17	ENVEQ MIN	0.50000	-1743.75400	-218.83219	-1769.40700
17	ENVEQ MIN	0.75000	-1714.49900	-208.00827	-1738.86900
17	ENVEQ MIN	1.00000	-1685.24400	-195.75875	-1711.80900
18	ENVEQ MAX	0.00000	0.00000	568.66901	0.00000
18	ENVEQ MAX	0.25000	0.00000	555.69812	0.00000
18	ENVEQ MAX	0.50000	0.00000	541.31166	0.00000
18	ENVEQ MAX	0.75000	0.00000	525.50963	0.00000
18	ENVEQ MAX	1.00000	0.00000	508.52381	0.00000
18	ENVEQ MIN	0.00000	-1912.30500	-133.21861	-1711.80900
18	ENVEQ MIN	0.25000	-1883.02400	-119.53708	-1730.58200
18	ENVEQ MIN	0.50000	-1853.74400	-104.44000	-1769.74600
18	ENVEQ MIN	0.75000	-1824.46300	-87.92735	-1921.40100
18	ENVEQ MIN	1.00000	-1795.18200	-69.99913	-2068.36400
19	ENVEQ MAX	0.00000	0.00000	727.78980	0.00000
19	ENVEQ MAX	0.25000	0.00000	709.28519	0.00000
19	ENVEQ MAX	0.50000	0.00000	689.96425	0.00000
19	ENVEQ MAX	0.75000	0.00000	669.23919	0.00000
19	ENVEQ MAX	1.00000	0.00000	647.11001	0.00000
19	ENVEQ MIN	0.00000	-2025.07300	-40.34165	-2068.36400
19	ENVEQ MIN	0.25000	-1995.79300	-21.00359	-2272.62400
19	ENVEQ MIN	0.50000	-1966.51200	-0.26141	-2471.39000
19	ENVEQ MIN	0.75000	-1937.23200	0.00000	-2664.26200
19	ENVEQ MIN	1.00000	-1937.33000	0.00000	-2850.84100
20	ENVEQ MAX	0.00000	0.00000	892.70274	0.00000
20	ENVEQ MAX	0.25000	0.00000	872.65739	0.00000
20	ENVEQ MAX	0.50000	0.00000	851.59750	0.00000
20	ENVEQ MAX	0.75000	0.00000	829.52308	0.00000
20	ENVEQ MAX	1.00000	0.00000	806.43413	0.00000
20	ENVEQ MIN	0.00000	-2158.15600	0.00000	-2850.84100
20	ENVEQ MIN	0.25000	-2158.40100	0.00000	-3065.12300
20	ENVEQ MIN	0.50000	-2158.64700	0.00000	-3274.25700
20	ENVEQ MIN	0.75000	-2158.89300	0.00000	-3477.99800
20	ENVEQ MIN	1.00000	-2159.13900	0.00000	-3676.09700
21	ENVEQ MAX	0.00000	0.00000	806.43434	0.00000
21	ENVEQ MAX	0.25000	0.00000	802.46658	0.00000
21	ENVEQ MAX	0.50000	0.00000	798.46912	0.00000
21	ENVEQ MAX	0.75000	0.00000	794.44197	0.00000
21	ENVEQ MAX	1.00000	0.00000	790.38512	0.00000
21	ENVEQ MIN	0.00000	-2159.13900	0.00000	-3676.09700
21	ENVEQ MIN	0.25000	-2159.15500	0.00000	-3708.71400
21	ENVEQ MIN	0.50000	-2159.12200	0.00000	-3741.16500
21	ENVEQ MIN	0.75000	-2159.03800	0.00000	-3773.44800
21	ENVEQ MIN	1.00000	-2158.90500	0.00000	-3805.56200
22	ENVEQ MAX	0.00000	0.00000	1002.62500	0.00000
22	ENVEQ MAX	0.25000	0.00000	994.14697	0.00000
22	ENVEQ MAX	0.50000	0.00000	985.54965	0.00000
22	ENVEQ MAX	0.75000	0.00000	976.83292	0.00000
22	ENVEQ MAX	1.00000	0.00000	967.99676	0.00000
22	ENVEQ MIN	0.00000	-2383.00200	0.00000	-3805.56200
22	ENVEQ MIN	0.25000	-2382.56700	0.00000	-3889.33400
22	ENVEQ MIN	0.50000	-2381.92100	0.00000	-3972.36800
22	ENVEQ MIN	0.75000	-2381.06100	0.00000	-4054.65600
22	ENVEQ MIN	1.00000	-2379.98900	0.00000	-4136.18600
23	ENVEQ MAX	0.00000	0.00000	967.99691	0.00000
23	ENVEQ MAX	0.10937	0.00000	958.69276	0.00000
23	ENVEQ MAX	0.21875	0.00000	949.25840	0.00000
23	ENVEQ MAX	0.32812	0.00000	939.69383	0.00000
23	ENVEQ MAX	0.43750	0.00000	929.99905	0.00000
23	ENVEQ MIN	0.00000	-2379.99000	0.00000	-4136.18600
23	ENVEQ MIN	0.10937	-2378.76600	0.00000	-4220.04900
23	ENVEQ MIN	0.21875	-2377.54200	0.00000	-4303.07400
23	ENVEQ MIN	0.32812	-2376.31700	0.00000	-4385.24700
23	ENVEQ MIN	0.43750	-2375.09300	0.00000	-4466.55900
24	ENVEQ MAX	0.64706	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.73529	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.82353	0.00000	0.00000	0.00000
24	ENVEQ MAX	0.91176	0.00000	0.00000	0.00000
24	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
24	ENVEQ MIN	0.64706	-990.40879	-2161.78000	-3627.52700
24	ENVEQ MIN	0.73529	-986.38331	-2133.56100	-3466.45200
24	ENVEQ MIN	0.82353	-982.35784	-2105.34300	-3307.49300
24	ENVEQ MIN	0.91176	-978.33236	-2077.12400	-3150.65100
24	ENVEQ MIN	1.00000	-974.30689	-2048.90600	-2995.92500
25	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
25	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
25	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
25	ENVEQ MIN	0.00000	-974.30679	-2048.90700	-2995.92500
25	ENVEQ MIN	0.25000	-971.90492	-2032.10000	-2904.61200
25	ENVEQ MIN	0.50000	-969.50306	-2015.35300	-2814.05100
25	ENVEQ MIN	0.75000	-967.10119	-1998.66700	-2724.23700
25	ENVEQ MIN	1.00000	-964.69932	-1982.04000	-2635.16900
26	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
26	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
26	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
26	ENVEQ MIN	0.00000	-989.61141	-1981.96300	-2635.16900
26	ENVEQ MIN	0.25000	-985.30416	-1952.29700	-2477.30800
26	ENVEQ MIN	0.50000	-980.99690	-1922.82400	-2321.82000
26	ENVEQ MIN	0.75000	-976.68964	-1893.54400	-2168.69000
26	ENVEQ MIN	1.00000	-972.38238	-1864.45800	-2017.90100
27	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
27	ENVEQ MAX	0.25000	0.00000	0.00000	57.29466
27	ENVEQ MAX	0.50000	0.00000	0.00000	165.26666
27	ENVEQ MAX	0.75000	0.00000	0.00000	268.07857
27	ENVEQ MAX	1.00000	0.00000	0.00000	369.45009
27	ENVEQ MIN	0.00000	-972.38231	-1864.45900	-2017.90100
27	ENVEQ MIN	0.25000	-962.88219	-1800.51800	-1693.55100
27	ENVEQ MIN	0.50000	-953.38207	-1736.57700	-1381.71100
27	ENVEQ MIN	0.75000	-943.88195	-1672.63700	-1085.17000
27	ENVEQ MIN	1.00000	-934.38183	-1608.69600	-799.63333
28	ENVEQ MAX	0.00000	0.00000	0.00000	369.45009
28	ENVEQ MAX	0.25000	0.00000	0.00000	569.22496
28	ENVEQ MAX	0.50000	0.00000	0.00000	881.43712
28	ENVEQ MAX	0.75000	0.00000	0.00000	1169.71900
28	ENVEQ MAX	1.00000	0.00000	0.00000	1434.04700
28	ENVEQ MIN	0.00000	-960.14023	-1608.60200	-799.63333
28	ENVEQ MIN	0.25000	-946.31943	-1515.58100	-434.05793
28	ENVEQ MIN	0.50000	-932.49863	-1422.56000	-241.49598
28	ENVEQ MIN	0.75000	-918.67784	-1329.53800	-65.75180
28	ENVEQ MIN	1.00000	-904.85704	-1236.51700	0.00000
29	ENVEQ MAX	0.00000	0.00000	0.00000	1434.04700
29	ENVEQ MAX	0.25000	0.00000	0.00000	1674.17200
29	ENVEQ MAX	0.50000	0.00000	0.00000	1890.39100
29	ENVEQ MAX	0.75000	0.00000	0.00000	2085.65100
29	ENVEQ MAX	1.00000	0.00000	0.00000	2257.85100
29	ENVEQ MIN	0.00000	-931.46054	-1236.40500	0.00000
29	ENVEQ MIN	0.25000	-917.65316	-1143.47400	0.00000
29	ENVEQ MIN	0.50000	-903.84578	-1050.54300	0.00000
29	ENVEQ MIN	0.75000	-890.03840	-957.61265	0.00000
29	ENVEQ MIN	1.00000	-876.23102	-864.68181	0.00000
30	ENVEQ MAX	0.00000	0.00000	0.00000	2257.85100
30	ENVEQ MAX	0.25000	0.00000	0.00000	2406.11200
30	ENVEQ MAX	0.50000	0.00000	0.00000	2530.46600
30	ENVEQ MAX	0.75000	0.00000	0.00000	2630.91400
30	ENVEQ MAX	1.00000	0.00000	0.00000	2707.45600
30	ENVEQ MIN	0.00000	-903.65288	-864.55379	0.00000
30	ENVEQ MIN	0.25000	-889.84550	-771.62295	0.00000
30	ENVEQ MIN	0.50000	-876.03812	-678.69211	0.00000
30	ENVEQ MIN	0.75000	-862.23074	-587.60140	0.00000
30	ENVEQ MIN	1.00000	-848.42337	-497.24305	0.00000
31	ENVEQ MAX	0.00000	0.00000	0.00000	2707.45600
31	ENVEQ MAX	0.25000	0.00000	0.00000	2760.05500
31	ENVEQ MAX	0.50000	0.00000	37.41015	2788.74700
31	ENVEQ MAX	0.75000	0.00000	79.88573	2793.53400
31	ENVEQ MAX	1.00000	0.00000	139.43849	2774.41300
31	ENVEQ MIN	0.00000	-876.63840	-497.10596	0.00000
31	ENVEQ MIN	0.25000	-862.83102	-406.74762	0.00000
31	ENVEQ MIN	0.50000	-849.02364	-316.38927	0.00000
31	ENVEQ MIN	0.75000	-836.58243	-226.03093	0.00000
31	ENVEQ MIN	1.00000	-850.38981	-136.21858	0.00000
32	ENVEQ MAX	0.00000	0.00000	136.22234	2774.41300
32	ENVEQ MAX	0.25000	0.00000	226.03624	2793.53200
32	ENVEQ MAX	0.50000	0.00000	316.39459	2788.74400
32	ENVEQ MAX	0.75000	0.00000	406.75293	2760.05000
32	ENVEQ MAX	1.00000	0.00000	497.11127	2707.45000
32	ENVEQ MIN	0.00000	-850.39264	-139.43381	0.00000
32	ENVEQ MIN	0.25000	-836.58526	-79.88326	0.00000
32	ENVEQ MIN	0.50000	-849.02136	-37.40768	0.00000
32	ENVEQ MIN	0.75000	-862.82873	0.00000	0.00000
32	ENVEQ MIN	1.00000	-876.63611	0.00000	0.00000
33	ENVEQ MAX	0.00000	0.00000	497.24836	2707.45000
33	ENVEQ MAX	0.25000	0.00000	587.60671	2630.90700
33	ENVEQ MAX	0.50000	0.00000	678.69748	2530.45800
33	ENVEQ MAX	0.75000	0.00000	771.62832	2406.10200
33	ENVEQ MAX	1.00000	0.00000	864.55916	2257.84000
33	ENVEQ MIN	0.00000	-848.42162	0.00000	0.00000
33	ENVEQ MIN	0.25000	-862.22900	0.00000	0.00000
33	ENVEQ MIN	0.50000	-876.03638	0.00000	0.00000
33	ENVEQ MIN	0.75000	-889.84375	0.00000	0.00000
33	ENVEQ MIN	1.00000	-903.65113	0.00000	0.00000
34	ENVEQ MAX	0.00000	0.00000	864.68717	2257.84000
34	ENVEQ MAX	0.25000	0.00000	957.70833	2085.45900
34	ENVEQ MAX	0.50000	0.00000	1050.72900	1889.98000
34	ENVEQ MAX	0.75000	0.00000	1143.75100	1673.49200
34	ENVEQ MAX	1.00000	0.00000	1236.77200	1433.05000
34	ENVEQ MIN	0.00000	-876.22981	0.00000	0.00000
34	ENVEQ MIN	0.25000	-890.05061	0.00000	0.00000
34	ENVEQ MIN	0.50000	-903.87141	0.00000	0.00000
34	ENVEQ MIN	0.75000	-917.69220	0.00000	0.00000
34	ENVEQ MIN	1.00000	-931.51300	0.00000	0.00000
35	ENVEQ MAX	0.00000	0.00000	1236.88400	1433.05000
35	ENVEQ MAX	0.25000	0.00000	1329.81500	1168.89600

FRAME	LOAD	DIST	P	V2	M3
35	ENVEQ MAX	0.50000	0.00000	1422.74600	880.83452
35	ENVEQ MAX	0.75000	0.00000	1515.67600	568.88938
35	ENVEQ MAX	1.00000	0.00000	1608.60700	369.43819
35	ENVEQ MIN	0.00000	-904.91085	0.00000	0.00000
35	ENVEQ MIN	0.25000	-918.71823	0.00000	-66.25139
35	ENVEQ MIN	0.50000	-932.52561	0.00000	-241.86363
35	ENVEQ MIN	0.75000	-946.33299	0.00000	-434.31832
35	ENVEQ MIN	1.00000	-960.14037	0.00000	-799.65453
36	ENVEQ MAX	0.00000	0.00000	1608.70100	369.43819
36	ENVEQ MAX	0.25000	0.00000	1672.64200	268.06617
36	ENVEQ MAX	0.50000	0.00000	1736.58300	165.25415
36	ENVEQ MAX	0.75000	0.00000	1800.52300	57.28166
36	ENVEQ MAX	1.00000	0.00000	1864.46400	0.00000
36	ENVEQ MIN	0.00000	-934.38253	0.00000	-799.65453
36	ENVEQ MIN	0.25000	-943.88265	0.00000	-1085.19200
36	ENVEQ MIN	0.50000	-953.38277	0.00000	-1381.73400
36	ENVEQ MIN	0.75000	-962.88289	0.00000	-1693.57500
36	ENVEQ MIN	1.00000	-972.38301	0.00000	-2017.92700
37	ENVEQ MAX	0.00000	0.00000	1864.46300	0.00000
37	ENVEQ MAX	0.25000	0.00000	1893.55000	0.00000
37	ENVEQ MAX	0.50000	0.00000	1922.82900	0.00000
37	ENVEQ MAX	0.75000	0.00000	1952.30200	0.00000
37	ENVEQ MAX	1.00000	0.00000	1981.96800	0.00000
37	ENVEQ MIN	0.00000	-972.38308	0.00000	-2017.92700
37	ENVEQ MIN	0.25000	-976.69034	0.00000	-2168.71500
37	ENVEQ MIN	0.50000	-980.99760	0.00000	-2321.84600
37	ENVEQ MIN	0.75000	-985.30486	0.00000	-2477.33500
37	ENVEQ MIN	1.00000	-989.61211	0.00000	-2635.19600
38	ENVEQ MAX	0.00000	0.00000	1982.04500	0.00000
38	ENVEQ MAX	0.25000	0.00000	1998.67200	0.00000
38	ENVEQ MAX	0.50000	0.00000	2015.35900	0.00000
38	ENVEQ MAX	0.75000	0.00000	2032.10500	0.00000
38	ENVEQ MAX	1.00000	0.00000	2048.91200	0.00000
38	ENVEQ MIN	0.00000	-964.70058	0.00000	-2635.19600
38	ENVEQ MIN	0.25000	-967.10245	0.00000	-2724.26400
38	ENVEQ MIN	0.50000	-969.50431	0.00000	-2814.07800
38	ENVEQ MIN	0.75000	-971.90618	0.00000	-2904.64000
38	ENVEQ MIN	1.00000	-974.30805	0.00000	-2995.95200
39	ENVEQ MAX	0.00000	0.00000	2048.91100	0.00000
39	ENVEQ MAX	0.08824	0.00000	2077.13000	0.00000
39	ENVEQ MAX	0.17647	0.00000	2105.34800	0.00000
39	ENVEQ MAX	0.26471	0.00000	2133.56700	0.00000
39	ENVEQ MAX	0.35294	0.00000	2161.78500	0.00000
39	ENVEQ MIN	0.00000	-974.30814	0.00000	-2995.95200
39	ENVEQ MIN	0.08824	-978.33362	0.00000	-3150.67900
39	ENVEQ MIN	0.17647	-982.35909	0.00000	-3307.52200
39	ENVEQ MIN	0.26471	-986.38457	0.00000	-3466.48100
39	ENVEQ MIN	0.35294	-990.41004	0.00000	-3627.55700
40	ENVEQ MAX	0.56250	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.67188	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.78125	0.00000	0.00000	0.00000
40	ENVEQ MAX	0.89063	0.00000	0.00000	0.00000
40	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
40	ENVEQ MIN	0.56250	-2375.09900	-930.00359	-4466.59000
40	ENVEQ MIN	0.67188	-2376.32300	-939.69837	-4385.27700
40	ENVEQ MIN	0.78125	-2377.54700	-949.26294	-4303.10300
40	ENVEQ MIN	0.89063	-2378.77100	-958.69730	-4220.07900
40	ENVEQ MIN	1.00000	-2379.99500	-968.00145	-4136.21500
41	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
41	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
41	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
41	ENVEQ MIN	0.00000	-2379.99400	-968.00129	-4136.21500
41	ENVEQ MIN	0.25000	-2381.06600	-976.83746	-4054.68400
41	ENVEQ MIN	0.50000	-2381.92600	-985.55419	-3972.39600
41	ENVEQ MIN	0.75000	-2382.57300	-994.15150	-3889.36100
41	ENVEQ MIN	1.00000	-2383.00700	-1002.62900	-3805.58900
42	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
42	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
42	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
42	ENVEQ MIN	0.00000	-2158.91400	-790.39075	-3805.58900
42	ENVEQ MIN	0.25000	-2159.04800	-794.44760	-3773.47500
42	ENVEQ MIN	0.50000	-2159.13200	-798.47475	-3741.19200
42	ENVEQ MIN	0.75000	-2159.16500	-802.47221	-3708.74100
42	ENVEQ MIN	1.00000	-2159.14900	-806.43997	-3676.12300
43	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.50000	0.00000	0.00000	0.00000
43	ENVEQ MAX	0.75000	0.00000	0.00000	0.00000
43	ENVEQ MAX	1.00000	0.00000	0.00000	0.00000
43	ENVEQ MIN	0.00000	-2159.14800	-806.43976	-3676.12300
43	ENVEQ MIN	0.25000	-2158.90300	-829.52871	-3478.02300
43	ENVEQ MIN	0.50000	-2158.65700	-851.60313	-3274.28100
43	ENVEQ MIN	0.75000	-2158.41100	-872.66302	-3065.14500
43	ENVEQ MIN	1.00000	-2158.16600	-892.70837	-2850.86200
44	ENVEQ MAX	0.00000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.25000	0.00000	0.00000	0.00000
44	ENVEQ MAX	0.50000	0.00000	0.25798	0.00000
44	ENVEQ MAX	0.75000	0.00000	21.00016	0.00000
44	ENVEQ MAX	1.00000	0.00000	40.33822	0.00000
44	ENVEQ MIN	0.00000	-1937.34400	-647.11555	-2850.86200
44	ENVEQ MIN	0.25000	-1937.24800	-669.24473	-2664.28100
44	ENVEQ MIN	0.50000	-1966.52800	-689.96979	-2471.40800
44	ENVEQ MIN	0.75000	-1995.80900	-709.29072	-2272.64000
44	ENVEQ MIN	1.00000	-2025.08900	-727.79533	-2068.37900
45	ENVEQ MAX	0.00000	0.00000	69.99598	0.00000
45	ENVEQ MAX	0.25000	0.00000	87.92419	0.00000
45	ENVEQ MAX	0.50000	0.00000	104.43684	0.00000
45	ENVEQ MAX	0.75000	0.00000	119.53393	0.00000
45	ENVEQ MAX	1.00000	0.00000	133.21545	0.00000
45	ENVEQ MIN	0.00000	-1795.20400	-508.52852	-2068.37900
45	ENVEQ MIN	0.25000	-1824.48400	-525.51434	-1921.41500
45	ENVEQ MIN	0.50000	-1853.76500	-541.31636	-1769.75800
45	ENVEQ MIN	0.75000	-1883.04600	-555.70282	-1730.59000
45	ENVEQ MIN	1.00000	-1912.32600	-568.67372	-1711.81500
46	ENVEQ MAX	0.00000	0.00000	195.75595	0.00000
46	ENVEQ MAX	0.25000	0.00000	208.00547	0.00000
46	ENVEQ MAX	0.50000	0.00000	218.82939	0.00000
46	ENVEQ MAX	0.75000	0.00000	228.22769	0.00000
46	ENVEQ MAX	1.00000	0.00000	236.20039	0.00000
46	ENVEQ MIN	0.00000	-1685.27100	-419.55827	-1711.81500
46	ENVEQ MIN	0.25000	-1714.52600	-431.32643	-1738.87400
46	ENVEQ MIN	0.50000	-1743.78000	-442.15034	-1769.41000
46	ENVEQ MIN	0.75000	-1773.03500	-451.54865	-1803.02000
46	ENVEQ MIN	1.00000	-1802.29000	-459.52134	-1839.29800
47	ENVEQ MAX	0.00000	0.00000	314.91595	0.00000
47	ENVEQ MAX	0.25000	0.00000	317.00653	0.00000
47	ENVEQ MAX	0.50000	0.00000	318.97090	0.00000
47	ENVEQ MAX	0.75000	0.00000	320.80907	0.00000
47	ENVEQ MAX	1.00000	0.00000	322.52103	0.00000
47	ENVEQ MIN	0.00000	-1577.89500	-411.02363	-1839.29800
47	ENVEQ MIN	0.25000	-1586.57400	-413.11421	-1861.34100
47	ENVEQ MIN	0.50000	-1595.25300	-415.07859	-1883.57200
47	ENVEQ MIN	0.75000	-1603.93100	-416.91675	-1905.98200
47	ENVEQ MIN	1.00000	-1612.61000	-418.62871	-1928.55800
48	ENVEQ MAX	0.00000	0.00000	322.52103	0.00000
48	ENVEQ MAX	0.13281	0.00000	324.49990	0.00000
48	ENVEQ MAX	0.26563	0.00000	326.27769	0.00000
48	ENVEQ MAX	0.39844	0.00000	327.85440	33.38600
48	ENVEQ MAX	0.53125	0.00000	329.23001	72.63655
48	ENVEQ MIN	0.00000	-1612.60900	-418.62861	-1928.55800
48	ENVEQ MIN	0.13281	-1623.55400	-420.60749	-1957.25300
48	ENVEQ MIN	0.26563	-1634.49900	-422.38528	-1986.60300
48	ENVEQ MIN	0.39844	-1645.44400	-423.96198	-2016.35300
48	ENVEQ MIN	0.53125	-1656.38800	-425.33760	-2046.31600

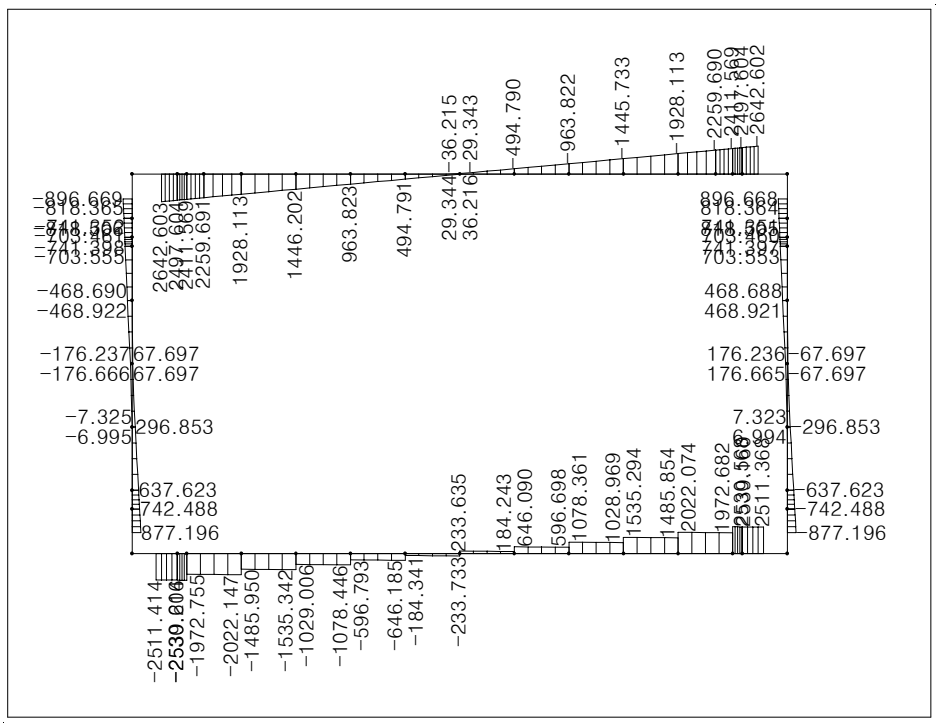
21. 단면력정리

21.1 상시

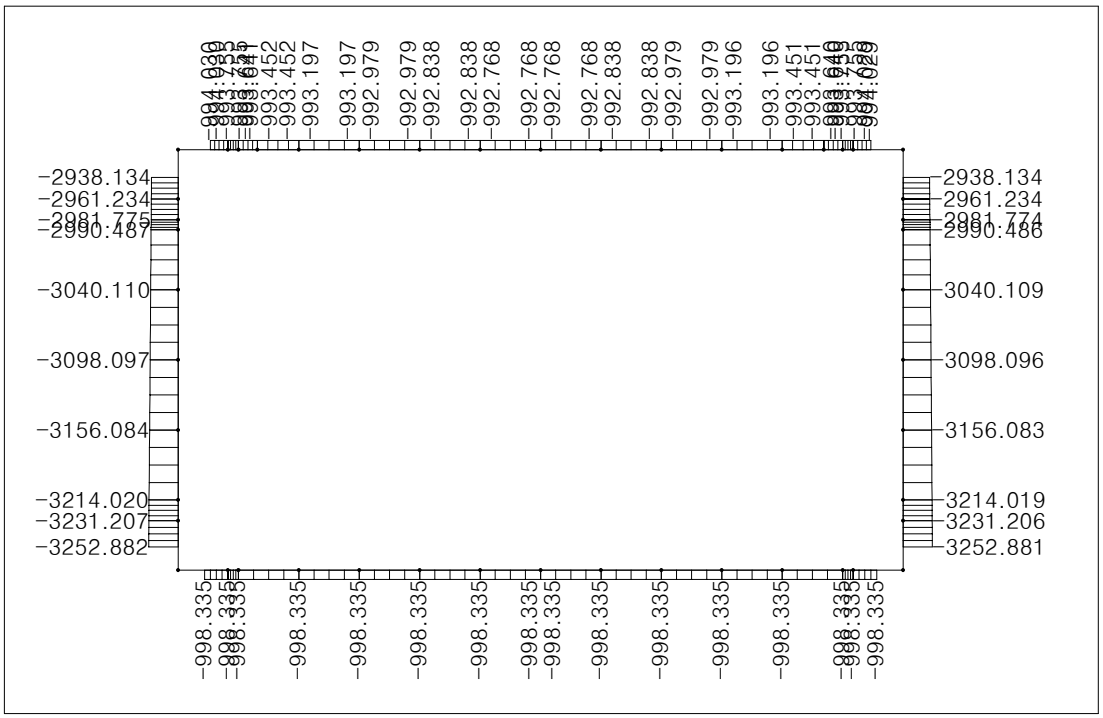
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



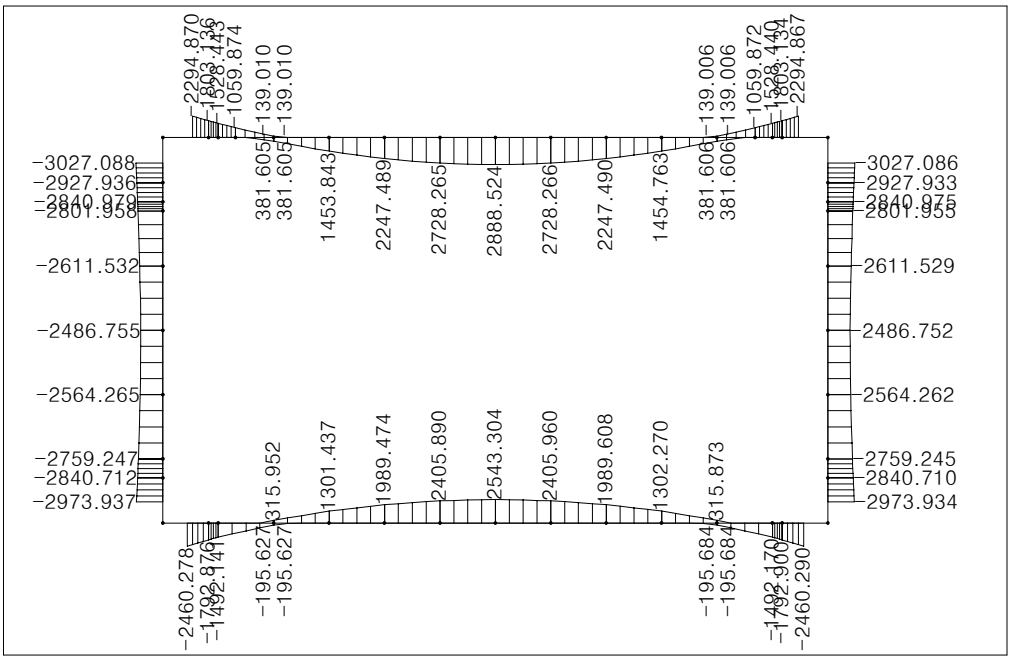
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

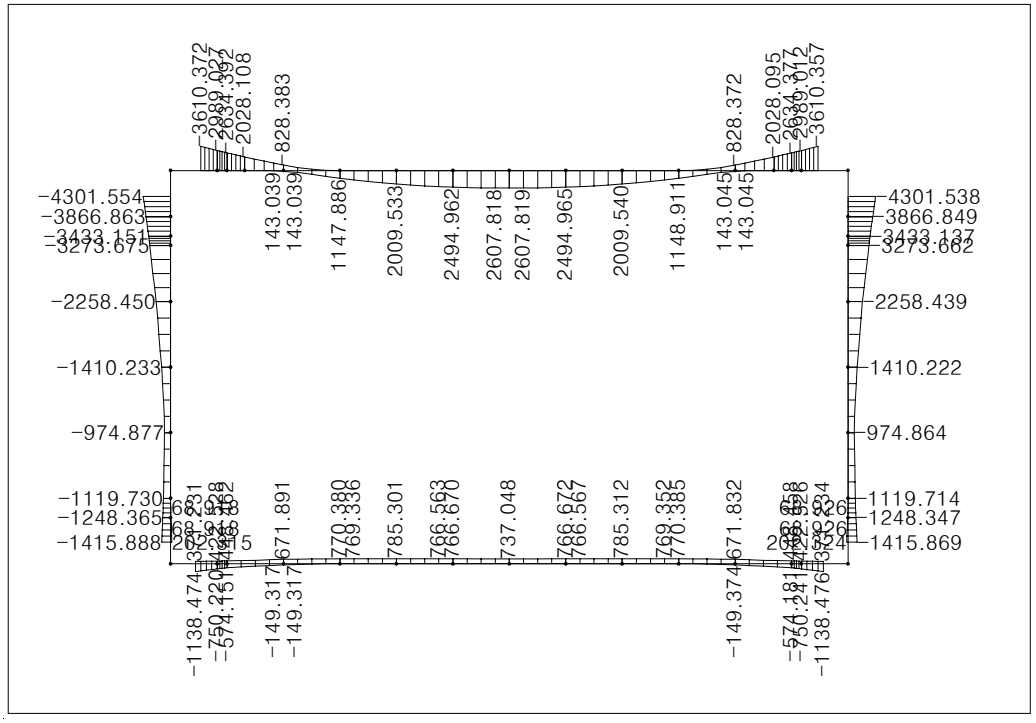


5) 단면력 정리

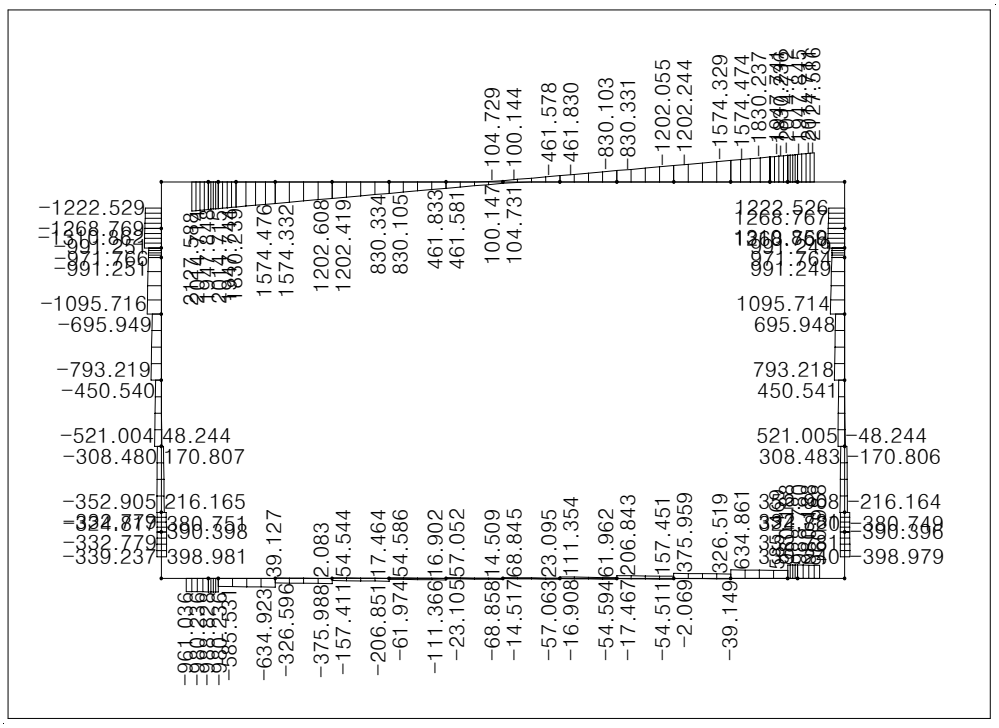
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	2831.19	1791.54	993.76	1803.14	1000.00	1766.67	
		중앙부	2	4326.48	36.22	992.77	2888.52	1000.00	1600.00	
		우측	3	2831.19	1791.41	993.76	1803.13	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	2597.30	1499.95	998.34	1792.88	1000.00	1600.00	
		측구부	5	803.83	2511.41	998.34	558.35	1000.00	1600.00	
		중앙부	6	3839.00	233.73	998.34	2543.30	1000.00	1600.00	
		우측	7	2597.34	1499.87	998.34	1792.90	1000.00	1600.00	
좌측 벽체	1 층	상부	8	4540.06	437.13	2961.23	2927.94	1000.00	1866.67	
		하부	9	4178.66	260.21	3231.21	2840.71	1000.00	1700.00	
우측 벽체	1 층	상부	10	4540.06	437.13	2961.23	2927.93	1000.00	1855.33	
		하부	11	4178.66	260.21	3231.21	2840.71	1000.00	1700.00	

21.2 지진시(기능수행)

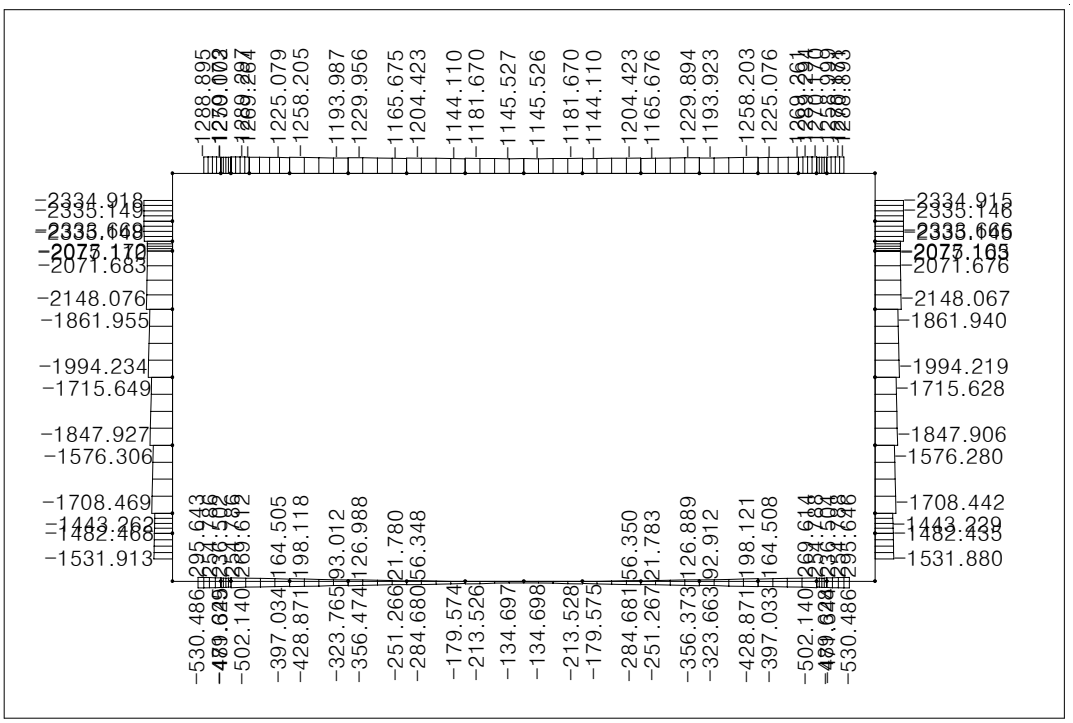
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

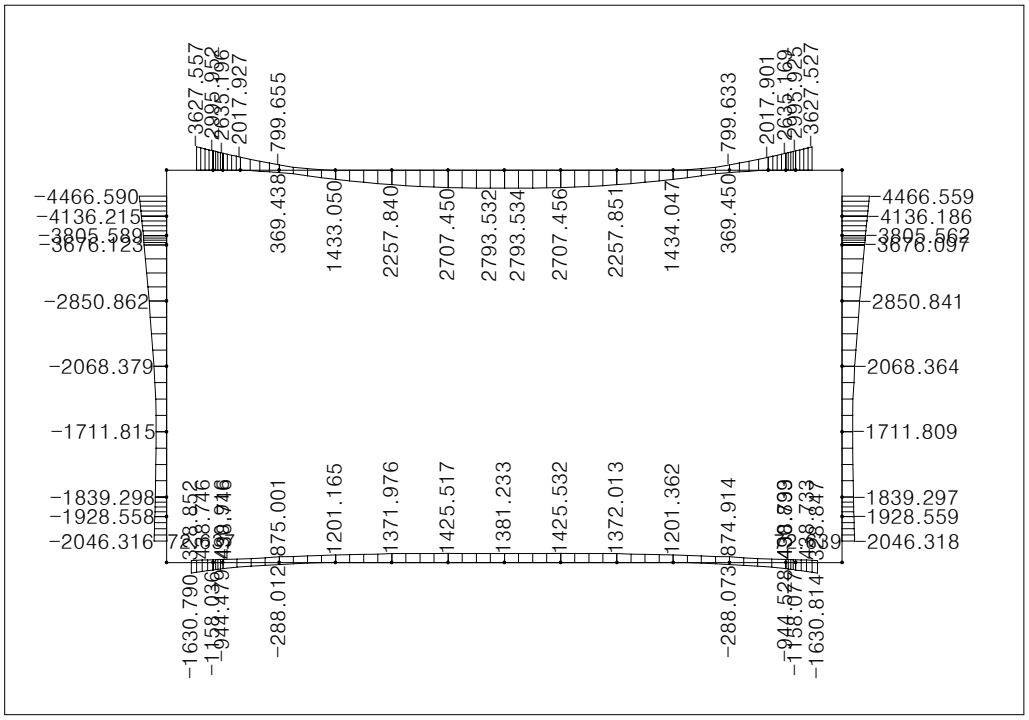


4) 단면력 정리

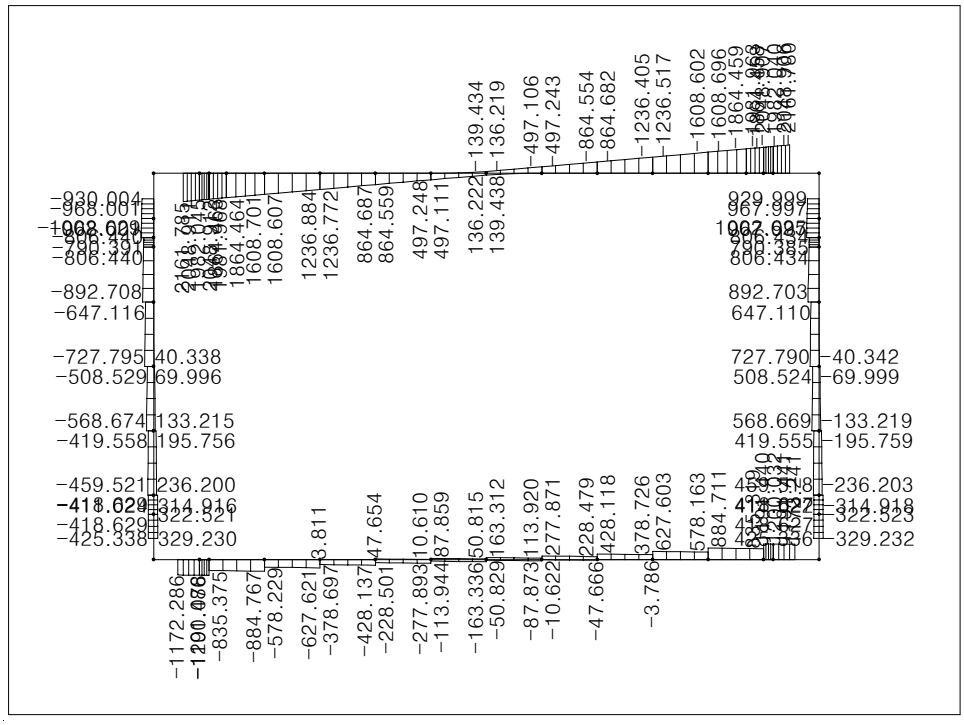
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	2989.03	1468.98	1270.17	1000.00	1766.67	
		중앙부	2	2597.62	104.73	1161.58	1000.00	1600.00	
		우측	3	2989.01	1468.88	1270.17	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	750.22	340.59	489.63	1000.00	1600.00	
		측구부	5	691.75	961.04	530.49	1000.00	1600.00	
		중앙부	6	737.05	68.86	142.75	1000.00	1600.00	
		우측	7	750.24	340.53	489.63	1000.00	1600.00	
좌측 벽체	1 층	상부	8	3866.86	707.85	2335.15	1000.00	1866.67	
		하부	9	1248.37	514.27	1482.47	1000.00	1700.00	
우측 벽체	1 층	상부	10	3866.85	707.85	2335.15	1000.00	1855.33	
		하부	11	1248.35	514.28	1482.44	1000.00	1700.00	

21.3 지진시(붕괴방지)

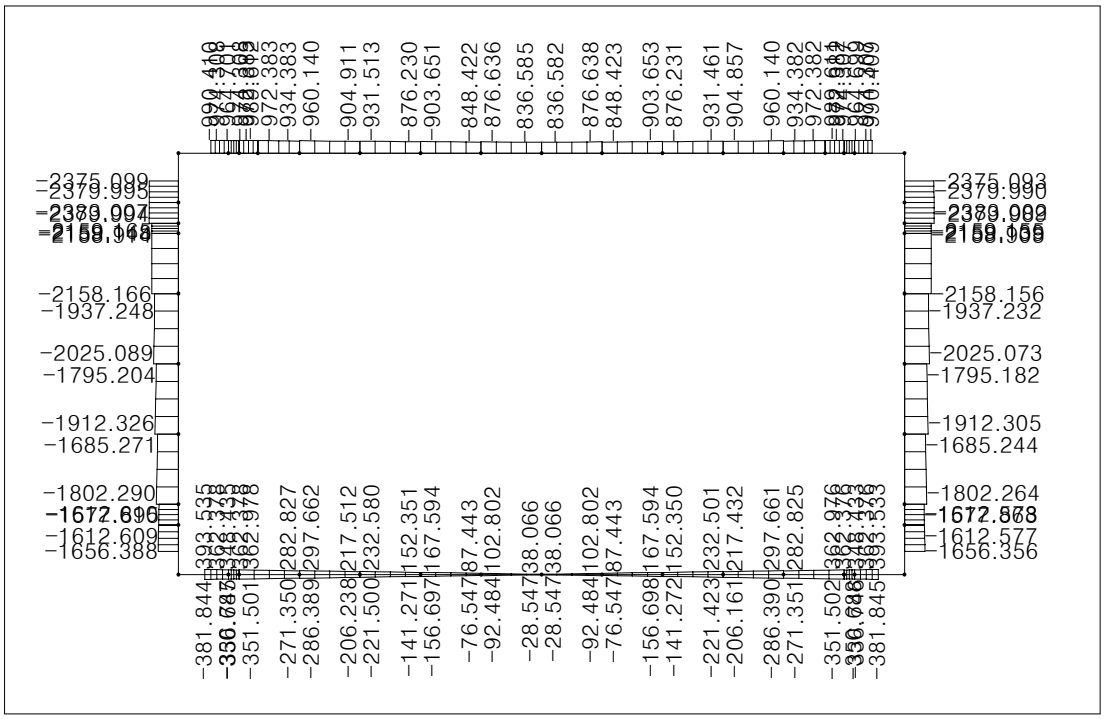
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	2995.95	1503.26	974.31	1000.00	1766.67	
		중앙부	2	2774.41	139.44	850.39	1000.00	1600.00	
		우측	3	2995.93	1503.15	974.31	1000.00	1766.67	
하부 슬래브	1 경간	좌측	4	1158.04	592.23	362.38	1000.00	1600.00	
		측구부	5	951.78	1172.29	393.54	1000.00	1600.00	
		중앙부	6	1381.23	163.34	38.07	1000.00	1600.00	
		우측	7	1158.08	592.18	362.38	1000.00	1600.00	
좌측 벽체	1 층	상부	8	4136.22	656.98	2379.99	1000.00	1866.67	
		하부	9	1928.56	562.89	1612.61	1000.00	1700.00	
우측 벽체	1 층	상부	10	4136.19	656.97	2379.99	1000.00	1855.33	
		하부	11	1928.56	562.89	1612.58	1000.00	1700.00	

21.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-2831.19	-	-2995.95	-2989.03	-2995.95	
		중앙부	2	4326.48	-	2774.41	2597.62	4326.48	
		우측	3	-2831.19	-	-2995.93	-2989.01	-2995.93	
하부 슬래브	1 경간	좌측	4	-2597.30	-	-1158.04	-750.22	-2597.30	
		측구부	5	803.83	-	951.78	691.75	951.78	
		중앙부	6	3839.00	-	1381.23	737.05	3839.00	
		우측	7	-2597.34	-	-1158.08	-750.24	-2597.34	
좌측 벽체	1 층	상부	8	-4540.06	-	-4136.22	-3866.86	-4540.06	
		하부	9	-4178.66	-	-1928.56	-1248.37	-4178.66	
우측 벽체	1 층	상부	10	-4540.06	-	-4136.19	-3866.85	-4540.06	
		하부	11	-4178.66	-	-1928.56	-1248.35	-4178.66	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	1791.54	-	1503.26	1468.98	1791.54	
		중앙부	2	36.22	-	139.44	104.73	139.44	
		우측	3	-1791.41	-	-1503.15	-1468.88	-1791.41	
하부 슬래브	1 경간	좌측	4	-1499.95	-	-592.23	-340.59	-1499.95	
		측구부	5	-2511.41	-	-1172.29	-961.04	-2511.41	
		중앙부	6	-233.73	-	-163.34	-68.86	-233.73	
		우측	7	1499.87	-	592.18	340.53	1499.87	
좌측 벽체	1 층	상부	8	-437.13	-	-656.98	-707.85	-707.85	
		하부	9	260.21	-	-562.89	-514.27	-562.89	
우측 벽체	1 층	상부	10	437.13	-	656.97	707.85	707.85	
		하부	11	-260.21	-	562.89	514.28	562.89	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-993.76	-	-974.31	-1270.17	-1270.17	
		중앙부	2	-992.77	-	-850.39	-1161.58	-1161.58	
		우측	3	-993.76	-	-974.31	-1270.17	-1270.17	
하부 슬래브	1 경간	좌측	4	-998.34	-	362.38	-489.63	-998.34	
		측구부	5	-998.34	-	393.54	-530.49	-998.34	
		중앙부	6	-998.34	-	38.07	-142.75	-998.34	
		우측	7	-998.34	-	362.38	-489.63	-998.34	
좌측 벽체	1 층	상부	8	-2961.23	-	-2379.99	-2335.15	-2961.23	
		하부	9	-3231.21	-	-1612.61	-1482.47	-3231.21	
우측 벽체	1 층	상부	10	-2961.23	-	-2379.99	-2335.15	-2961.23	
		하부	11	-3231.21	-	-1612.58	-1482.44	-3231.21	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-1803.14	-	-	-	-1803.14	
		중앙부	2	2888.52	-	-	-	2888.52	
		우측	3	-1803.13	-	-	-	-1803.13	
하부 슬래브	1 경간	좌측	4	-1792.88	-	-	-	-1792.88	
		측구부	5	558.35	-	-	-	558.35	
		중앙부	6	2543.30	-	-	-	2543.30	
		우측	7	-1792.90	-	-	-	-1792.90	
좌측 벽체	1 층	상부	8	-2927.94	-	-	-	-2927.94	
		하부	9	-2840.71	-	-	-	-2840.71	
우측 벽체	1 층	상부	10	-2927.93	-	-	-	-2927.93	
		하부	11	-2840.71	-	-	-	-2840.71	

22. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1623	2995.95	4821.04	5599.03	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.61
		중앙부	2	1000	1470	4326.48	4824.12	9153.09	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.12
		우측	3	1000	1623	2995.93	4821.04	5598.97	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.61
하부슬래브	1경간	좌측	4	1000	1471	2597.30	4227.54	5362.79	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.63
		측구부	5	1000	1177	951.78	2323.02	2422.51	H25 - 8.0EA + H25 - 4.0EA	6080.40	2.44
		중앙부	6	1000	1476	3839.00	4362.62	8031.18	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.14
		우측	7	1000	1471	2597.34	4227.54	5362.87	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.63
좌측벽체	1층	상부	8	1000	1723	4540.06	5133.59	8082.34	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.13
		하부	9	1000	1571	4178.66	4530.93	8194.60	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.08
우측벽체	1층	상부	10	1000	1711	4540.06	5098.17	8140.68	H29 - 8.0EA + H25 - 8.0EA	9192.80	1.12
		하부	11	1000	1571	4178.65	4530.93	8194.58	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.08

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	945.6	1791.5	2102.21	2.00	290.51	H16	150	397.20	O.K
		중앙부	2	954.8	139.4	1538.68	2.00	-	H16	300	397.20	O.K
		우측	3	945.6	1791.4	2102.21	2.00	290.46	H16	150	397.20	O.K
하부슬래브	1경간	좌측	4	955.6	1499.9	1701.18	2.00	185.01	H13	150	253.40	O.K
		중앙부	6	958.6	233.7	1332.62	2.00	-	H13	300	253.40	O.K
		우측	7	955.6	1499.9	1701.18	2.00	184.98	H13	150	253.40	O.K
좌측벽체	1층	상부	8	1010.6	707.9	1404.86	2.00	-	H13	300	253.40	O.K
		중앙부	8	1052.2	793.2	1462.73	2.00	-	H13	300	253.40	O.K
		하부	9	1020.5	562.9	1418.67	2.00	-	H13	300	253.40	O.K
우측벽체	1층	상부	10	1010.6	707.9	1404.86	2.00	-	H13	300	253.40	O.K
		중앙부	10	1052.2	793.2	1462.73	2.00	-	H13	300	253.40	O.K
		하부	11	1020.5	562.9	1418.67	2.00	-	H13	300	253.40	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1622.57	100.00	2995.95	1791.54

* 강도감소계수(Φ) 산정

T = As x fy = 9192.800 x 400.00 = 3677120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 160.223 mm, c = 160.223 / β1 = 160.223 / 0.85 = 188.498 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 188.498) / 188.498 = 0.02353

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 5599.026 \text{ mm}^2$$

* 사용철근량 = 9192.8 mm² (철근도심 : 144.1 mm), [사용률 = 1.642]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00567

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 160.223 mm

ΦMn = 0.85 x 9192.800 x 400 x (1622.57 - a/2) = 4821.038 kN.m

≥ Mu (= 2995.952 kN.m) ∴ O.K [안전률 1.609]

* 전단에 대한 검토 (d = 1455.90 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1455.90 = 945.638 kN

< Vu (= 1791.539 kN) , 전단보강 필요.

Av_req = (1791.539-945.638) x 150.00 / (400x1455.90xΦ) x 1000 = 290.507 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1455.90 / 150.00 x 1000 = 1542.094 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1455.90 / 1000 = 5043.402 kN ≥ 1542.094 kN ∴ O.K

ΦVn = 0.75 x (1260.850 + 1542.094) = 2102.208 kN ≥ 1791.539 kN ∴ O.K

▣ TITLE : 상부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1470.00	80.00	4326.48	139.44

* 강도감소계수(Φ) 산정

T = As x fy = 10278.400 x 400.00 = 4111360.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 179.144 mm, c = 179.144 / β1 = 179.144 / 0.85 = 210.758 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 210.758) / 210.758 = 0.01864

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 9153.090 \text{ mm}^2$$

* 사용철근량 = 10278.4 mm² (철근도심 : 130.0 mm), [사용률 = 1.123]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00699

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 179.144 mm

ΦMn = 0.85 x 10278.400 x 400 x (1470.00 - a/2) = 4824.121 kN.m

≥ Mu (= 4326.480 kN.m) ∴ O.K [안전률 1.115]

* 전단에 대한 검토 (d = 1470.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1470.00 = 954.793 kN

≥ Vu (= 139.438 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1622.57	100.00	2995.93	1791.41

* 강도감소계수(Φ) 산정

T = As x fy = 9192.800 x 400.00 = 3677120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 160.223 mm, c = 160.223 / β1 = 160.223 / 0.85 = 188.498 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 188.498) / 188.498 = 0.02353

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 5598.974 \text{ mm}^2$$

* 사용철근량 = 9192.8 mm² (철근도심 : 144.1 mm), [사용률 = 1.642]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00567

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 160.223 mm

ΦMn = 0.85 x 9192.800 x 400 x (1622.57 - a/2) = 4821.038 kN.m

≥ Mu (= 2995.925 kN.m) ∴ O.K [안전률 1.609]

* 전단에 대한 검토 (d = 1455.90 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1455.90 = 945.638 kN

< Vu (= 1791.405 kN) , 전단보강 필요.

Av_req = (1791.405-945.638) x 150.00 / (400x1455.90xΦ) x 1000 = 290.461 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1455.90 / 150.00 x 1000 = 1542.094 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1455.90 / 1000 = 5043.402 kN ≥ 1542.094 kN ∴ O.K

ΦVn = 0.75 x (1260.850 + 1542.094) = 2102.208 kN ≥ 1791.405 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1471.20	100.00	2597.30	1499.95

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1500.00 - 182.970) / 182.970 = 0.02159

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 5362.792 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.664]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00607

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1471.20 - a/2) = 4227.544 kN.m

≥ Mu (= 2597.304 kN.m) ∴ O.K [안전률 1.628]

* 전단에 대한 검토 (d = 1471.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1471.20 = 955.574 kN

< Vu (= 1499.948 kN) , 전단보강 필요.

Av_req = (1499.948-955.574) x 150.00 / (400x1471.20xΦ) x 1000 = 185.010 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 1471.20 / 150.00 x 1000 = 994.141 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1471.20 / 1000 = 5096.397 kN ≥ 994.141 kN ∴ O.K

ΦVn = 0.75 x (1274.099 + 994.141) = 1701.180 kN ≥ 1499.948 kN ∴ O.K

▣ TITLE : 하부슬래브 측구부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1290.00	1176.67	80.00	951.78	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 6080.400 x 400.00 = 2432160.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 105.976 mm, c = 105.976 / β1 = 105.976 / 0.85 = 124.678 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1210.00 - 124.678) / 124.678 = 0.02611

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2422.509 \text{ mm}^2$$

* 사용철근량 = 6080.4 mm² (철근도심 : 113.3 mm), [사용률 = 2.510]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

2단 : H25 - 4.0 EA (= 2026.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00517

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 105.976 mm

ΦMn = 0.85 x 6080.400 x 400 x (1176.67 - a/2) = 2323.021 kN.m

≥ Mu (= 951.777 kN.m) ∴ O.K [안전률 2.441]

▣ TITLE : 하부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1475.91	80.00	3839.00	233.73

* 강도감소계수(Φ) 산정

T = As x fy = 9192.800 x 400.00 = 3677120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 160.223 mm, c = 160.223 / β1 = 160.223 / 0.85 = 188.498 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 188.498) / 188.498 = 0.02119

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 8031.182 \text{ mm}^2$$

* 사용철근량 = 9192.8 mm² (철근도심 : 124.1 mm), [사용률 = 1.145]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00623

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 160.223 mm

ΦMn = 0.85 x 9192.800 x 400 x (1475.90 - a/2) = 4362.624 kN.m

≥ Mu (= 3838.997 kN.m) ∴ O.K [안전률 1.136]

* 전단에 대한 검토 (d = 1475.90 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1475.90 = 958.628 kN

≥ Vu (= 233.733 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1471.20	100.00	2597.34	1499.87

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1500.00 - 182.970) / 182.970 = 0.02159

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 5362.867 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.664]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00607

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1471.20 - a/2) = 4227.544 kN.m

≥ Mu (= 2597.339 kN.m) ∴ O.K [안전률 1.628]

* 전단에 대한 검토 (d = 1471.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1471.20 = 955.574 kN

< Vu (= 1499.865 kN) , 전단보강 필요.

Av_req = (1499.865-955.574) x 150.00 / (400x1471.20xΦ) x 1000 = 184.982 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 1471.20 / 150.00 x 1000 = 994.141 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1471.20 / 1000 = 5096.397 kN ≥ 994.141 kN ∴ O.K

ΦVn = 0.75 x (1274.099 + 994.141) = 1701.180 kN ≥ 1499.865 kN ∴ O.K

▣ TITLE : 좌측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1866.67	1722.57	100.00	4540.06	707.85

* 강도감소계수(Φ) 산정

T = As x fy = 9192.800 x 400.00 = 3677120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 160.223 mm, c = 160.223 / β1 = 160.223 / 0.85 = 188.498 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1766.67 - 188.498) / 188.498 = 0.02512

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 8082.338 \text{ mm}^2$$

* 사용철근량 = 9192.8 mm² (철근도심 : 144.1 mm), [사용률 = 1.137]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00534

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 160.223 mm

ΦMn = 0.85 x 9192.800 x 400 x (1722.57 - a/2) = 5133.593 kN.m

≥ Mu (= 4540.064 kN.m) ∴ O.K [안전률 1.131]

* 전단에 대한 검토 (d = 1555.90 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1555.90 = 1010.590 kN

≥ Vu (= 707.852 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1700.00	1571.20	100.00	4178.66	562.89

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1600.00 - 182.970) / 182.970 = 0.02323

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 8194.595 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.089]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00568

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1571.20 - a/2) = 4530.933 kN.m

≥ Mu (= 4178.660 kN.m) ∴ O.K [안전률 1.084]

* 전단에 대한 검토 (d = 1571.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1571.20 = 1020.526 kN

≥ Vu (= 562.892 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 상부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1855.33	1711.24	100.00	4540.06	707.85

* 강도감소계수(Φ) 산정

T = As x fy = 9192.800 x 400.00 = 3677120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 160.223 mm, c = 160.223 / β1 = 160.223 / 0.85 = 188.498 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1755.33 - 188.498) / 188.498 = 0.02494

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 8140.678 \text{ mm}^2$$

* 사용철근량 = 9192.8 mm² (철근도심 : 144.1 mm), [사용률 = 1.129]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00537

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 160.223 mm

ΦMn = 0.85 x 9192.800 x 400 x (1711.24 - a/2) = 5098.170 kN.m

≥ Mu (= 4540.059 kN.m) ∴ O.K [안전률 1.123]

* 전단에 대한 검토 (d = 1555.90 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1555.90 = 1010.590 kN

≥ Vu (= 707.852 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 하부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1700.00	1571.20	100.00	4178.66	562.89

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1600.00 - 182.970) / 182.970 = 0.02323

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 8194.585 \text{ mm}^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.089]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00568

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1571.20 - a/2) = 4530.933 kN.m

≥ Mu (= 4178.655 kN.m) ∴ O.K [안전률 1.084]

* 전단에 대한 검토 (d = 1571.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1571.20 = 1020.526 kN

≥ Vu (= 562.887 kN) , 전단보강 불필요.

23. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 9192.800 × 0.20 = 1838.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1838.560 ∴ O.K

2) 상부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 10278.400 × 0.20 = 2055.68 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 2055.680 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 9192.800 × 0.20 = 1838.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1838.560 ∴ O.K

4) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1784.640 ∴ O.K

5) 하부슬래브 : 추가

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1290 × 0.0020 = 2580.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 6080.400 × 0.20 = 1216.08 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1216.080 ∴ O.K

6) 하부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 3.3EA = 3308.676 ㎟ ≥ 1800.000 ∴ O.K
H16 - 13.3EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 9192.800 × 0.20 = 1838.56 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1838.560 ∴ O.K

7) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 20EA = 5296.662 ㎟ ≥ 1800.000 ∴ O.K
H16 - 6.7EA (차도부 수평철근)

② Req's As = 사용 주철근량 × 20%
= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1784.640 ∴ O.K

8) 좌측벽체 : 상부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 9192.800 × 0.20 = 1838.56 ㎟

∴ Used As = H19 - 6.7EA = 1910.955 ㎟ ≥ 1838.560 ∴ O.K

9) 좌측벽체 : 하부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H19 - 6.7EA = 1910.955 ㎟ ≥ 1784.640 ∴ O.K

10) 우측벽체 : 상부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 사용 주철근량 × 20%
= 9192.800 × 0.20 = 1838.56 ㎟

∴ Used As = H19 - 6.7EA = 1910.955 ㎟ ≥ 1838.560 ∴ O.K

11) 우측벽체 : 하부

① Req's As = B × H × 0.0025 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1700 × 0.0025 = 4250.00 ㎟

∴ Used As = H19 - 10EA = 2865.000 ㎟ ≥ 1800.000 ∴ O.K

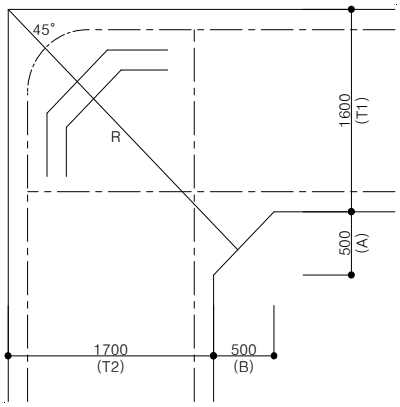
② Req's As = 사용 주철근량 × 20%

= 8923.200 × 0.20 = 1784.64 ㎟

∴ Used As = H19 - 6.7EA = 1910.955 ㎟ ≥ 1784.640 ∴ O.K

24. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 3027.088 kN.m
- 절점부 휨모멘트 : Mo = 3027.088 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 2687.006 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

H25 @250 - 4EA = 2026.800 mm²

∴ Total Asb = 4596.400 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 3027.09 \times 10^6}{2687.006^2 \times 1000} = 2.096 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 3027.09 \times 10^6}{2687.006 \times 180} = 12517.395 \text{ mm}$$

Asb = 4596.400 mm²

Req'd As = As - Asb

= 12517.395 mm² - 4596.400 mm²

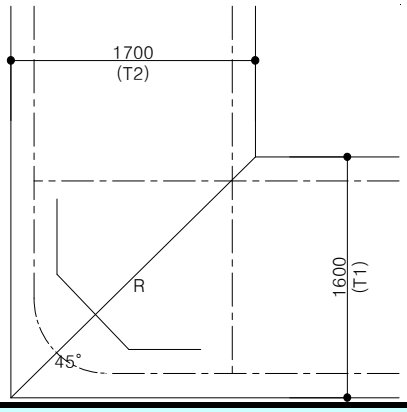
= 7920.995 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H29 - 4EA

∴ Total As = 8923.200 mm² > Req'd As (= 7920.995 mm²) ----------> O.K !!!

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 2973.937 kN.m
- 절점부 휨모멘트 : Mo = 2973.937 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 2334.524$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

∴ Total Asb = 3176.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 2973.94 \times 10^6}{2334.524^2 \times 1000} = 2.728 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 2973.94 \times 10^6}{2334.524 \times 180} = 14154.385 \text{ mm}$$

Asb = 3176.800 mm²

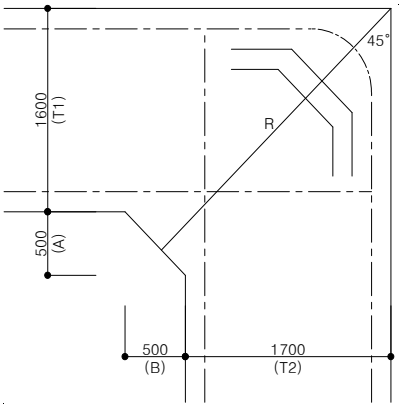
Req'd As = As - Asb
= 14154.385 mm² - 3176.800 mm²
= 10977.585 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H29 - 8EA

∴ Total As = 11492.800 mm² > Req'd As (= 10977.585 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 3027.086 kN.m
- 절점부 휨모멘트 : Mo = 3027.086 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$= 2687.006$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

H25 @250 - 4EA = 2026.800 mm²

∴ Total Asb = 4596.400 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 3027.09 \times 10^6}{2687.006^2 \times 1000} = 2.096 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 3027.09 \times 10^6}{2687.006 \times 180} = 12517.386 \text{ mm}$$

Asb = 4596.400 mm²

Req'd As = As - Asb

= 12517.386 mm² - 4596.400 mm²

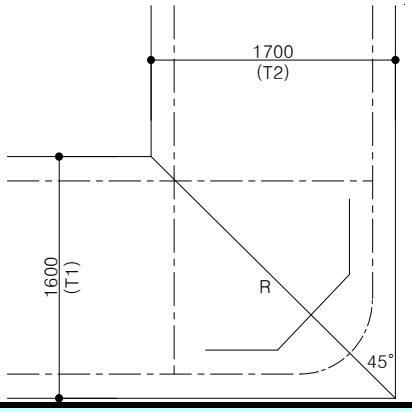
= 7920.986 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H29 - 4EA

∴ Total As = 8923.200 mm² > Req'd As (= 7920.986 mm²) ----------> O.K !!!

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 2973.934 kN.m
- 절점부 휨모멘트 : Mo = 2973.934 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 2334.524$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

∴ Total Asb = 3176.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 2973.93 \times 10^6}{2334.524^2 \times 1000} = 2.728 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 2973.93 \times 10^6}{2334.524 \times 180} = 14154.371 \text{ mm}$$

Asb = 3176.800 mm²

Req'd As = As - Asb
= 14154.371 mm² - 3176.800 mm²
= 10977.571 mm²

- 사용보강철근

Use'd As = H32 - 8EA , H29 - 8EA

∴ Total As = 11492.800 mm² > Req'd As (= 10977.571 mm²) ----------> O.K !!!

25. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 ㎜)

구분	부재 위치			유효높이 (㎜)	인장사용철근량	철근 간격(㎜)	최대 간격 (㎜)	검토 결과	S.F
상부슬래브	1경간	좌측	1	1623	H29 - 8.0EA + H25 - 8.0EA	125	384.541	O.K	3.076
		중앙부	2	1470	H29 - 8.0EA + H29 - 8.0EA	125	211.412	O.K	1.691
		우측	3	1623	H29 - 8.0EA + H25 - 8.0EA	125	384.542	O.K	3.076
하부슬래브	1경간	좌측	4	1471	H32 - 8.0EA + H29 - 4.0EA	125	318.185	O.K	2.545
		측구부	5	1177	H25 - 8.0EA + H25 - 4.0EA	125	743.973	O.K	5.952
		중앙부	6	1476	H29 - 8.0EA + H25 - 8.0EA	125	220.661	O.K	1.765
		우측	7	1471	H32 - 8.0EA + H29 - 4.0EA	125	318.178	O.K	2.545
좌측벽체	1층	상부	8	1723	H29 - 8.0EA + H25 - 8.0EA	125	178.294	O.K	1.426
		하부	9	1571	H32 - 8.0EA + H29 - 4.0EA	125	146.924	O.K	1.175
우측벽체	1층	상부	10	1711	H29 - 8.0EA + H25 - 8.0EA	125	175.619	O.K	1.405
		하부	11	1571	H32 - 8.0EA + H29 - 4.0EA	125	146.924	O.K	1.175

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1803.136 x 1000000 / [9192.800 x (1622.571 - 397.131/3)]
= 131.625 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x9192.800/1000.0 + 7x9192.800/1000.0 x √[(1 + 2x1000.0x1622.6/(7x9192.800)]
= 397.131 mm

사용철근량 = 9192.8 mm² (철근도심 : 144.1 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 131.62) - 2.5 x 85.50 = 384.54 mm
300 x (Kcr / fs) = 300 x (210 / 131.62) = 478.63 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 384.54 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 384.54 mm) ∴ O.K

2) 상부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2888.524 x 1000000 / [10278.400 x (1470.000 - 393.568/3)]
= 209.909 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10278.400/1000.0 + 7x10278.400/1000.0 x √[(1 + 2x1000.0x1470.0/(7x10278.400)]
= 393.568 mm

사용철근량 = 10278.4 mm² (철근도심 : 130.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 209.91) - 2.5 x 65.50 = 211.41 mm
300 x (Kcr / fs) = 300 x (210 / 209.91) = 300.13 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 211.41 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 211.41 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1803.134 x 1000000 / [9192.800 x (1622.571 - 397.131/3)]
= 131.625 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x9192.800/1000.0 + 7x9192.800/1000.0 x √[(1 + 2x1000.0x1622.6/(7x9192.800)]
= 397.131 mm

사용철근량 = 9192.8 mm² (철근도심 : 144.1 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 131.62) - 2.5 x 85.50 = 384.54 mm
300 x (Kcr / fs) = 300 x (210 / 131.62) = 478.63 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 384.54 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 384.54 mm) ∴ O.K

4) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1792.876 x 1000000 / [8923.200 x (1471.203 - 370.771/3)]
= 149.095 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1471.2/(7x8923.200)]
= 370.771 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 149.10) - 2.5 x 84.00 = 318.18 mm
300 x (Kcr / fs) = 300 x (210 / 149.10) = 422.55 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 318.18 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 318.18 mm) ∴ O.K

5) 하부슬래브 추가

① 응력 산정

fs = M / [As x (d - χ/3)] = 558.353 x 1000000 / [6080.400 x (1176.667 - 276.774/3)]
= 84.681 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6080.400/1000.0 + 7x6080.400/1000.0 x √[(1 + 2x1000.0x1176.7/(7x6080.400)]
= 276.774 mm

사용철근량 = 6080.4 mm² (철근도심 : 113.3 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)
2단 : H25 - 4.0 EA (= 2026.8 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 25/2 = 67.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 84.68) - 2.5 x 67.50 = 761.22 mm
300 x (Kcr / fs) = 300 x (210 / 84.68) = 743.97 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 743.97 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 743.97 mm) ∴ O.K

6) 하부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2543.304 x 1000000 / [9192.800 x (1475.905 - 376.205/3)]
= 204.859 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x9192.800/1000.0 + 7x9192.800/1000.0 x √[(1 + 2x1000.0x1475.9/(7x9192.800)]
= 376.205 mm

사용철근량 = 9192.8 mm² (철근도심 : 124.1 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 204.86) - 2.5 x 65.50 = 220.66 mm
300 x (Kcr / fs) = 300 x (210 / 204.86) = 307.53 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 220.66 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 220.66 mm) ∴ O.K

7) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1792.900 x 1000000 / [8923.200 x (1471.203 - 370.771/3)]
= 149.097 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1471.2/(7x8923.200)]
= 370.771 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 149.10) - 2.5 x 84.00 = 318.18 mm
300 x (Kcr / fs) = 300 x (210 / 149.10) = 422.54 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 318.18 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 318.18 mm) ∴ O.K

8) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2927.936 x 1000000 / [9192.800 x (1722.571 - 410.871/3)]
= 200.871 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x9192.800/1000.0 + 7x9192.800/1000.0 x √[(1 + 2x1000.0x1722.6/(7x9192.800)]
= 410.871 mm

사용철근량 = 9192.8 mm² (철근도심 : 144.1 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 200.87) - 2.5 x 85.50 = 178.29 mm
300 x (Kcr / fs) = 300 x (210 / 200.87) = 313.63 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 178.29 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 178.29 mm) ∴ O.K

9) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2840.712 x 1000000 / [8923.200 x (1571.203 - 384.957/3)]
= 220.635 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1571.2/(7x8923.200)]
= 384.957 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 220.64) - 2.5 x 84.00 = 146.92 mm
300 x (Kcr / fs) = 300 x (210 / 220.64) = 285.54 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 146.92 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 146.92 mm) ∴ O.K

10) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2927.933 x 1000000 / [9192.800 x (1711.238 - 409.334/3)]
= 202.251 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x9192.800/1000.0 + 7x9192.800/1000.0 x √[(1 + 2x1000.0x1711.2/(7x9192.800)]
= 409.334 mm

사용철근량 = 9192.8 mm² (철근도심 : 144.1 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 202.25) - 2.5 x 85.50 = 175.62 mm
300 x (Kcr / fs) = 300 x (210 / 202.25) = 311.49 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 175.62 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 175.62 mm) ∴ O.K

11) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 2840.710 x 1000000 / [8923.200 x (1571.203 - 384.957/3)]
= 220.635 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1571.2/(7x8923.200)]
= 384.957 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 220.64) - 2.5 x 84.00 = 146.92 mm
300 x (Kcr / fs) = 300 x (210 / 220.64) = 285.54 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 146.92 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 146.92 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 12.350 m
- fy = 400 MPa
- 부재두께(T) = 1.60 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28
T = 12.350 / 28
T = 0.441 m < 1.600 m ----------> O.K

26. 기초 지지력 검토

(1) 하중산정

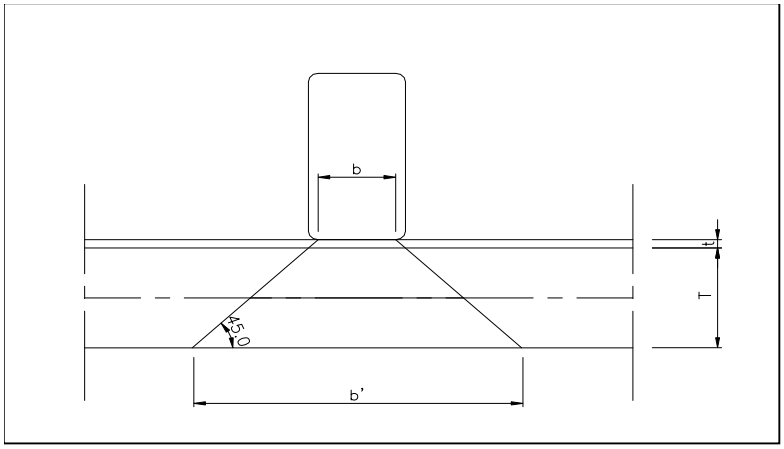
1) 고정하중

- 구체자중 = 1573.950 / 14.050 = 112.025 kN/m²
- 상부연직하중 = 252.706 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.08 × 23.00 = 1.840 kN/m²

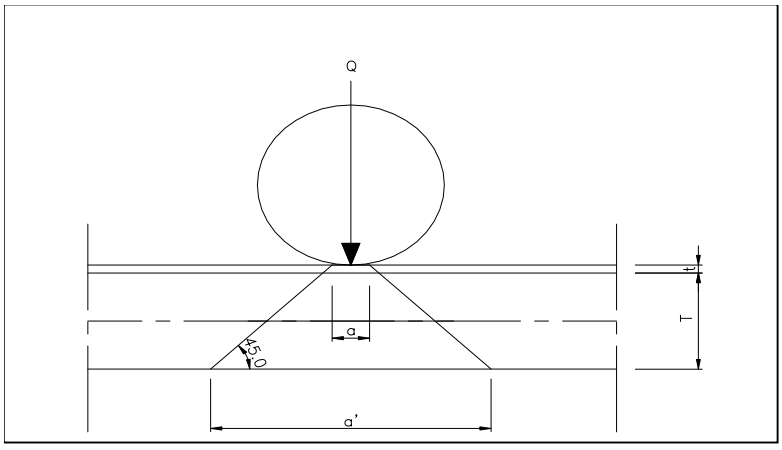
2) 활하중

- 도로 노면 활하중 = 10.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중



t = 80 mm (암거내부 포장두께)
T = 1600 mm (하부 슬래브 두께)
b' = 0.500 + 2 × (1.600 + 0.080) × cot 45°
= 3.860 m



a' = 0.200 + 2 × (1.600 + 0.080) × cot 45°
= 3.560 m

Qz = 96.0 / (3.860 × 3.560)= 6.986 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 112.02 + 252.71 + 10.00 + 1.84 + 6.99

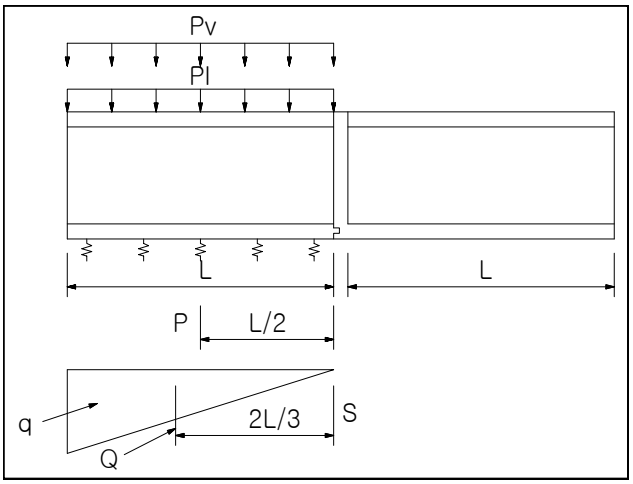
= 383.557 kN/m²

2) 지반의 허용연직지지력 : 지반조사보고서 참고

Qa' = 700.000 kN/m² > Qmax = 383.557 kN/m² ..... O.K !!!

27. 신축이음부 검토

※ 가정 : BOX-TYPE 종방향의 강성 EI는 무한대로 하고, 저면은 스프링 받침으로 한다



$P = \sum Pl + \sum Pv \qquad Q = \sum q$

$P - S - Q = 0$

$P \times L/2 - Q \times 2/3 \times L = 0$

윗식에서

$S = -1/4 \times P$

Pv = B × H × γt

= 14.05 x 13.189 x 19.0

= 3520.8 kN/m

Po = 2 × T1 / 3.0 ÷ 2 × 96 / 3 = 64.0 kN/m

Pl = 2 × Po × (1 + i) = 2 × 64.0 × (1 + 0.2) = 153.6 kN/m

P = (Pv+Pl) × L = (3520.8 + 153.6)x 40.0 = 146902.7 kN

S = P / 4 = 146903 / 4 = 36725.7 kN

(∴ τa = 80 MPa)

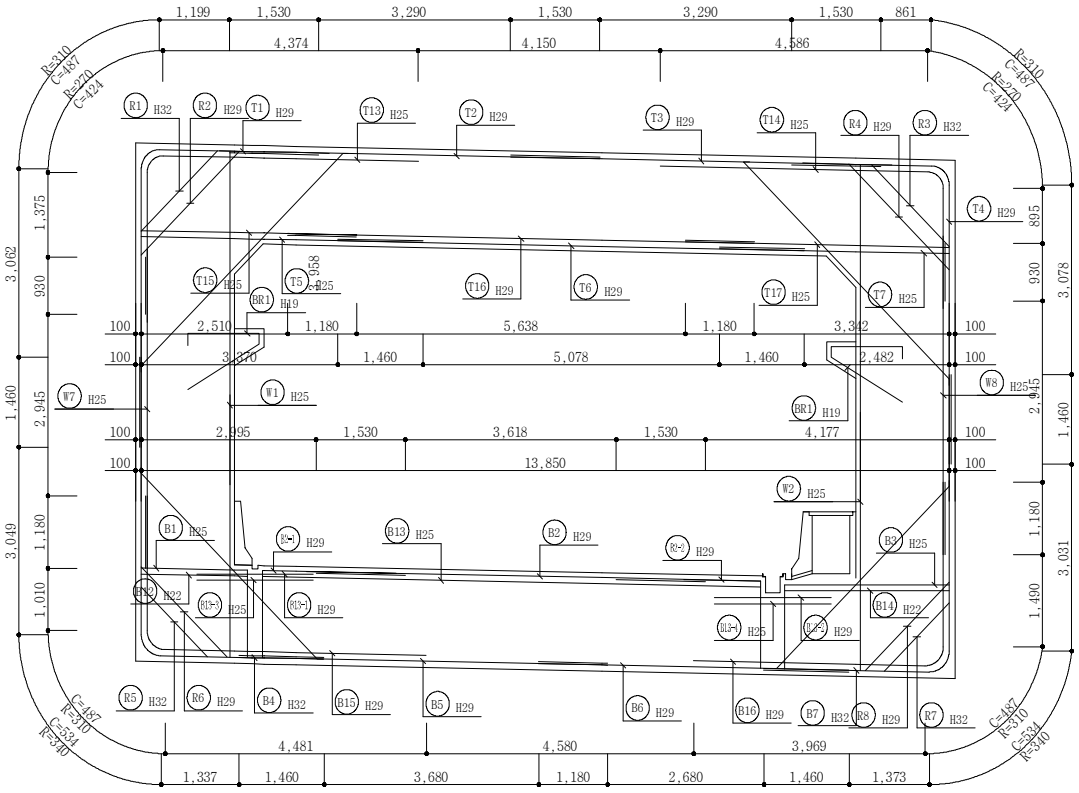
☞ 소요철근량 Areq = S / τa = 36725.7 x 1000 / 80 = 459,071 mm²

☞ 사용철근량 As = D32- 768 EA = 794.2 x 768 = 609,946 mm²

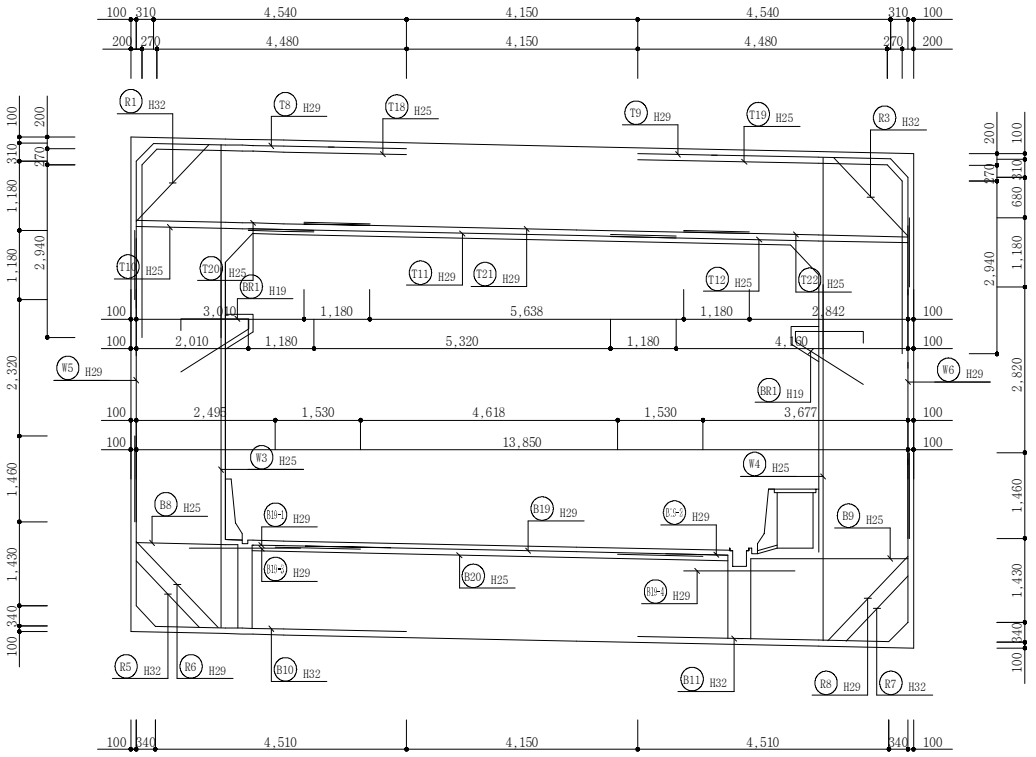
609,946 mm² > 459,071 ……O.K

27. 주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



1.23 차량용 피난연결통로

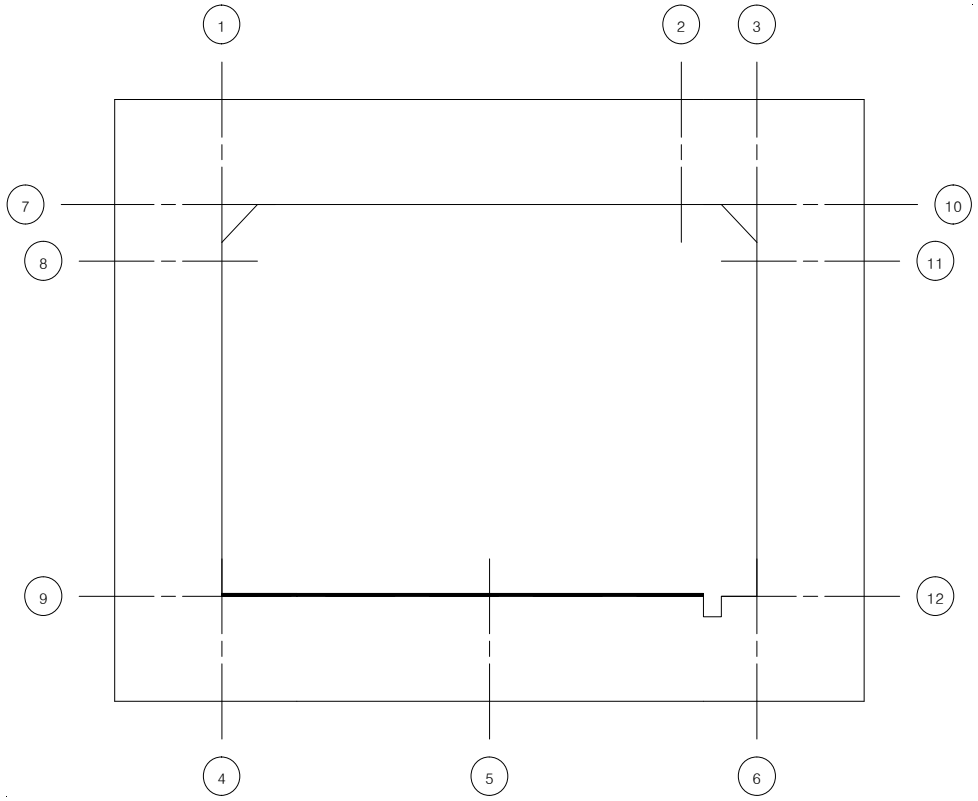
피난연결통로 구조계산서

▣ STA. 1K+230.300 (BLOCK1 : 단면 A-A)
▣ 토 피(FH) = 10.50 m ▣ 선 형 = ∞
▣ 지반 조건 : 토사
▣ 구조형식 : 지중 1 련
(내공 : 7.5M × 5.22M, 사각 : 90°)

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. 단면력정리
16. 단면검토 및 철근량 산정
17. 수평철근 검토
18. 절점부 검토
19. 사용성 검토
20. 기초 지지력 검토
21. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qu(kN)	Qa(kN)	비 고
직접기초	329.52	3761.22	700.00	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	1839.6	3590.834	1.952	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1438	3456.59	4126.41	7402.61	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.19
		중앙부	2	1000	1320	1917.88	2228.22	4401.23	H29 - 8.0EA	5139.20	1.16
		우측	3	1000	1438	3456.59	4126.41	7402.61	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.19
하부슬래브	1경간	좌측	4	1000	1272	2299.51	2946.31	5527.59	H29 - 8.0EA + H25 - 4.0EA	7166.00	1.28
		중앙부	5	1000	1320	1653.27	2228.22	3777.98	H29 - 8.0EA	5139.20	1.35
		우측	6	1000	1272	2299.51	2946.31	5527.59	H29 - 8.0EA + H25 - 4.0EA	7166.00	1.28
좌측벽체	1층	상부	7	1000	1538	3711.07	6464.94	-	H32 - 8.0EA + H29 - 4.0EA	12020.00	1.74
		중앙부 (외측)	8	1000	1371	2499.81	6448.18	-	H32 - 8.0EA + H29 - 4.0EA	12020.00	2.58
		중앙부 (내측)	8	1000	1420	1808.18	3336.10	-	H22 - 8.0EA	12020.00	1.85
		하부	9	1000	1372	2432.45	5865.85	-	H29 - 8.0EA + H25 - 4.0EA	10262.80	2.41
우측벽체	1층	상부	10	1000	1538	3711.07	6385.03	-	H32 - 8.0EA + H29 - 4.0EA	10471.60	1.72
		중앙부 (외측)	11	1000	1371	2499.81	6448.18	-	H32 - 8.0EA + H29 - 4.0EA	12020.00	2.58
		중앙부 (내측)	11	1000	1420	1808.18	3336.10	-	H22 - 8.0EA	12020.00	1.85
		하부	12	1000	1372	2432.45	5865.85	-	H29 - 8.0EA + H25 - 4.0EA	10262.80	2.41

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부 슬래브	1 경간	좌측	1	1800.0	3972.0	O.K	1480.5	2647.3	O.K
		중앙부	2	1800.0	3972.0	O.K	880.2	1324.7	O.K
		우측	3	1800.0	3972.0	O.K	1480.5	2647.3	O.K
하부 슬래브	1 경간	좌측	4	1800.0	2647.3	O.K	1105.5	1324.7	O.K
		중앙부	5	1800.0	1986.0	O.K	755.6	1324.7	O.K
		우측	6	1800.0	2647.3	O.K	1105.5	1324.7	O.K
좌측 벽체	1 층	상부	7	1800.0	1986.0	O.K	0.0	1324.7	O.K
		중앙부	8	1800.0	1986.0	O.K	0.0	1324.7	O.K
		중앙부	8	1800.0	1986.0	O.K	0.0	661.3	O.K
		하부	9	1800.0	1986.0	O.K	0.0	1324.7	O.K
우측 벽체	1 층	상부	10	1800.0	1986.0	O.K	0.0	1324.7	O.K
		중앙부	11	1800.0	1986.0	O.K	0.0	1324.7	O.K
		중앙부	11	1800.0	1986.0	O.K	0.0	661.3	O.K
		하부	12	1800.0	1986.0	O.K	0.0	1324.7	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	825.7	1181.4	1330.59	2.00	279.83	H16	300	397.20	O.K
		우측	3	825.7	1181.4	1330.59	2.00	279.83	H16	300	397.20	O.K
하부슬래브	1경간	좌측	4	826.0	812.3	1331.13	2.00	-	H16	300	397.20	O.K
		우측	6	826.0	812.3	1331.13	2.00	-	H16	300	397.20	O.K
좌측벽체	1층	상부	7	960.5	1869.8	2531.88	2.00	331.59	H19	150	573.00	O.K
		하부	9	971.0	581.8	2542.96	2.00	131.25	H19	150	573.00	O.K
우측벽체	1층	상부	10	960.5	1869.8	2531.88	2.00	331.59	H19	150	573.00	O.K
		하부	12	971.0	581.8	2542.96	2.00	131.25	H19	150	573.00	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	1438	H32 - 8.0EA + H29 - 4.0EA	125	912.693	O.K	7.302
		중앙부	2	1320	H29 - 8.0EA	125	809.989	O.K	6.480
		우측	3	1438	H32 - 8.0EA + H29 - 4.0EA	125	912.693	O.K	7.302
하부슬래브	1경간	좌측	4	1272	H29 - 8.0EA + H25 - 4.0EA	125	470.352	O.K	3.763
		중앙부	5	1320	H29 - 8.0EA	125	237.554	O.K	1.900
		우측	6	1272	H29 - 8.0EA + H25 - 4.0EA	125	470.288	O.K	3.762
좌측벽체	1층	상부	7	1538	H32 - 8.0EA + H29 - 4.0EA	125	611.770	O.K	4.894
		중앙부	8	1371	H32 - 8.0EA + H29 - 4.0EA	125	633.109	O.K	5.065
		중앙부	8	1420	H22 - 8.0EA	-	-	-	-
		하부	9	1372	H29 - 8.0EA + H25 - 4.0EA	125	318.226	O.K	2.546
우측벽체	1층	상부	10	1538	H32 - 8.0EA + H29 - 4.0EA	125	611.770	O.K	4.894
		중앙부	11	1371	H32 - 8.0EA + H29 - 4.0EA	125	633.109	O.K	5.065
		중앙부	11	1420	H22 - 8.0EA	-	-	-	-
		하부	12	1372	H29 - 8.0EA + H25 - 4.0EA	125	318.226	O.K	2.546

2. 설 계 조 건

1) 구조형식

- 지중 1 련 피난연결통로 (내공 : 7.5M × 5.22M, 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (ω_c) = 25.00 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sd
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 10.000 kN/m² (∵ 토피 : 10.500 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

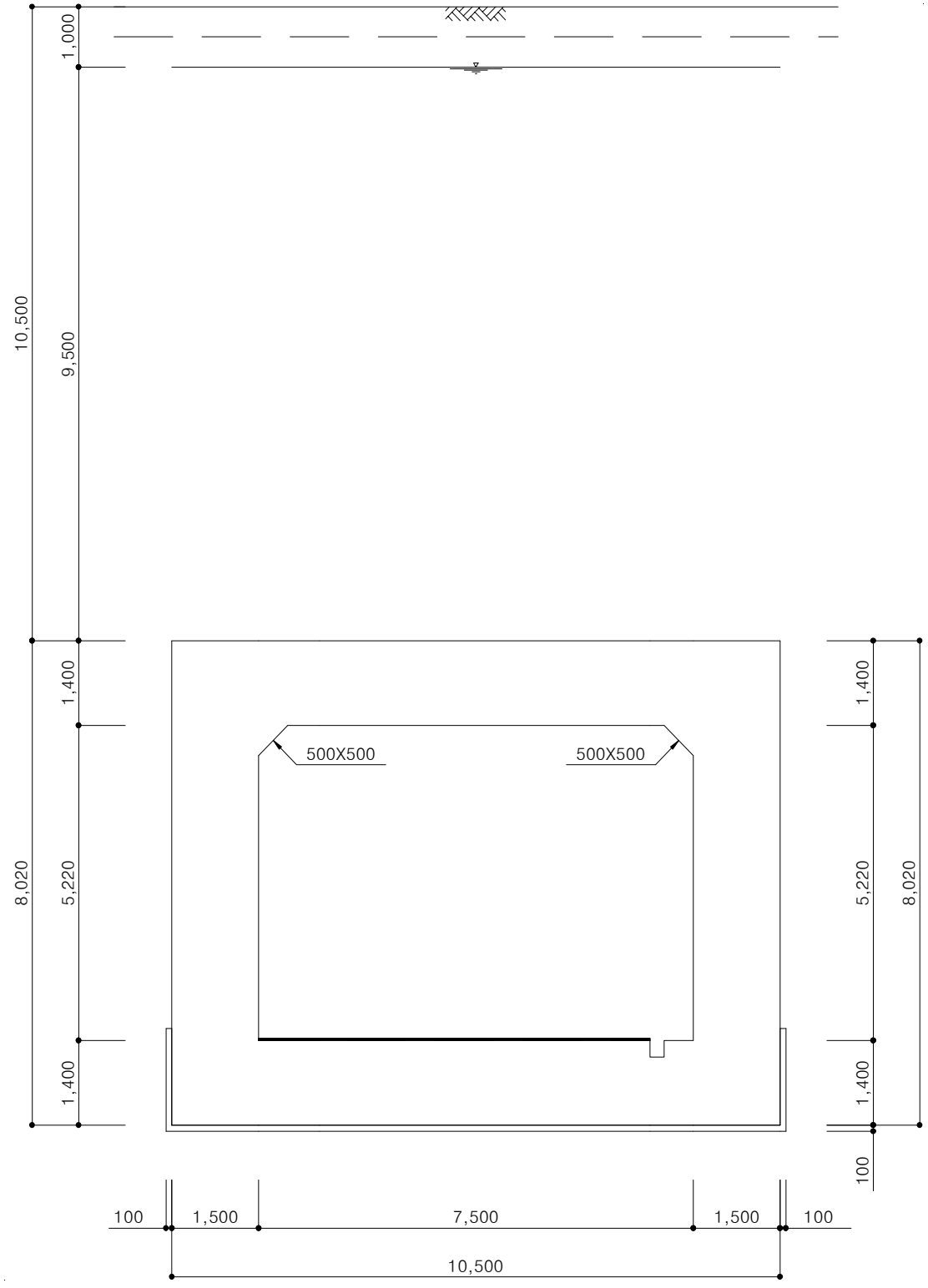
10) 사용프로그램 : SAP2000

11) 참고문헌

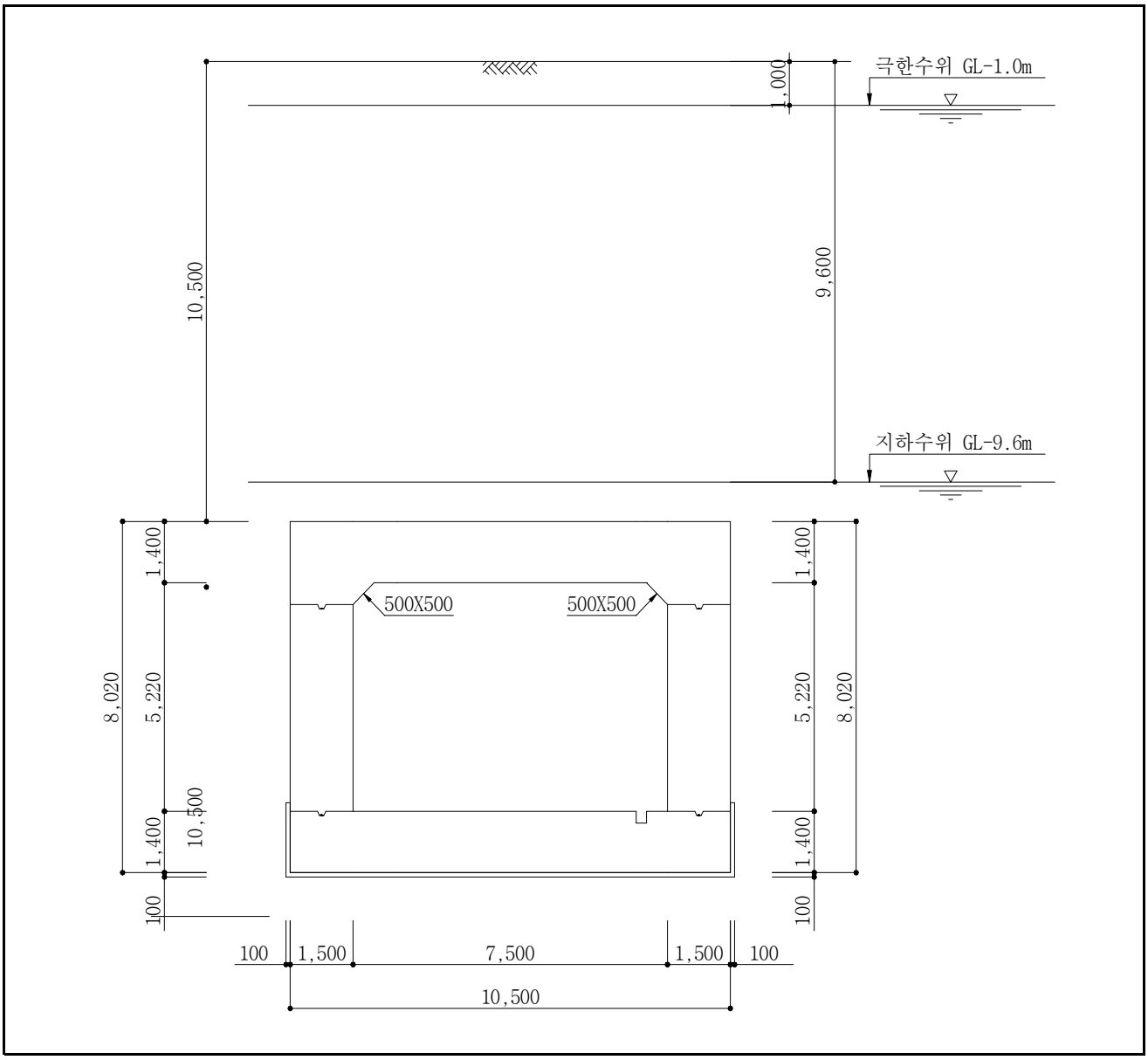
- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정

1) 단 면 가 정


1,000
10,500
9,500
1,400
500X500
500X500
8,020
5,220
1,400
1,400
5,220
8,020
1,400
100
100
1,500
7,500
1,500
100
10,500

4. 부력 검토



4.1 부력 검토 결과

구 분	작용력(kN/m)	저항력(kN/m)	비 고
시 공 중	105.000	759.000	지하수위를 6.571m 이하로 유지
완공후 (지하수위 G.L -9.6m)	936.600	3,647.025	F.S = 3.894 > 1.200 ------ O.K
완공후 (극한수위 G.L-1.0m)	1,839.600	3,590.834	F.S = 1.952 > 1.050 ------ O.K

4.2 시공중 부력 검토(상부슬래브 폐합전 단면 검토)

4.2.1 굴착고 : 18.520 m

4.2.2 부력 작용폭 : 10.500 m

4.2.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × Hw × 10.500 m = 105.000 Hw kN/m

= 10.000 × Hw × 0.000 m = 0.000 Hw kN/m

= 105.000 Hw

여기서, U : 부력 (kN/m)

μ : 단위 부력 (kN/m^2)

r_w : 물의 단위 중량 (kN/m^3)

Hw : 지하수위로부터 구조물 바닥슬래브 하면까지의 높이 (m)

B : 부력이 작용하는 구조물의 폭 (m)

4.2.4 작용력

$R = W_1 + W_2 + F$ = 759.000 + 0.000 + 0.000 = 759.000 kN/m

여기서, W_1 : 구체자중 (kN/m)

W_2 : 상재하중 (kN/m)

F : 주면마찰력 (kN/m) ⇒ 구조물 벽체와 주변뒷채움 흙과의 접촉불확실성을 고려하여 무시한다.

(1) W_1 (구체자중)

① 하부슬래브

(1.400 × 10.500)× 25.000 = 367.500 kN/m

② 벽체

(1.500 × 5.220)× 2 EA × 25.000 = 391.500 kN/m

소 계 = 759.000 kN/m

(2) W_2 (상재하중) : 없음

(3) F (주면마찰력) : 없음

4.2.5 안정검토

$$F_s = \frac{R}{U} = \frac{759.000}{105.000\ Hw} \geq 1.1 \quad \Rightarrow H \leq 6.571\ m$$

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 6.571m이하로 유지.

4.3 완공후 부력 검토 (지하수위 : G.L-9.6m)

4.3.1 굴착고 : 18.520 m

4.3.2 부력 작용폭 : 10.500 m

4.3.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 8.920 × 10.500 = 936.600 KN/m

10.000 × 0.000 × 0.000 = 0.000 KN/m

= 936.600 KN/m

4.3.4 저항력

$R = W_1 + W_2 + F$ = 1132.750 + 2134.388 + 379.887 = 3647.025 KN/m

(1) W_1 (구체자중)

① 시공중부력검토 구체자중 = 759.000 KN/m

② 상부 슬래브

(1.400 × 10.500)× 25.000 = 367.500 kN/m

③ 헌치

(0.500 × 0.500)× 1/2 × 2 EA × 25.000 = 6.250 kN/m

소 계 = 1132.750 kN/m

(2) W2 (상재하중)

① 아스팔트(램프)

(0.450 × 10.500)× 23.000 = 108.675 kN/m

② 상재토

지하수위 이상

되메움토 : (9.150 × 10.500)× 19.000 = 1825.425 kN/m

지하수위 이하

되메움토 : (0.900 × 10.500)× 20.000 = 189.000 kN/m

③ 방수몰탈

(0.050 × 10.500)× 21.500 = 11.288 kN/m

TOTAL = 2134.388 kN/m

(3) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로 적용

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi = 1 - \sin 30$ = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 9.600 m

지하수위 이하 구간(H_2) = 0.900 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

= 2 × 0.0 × 0.000 + 0.500 ×(19.0 × 9.600 ² + 10.0 × 0.900 ²

+ 2 × 19.0 × 9.600 × 0.900)× tan 20° = 379.887 kN/m

4.3.5 안정검토

$$F_s = \frac{R}{U} = \frac{3647.025}{936.600} = 3.894 \geq 1.200$$ ∴ O.K

4.4 완공후 부력 검토 (극한수위 : G.L - 1.000 m)

4.4.1 굴착고 : 18.520 m

4.4.2 부력 작용폭 : 10.500 m

4.4.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 17.520 × 10.500 = 1839.600 KN/m

10.000 × 0.000 × 0.000 = 0.000 KN/m

= 1839.600 KN/m

4.4.4 저항력

$R = W_1 + W_2 + F$ = 1132.750 + 2224.688 + 233.396 = 3590.834 KN/m

(1) W_1 (구체자중)

① 실수위시 부력검토 구체자중 = 1132.750 KN/m

TOTAL = 1132.750 kN/m

(2) W_2 (상재하중)

① 아스팔트

(0.450 × 10.500)× 23.000 = 108.675 kN/m

② 상재토

지하수위 이상

되메움토 : (0.550 × 10.500)× 19.000 = 109.725 kN/m

지하수위 이하

되메움토 : (9.500 × 10.500)× 20.000 = 1995.000 kN/m

③ 방수몰탈

(0.050 × 10.500)× 21.500 = 11.288 kN/m

TOTAL = 2224.688 kN/m

(3) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로 적

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi =$ 1 − sin = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 1.000 m

지하수위 이하 구간(H_2) = 9.500 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

= 2 × 30.0 × 0.000 + 0.500 ×(19.0 × 1.000 ² + 10.0 × 9.500 ²

+ 2 × 19.0 × 1.000 × 9.500)× tan 20° = 233.396 kN/m

4.4.5 안정검토

$F_s = \frac{R}{U} = \frac{3590.834}{1839.600} = 1.952 \geq 1.050$ ∴ O.K

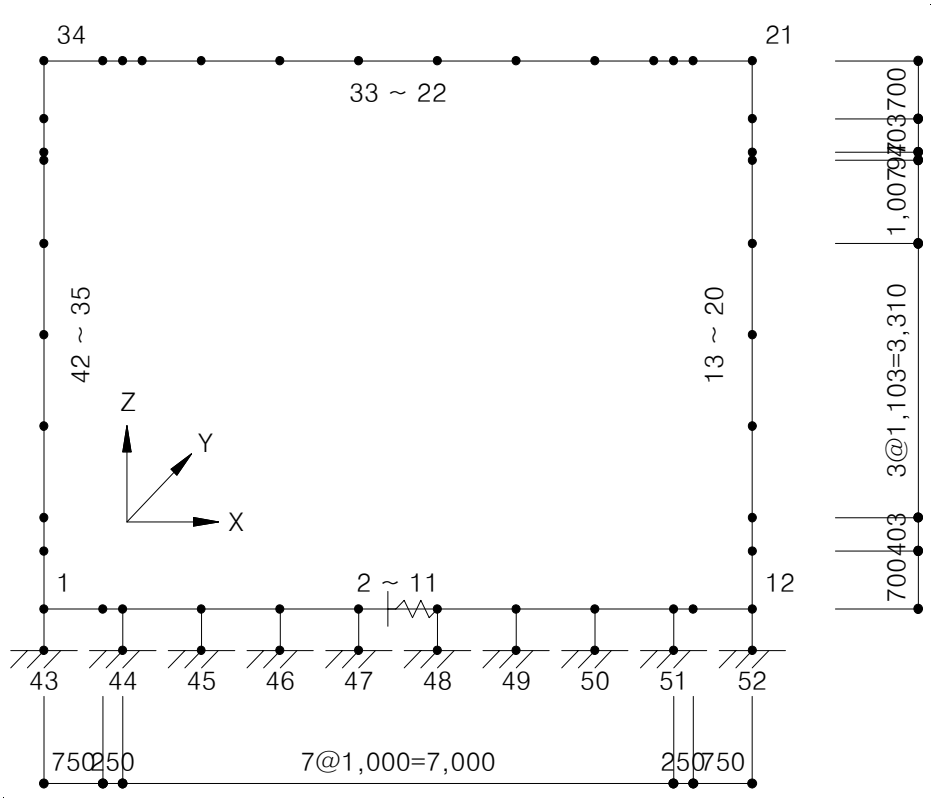
5. 해석모델 및 단면제원 (상시)

1) Modeling

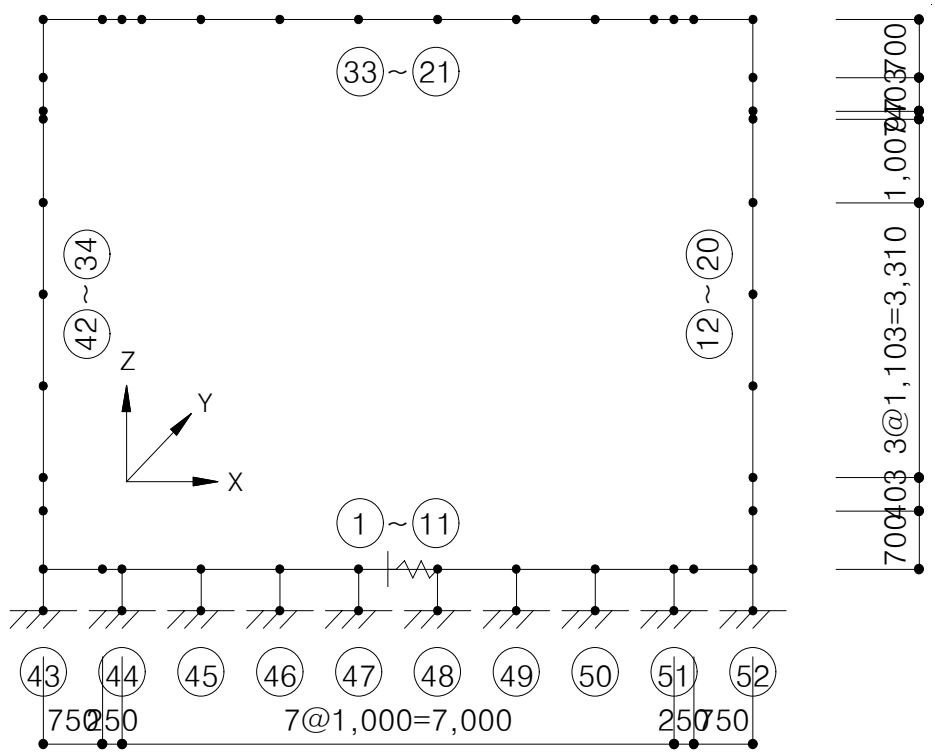
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.400 × 1.000	= 1.400	0.22867	1~11,24~30
2	1.500 × 1.000	= 1.500	0.28125	12~17,37~42
4	2.000 × 1.000	= 2.000	0.66667	20,34
5	1.900 × 1.000	= 1.900	0.57158	21,33

NO	A (m²)		I (m⁴)	절 점
3	1.597 × 1.000	= 1.597	0.33920	19,36
6	1.650 × 1.000	= 1.650	0.37434	23,32

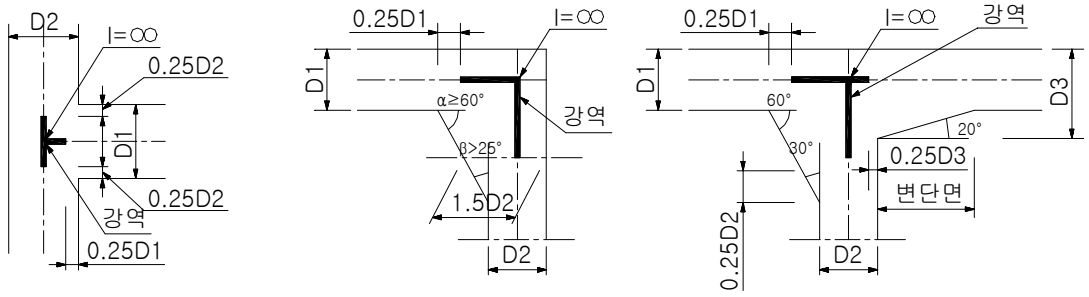
NO	Section(Tapper)	부 재
7	SEC 2 ~ 3	18
8	SEC 3 ~ 4	19
9	SEC 5 ~ 6	22
10	SEC 6 ~ 1	23
11	SEC 1 ~ 6	31
12	SEC 6 ~ 5	32
13	SEC 4 ~ 3	35
14	SEC 3 ~ 2	36

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	27	5.000	7.120
2	0.750	0.500	28	4.000	7.120
3	1.000	0.500	29	3.000	7.120
4	2.000	0.500	30	2.000	7.120
5	3.000	0.500	31	1.250	7.120
6	4.000	0.500	32	1.000	7.120
7	5.000	0.500	33	0.750	7.120
8	6.000	0.500	34	0.000	7.120
9	7.000	0.500	35	0.000	6.420
10	8.000	0.500	36	0.000	6.017
11	8.250	0.500	37	0.000	5.920
12	9.000	0.500	38	0.000	4.913
13	9.000	1.200	39	0.000	3.810
14	9.000	1.603	40	0.000	2.707
15	9.000	2.707	41	0.000	1.603
16	9.000	3.810	42	0.000	1.200
17	9.000	4.913	43	0.000	0.000
18	9.000	5.920	44	1.000	0.000
19	9.000	6.017	45	2.000	0.000
20	9.000	6.420	46	3.000	0.000
21	9.000	7.120	47	4.000	0.000
22	8.250	7.120	48	5.000	0.000
23	8.000	7.120	49	6.000	0.000
24	7.750	7.120	50	7.000	0.000
25	7.000	7.120	51	8.000	0.000
26	6.000	7.120	52	9.000	0.000

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 34 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1500 / 2 + 500 - (1400 × 500) / (2 × 500) = 550 mm

(2) 34 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1400 / 2 + 500 - (1500 × 500) / (2 × 500) = 450 mm

(3) 21 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1500 / 2 + 500 - (1400 × 500) / (2 × 500) = 550 mm

(4) 21 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1400 / 2 + 500 - (1500 × 500) / (2 × 500) = 450 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1500 / 2 - 0.25 × 1400 = 400 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1400 / 2 - 0.25 × 1500 = 325 mm

(7) 12 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1500 / 2 - 0.25 × 1400 = 400 mm

(8) 12 지점 - 슬래브 벽체 연결부

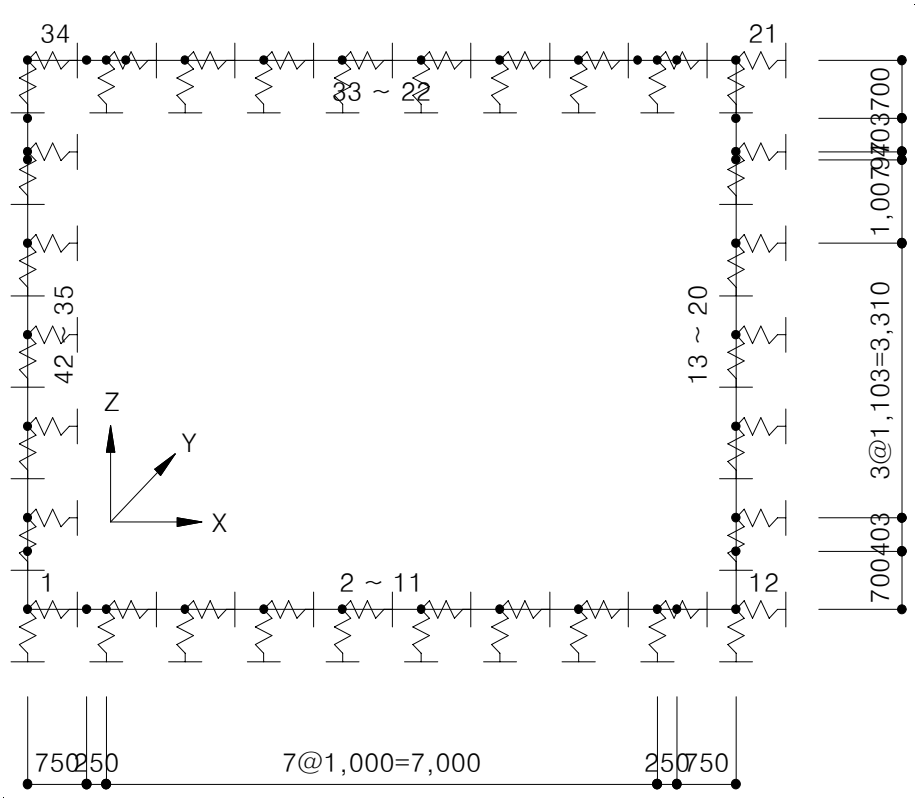
D2 / 2 - 0.25 × D1 = 1400 / 2 - 0.25 × 1500 = 325 mm

6. 해석모델 및 단면제원 (지진시)

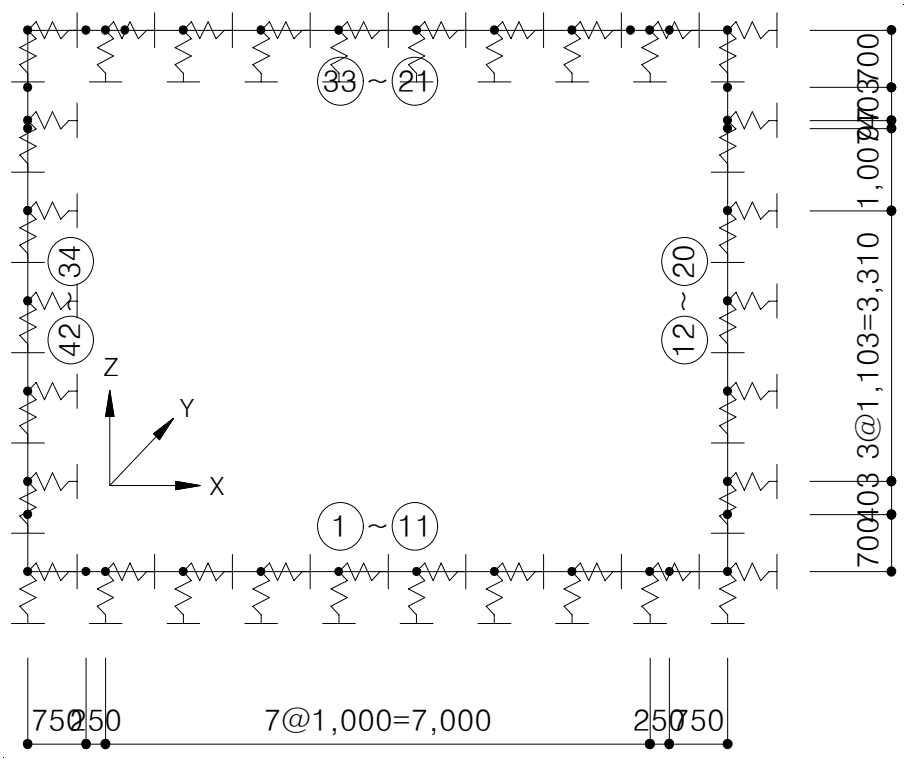
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	1.400 × 1.000	= 1.400	0.22867	1~11,24~30
2	1.500 × 1.000	= 1.500	0.28125	12~17,37~42
4	2.000 × 1.000	= 2.000	0.66667	20,34
5	1.900 × 1.000	= 1.900	0.57158	21,33

NO	A (m²)		I (m⁴)	절 점
3	1.597 × 1.000	= 1.597	0.33920	19,36
6	1.650 × 1.000	= 1.650	0.37434	23,32

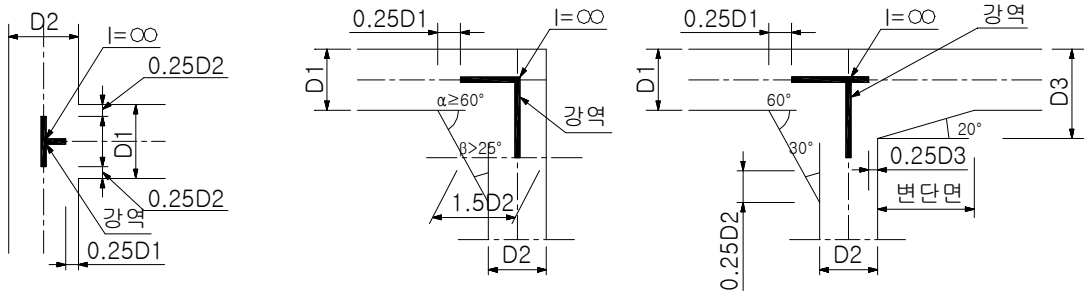
NO	Section(Tapper)	부 재
7	SEC 2 ~ 3	18
8	SEC 3 ~ 4	19
9	SEC 5 ~ 6	22
10	SEC 6 ~ 1	23
11	SEC 1 ~ 6	31
12	SEC 6 ~ 5	32
13	SEC 4 ~ 3	35
14	SEC 3 ~ 2	36

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.000	22	8.250	6.620
2	0.750	0.000	23	8.000	6.620
3	1.000	0.000	24	7.750	6.620
4	2.000	0.000	25	7.000	6.620
5	3.000	0.000	26	6.000	6.620
6	4.000	0.000	27	5.000	6.620
7	5.000	0.000	28	4.000	6.620
8	6.000	0.000	29	3.000	6.620
9	7.000	0.000	30	2.000	6.620
10	8.000	0.000	31	1.250	6.620
11	8.250	0.000	32	1.000	6.620
12	9.000	0.000	33	0.750	6.620
13	9.000	0.700	34	0.000	6.620
14	9.000	1.103	35	0.000	5.920
15	9.000	2.207	36	0.000	5.517
16	9.000	3.310	37	0.000	5.420
17	9.000	4.413	38	0.000	4.413
18	9.000	5.420	39	0.000	3.310
19	9.000	5.517	40	0.000	2.207
20	9.000	5.920	41	0.000	1.103
21	9.000	6.620	42	0.000	0.700

8) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 34 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1500 / 2 + 500 - (1400 × 500) / (2 × 500) = 550 mm

(2) 34 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1400 / 2 + 500 - (1500 × 500) / (2 × 500) = 450 mm

(3) 21 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1500 / 2 + 500 - (1400 × 500) / (2 × 500) = 550 mm

(4) 21 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1400 / 2 + 500 - (1500 × 500) / (2 × 500) = 450 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1500 / 2 - 0.25 × 1400 = 400 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1400 / 2 - 0.25 × 1500 = 325 mm

(7) 12 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 1500 / 2 - 0.25 × 1400 = 400 mm

(8) 12 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1400 / 2 - 0.25 × 1500 = 325 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 300000.00 kN/m²

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

Bv = √(B × B) = √(10.500 × 10.500) = 10.500 m

Kvo = 1 / 0.3 × 1 × 300000 = 1000000.00 kN/m³

Kv(BxB) = 1000000.00 × (10.500 / 0.3) $^{-3 / 4}$ = 69494.27 kN/m³

Kv(BxL) = 0.88 × Kv(BxB) = 0.88 × 69494.265 = 61154.95 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.500/2 + 1.000/2) = 76444 kN/m	1,12
Kv2	Kv x (1.000/2 + 1.000/2) = 61155 kN/m	3~10
Kh	1E10 kN/m (무한강성)	7

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 모래(SP) (EL. : 11.617 ~ 0.717, N=5)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 1.0 × Vo = 1.0 × 289.0 = 289.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 289.0^2 = 170277.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 170277.0 = 449531.3 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.8 × Vo = 0.8 × 289.0 = 231.2 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 231.2^2 = 108977.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 108977.0 = 287699.3 kN/m^2

(2) 풍화 잔류토(RS) (EL. : 0.717 ~ -2.383, N=14)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 424.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 1.0 × Vo = 1.0 × 424.0 = 424.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 424.0^2 = 366516.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 366516.0 = 967602.2 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 424.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 1.0 × Vo = 1.0 × 424.0 = 424.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 424.0^2 = 366516.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 366516.0 = 967602.2 kN/m^2

(3) 풍화암(WR) (EL. : -2.383 ~ -18.383, N=50)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 1.0 × Vo = 1.0 × 631.0 = 631.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 631.0² = 811745.0 kN/m²
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.3) × 811745.0 = 2110537.0 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 1.0 × Vo = 1.0 × 631.0 = 631.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 631.0² = 811745.0 kN/m²
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.3) × 811745.0 = 2110537.0 kN/m²

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제3토층 ,풍화 잔류토(RS)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

α = 1,L = 16.040m

Bv = √(B × B) = √(10.500 × 10.500) = 10.500 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 967602.2 = 3225340.67 kN/m³

Kv(B×B) = 3225340.670 × (10.500 / 0.3)$^{-3/4}$ = 224142.68 kN/m³

Kv(BxL) = 0.88 × Kv(BxB) = 0.88 × 224142.680 = 197245.56 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 197245.560 = 65748.52 kN/m³

(2) 하부슬래브 : 제4토층 , 풍화암(WR)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

α = 1,L = 16.040m

Bv = √(B × B) = √(10.500 × 10.500) = 10.500 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kv(B×B) = 7035123.330 × (10.500 / 0.3)$^{-3/4}$ = 488900.73 kN/m³

Kv(BxL) = 0.88 × Kv(BxB) = 0.88 × 488900.730 = 430232.64 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 430232.640 = 143410.88 kN/m³

(3) 측벽 : 제3토층 , 풍화 잔류토(RS)

① 수평방향 지반반력계수

$$K_{(H\times L)} = K_{(H\times H)} \times \frac{(1+0.5\frac{H}{L})}{1.5}$$ α = 1,L = 16.040m

Bh = √(H × H) = √(8.020 × 8.020) = 8.020 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 967602.2 = 3225340.67 kN/m³

Kh(H×H) = 3225340.670 × (8.020 / 0.3)$^{-3/4}$ = 274337.87 kN/m³

Kh(HxL) = 0.830 × Kh(HxH) = 0.830 × 274337.870 = 227700.43 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 227700.430 = 75900.14 kN/m³

(4) 측벽 : 제4토층 , 풍화암(WR)

① 수평방향 지반반력계수

$$K_{(H\times L)} = K_{(H\times H)} \times \frac{(1+0.5\frac{H}{L})}{1.5}$$ α = 1,L = 16.040m

Bh = √(H × H) = √(8.020 × 8.020) = 8.020 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kh(H×H) = 7035123.330 × (8.020 / 0.3)$^{-3/4}$ = 598386.63 kN/m³

Kh(HxL) = 0.830 × Kh(HxH) = 0.830 × 598386.630 = 496660.90 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 496660.900 = 165553.63 kN/m³

(5) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.000/2 + 1.000/2) = 197246 kN/m	23,25~30,32
Ksb1	Ksb x (1.000/2 + 1.000/2) = 65749 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.103/2 + 1.103/2) = 547981 kN/m	14~16,39~41
Kss1	Kss x (1.103/2 + 1.103/2) = 182660 kN/m	
Kh2	Kh x (1.103/2 + 1.103/2) = 251229 kN/m	17,19,36,38
Kss2	Kss x (1.103/2 + 1.103/2) = 83743 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.000/2 + 1.000/2) = 430233 kN/m	3~10
Ksb1	Ksb x (1.000/2 + 1.000/2) = 143411 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.500/2 + 1.000/2) = 537791 kN/m	1,12
Ksb1	Kh x (1.103/2 + 1.400/2) = 621653 kN/m	
Kv2	Kv x (1.000/2 + 1.500/2) = 246557 kN/m	21,34
Ksb2	Kh x (1.103/2 + 1.400/2) = 285005 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제3토층 ,풍화 잔류토(RS)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$ α = 1,L = 16.040m

Bv = √(B × B) = √(10.500 × 10.500) = 10.500 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 967602.2 = 3225340.67 kN/m³

Kv(B×B') = 3225340.670 × (10.500 / 0.3)$^{-3/4}$ = 224142.68 kN/m³

Kv(BxL) = 0.88 × Kv(BxB) = 0.88 × 224142.680 = 197245.56 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 197245.560 = 65748.52 kN/m³

(2) 하부슬래브 : 제4토층 , 풍화암(WR)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$ α = 1,L = 16.040m

Bv = √(B × B) = √(10.500 × 10.500) = 10.500 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kv(B×B') = 7035123.330 × (10.500 / 0.3)$^{-3/4}$ = 488900.73 kN/m³

Kv(BxL) = 0.88 × Kv(BxB) = 0.88 × 488900.730 = 430232.64 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 430232.640 = 143410.88 kN/m³

(3) 측벽 : 제3토층 , 풍화 잔류토(RS)

① 수평방향 지반반력계수

$$K_{(H\times L)} = K_{(H\times H)} \times \frac{(1+0.5\frac{H}{L})}{1.5}$$ α = 1,L = 16.040m

Bh = √(H × H) = √(8.020 × 8.020) = 8.020 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 967602.2 = 3225340.67 kN/m³

Kh(H×H') = 3225340.670 × (8.020 / 0.3)$^{-3/4}$ = 274337.87 kN/m³

Kh(HxL) = 0.830 × Kh(HxH' = 0.830 × 274337.870 = 227700.43 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 227700.430 = 75900.14 kN/m³

(4) 측벽 : 제4토층 , 풍화암(WR)

① 수평방향 지반반력계수

$$K_{(H\times L)} = K_{(H\times H)} \times \frac{(1+0.5\frac{H}{L})}{1.5}$$

α = 1,L = 16.040m

Bh = √(H × H) = √(8.020 × 8.020) = 8.020 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kh(H×H) = 7035123.330 × (8.020 / 0.3)$^{-3/4}$ = 598386.63 kN/m³

Kh(HxL) = 0.830 × Kh(HxH) = 0.830 × 598386.630 = 496660.90 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 496660.900 = 165553.63 kN/m³

(5) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.000/2 + 1.000/2) = 197246 kN/m	23,25~30,32
Ksb1	Ksb x (1.000/2 + 1.000/2) = 65749 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.103/2 + 1.103/2) = 547981 kN/m	14~16,39~41
Kss1	Kss x (1.103/2 + 1.103/2) = 182660 kN/m	
Kh2	Kh x (1.103/2 + 1.103/2) = 251229 kN/m	17,19,36,38
Kss2	Kss x (1.103/2 + 1.103/2) = 83743 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.000/2 + 1.000/2) = 430233 kN/m	3~10
Ksb1	Ksb x (1.000/2 + 1.000/2) = 143411 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.500/2 + 1.000/2) = 537791 kN/m	1,12
Ksb1	Kh x (1.103/2 + 1.400/2) = 621653 kN/m	
Kv2	Kv x (1.000/2 + 1.500/2) = 246557 kN/m	21,34
Ksb2	Kh x (1.103/2 + 1.400/2) = 285005 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

	성능기 / 준 재현주기	기 능 수 행	붕 괴 방 지
설계지진	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.16 = 0.091
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.16 = 0.224

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 토 사	: 10.000 × 19.00	=	190.000	kN/m²
	∴ Total Wd1	=	201.500	kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00	=	9.500	kN/m²
- 흙(지하수위 이하)	: 9.500 × 10.00	=	95.000	kN/m²
	∴ Total Wd2	=	116.000	kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

토피고(D,m)	도로면의 활하중 (kN/m²)	토피고(D,m)	도로면의 활하중 (kN/m²)
1.0	39.0	1.5	25.0
2.0	18.0	2.5	14.0
3.0	11.0	3.5	10.0
4.0	10.0	5.0	10.0
6.0	10.0	7.0	10.0
8.0	10.0	9.0	10.0
10.0	10.0		

주) 중간토피에 대한 것은 그 상위의 것을 취한다.

① 상부 슬래브에 작용하는 하중 (WI1) - 토피 4m 이상

- WI1 = 10.000 kN/m²

② 측벽에 작용하는 하중 (WI2)

- WI2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 10.700 × 19.000) × 0.500 = 107.400 kN/m²
Wh2 = 107.400 + 0.700 × 19.000 × 0.500 = 114.050 kN/m²
Wh3 = 114.050 + 0.403 × 19.000 × 0.500 = 117.881 kN/m²
Wh4 = 117.881 + 0.097 × 19.000 × 0.500 = 118.800 kN/m²
Wh5 = 118.800 + 1.007 × 19.000 × 0.500 = 128.364 kN/m²
Wh6 = 128.364 + 1.103 × 19.000 × 0.500 = 138.845 kN/m²
Wh7 = 138.845 + 1.103 × 19.000 × 0.500 = 149.326 kN/m²
Wh8 = 149.326 + 1.103 × 19.000 × 0.500 = 159.809 kN/m²
Wh9 = 159.809 + 0.403 × 19.000 × 0.500 = 163.640 kN/m²
Wh10 = 163.640 + 0.700 × 19.000 × 0.500 = 170.290 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 10.200 × 10.00 = 61.500 kN/m²
Wh2 = 61.500 + 0.700 × 10.000 × 0.500 = 65.000 kN/m²
Wh3 = 65.000 + 0.403 × 10.000 × 0.500 = 67.017 kN/m²
Wh4 = 67.017 + 0.097 × 10.000 × 0.500 = 67.500 kN/m²
Wh5 = 67.500 + 1.007 × 10.000 × 0.500 = 72.533 kN/m²
Wh6 = 72.533 + 1.103 × 10.000 × 0.500 = 78.050 kN/m²
Wh7 = 78.050 + 1.103 × 10.000 × 0.500 = 83.567 kN/m²
Wh8 = 83.567 + 1.103 × 10.000 × 0.500 = 89.083 kN/m²
Wh9 = 89.083 + 0.403 × 10.000 × 0.500 = 91.100 kN/m²
Wh10 = 91.100 + 0.700 × 10.000 × 0.500 = 94.600 kN/m²

6) 지하수압 (지하수위 : GL = -1.000 m)

① 상부슬래브에 작용하는 하중

- Ww1 = 9.500 × 10.000 = 95.000 kN/m²

② 측벽에 작용하는 하중

- Ww2 = 10.200 × 10.000 = 102.000 kN/m²
Ww3 = 102.000 + 0.700 × 10.000 = 109.000 kN/m²
Ww4 = 109.000 + 0.403 × 10.000 = 113.033 kN/m²
Ww5 = 113.033 + 0.097 × 10.000 = 114.000 kN/m²
Ww6 = 114.000 + 1.007 × 10.000 = 124.067 kN/m²
Ww7 = 124.067 + 1.103 × 10.000 = 135.100 kN/m²
Ww8 = 135.100 + 1.103 × 10.000 = 146.133 kN/m²
Ww9 = 146.133 + 1.103 × 10.000 = 157.167 kN/m²
Ww10 = 157.167 + 0.403 × 10.000 = 161.200 kN/m²
Ww11 = 161.200 + 0.700 × 10.000 = 168.200 kN/m²

③ 하부슬래브에 작용하는 하중

- Ww12 = (10.500 + 8.020 - 1.000) × 10.000 = 175.200 kN/m²

7) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

8) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 15 \times 10^{-5}$
- 온도선팽창 계수 $\alpha = 1.0 \times 10^{-5}$
- $\Delta T = -\frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
실트 섞인 모래(SM	2.200	156.000	124.800	20.000	0.056	0.071
모래(SP)	8.700	289.000	231.200	20.000	0.120	0.151
풍화 잔류토(RS)	3.100	424.000	424.000	20.000	0.029	0.029
풍화암(WR)	16.000	631.000	631.000	20.000	0.101	0.101
계					0.306	0.352

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.306 = 0.383	1.25 Tg' = 1.25 × 0.352 = 0.440

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575
To(sec)	To = 0.2 × Ts = 0.2 × 0.575 = 0.115	To = 0.2 × Ts = 0.2 × 0.575 = 0.115

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $$C_d = \frac{1.5}{40h+1} + 0.5$$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa)

- 붕괴방지수준시(재현주기 1000년적용)

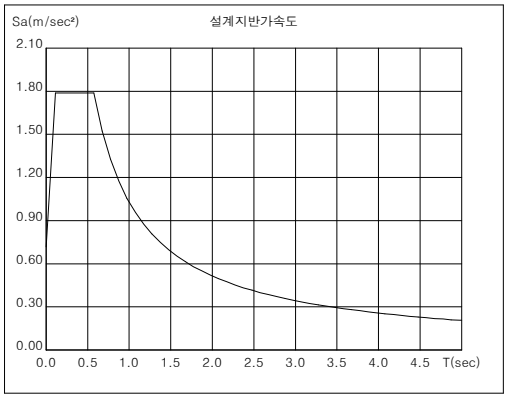
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 1.789 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 3.664 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg

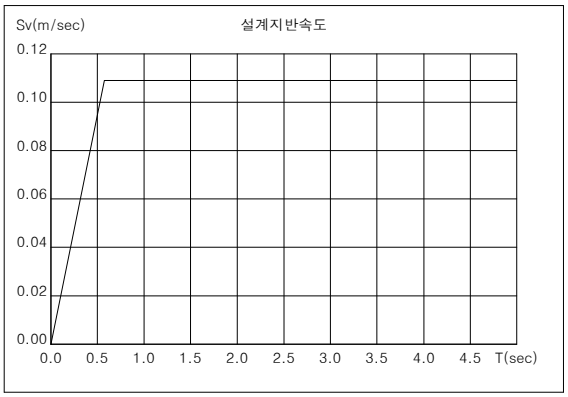
5) 속도 응답스펙트럼(Sv)　　- 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.383 / 2π × 1.789 = 0.109 m/s	Sv = Tg/2π × Sa = 0.440 / 2π × 3.664 = 0.257 m/s

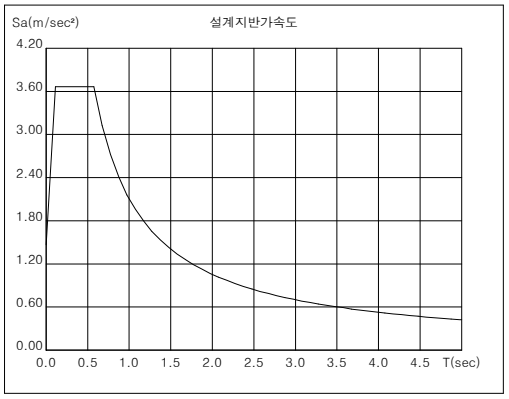
6) 설계응답 응답스펙트럼

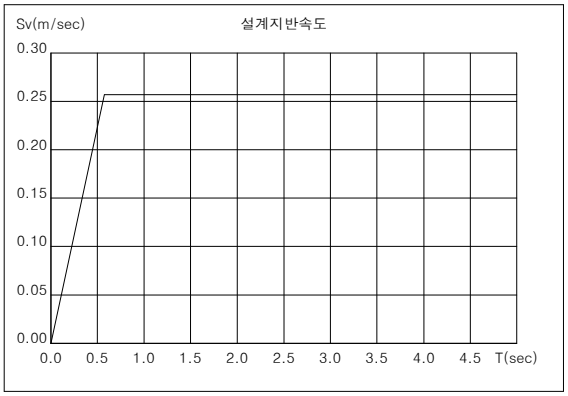
(1) 기능수행수준





(2) 붕괴방지수준





7) 층별 변위값 정리

- 제 1층의 두께(H1) = 14.000 m
- 제 2층의 두께(H2) = 16.000 m
- 제 1층의 습윤단위 체적중량(γ1) = 20.000 kN/m³
- 제 2층의 습윤단위 체적중량(γ2) = 20.000 kN/m³
- 제 1층의 평균전단파속도(Vsod1) = 257.171 m/sec
- 제 2층의 평균전단파속도(Vsod2) = 631.000 m/sec
- 제 1층과 제2층의 임피던스비(α)
  (γ1×Vsod1) / (γ2×Vsod2) = (20.000 × 257.171) / (20.000 × 631.000)
  = 0.408

- 지반의 설계 고유 진동수(Wo)

$(1+\alpha)\times\cos[Wo\times(H1/Vsod1 + H2/Vsod2)] + (1-\alpha)\times\cos[Wo\times(H1/Vsod1 - H2/Vsod2)] = 0$

$(1 + 0.408) \times \cos[Wo \times (14.000 / 257.171 + 16.000 / 631.000)] +$

$(1 - 0.408) \times \cos[Wo \times (14.000 / 257.171 - 16.000 / 631.000)] = 0$

에서 시행착오법으로 산정, Wo = 23.815

- 각 층별 변위 계산식

  - 제1층 변위 계산식

$Uh1 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times x1/Vsod1)$

  - 제2층 변위 계산식

$Uh2 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times H1/Vsod1) \times$

$[\cos(Wo \times x2/Vsod2) - \sin(Wo \times x2/Vsod2) / \tan(Wo \times H2/Vsod2)]$

8) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 11.200 m
- 하부슬래브 EL. = 17.820 m
- 기반암 심도(H) = 30.000 m

$Po = Ksb,top \times (U(Zu) - U(Zb))$

기능수행수준	붕괴방지수준
$Po = 65748.520 \times (0.004303 - 0.001791)$ $= 165.160\ kN/m^2$	$Po = 65748.520 \times (0.011656 - 0.004851)$ $= 447.419\ kN/m^2$

9) 측벽 지반변위 하중

$P(z) = Kh \times (Uh(z) - Uh(b))$

(1) 기능수행수준

z(m)	Kh (kN/m^3)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m^2)
11.200	227700.430	0.004303	0.002512	571.983
11.900	227700.430	0.003822	0.002031	462.460
12.303	227700.430	0.003538	0.001747	397.793
12.400	227700.430	0.003469	0.001678	382.081
13.407	227700.430	0.002735	0.000944	214.949
14.510	496660.900	0.002227	0.000436	216.544
15.613	496660.900	0.002085	0.000294	146.018
16.717	496660.900	0.001940	0.000149	74.002
17.120	496660.900	0.001886	0.000095	47.183
17.820	496660.900	0.001791	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
11.200	227700.430	0.011656	0.006805	1549.501
11.900	227700.430	0.010354	0.005503	1253.035
12.303	227700.430	0.009584	0.004733	1077.706
12.400	227700.430	0.009396	0.004545	1034.898
13.407	227700.430	0.007409	0.002558	582.458
14.510	496660.900	0.006034	0.001183	587.550
15.613	496660.900	0.005649	0.000798	396.335
16.717	496660.900	0.005254	0.000403	200.154
17.120	496660.900	0.005108	0.000257	127.642
17.820	496660.900	0.004851	0.000000	0.000

10) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

구분	기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
Vu	170277.000 × 0.000647 = 110.170	108977.000 × 0.001753 = 191.040
Vb	811745.000 × 0.000135 = 109.590	811745.000 × 0.000365 = 296.290
Vs	(110.170 + 109.590) / 2 = 109.880	(191.040 + 296.290) / 2 = 243.670

11) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fu = 1.400×25.000×0.091×(1 - 0.015×11.200) = 2.650	fu = 1.400×25.000×0.224×(1 - 0.015×11.200) = 6.523

② 하부슬래브

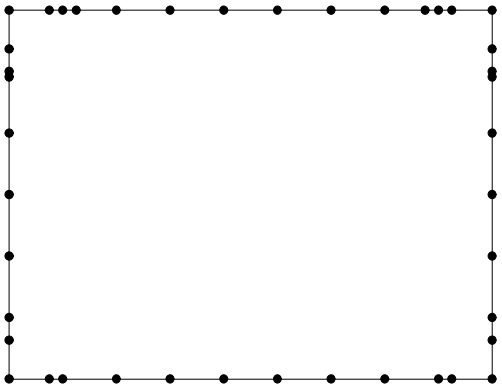
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fb = 1.400×25.000×0.091×(1 - 0.015×17.820) = 2.334	fb = 1.400×25.000×0.224×(1 - 0.015×17.820) = 5.744

③ 측벽

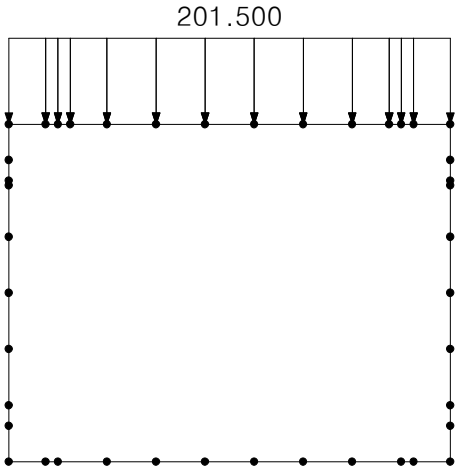
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
f1 = 1.500×25.000×0.091×(1-0.015×11.200) = 2.839	f1 = 1.500×25.000×0.224×(1-0.015×11.200) = 6.989
f2 = 1.500×25.000×0.091×(1-0.015×11.900) = 2.803	f2 = 1.500×25.000×0.224×(1-0.015×11.900) = 6.901
f3 = 1.500×25.000×0.091×(1-0.015×12.303) = 2.783	f3 = 1.500×25.000×0.224×(1-0.015×12.303) = 6.850
f4 = 1.500×25.000×0.091×(1-0.015×12.400) = 2.778	f4 = 1.500×25.000×0.224×(1-0.015×12.400) = 6.838
f5 = 1.500×25.000×0.091×(1-0.015×13.407) = 2.726	f5 = 1.500×25.000×0.224×(1-0.015×13.407) = 6.711
f6 = 1.500×25.000×0.091×(1-0.015×14.510) = 2.670	f6 = 1.500×25.000×0.224×(1-0.015×14.510) = 6.572
f7 = 1.500×25.000×0.091×(1-0.015×15.613) = 2.613	f7 = 1.500×25.000×0.224×(1-0.015×15.613) = 6.433
f8 = 1.500×25.000×0.091×(1-0.015×16.717) = 2.557	f8 = 1.500×25.000×0.224×(1-0.015×16.717) = 6.294
f9 = 1.500×25.000×0.091×(1-0.015×17.120) = 2.536	f9 = 1.500×25.000×0.224×(1-0.015×17.120) = 6.243
f10 = 1.500×25.000×0.091×(1-0.015×17.820) = 2.500	f10 = 1.500×25.000×0.224×(1-0.015×17.820) = 6.155

11. 하 중 재 하 (상시)

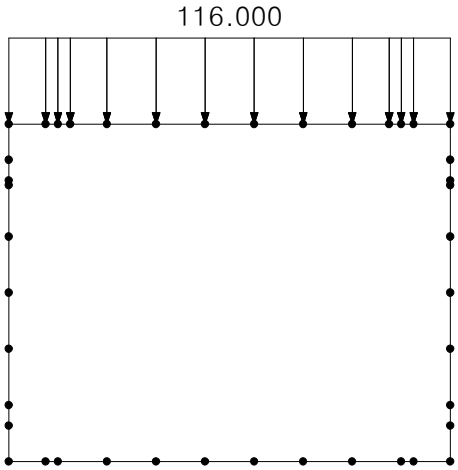
1) CASE1 - 구체자중(SW)



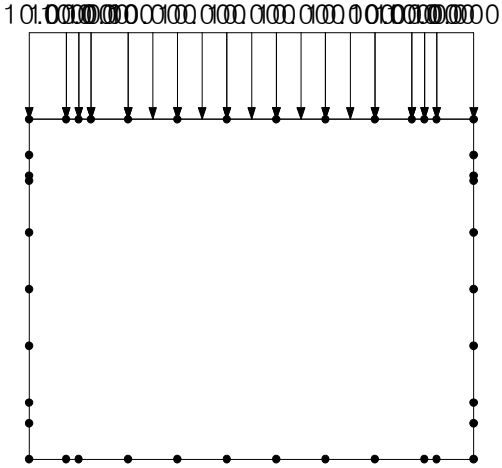
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



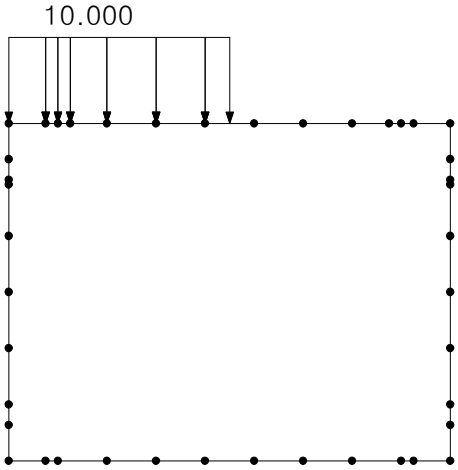
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



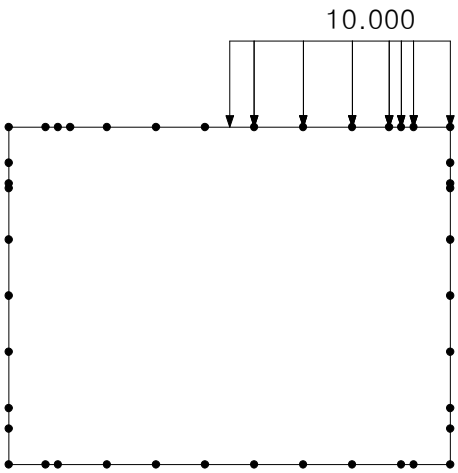
4) CASE4 - 만재활하중(LIVEFU)



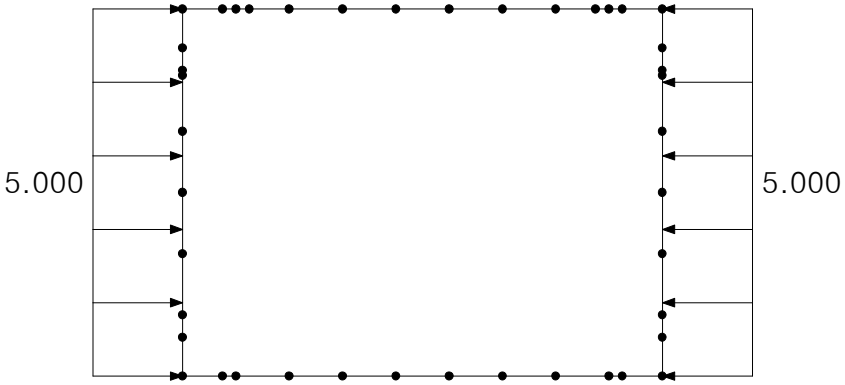
5) CASE5 - 편재활하중(좌측)(LIVELE)



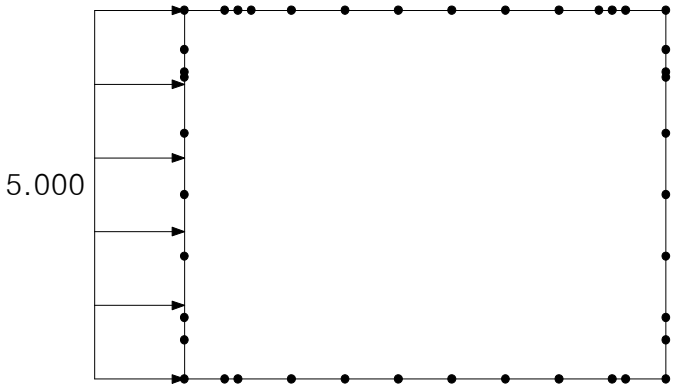
6) CASE6 - 편재활하중(우측)(LIVERI)



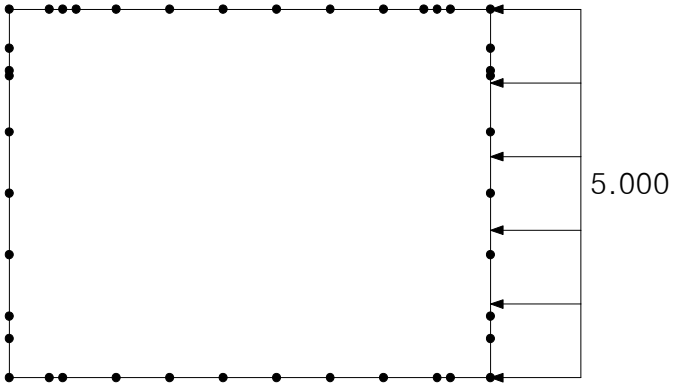
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



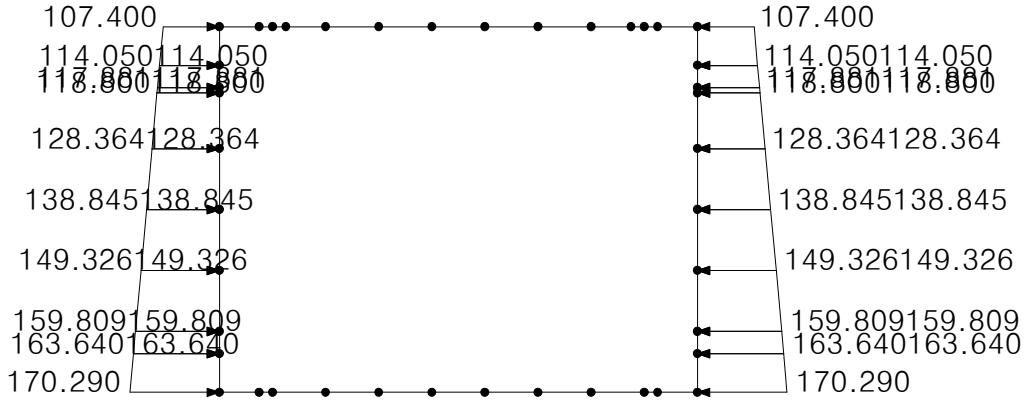
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



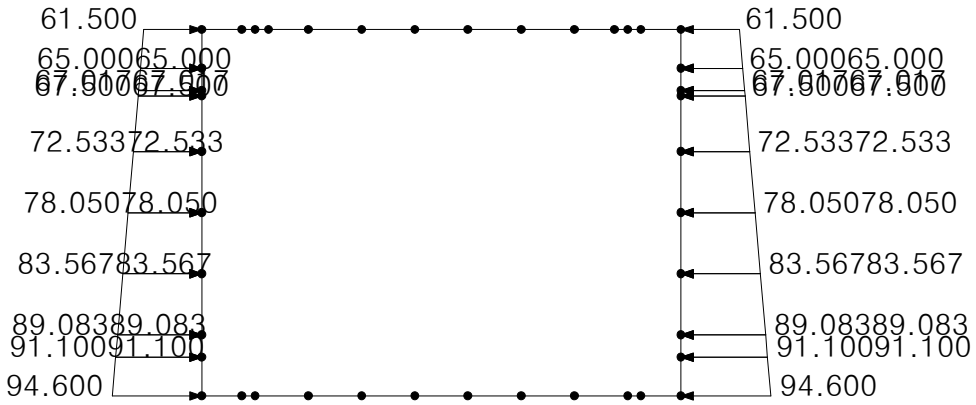
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



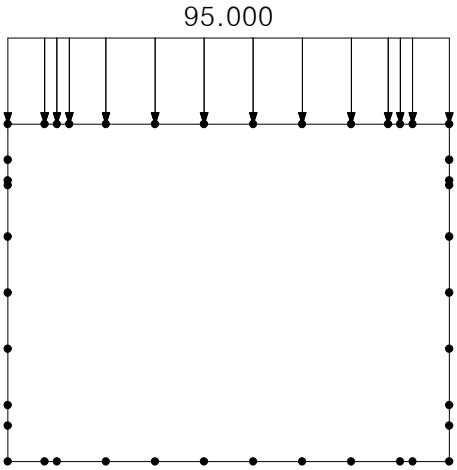
10) CASE10 - 양토압 : 지하수無(SOILB)



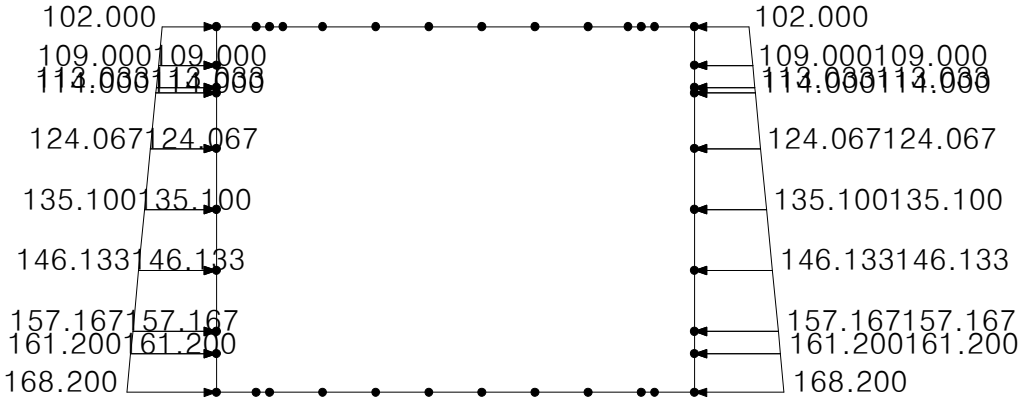
11) CASE11 - 양토압 : 지하수有(SOILBW)



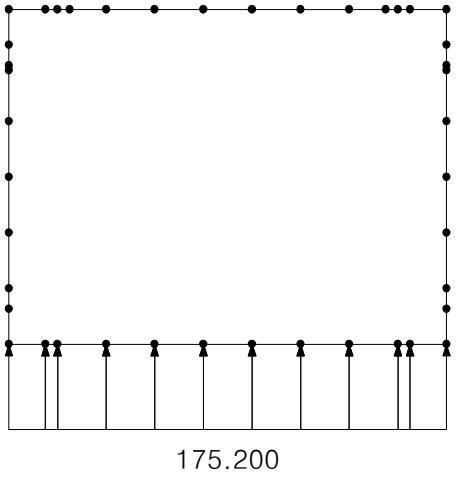
12) CASE12 - 연직수압(WATERV)



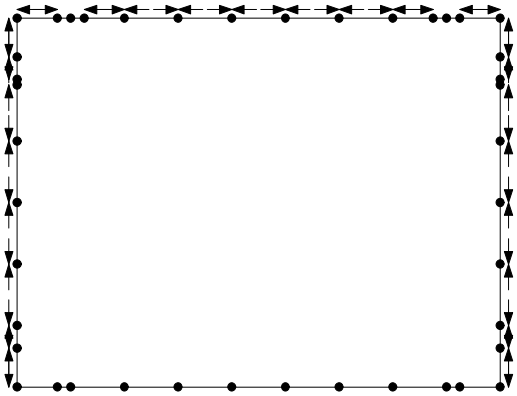
13) CASE13 - 수평수압(WATERH)



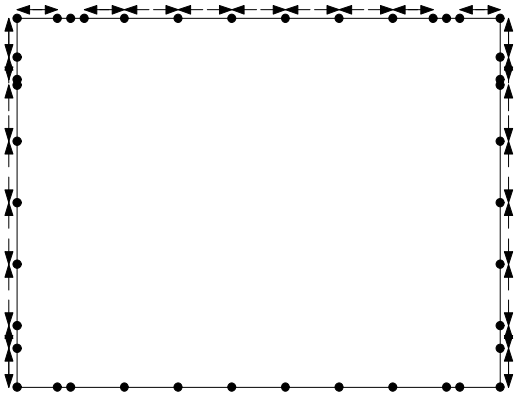
14) CASE14 - 부력(BUOYANCY)



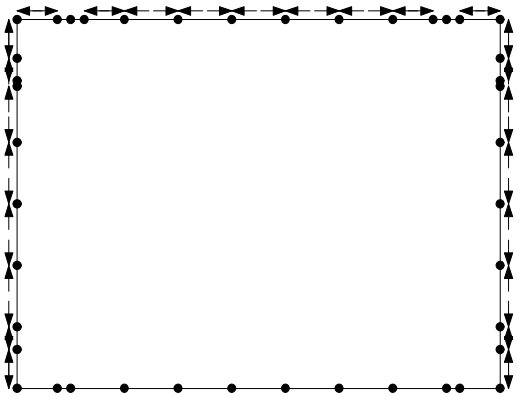
15) CASE15 - 온도변화(+) +10° C(TEMPPLUS)



16) CASE16 - 온도변화(-) -10° C(TEMPMINU)

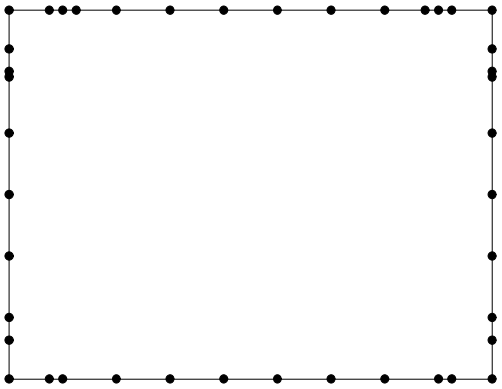


17) CASE17 - 건조수축 -15° C(SHRINK)

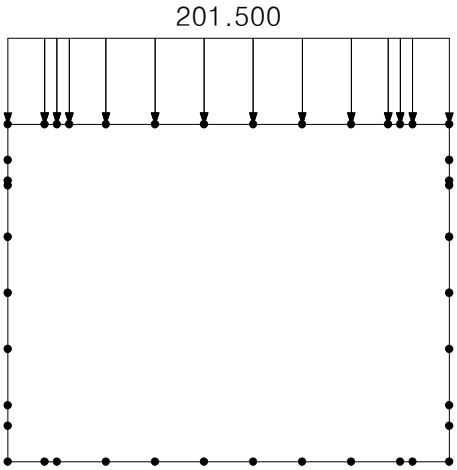


12. 하중 재하 (기능수행)

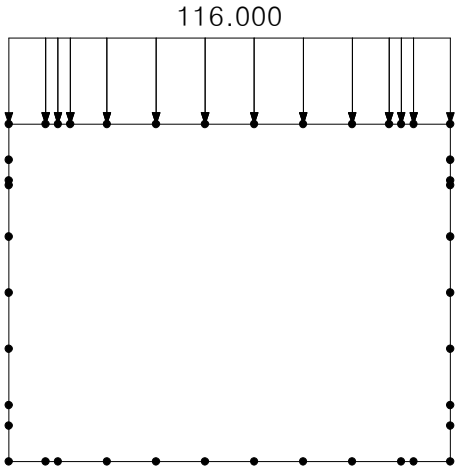
1) CASE1 - 구체자중(SW)



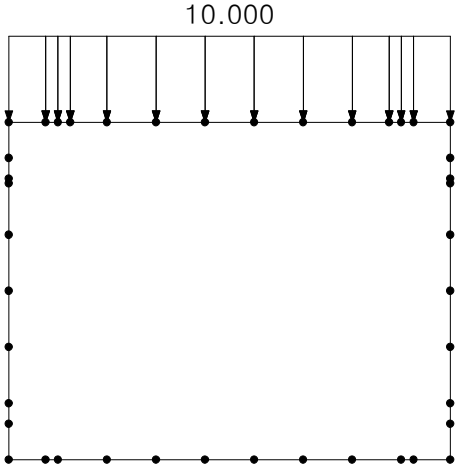
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



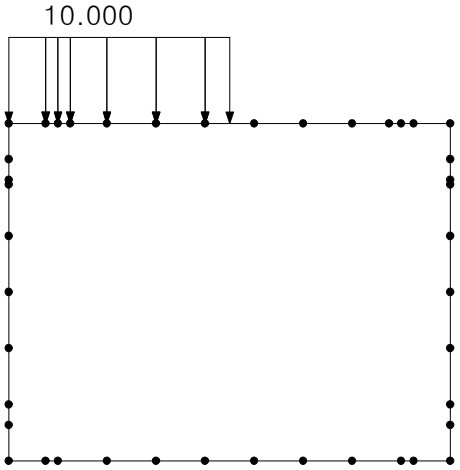
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



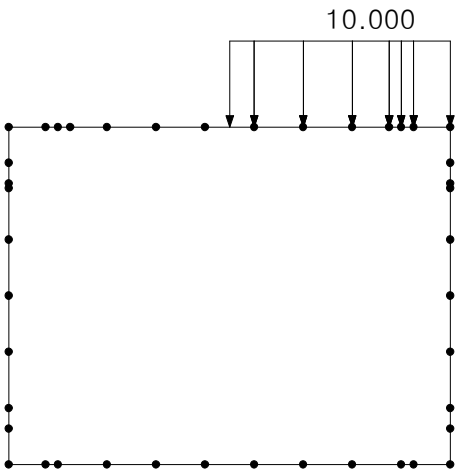
4) CASE4 - 지진시 만재활하중(LIVEFUE)



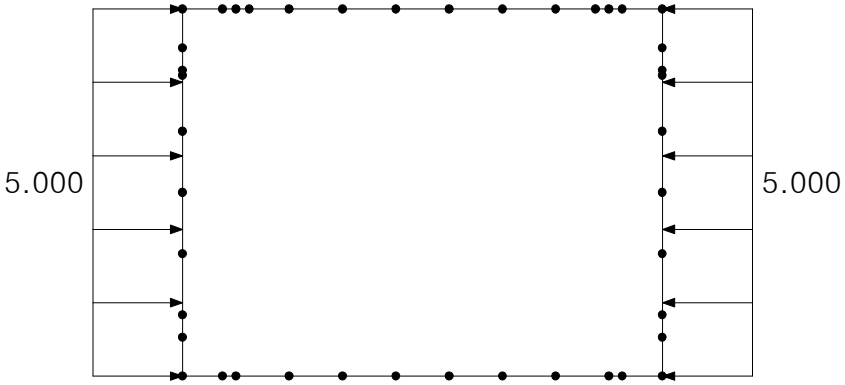
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



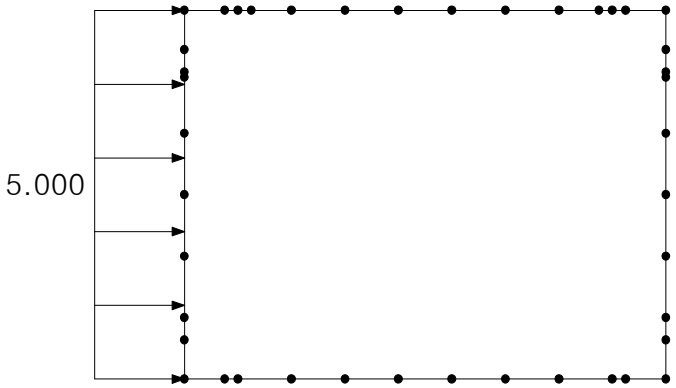
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



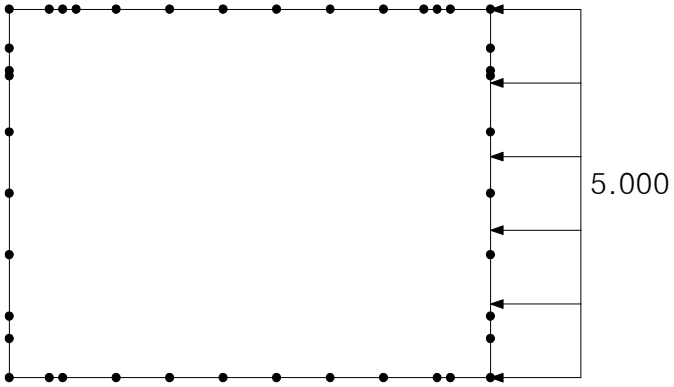
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



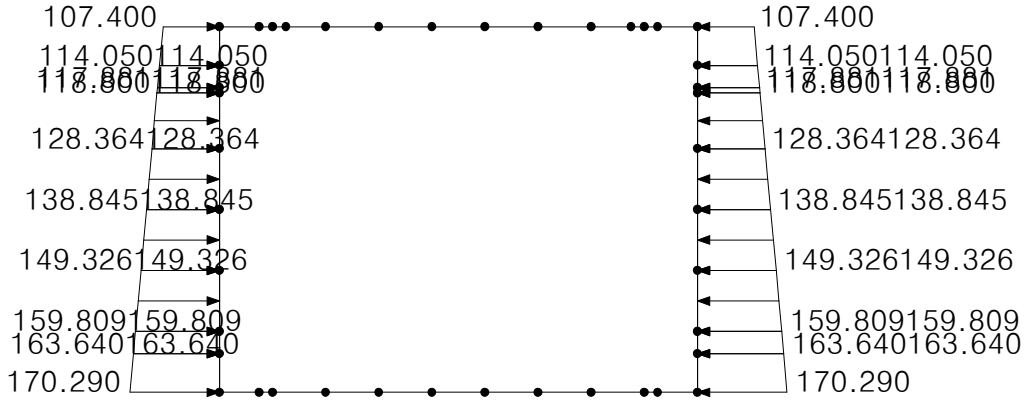
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



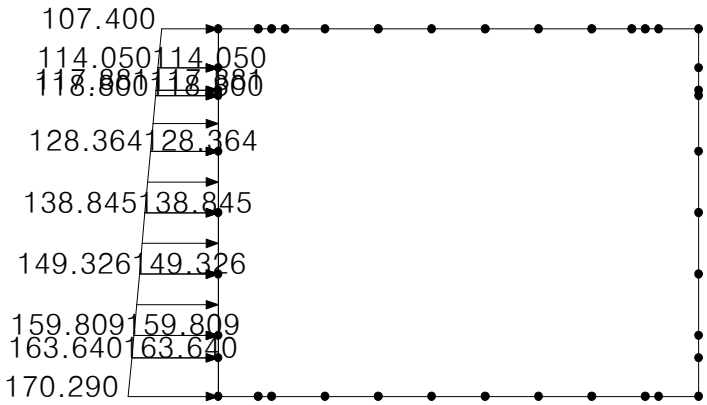
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



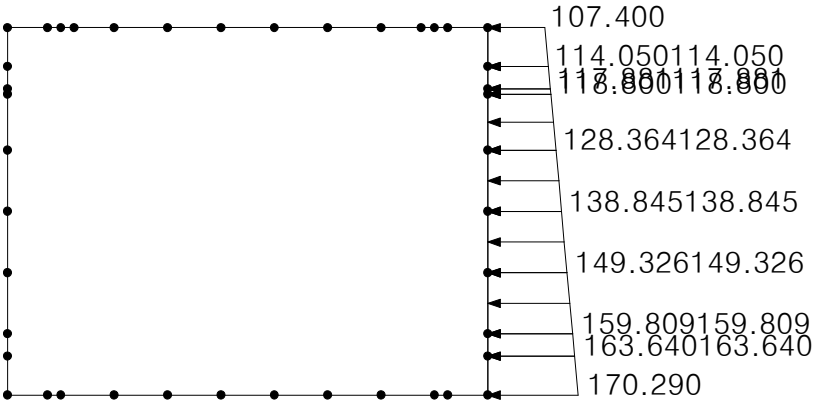
10) CASE10 - 지진시 양토압 2(SOILBE2)



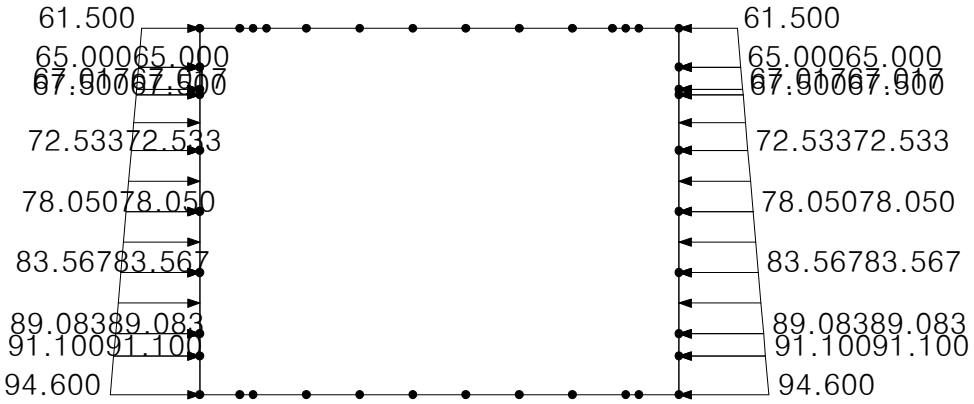
11) CASE11 - 지진시 편토압(좌측) 2(SOILLE2)



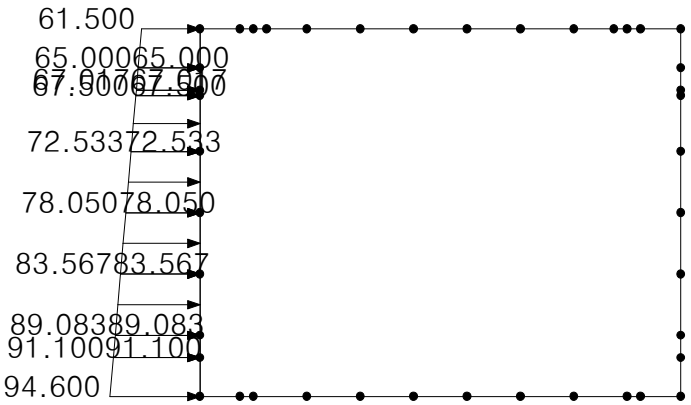
12) CASE12 - 지진시 편토압(우측) 2(SOILRE2)



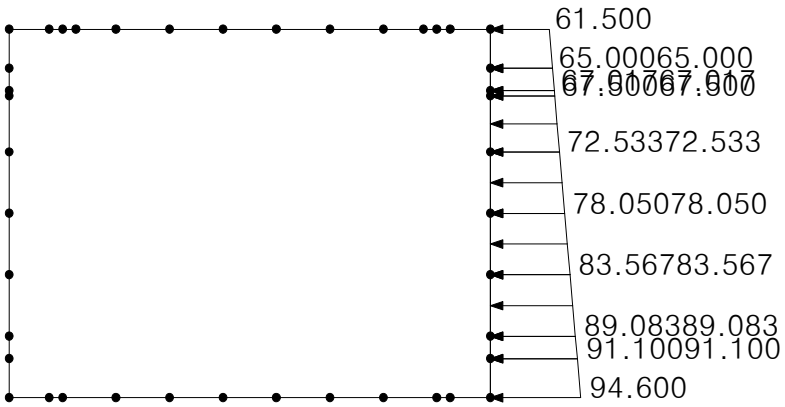
13) CASE13 - 지진시 양토압 2 : 지하수有(SOILBWE2)



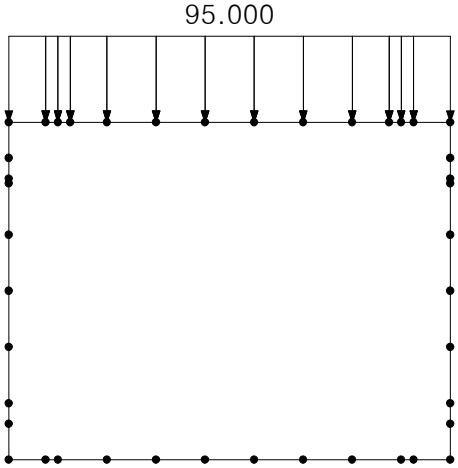
14) CASE14 - 지진시 편토압(좌측) 2 : 지하수有(SOILLWE2)



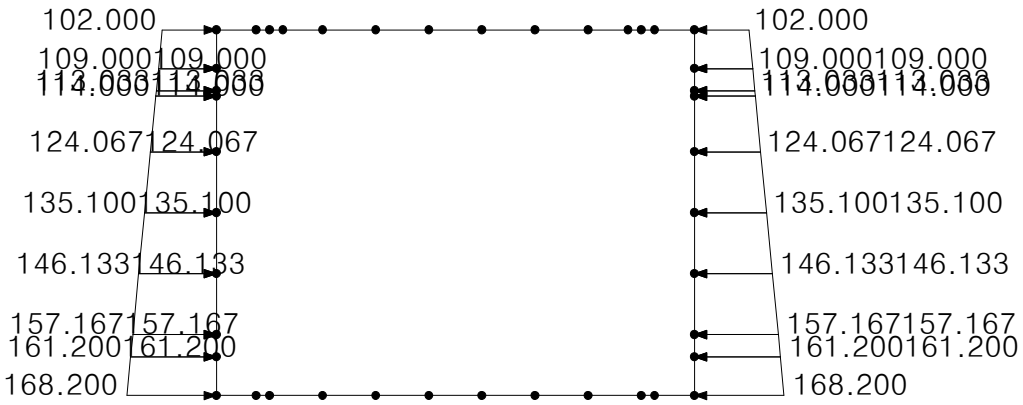
15) CASE15 - 지진시 편토압(우측) 2 : 지하수有(SOILRWE2)



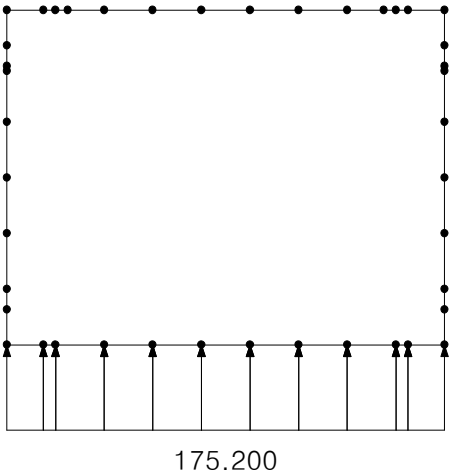
16) CASE16 - 연직수압(WATERV)



17) CASE17 - 수평수압(WATERH)

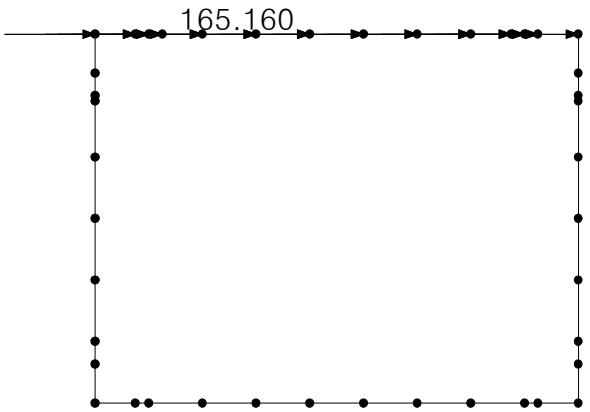


18) CASE18 - 부력(BUOYANCY)

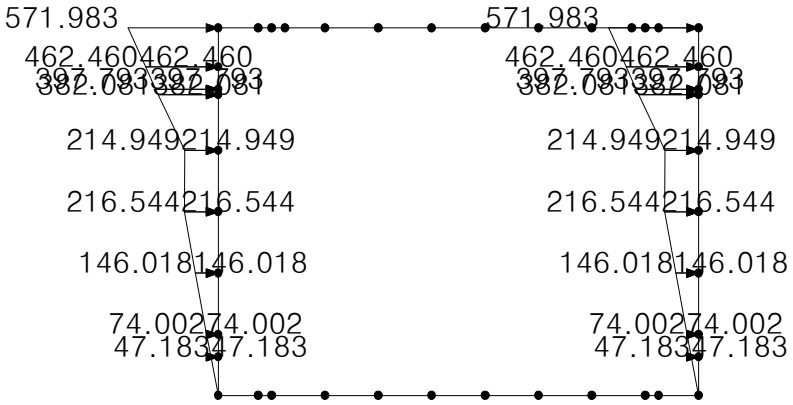


- 지진재하방향(좌측에서 우측으로)

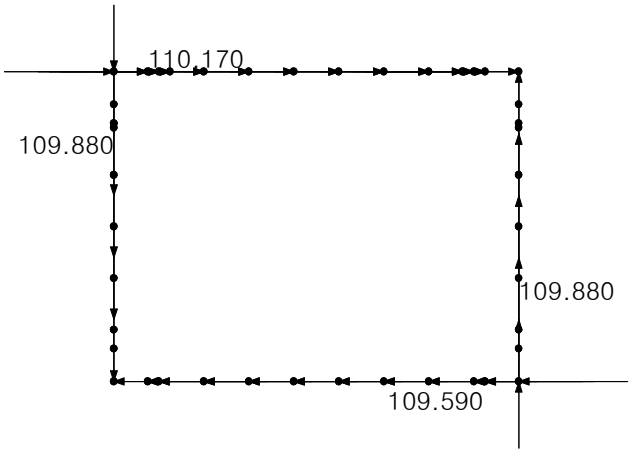
19) CASE19 - 슬래브 지반변위(기능수행)(FUNSLAB)



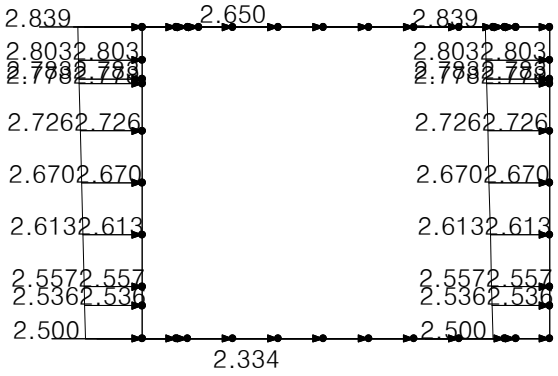
20) CASE20 - 벽체 지반변위(기능수행)(FUNWALL)



21) CASE21 - 주면전단력(기능수행)(FUNMS)

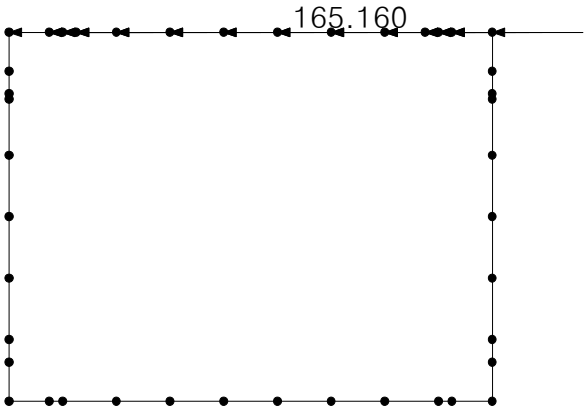


22) CASE22 - 구체 관성력(기능수행)(FUNINER)

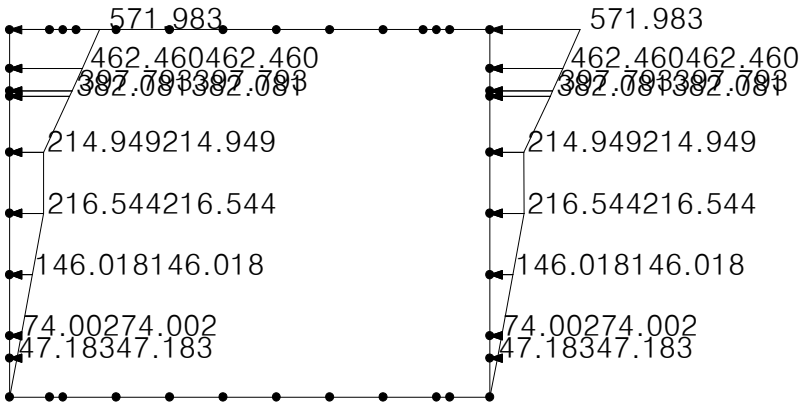


- 지진재하방향(우측에서 좌측으로)

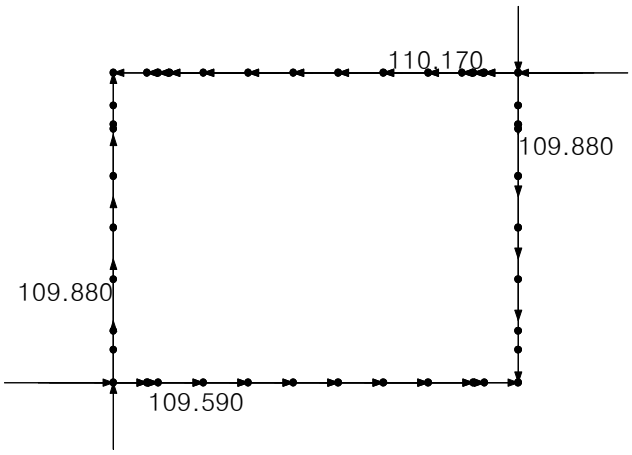
23) CASE23 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



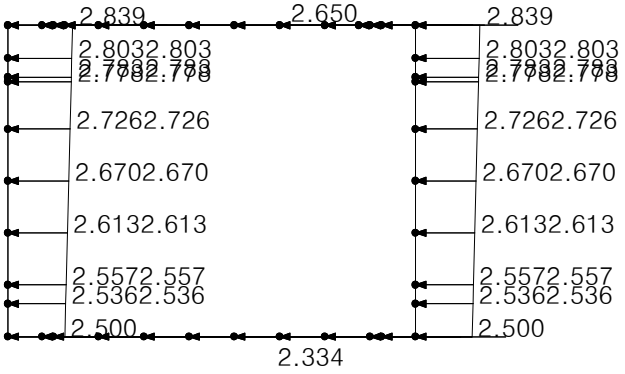
24) CASE24 - 벽체 지반변위(기능수행)2(FUNWALL2)



25) CASE25 - 주면전단력(기능수행)2(FUNMS2)

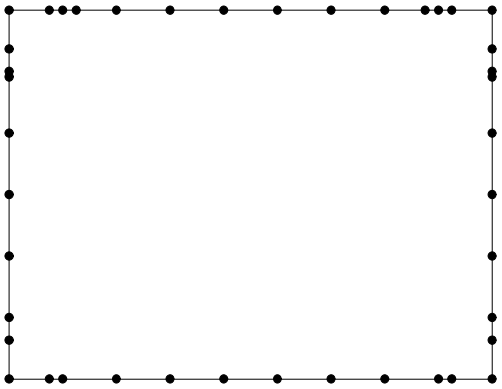


26) CASE26 - 구체 관성력(기능수행)2(FUNINER2)

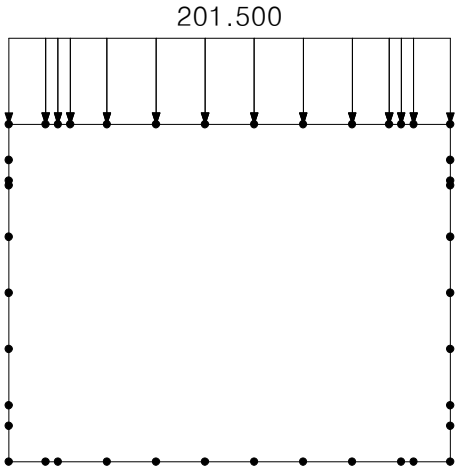


13. 하중 재하 (붕괴방지)

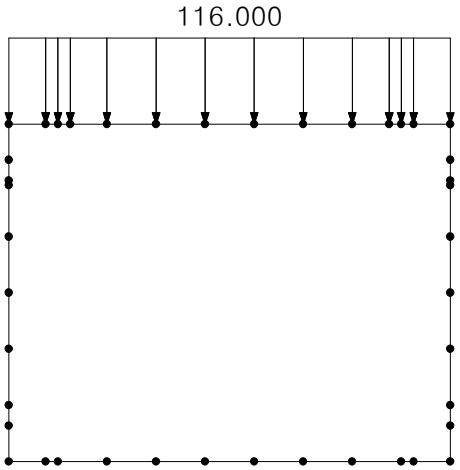
1) CASE1 - 구체자중(SW)



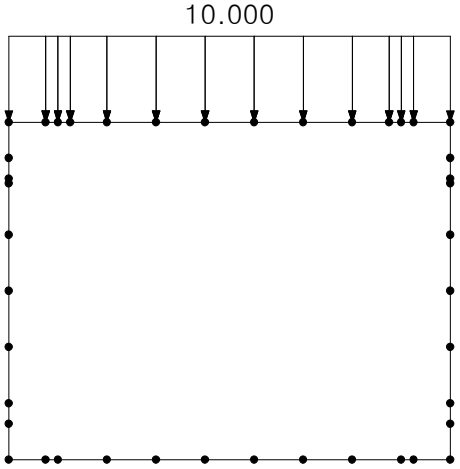
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



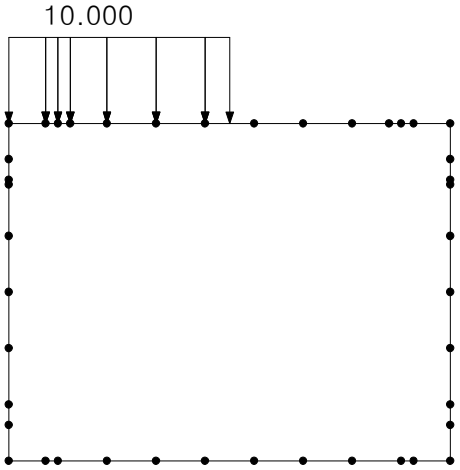
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



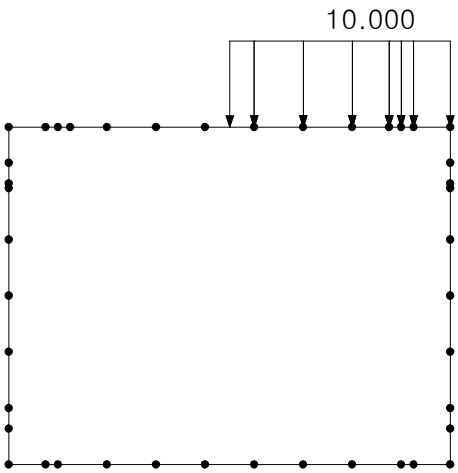
4) CASE4 - 지진시 만재활하중(LIVEFUE)



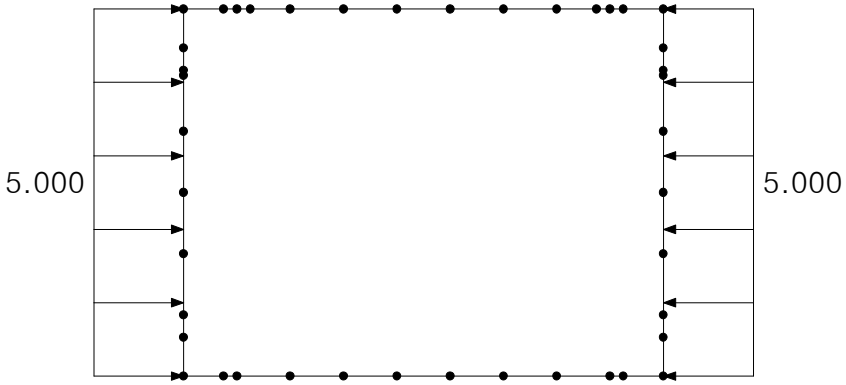
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



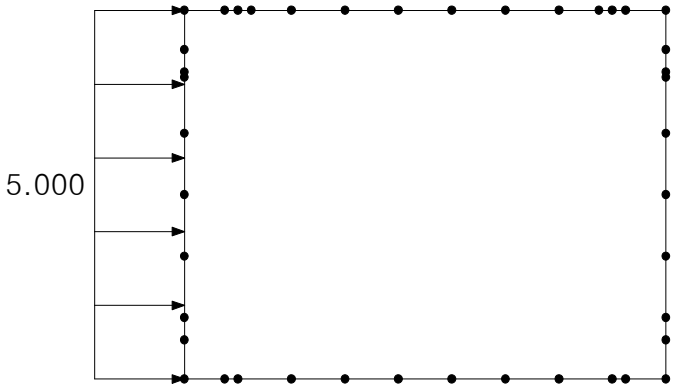
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



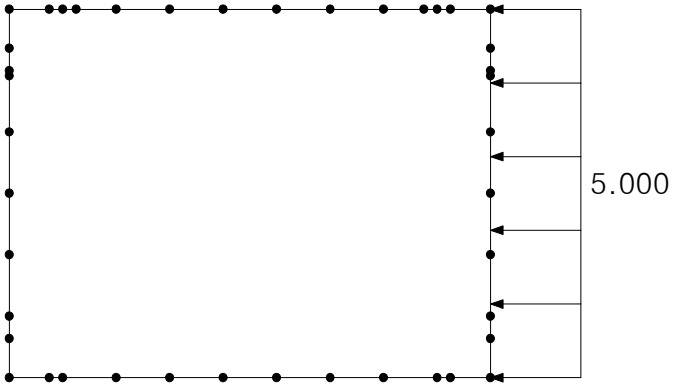
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



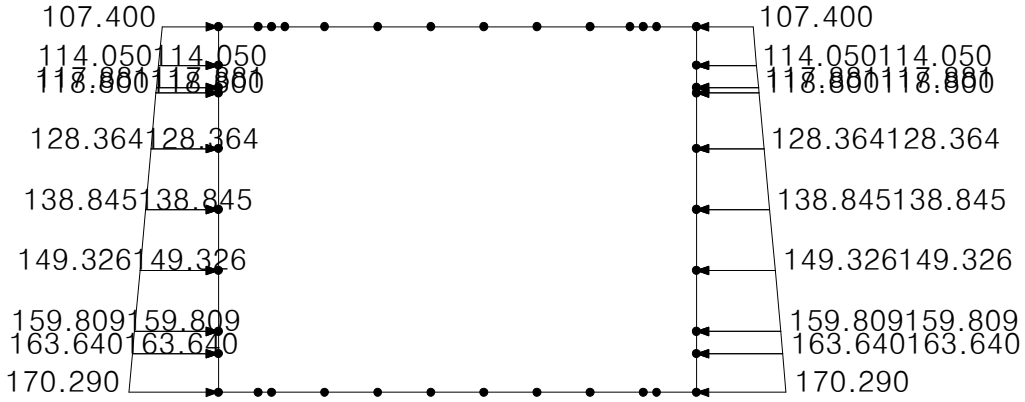
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



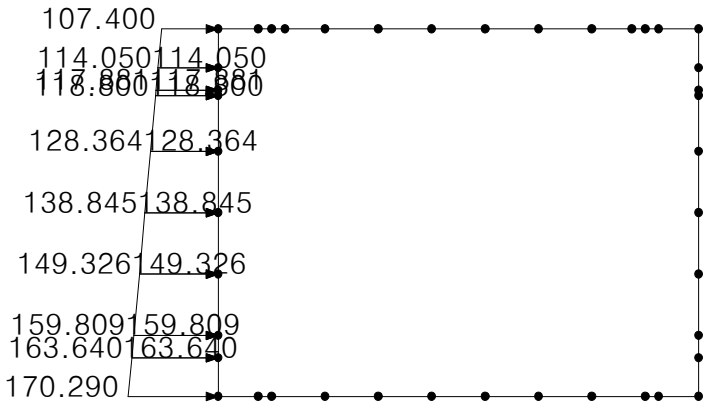
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



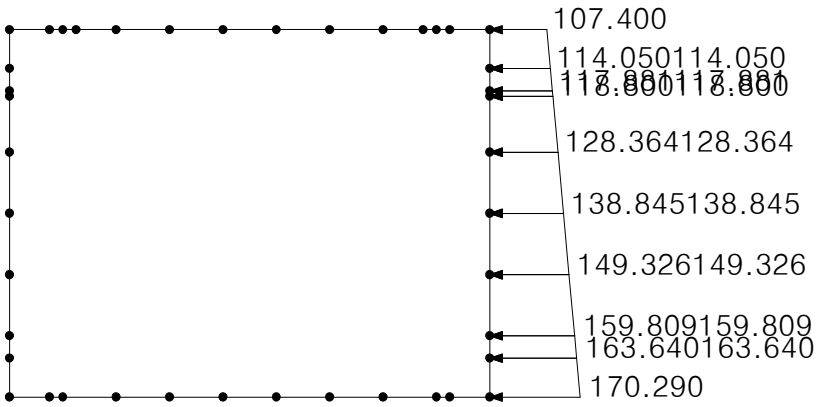
10) CASE10 - 지진시 양토압(SOILBE)



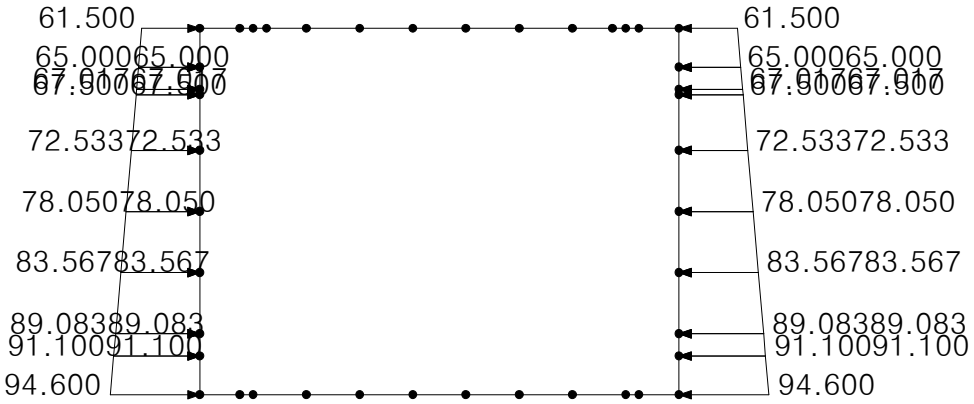
11) CASE11 - 지진시 편토압(좌측)(SOILLE)



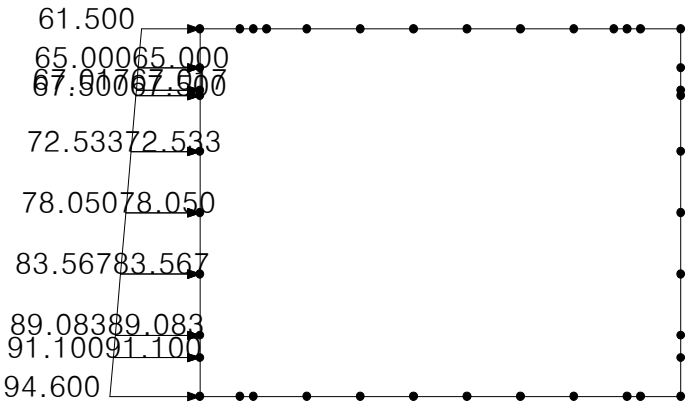
12) CASE12 - 지진시 편토압(우측)(SOILRE)



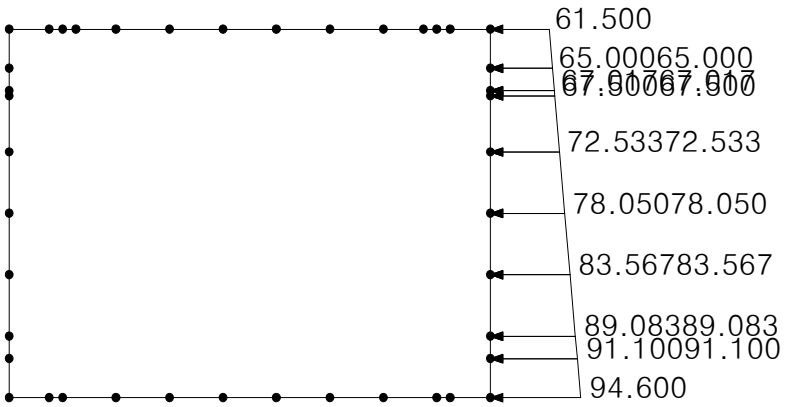
13) CASE13 - 지진시 양토압 : 지하수有(SOILBWE)



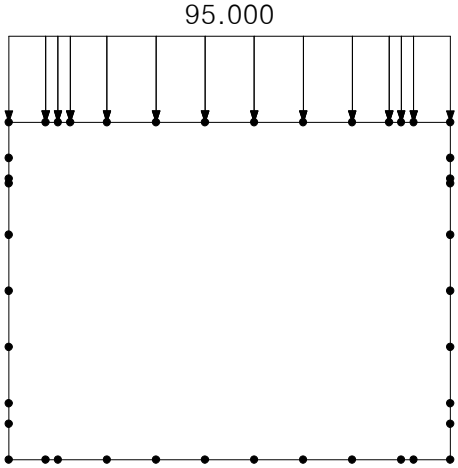
14) CASE14 - 지진시 편토압(좌측) : 지하수有(SOILLWE)



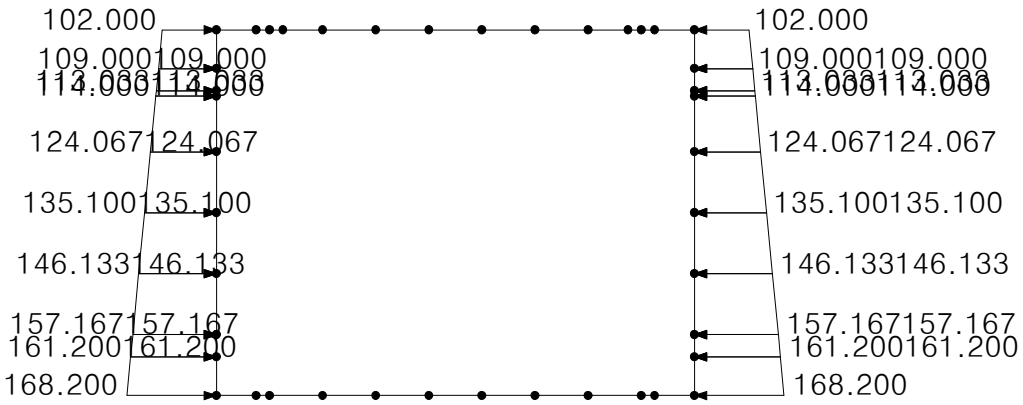
15) CASE15 - 지진시 편토압(우측) : 지하수有(SOILRWE)



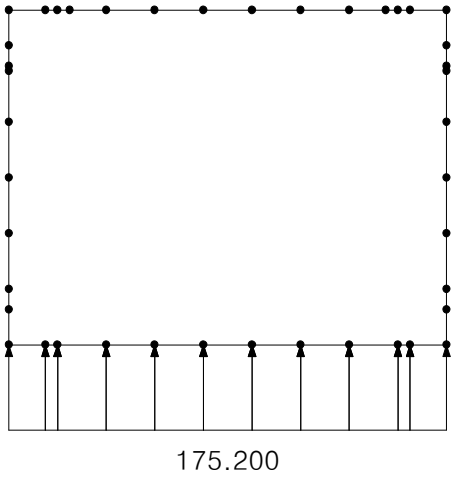
16) CASE16 - 연직수압(WATERV)



17) CASE17 - 수평수압(WATERH)

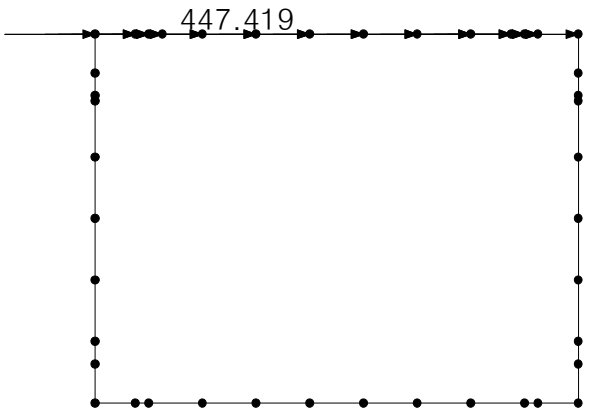


18) CASE18 - 부력(BUOYANCY)

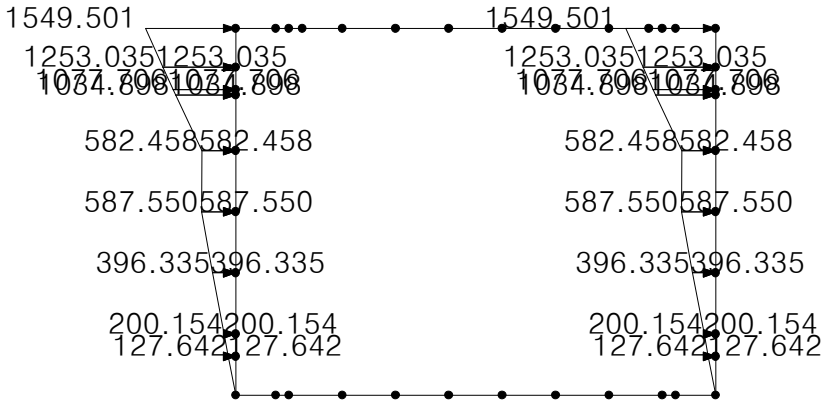


- 지진재하방향(좌측에서 우측으로)

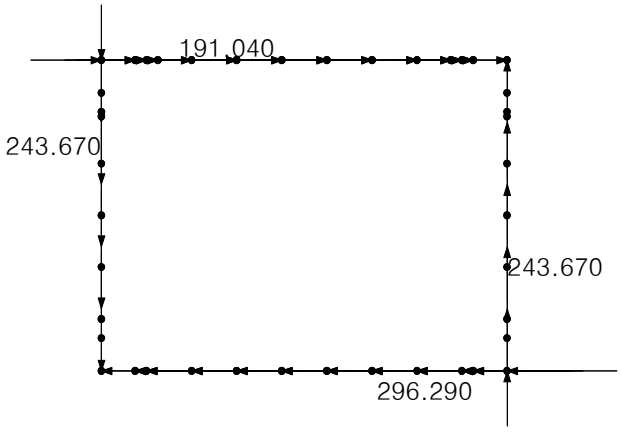
19) CASE19 - 슬래브 지반변위(붕괴방지)(COLSLAB)



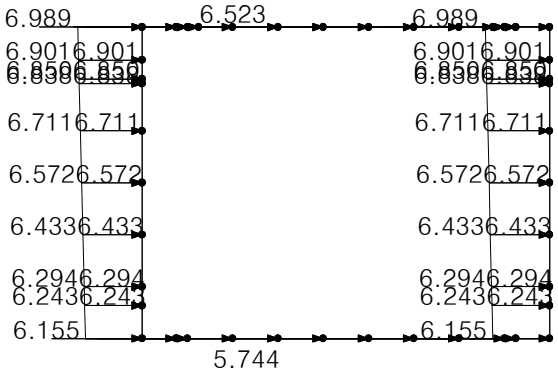
20) CASE20 - 벽체 지반변위(붕괴방지)(COLWALL)



21) CASE21 - 주면전단력(붕괴방지)(COLMS)

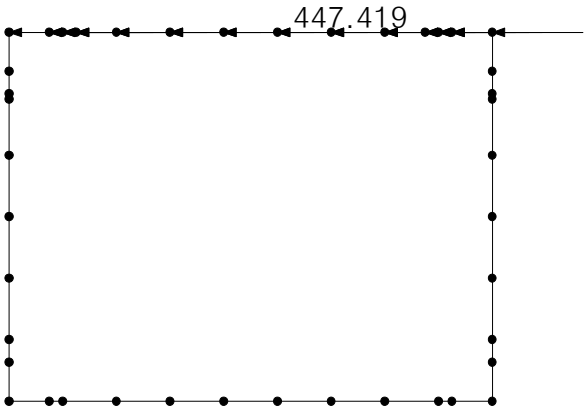


22) CASE22 - 구체 관성력(붕괴방지)(COLINER)

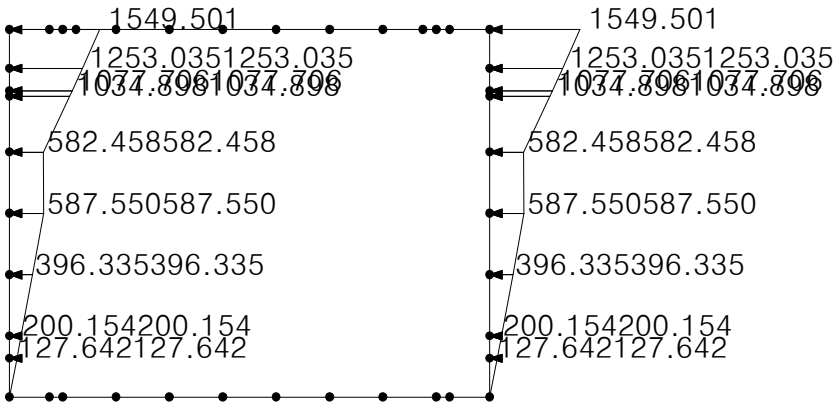


- 지진재하방향(우측에서 좌측으로)

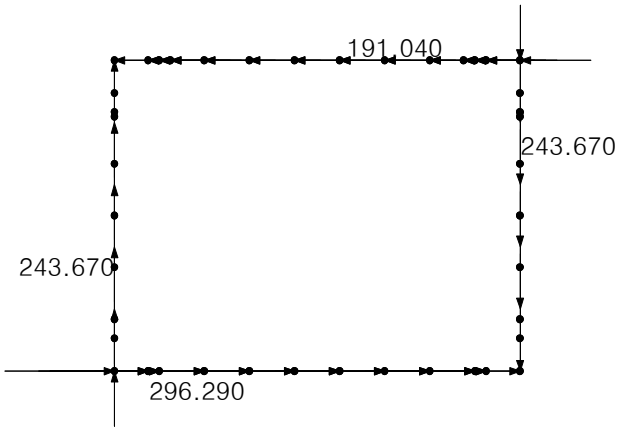
23) CASE23 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



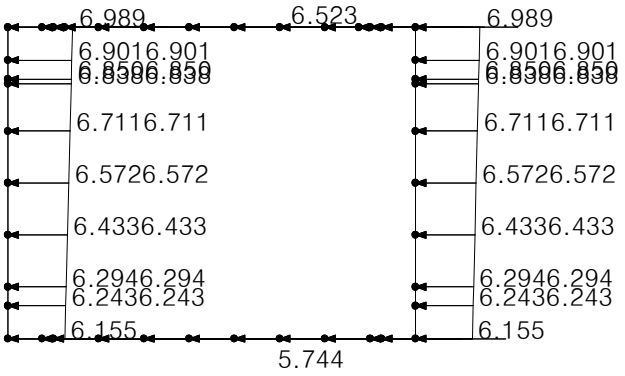
24) CASE24 - 벽체 지반변위(붕괴방지)2(COLWALL2)



25) CASE25 - 주면전단력(붕괴방지)2(COLMS2)



26) CASE26 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 0.875, h = 10.500 m

1) 계수하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.400						
LC2	1.200	1.400	1.600	1.600	1.200		
LC3	1.200		1.000				
LC4	1.200	1.400	1.600	0.800	1.200		
LC5	0.900	0.900		1.600			
LC6	0.900	0.900		0.800			
LC7	1.200	1.400	1.600	1.600	1.200	1.200	●
LC8	1.200	1.400	1.600	0.800	1.200	1.200	●
LC9	0.900	0.900		1.600			●
LC10	0.900	0.900		0.800			●

2) 사용하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.000						
LC2	1.000	1.000	1.000	1.000	1.000		
LC3	1.000		1.000				
LC4	1.000	1.000	1.000	0.500	1.000		
LC5	1.000	1.000		1.000			
LC6	1.000	1.000		0.500			
LC7	1.000	1.000	1.000	1.000	1.000	1.000	●
LC8	1.000	1.000	1.000	0.500	1.000	1.000	●
LC9	1.000	1.000		1.000			●
LC10	1.000	1.000		0.500			●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

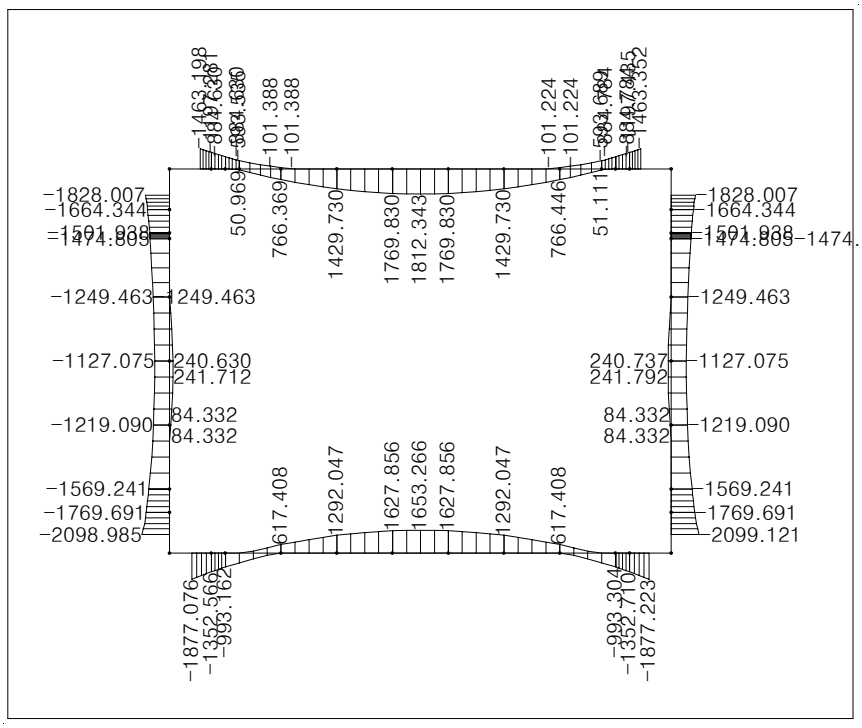
4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

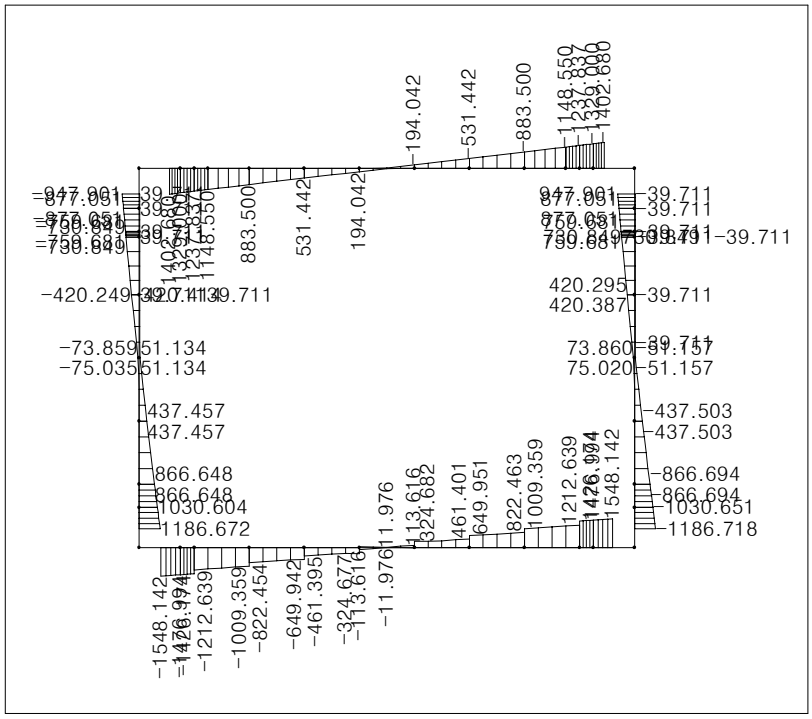
15. 단면력정리

15.1 상시

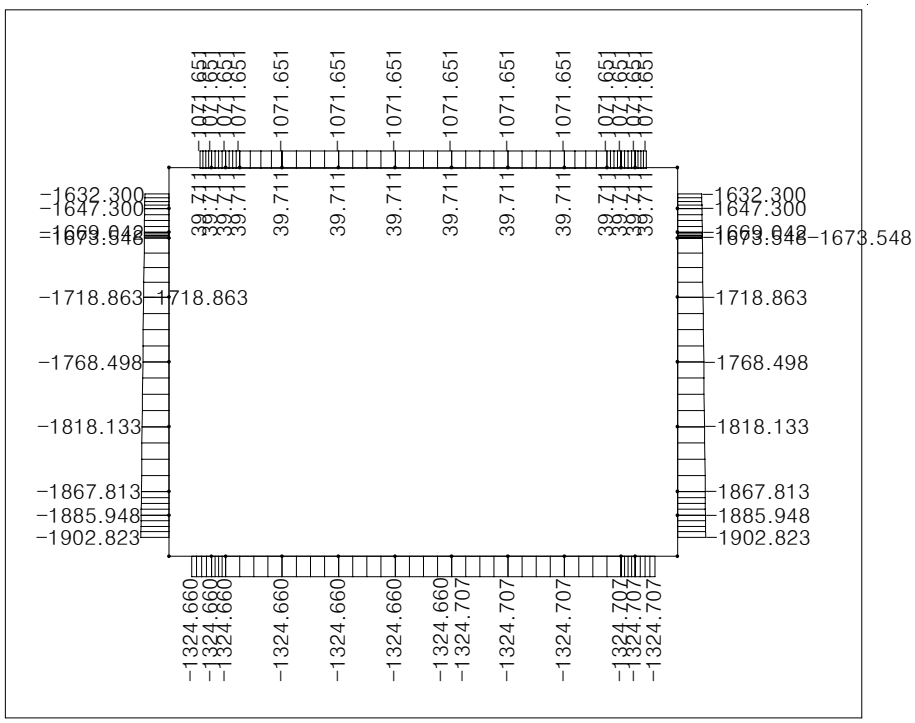
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



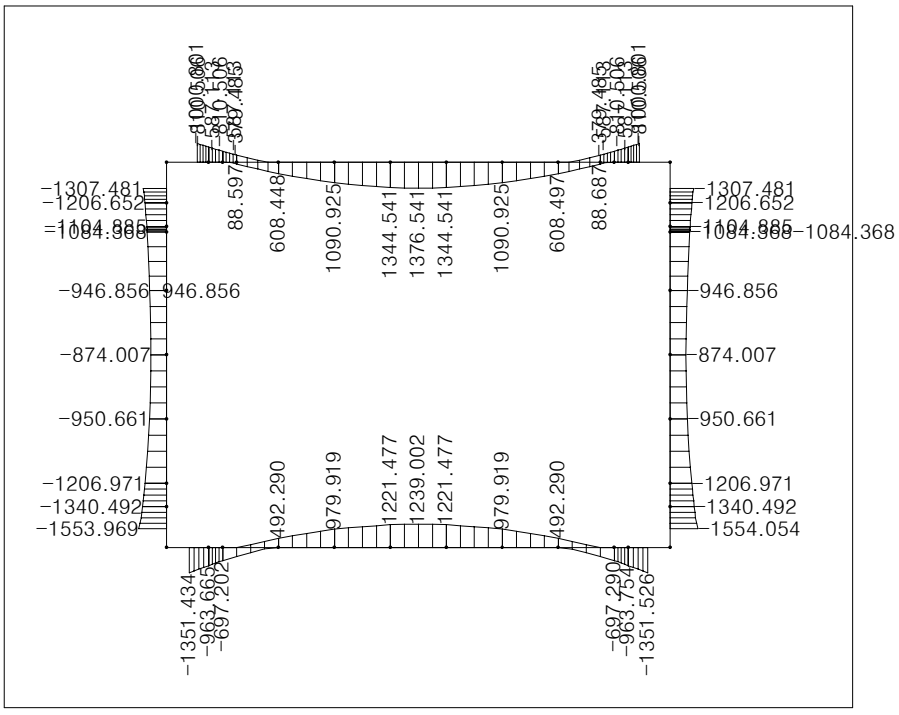
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

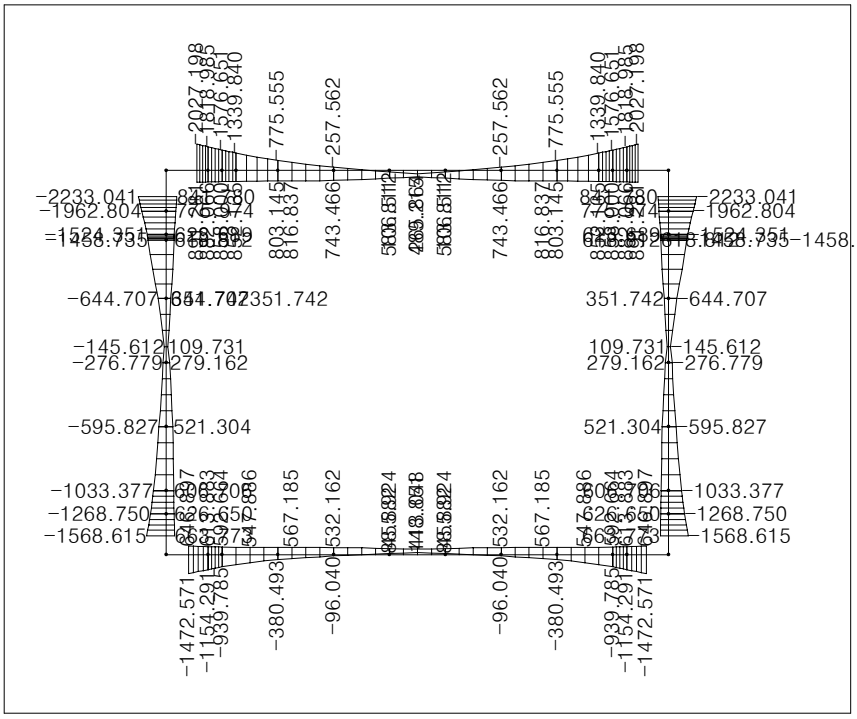


5) 단면력 정리

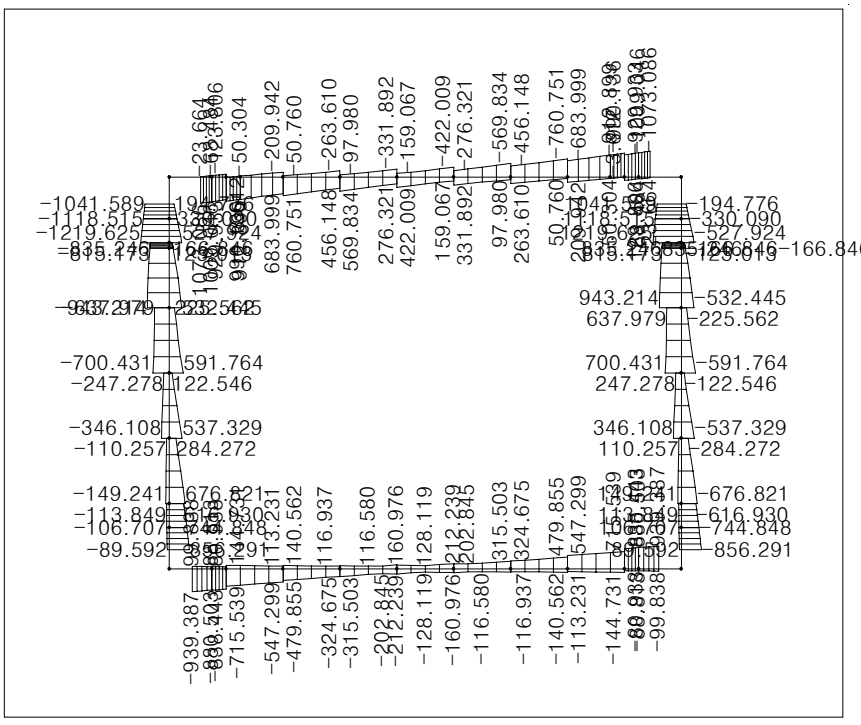
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	1197.28	865.83	1071.65	810.51	1000.00	1566.67	
		중앙부	2	604.99	949.76	1071.65	491.09	1000.00	1400.00	
		우측	3	1197.44	865.83	1071.65	810.51	1000.00	1566.67	
하부 슬래브	1 경간	좌측	4	1352.57	812.29	1324.66	963.67	1000.00	1400.00	
		중앙부	5	1653.27	11.98	1324.66	1239.00	1000.00	1400.00	
		우측	6	1352.71	812.30	1324.71	963.75	1000.00	1400.00	
좌측 벽체	1 층	상부	7	1664.34	453.49	1647.30	1206.65	1000.00	1666.67	
		중앙부 (외측)	8	1408.75	654.97	1684.88	1043.92	1000.00	1500.00	
		중앙부 (내측)	9	0.00	654.97	1684.88	0.00	1000.00	1500.00	
		하부	10	1769.69	477.89	1885.95	1340.49	1000.00	1500.00	
우측 벽체	1 층	상부	11	1664.34	453.54	1647.30	1206.65	1000.00	1666.67	
		중앙부 (외측)	12	1408.75	654.97	1684.88	1043.92	1000.00	1500.00	
		중앙부 (내측)	13	0.00	654.97	1684.88	0.00	1000.00	1500.00	
		하부	14	1769.69	477.94	1885.95	1340.49	1000.00	1500.00	

15.2 지진시(기능수행)

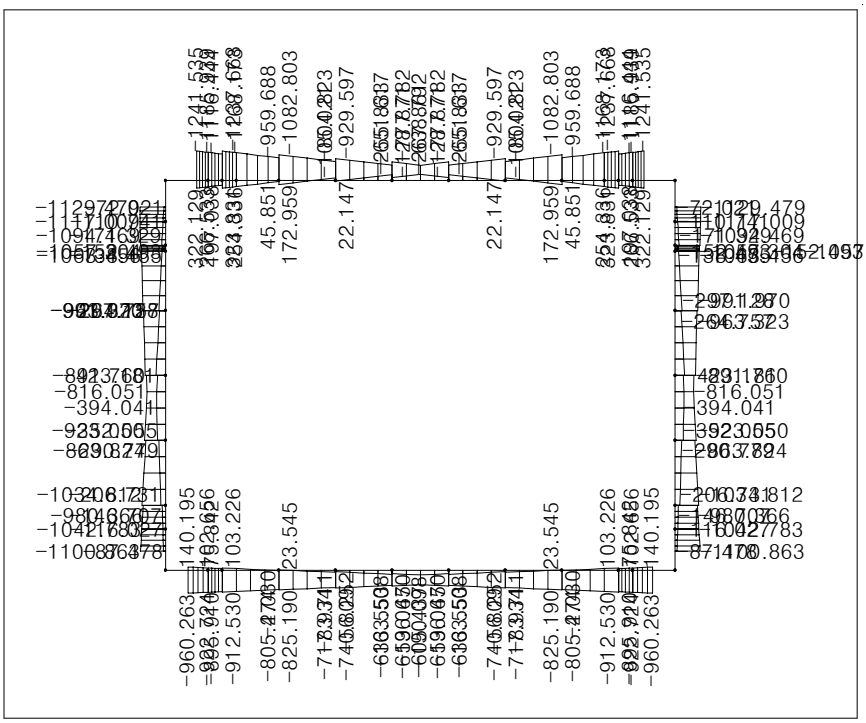
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

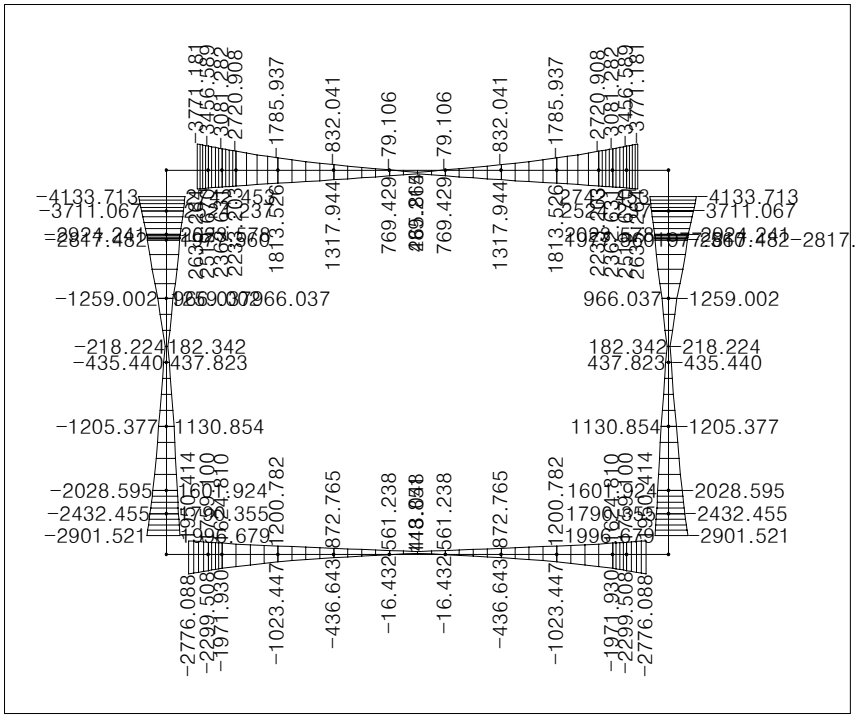


4) 단면력 정리

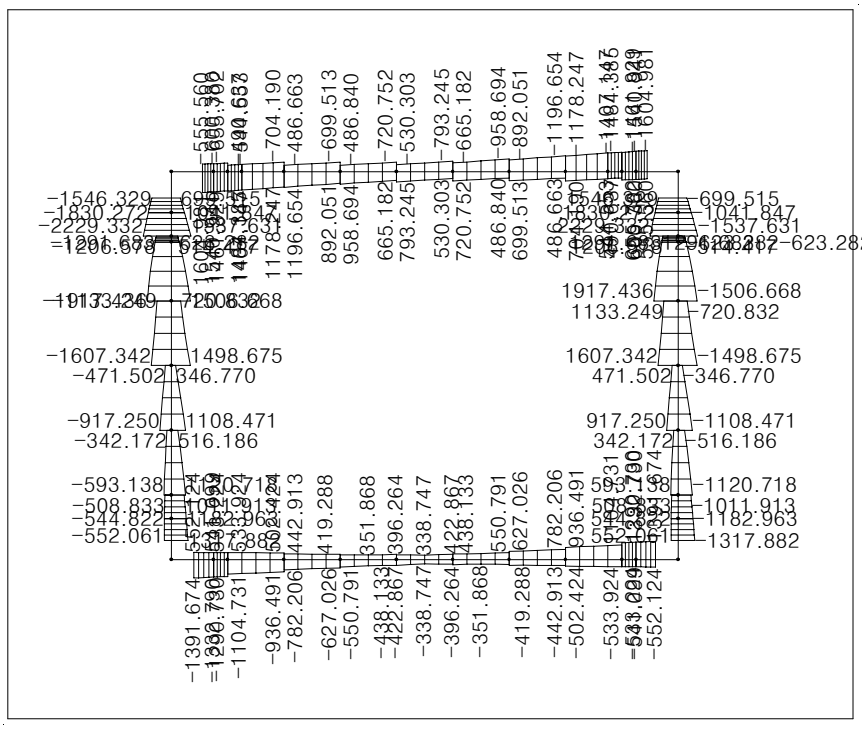
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	1818.99	745.49	1185.94	1000.00	1566.67	
		중앙부	2	814.82	741.22	1011.81	1000.00	1400.00	
		우측	3	1818.99	745.49	1185.94	1000.00	1566.67	
하부 슬래브	1 경간	좌측	4	1154.29	471.44	922.72	1000.00	1400.00	
		중앙부	5	413.05	128.12	605.44	1000.00	1400.00	
		우측	6	1154.29	471.44	922.72	1000.00	1400.00	
좌측 벽체	1 층	상부	7	1962.80	939.07	1117.01	1000.00	1666.67	
		중앙부 (외측)	8	1276.03	879.45	1040.97	1000.00	1500.00	
		중앙부 (내측)	9	584.40	879.45	1040.97	1000.00	1500.00	
		하부	10	1268.75	324.45	1042.78	1000.00	1500.00	
우측 벽체	1 층	상부	11	1962.80	939.07	1117.01	1000.00	1666.67	
		중앙부 (외측)	12	1276.03	879.45	1040.97	1000.00	1500.00	
		중앙부 (내측)	13	584.40	879.45	1040.97	1000.00	1500.00	
		하부	14	1268.75	324.45	1042.78	1000.00	1500.00	

15.3 지진시(붕괴방지)

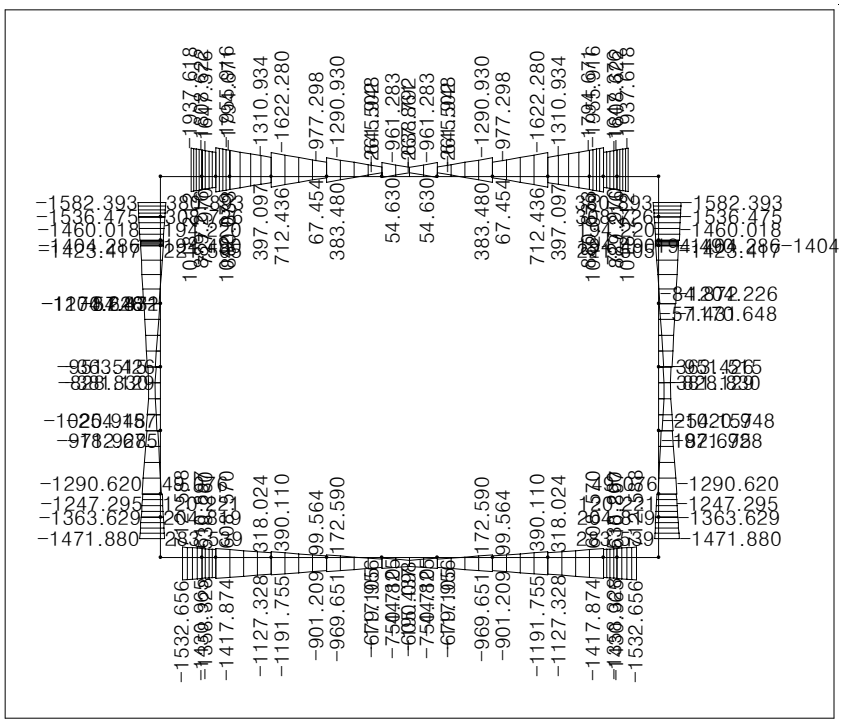
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	3456.59	1181.39	1808.62	1000.00	1566.67	
		중앙부	2	1917.88	1235.47	1431.87	1000.00	1400.00	
		우측	3	3456.59	1181.39	1808.62	1000.00	1566.67	
하부 슬래브	1 경간	좌측	4	2299.51	773.79	1430.97	1000.00	1400.00	
		중앙부	5	413.05	338.75	605.44	1000.00	1400.00	
		우측	6	2299.51	773.79	1430.97	1000.00	1400.00	
좌측 벽체	1 층	상부	7	3711.07	1869.84	1536.48	1000.00	1666.67	
		중앙부 (외측)	8	2499.81	1492.27	1354.27	1000.00	1500.00	
		중앙부 (내측)	9	1808.18	1492.27	1354.27	1000.00	1500.00	
		하부	10	2432.46	581.83	1363.63	1000.00	1500.00	
우측 벽체	1 층	상부	11	3711.07	1869.84	1536.48	1000.00	1666.67	
		중앙부 (외측)	12	2499.81	1492.27	1354.27	1000.00	1500.00	
		중앙부 (내측)	13	1808.18	1492.27	1354.27	1000.00	1500.00	
		하부	14	2432.46	581.83	1363.63	1000.00	1500.00	

15.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-1197.28	-	-3456.59	-1818.99	-3456.59	
		중앙부	2	604.99	-	1917.88	814.82	1917.88	
		우측	3	-1197.44	-	-3456.59	-1818.99	-3456.59	
하부 슬래브	1 경간	좌측	4	-1352.57	-	-2299.51	-1154.29	-2299.51	
		중앙부	5	1653.27	-	413.05	413.05	1653.27	
		우측	6	-1352.71	-	-2299.51	-1154.29	-2299.51	
좌측 벽체	1 층	상부	7	-1664.34	-	-3711.07	-1962.80	-3711.07	
		중앙부 (외측)	8	-1408.75	-	-2499.81	-1276.03	-2499.81	
		중앙부 (내측)	9	-	-	1808.18	584.40	1808.18	
		하부	10	-1769.69	-	-2432.46	-1268.75	-2432.46	
우측 벽체	1 층	상부	11	-1664.34	-	-3711.07	-1962.80	-3711.07	
		중앙부 (외측)	12	-1408.75	-	-2499.81	-1276.03	-2499.81	
		중앙부 (내측)	13	-	-	1808.18	584.40	1808.18	
		하부	14	-1769.69	-	-2432.46	-1268.75	-2432.46	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	865.83	-	1181.39	745.49	1181.39	
		중앙부	2	-949.76	-	-1235.47	-741.22	-1235.47	
		우측	3	-865.83	-	-1181.39	-745.49	-1181.39	
하부 슬래브	1 경간	좌측	4	-812.29	-	-773.79	-471.44	-812.29	
		중앙부	5	-11.98	-	-338.75	-128.12	-338.75	
		우측	6	812.30	-	773.79	471.44	812.30	
좌측 벽체	1 층	상부	7	-453.49	-	-1869.84	-939.07	-1869.84	
		중앙부 (외측)	8	-654.97	-	-1492.27	-879.45	-1492.27	
		중앙부 (내측)	9	-654.97	-	-1492.27	-879.45	-1492.27	
		하부	10	477.89	-	581.83	324.45	581.83	
우측 벽체	1 층	상부	11	453.54	-	1869.84	939.07	1869.84	
		중앙부 (외측)	12	654.97	-	1492.27	879.45	1492.27	
		중앙부 (내측)	13	654.97	-	1492.27	879.45	1492.27	
		하부	14	-477.94	-	-581.83	-324.45	-581.83	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-1071.65	-	-1808.62	-1185.94	-1808.62	
		중앙부	2	-1071.65	-	-1431.87	-1011.81	-1431.87	
		우측	3	-1071.65	-	-1808.62	-1185.94	-1808.62	
하부 슬래브	1 경간	좌측	4	-1324.66	-	-1430.97	-922.72	-1430.97	
		중앙부	5	-1324.66	-	-605.44	-605.44	-1324.66	
		우측	6	-1324.71	-	-1430.97	-922.72	-1430.97	
좌측 벽체	1 층	상부	7	-1647.30	-	-1536.48	-1117.01	-1647.30	
		중앙부 (외측)	8	-1684.88	-	-1354.27	-1040.97	-1684.88	
		중앙부 (내측)	9	-1684.88	-	-1354.27	-1040.97	-1684.88	
		하부	10	-1885.95	-	-1363.63	-1042.78	-1885.95	
우측 벽체	1 층	상부	11	-1647.30	-	-1536.48	-1117.01	-1647.30	
		중앙부 (외측)	12	-1684.88	-	-1354.27	-1040.97	-1684.88	
		중앙부 (내측)	13	-1684.88	-	-1354.27	-1040.97	-1684.88	
		하부	14	-1885.95	-	-1363.63	-1042.78	-1885.95	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-810.51	-	-	-	-810.51	
		중앙부	2	491.09	-	-	-	491.09	
		우측	3	-810.51	-	-	-	-810.51	
하부 슬래브	1 경간	좌측	4	-963.67	-	-	-	-963.67	
		중앙부	5	1239.00	-	-	-	1239.00	
		우측	6	-963.75	-	-	-	-963.75	
좌측 벽체	1 층	상부	7	-1206.65	-	-	-	-1206.65	
		중앙부 (외측)	8	-1043.92	-	-	-	-1043.92	
		중앙부 (내측)	9	-	-	-	-	-	
		하부	10	-1340.49	-	-	-	-1340.49	
우측 벽체	1 층	상부	11	-1206.65	-	-	-	-1206.65	
		중앙부 (외측)	12	-1043.92	-	-	-	-1043.92	
		중앙부 (내측)	13	-	-	-	-	-	
		하부	14	-1340.49	-	-	-	-1340.49	

16. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1438	3456.59	4126.41	7402.61	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.19
		중앙부	2	1000	1320	1917.88	2228.22	4401.23	H29 - 8.0EA	5139.20	1.16
		우측	3	1000	1438	3456.59	4126.41	7402.61	H32 - 8.0EA + H29 - 4.0EA	8923.20	1.19
하부슬래브	1경간	좌측	4	1000	1272	2299.51	2946.31	5527.59	H29 - 8.0EA + H25 - 4.0EA	7166.00	1.28
		중앙부	5	1000	1320	1653.27	2228.22	3777.98	H29 - 8.0EA	5139.20	1.35
		우측	6	1000	1272	2299.51	2946.31	5527.59	H29 - 8.0EA + H25 - 4.0EA	7166.00	1.28
좌측벽체	1층	상부	7	1000	1538	3711.07	6464.94	-	H32 - 8.0EA + H29 - 4.0EA	12020.00	1.74
		중앙부 (외측)	8	1000	1371	2499.81	6448.18	-	H32 - 8.0EA + H29 - 4.0EA	12020.00	2.58
		중앙부 (내측)	8	1000	1420	1808.18	3336.10	-	H22 - 8.0EA	12020.00	1.85
		하부	9	1000	1372	2432.45	5865.85	-	H29 - 8.0EA + H25 - 4.0EA	10262.80	2.41
우측벽체	1층	상부	10	1000	1538	3711.07	6385.03	-	H32 - 8.0EA + H29 - 4.0EA	10471.60	1.72
		중앙부 (외측)	11	1000	1371	2499.81	6448.18	-	H32 - 8.0EA + H29 - 4.0EA	12020.00	2.58
		중앙부 (내측)	11	1000	1420	1808.18	3336.10	-	H22 - 8.0EA	12020.00	1.85
		하부	12	1000	1372	2432.45	5865.85	-	H29 - 8.0EA + H25 - 4.0EA	10262.80	2.41

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	825.7	1181.4	1330.59	2.00	279.83	H16	300	397.20	O.K
		우측	3	825.7	1181.4	1330.59	2.00	279.83	H16	300	397.20	O.K
하부슬래브	1경간	좌측	4	826.0	812.3	1331.13	2.00	-	H16	300	397.20	O.K
		우측	6	826.0	812.3	1331.13	2.00	-	H16	300	397.20	O.K
좌측벽체	1층	상부	7	960.5	1869.8	2531.88	2.00	331.59	H19	150	573.00	O.K
		하부	9	971.0	581.8	2542.96	2.00	131.25	H19	150	573.00	O.K
우측벽체	1층	상부	10	960.5	1869.8	2531.88	2.00	331.59	H19	150	573.00	O.K
		하부	12	971.0	581.8	2542.96	2.00	131.25	H19	150	573.00	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1566.67	1437.87	100.00	3456.59	1181.39

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1466.67 - 182.970) / 182.970 = 0.02105

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \;,\; As = 7402.607\ mm^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.205]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00621

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1437.87 - a/2) = 4126.415 kN.m

≥ Mu (= 3456.589 kN.m) ∴ O.K [안전률 1.194]

* 전단에 대한 검토 (d = 1271.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1271.20 = 825.671 kN

< Vu (= 1181.394 kN) , 전단보강 필요.

Av_req = (1181.394-825.671) x 300.00 / (400x1271.20xΦ) x 1000 = 279.832 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1271.20 / 300.00 x 1000 = 673.229 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1271.20 / 1000 = 4403.577 kN ≥ 673.229 kN ∴ O.K

ΦVn = 0.75 x (1100.894 + 673.229) = 1330.593 kN ≥ 1181.394 kN ∴ O.K

▣ TITLE : 상부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1400.00	1320.00	80.00	1917.88	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1320.00 - 105.379) / 105.379 = 0.03458

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4401.225 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm), [사용률 = 1.168]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00389

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1320.00 - a/2) = 2228.217 kN.m

≥ Mu (= 1917.875 kN.m) ∴ O.K [안전률 1.162]

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1566.67	1437.87	100.00	3456.59	1181.39

* 강도감소계수(Φ) 산정

T = As x fy = 8923.200 x 400.00 = 3569280.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 155.524 mm, c = 155.524 / β1 = 155.524 / 0.85 = 182.970 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1466.67 - 182.970) / 182.970 = 0.02105

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \;,\; As = 7402.607\ mm^2$$

* 사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm), [사용률 = 1.205]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 4.0 EA (= 2569.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00621

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 155.524 mm

ΦMn = 0.85 x 8923.200 x 400 x (1437.87 - a/2) = 4126.415 kN.m

≥ Mu (= 3456.589 kN.m) ∴ O.K [안전률 1.194]

* 전단에 대한 검토 (d = 1271.20 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1271.20 = 825.671 kN

< Vu (= 1181.394 kN) , 전단보강 필요.

Av_req = (1181.394-825.671) x 300.00 / (400x1271.20xΦ) x 1000 = 279.832 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1271.20 / 300.00 x 1000 = 673.229 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1271.20 / 1000 = 4403.577 kN ≥ 673.229 kN ∴ O.K

ΦVn = 0.75 x (1100.894 + 673.229) = 1330.593 kN ≥ 1181.394 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1400.00	1271.72	100.00	2299.51	812.29

* 강도감소계수(Φ) 산정

T = As x fy = 7166.000 x 400.00 = 2866400.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 124.898 mm, c = 124.898 / β1 = 124.898 / 0.85 = 146.938 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1300.00 - 146.938) / 146.938 = 0.02354

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \;,\; As = 5527.590\ mm^2$$

* 사용철근량 = 7166.0 mm² (철근도심 : 128.3 mm), [사용률 = 1.296]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 4.0 EA (= 2026.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00563

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 124.898 mm

ΦMn = 0.85 x 7166.000 x 400 x (1271.72 - a/2) = 2946.308 kN.m

≥ Mu (= 2299.508 kN.m) ∴ O.K [안전률 1.281]

* 전단에 대한 검토 (d = 1271.72 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1271.72 = 826.004 kN

≥ Vu (= 812.290 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1400.00	1320.00	80.00	1653.27	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1320.00 - 105.379) / 105.379 = 0.03458

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \;,\; As = 3777.978 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm), [사용률 = 1.360]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00389

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1320.00 - a/2) = 2228.217 kN.m

≥ Mu (= 1653.266 kN.m) ∴ O.K [안전률 1.348]

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1400.00	1271.72	100.00	2299.51	812.30

* 강도감소계수(Φ) 산정

T = As x fy = 7166.000 x 400.00 = 2866400.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 124.898 mm, c = 124.898 / β1 = 124.898 / 0.85 = 146.938 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1300.00 - 146.938) / 146.938 = 0.02354

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 5527.590 \text{ mm}^2$$

* 사용철근량 = 7166.0 mm² (철근도심 : 128.3 mm), [사용률 = 1.296]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H25 - 4.0 EA (= 2026.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00563

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 124.898 mm

ΦMn = 0.85 x 7166.000 x 400 x (1271.72 - a/2) = 2946.308 kN.m

≥ Mu (= 2299.508 kN.m) ∴ O.K [안전률 1.281]

* 전단에 대한 검토 (d = 1271.72 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1271.72 = 826.004 kN

≥ Vu (= 812.299 kN) , 전단보강 불필요.

▣ TITLE : 좌측벽체 상부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,667	100	1,538	1647.3	3711.067	2252.8

㉯ 철근비 검토

As = 8923.200 ㎟ (인장중심 = 128.80 mm), 1단 : H32- 8.0EA, d1 = 100.00 mm
2단 : H29- 4.0EA, d1 = 200.00 mm

Asf = 3096.800 ㎟ (압축중심 = 80.00 mm), 1단 : H22- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0080) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1666.7 x 1000.0 = 38250000.0 N

Cs = As x fy = 3569280.0 N, Cs' = Asf x fy = 1238720.0 N

Xp = (38250000.0 x 833.33 + 3569280.0 x 128.797 + 1238720.0 x 1586.667) / 43058000.0
= 796.603 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 922.72 mm, ab = k1 x cb = 784.31 mm

Cc = 0.85 x 27.0 x 784313.609 = 17999.997 kN, ∑Csi = 1167.648 kN, ∑Tsi = 3569.280 kN

Pb = 17999.997 + 1167.648 - 3569.280 = 15598.366 kN

Mb = Cc x 1145.713 + ∑(Csi*di) + ∑(Tsi*di) = 11908.420 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 763.440 mm, e = Mu/Pu = 2252.818 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 296.18 mm, a = k1 x c = 251.75 mm 를 사용.

Cc = 0.85 x 27.0 x 251754.399 = 5777.763 kN

∑Csi = 1167.648 kN, ∑Tsi = 3569.280 kN

Pn = 5777.763 + 1167.648 - 3569.280 = 3376.132 kN

Mn = Cc x 1411.993 + ∑(Csi*di) + ∑(Tsi*di) = 7605.836 kN.m

- 편심오차 : |e - Mn/Pn(=2252.825)| = 0.0075 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1666.67 - 100.00 = 1566.667 mm

c = 296.182 mm, a = k1 x c = 251.754 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1566.67-296.18) / 296.18 = 0.01287

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 31165.713 kN ≥ Pn = 3376.132 kN

ΦPn = 0.85 x 3376.132 = 2869.712 kN ≥ Pu = 1647.300 kN ∴ O.K

ΦMn = ΦPn x 2.253 = 6464.939 kN.m ≥ Mu = 3711.067 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1371.20 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1371.20 = 960.486 kN

< Vu (= 1869.844 kN) , 전단보강 필요.

Req Av = (1869.844 - 960.486) x 150.00 / (400.0 x 1371.20 x Φ) = 331.591 mm²

Use Av = 573.000 mm² (H19-2.0 EA, C.T.C 150 mm)

Vs = 573.000 x 400.0 x 1371.20 / 150.00 = 2095.198 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1371.20 = 4749.987 kN ≥ 2095.198 kN ∴ O.K

ΦVn = 0.75 x (1280.647 + 2095.198) = 2531.884 kN ≥ 1869.844 kN ∴ O.K

▣ TITLE : 좌측벽체 중앙부_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,500	100	1,371	1684.876	2499.806	1483.7

㉯ 철근비 검토

As = 8923.200 ㎟ (인장중심 = 128.80 mm), 1단 : H32- 8.0EA, d1 = 100.00 mm

2단 : H29- 4.0EA, d1 = 200.00 mm

Asf = 3096.800 ㎟ (압축중심 = 80.00 mm), 1단 : H22- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0080) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1500.0 x 1000.0 = 34425000.0 N

Cs = As x fy = 3569280.0 N, Cs' = Asf x fy = 1238720.0 N

Xp = (34425000.0 x 750.00 + 3569280.0 x 128.797 + 1238720.0 x 1420.000) / 39233000.0

= 714.639 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 822.72 mm, ab = k1 x cb = 699.31 mm

Cc = 0.85 x 27.0 x 699313.609 = 16049.247 kN, ∑Csi = 1167.648 kN, ∑Tsi = 3569.280 kN

Pb = 16049.247 + 1167.648 - 3569.280 = 13647.616 kN

Mb = Cc x 1021.546 + ∑(Csi*di) + ∑(Tsi*di) = 9907.368 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 725.941 mm, e = Mu/Pu = 1483.674 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 385.22 mm, a = k1 x c = 327.44 mm 를 사용.

Cc = 0.85 x 27.0 x 327437.006 = 7514.679 kN

∑Csi = 1167.648 kN, ∑Tsi = 3569.280 kN

Pn = 7514.679 + 1167.648 - 3569.280 = 5113.048 kN

Mn = Cc x 1207.485 + ∑(Csi*di) + ∑(Tsi*di) = 7586.091 kN.m

- 편심오차 : |e - Mn/Pn(=1483.673)| = 0.0006 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1500.00 - 100.00 = 1400.000 mm

c = 385.220 mm, a = k1 x c = 327.437 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1400.00-385.22) / 385.22 = 0.00790

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 31165.713 kN ≥ Pn = 5113.048 kN

ΦPn = 0.85 x 5113.048 = 4346.091 kN ≥ Pu = 1684.876 kN ∴ O.K

ΦMn = ΦPn x 1.484 = 6448.180 kN.m ≥ Mu = 2499.806 kN.m ∴ O.K

▣ TITLE : 좌측벽체 중앙부_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,500	80	1,420	1684.876	1808.179	1073.2

㉯ 철근비 검토

As = 3096.800 ㎟ (인장중심 = 80.00 mm), 1단 : H22- 8.0EA, d1 = 80.00 mm

Asf = 8923.200 ㎟ (압축중심 = 128.80 mm), 1단 : H32- 8.0EA, d1 = 100.00 mm

2단 : H29- 4.0EA, d1 = 200.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0080) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1500.0 x 1000.0 = 34425000.0 N

Cs = As x fy = 1238720.0 N, Cs' = Asf x fy = 3569280.0 N

Xp = (34425000.0 x 750.00 + 1238720.0 x 80.000 + 3569280.0 x 1371.203) / 39233000.0

= 785.361 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 852.00 mm, ab = k1 x cb = 724.20 mm

Cc = 0.85 x 27.0 x 724200.000 = 16620.390 kN, ∑Csi = 3364.493 kN, ∑Tsi = 1238.720 kN

Pb = 16620.390 + 3364.493 - 1238.720 = 18746.163 kN

Mb = Cc x 1057.900 + ∑(Csi*di) + ∑(Tsi*di) = 8704.148 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 464.316 mm, e = Mu/Pu = 1073.182 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 181.63 mm, a = k1 x c = 154.39 mm 를 사용.

Cc = 0.85 x 27.0 x 154389.262 = 3543.234 kN

∑Csi = 1352.672 kN, ∑Tsi = 1238.720 kN

Pn = 3543.234 + 1352.672 - 1238.720 = 3657.185 kN

Mn = Cc x 1342.805 + ∑(Csi*di) + ∑(Tsi*di) = 3924.812 kN.m

- 편심오차 : |e - Mn/Pn(=1073.178)| = 0.0038 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1500.00 - 80.00 = 1420.000 mm

c = 181.634 mm, a = k1 x c = 154.389 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1420.00-181.63) / 181.63 = 0.02045

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 31165.713 kN ≥ Pn = 3657.185 kN

ΦPn = 0.85 x 3657.185 = 3108.607 kN ≥ Pu = 1684.876 kN ∴ O.K

ΦMn = ΦPn x 1.073 = 3336.102 kN.m ≥ Mu = 1808.179 kN.m ∴ O.K

▣ TITLE : 좌측벽체 하부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,500	100	1,372	1885.948	2432.455	1289.8

㉯ 철근비 검토

As = 7166.000 mm² (인장중심 = 128.28 mm), 1단 : H29- 8.0EA, d1 = 100.00 mm

2단 : H25- 4.0EA, d1 = 200.00 mm

Asf = 3096.800 mm² (압축중심 = 80.00 mm), 1단 : H22- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0068) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1500.0 x 1000.0 = 34425000.0 N

Cs = As x fy = 2866400.0 N, Cs' = Asf x fy = 1238720.0 N

Xp = (34425000.0 x 750.00 + 2866400.0 x 128.284 + 1238720.0 x 1420.000) / 38530120.0

= 725.288 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 823.03 mm, ab = k1 x cb = 699.58 mm

Cc = 0.85 x 27.0 x 699575.384 = 16055.255 kN, ∑Csi = 1167.648 kN, ∑Tsi = 2866.400 kN

Pb = 16055.255 + 1167.648 - 2866.400 = 14356.503 kN

Mb = Cc x 1021.929 + ∑(Csi*di) + ∑(Tsi*di) = 9344.697 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 650.903 mm, e = Mu/Pu = 1289.778 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 361.36 mm, a = k1 x c = 307.16 mm 를 사용.

Cc = 0.85 x 27.0 x 307158.162 = 7049.280 kN

∑Csi = 1167.648 kN, ∑Tsi = 2866.400 kN

Pn = 7049.280 + 1167.648 - 2866.400 = 5350.528 kN

Mn = Cc x 1218.137 + ∑(Csi*di) + ∑(Tsi*di) = 6900.971 kN.m

- 편심오차 : |e - Mn/Pn(=1289.774)| = 0.0046 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1500.00 - 100.00 = 1400.000 mm

c = 361.363 mm, a = k1 x c = 307.158 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1400.00-361.36) / 361.36 = 0.00862

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 30635.671 kN ≥ Pn = 5350.528 kN

ΦPn = 0.85 x 5350.528 = 4547.949 kN ≥ Pu = 1885.948 kN ∴ O.K

ΦMn = ΦPn x 1.290 = 5865.846 kN.m ≥ Mu = 2432.455 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1371.72 = 970.970 kN

ΦVc/2 < Vu (= 581.826 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 mm²

Av_use = H19 - 2.0 EA = 573.000 mm² ∴ O.K

▣ TITLE : 우측벽체 상부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,667	100	1,538	1647.3	3711.067	2252.8

㉯ 철근비 검토

As = 8923.200 mm² (인장중심 = 128.80 mm), 1단 : H32- 8.0EA, d1 = 100.00 mm
2단 : H29- 4.0EA, d1 = 200.00 mm

Asf = 1548.400 mm² (압축중심 = 80.00 mm), 1단 : H22- 4.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0070) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1666.7 x 1000.0 = 38250000.0 N

Cs = As x fy = 3569280.0 N, Cs' = Asf x fy = 619360.0 N

Xp = (38250000.0 x 833.33 + 3569280.0 x 128.797 + 619360.0 x 1586.667) / 42438640.0
= 785.073 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 922.72 mm, ab = k1 x cb = 784.31 mm

Cc = 0.85 x 27.0 x 784313.609 = 17999.997 kN, ∑Csi = 583.824 kN, ∑Tsi = 3569.280 kN

Pb = 17999.997 + 583.824 - 3569.280 = 15014.542 kN

Mb = Cc x 1145.713 + ∑(Csi*di) + ∑(Tsi*di) = 11620.286 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 773.935 mm, e = Mu/Pu = 2252.818 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 323.97 mm, a = k1 x c = 275.37 mm 를 사용.

Cc = 0.85 x 27.0 x 275374.976 = 6319.856 kN

∑Csi = 583.824 kN, ∑Tsi = 3569.280 kN

Pn = 6319.856 + 583.824 - 3569.280 = 3334.400 kN

Mn = Cc x 1400.182 + ∑(Csi*di) + ∑(Tsi*di) = 7511.803 kN.m

- 편심오차 : |e - Mn/Pn(=2252.820)| = 0.0021 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1666.67 - 100.00 = 1566.667 mm

c = 323.971 mm, a = k1 x c = 275.375 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1566.67-323.97) / 323.97 = 0.01151

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 30698.653 kN ≥ Pn = 3334.400 kN

ΦPn = 0.85 x 3334.400 = 2834.240 kN ≥ Pu = 1647.300 kN ∴ O.K

ΦMn = ΦPn x 2.253 = 6385.027 kN.m ≥ Mu = 3711.067 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1371.20 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1371.20 = 960.486 kN

< Vu (= 1869.844 kN) , 전단보강 필요.

Req Av = (1869.844 - 960.486) x 150.00 / (400.0 x 1371.20 x Φ) = 331.591 mm²

Use Av = 573.000 mm² (H19-2.0 EA, C.T.C 150 mm)

Vs = 573.000 x 400.0 x 1371.20 / 150.00 = 2095.198 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1371.20 = 4749.987 kN ≥ 2095.198 kN ∴ O.K

ΦVn = 0.75 x (1280.647 + 2095.198) = 2531.884 kN ≥ 1869.844 kN ∴ O.K

▣ TITLE : 우측벽체 중앙부_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,500	100	1,371	1684.876	2499.806	1483.7

㉯ 철근비 검토

As = 8923.200 ㎟ (인장중심 = 128.80 mm), 1단 : H32- 8.0EA, d1 = 100.00 mm

2단 : H29- 4.0EA, d1 = 200.00 mm

Asf = 3096.800 ㎟ (압축중심 = 80.00 mm), 1단 : H22- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0080) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1500.0 x 1000.0 = 34425000.0 N

Cs = As x fy = 3569280.0 N, Cs' = Asf x fy = 1238720.0 N

Xp = (34425000.0 x 750.00 + 3569280.0 x 128.797 + 1238720.0 x 1420.000) / 39233000.0

= 714.639 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 822.72 mm, ab = k1 x cb = 699.31 mm

Cc = 0.85 x 27.0 x 699313.609 = 16049.247 kN, ∑Csi = 1167.648 kN, ∑Tsi = 3569.280 kN

Pb = 16049.247 + 1167.648 - 3569.280 = 13647.616 kN

Mb = Cc x 1021.546 + ∑(Csi*di) + ∑(Tsi*di) = 9907.368 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 725.941 mm, e = Mu/Pu = 1483.674 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 385.22 mm, a = k1 x c = 327.44 mm 를 사용.

Cc = 0.85 x 27.0 x 327437.006 = 7514.679 kN

∑Csi = 1167.648 kN, ∑Tsi = 3569.280 kN

Pn = 7514.679 + 1167.648 - 3569.280 = 5113.048 kN

Mn = Cc x 1207.485 + ∑(Csi*di) + ∑(Tsi*di) = 7586.091 kN.m

- 편심오차 : |e - Mn/Pn(=1483.673)| = 0.0006 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1500.00 - 100.00 = 1400.000 mm

c = 385.220 mm, a = k1 x c = 327.437 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1400.00-385.22) / 385.22 = 0.00790

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 31165.713 kN ≥ Pn = 5113.048 kN

ΦPn = 0.85 x 5113.048 = 4346.091 kN ≥ Pu = 1684.876 kN ∴ O.K

ΦMn = ΦPn x 1.484 = 6448.180 kN.m ≥ Mu = 2499.806 kN.m ∴ O.K

▣ TITLE : 우측벽체 중앙부_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,500	80	1,420	1684.876	1808.179	1073.2

㉯ 철근비 검토

As = 3096.800 ㎟ (인장중심 = 80.00 mm), 1단 : H22- 8.0EA, d1 = 80.00 mm

Asf = 8923.200 ㎟ (압축중심 = 128.80 mm), 1단 : H32- 8.0EA, d1 = 100.00 mm

2단 : H29- 4.0EA, d1 = 200.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0080) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1500.0 x 1000.0 = 34425000.0 N

Cs = As x fy = 1238720.0 N, Cs' = Asf x fy = 3569280.0 N

Xp = (34425000.0 x 750.00 + 1238720.0 x 80.000 + 3569280.0 x 1371.203) / 39233000.0

= 785.361 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 852.00 mm, ab = k1 x cb = 724.20 mm

Cc = 0.85 x 27.0 x 724200.000 = 16620.390 kN, ∑Csi = 3364.493 kN, ∑Tsi = 1238.720 kN

Pb = 16620.390 + 3364.493 - 1238.720 = 18746.163 kN

Mb = Cc x 1057.900 + ∑(Csi*di) + ∑(Tsi*di) = 8704.148 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 464.316 mm, e = Mu/Pu = 1073.182 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 181.63 mm, a = k1 x c = 154.39 mm 를 사용.

Cc = 0.85 x 27.0 x 154389.262 = 3543.234 kN

∑Csi = 1352.672 kN, ∑Tsi = 1238.720 kN

Pn = 3543.234 + 1352.672 - 1238.720 = 3657.185 kN

Mn = Cc x 1342.805 + ∑(Csi*di) + ∑(Tsi*di) = 3924.812 kN.m

- 편심오차 : |e - Mn/Pn(=1073.178)| = 0.0038 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1500.00 - 80.00 = 1420.000 mm

c = 181.634 mm, a = k1 x c = 154.389 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1420.00-181.63) / 181.63 = 0.02045

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 31165.713 kN ≥ Pn = 3657.185 kN

ΦPn = 0.85 x 3657.185 = 3108.607 kN ≥ Pu = 1684.876 kN ∴ O.K

ΦMn = ΦPn x 1.073 = 3336.102 kN.m ≥ Mu = 1808.179 kN.m ∴ O.K

▣ TITLE : 우측벽체 하부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,500	100	1,372	1885.948	2432.455	1289.8

㉯ 철근비 검토

As = 7166.000 mm² (인장중심 = 128.28 mm), 1단 : H29- 8.0EA, d1 = 100.00 mm

2단 : H25- 4.0EA, d1 = 200.00 mm

Asf = 3096.800 mm² (압축중심 = 80.00 mm), 1단 : H22- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0068) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1500.0 x 1000.0 = 34425000.0 N

Cs = As x fy = 2866400.0 N, Cs' = Asf x fy = 1238720.0 N

Xp = (34425000.0 x 750.00 + 2866400.0 x 128.284 + 1238720.0 x 1420.000) / 38530120.0

= 725.288 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 823.03 mm, ab = k1 x cb = 699.58 mm

Cc = 0.85 x 27.0 x 699575.384 = 16055.255 kN, ∑Csi = 1167.648 kN, ∑Tsi = 2866.400 kN

Pb = 16055.255 + 1167.648 - 2866.400 = 14356.503 kN

Mb = Cc x 1021.929 + ∑(Csi*di) + ∑(Tsi*di) = 9344.697 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 650.903 mm, e = Mu/Pu = 1289.778 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 361.36 mm, a = k1 x c = 307.16 mm 를 사용.

Cc = 0.85 x 27.0 x 307158.162 = 7049.280 kN

∑Csi = 1167.648 kN, ∑Tsi = 2866.400 kN

Pn = 7049.280 + 1167.648 - 2866.400 = 5350.528 kN

Mn = Cc x 1218.137 + ∑(Csi*di) + ∑(Tsi*di) = 6900.971 kN.m

- 편심오차 : |e - Mn/Pn(=1289.774)| = 0.0046 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1500.00 - 100.00 = 1400.000 mm

c = 361.363 mm, a = k1 x c = 307.158 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1400.00-361.36) / 361.36 = 0.00862

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 30635.671 kN ≥ Pn = 5350.528 kN

ΦPn = 0.85 x 5350.528 = 4547.949 kN ≥ Pu = 1885.948 kN ∴ O.K

ΦMn = ΦPn x 1.290 = 5865.846 kN.m ≥ Mu = 2432.455 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1371.72 = 970.970 kN

ΦVc/2 < Vu (= 581.826 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 mm²

Av_use = H19 - 2.0 EA = 573.000 mm² ∴ O.K

17. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1400 × 0.0020 = 2800.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 7402.607 × 0.20 = 1480.52 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1480.521 ∴ O.K

2) 상부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1400 × 0.0020 = 2800.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 4401.225 × 0.20 = 880.25 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 880.245 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1400 × 0.0020 = 2800.00 ㎟

∴ Used As = H16 - 20EA = 3972.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 7402.607 × 0.20 = 1480.52 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1480.521 ∴ O.K

4) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1400 × 0.0020 = 2800.00 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 5527.590 × 0.20 = 1105.52 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1105.518 ∴ O.K

5) 하부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1400 × 0.0020 = 2800.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 3777.978 × 0.20 = 755.60 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 755.596 ∴ O.K

6) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1130 × 0.0020 = 2260.00 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 5527.590 × 0.20 = 1105.52 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1105.518 ∴ O.K

7) 좌측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1500 × 0.0020 = 3000.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

8) 좌측벽체 : 중앙부_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1500 × 0.0020 = 3000.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

9) 좌측벽체 : 중앙부_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1500 × 0.0020 = 3000.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

10) 좌측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1500 × 0.0020 = 3000.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

11) 우측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1500 × 0.0020 = 3000.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

12) 우측벽체 : 중앙부_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1500 × 0.0020 = 3000.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

13) 우측벽체 : 중앙부_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1500 × 0.0020 = 3000.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

14) 우측벽체 : 하부

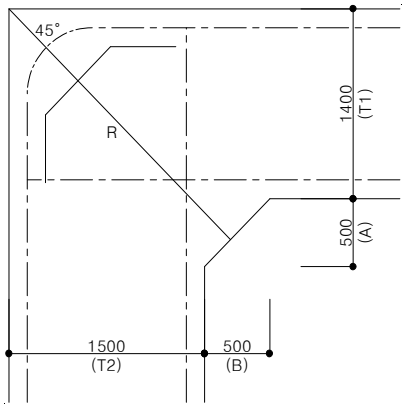
① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1500 × 0.0020 = 3000.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

18. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 1307.481 kN.m
- 절점부 휨모멘트 : Mo = 1307.481 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 2404.163 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

∴ Total Asb = 3176.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 1307.48 \times 10^6}{2404.163^2 \times 1000} = 1.131 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 1307.48 \times 10^6}{2404.163 \times 180} = 6042.671 \text{ mm}^2$$

Asb = 3176.800 mm²

Req'd As = As - Asb

= 6042.671 mm² - 3176.800 mm²

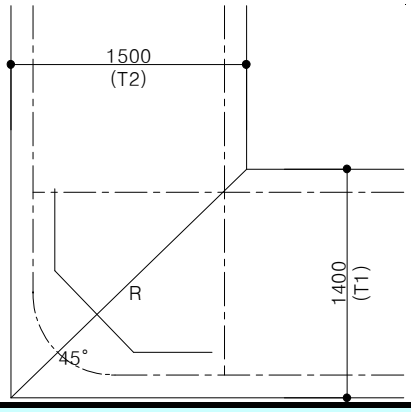
= 2865.871 mm²

- 사용보강철근

Use'd As = H25 - 8EA

∴ Total As = 4053.600 mm² > Req'd As (= 2865.871 mm²) ----------> O.K !!!

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 1553.969 kN.m
- 절점부 휨모멘트 : Mo = 1553.969 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 2051.828$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 1553.97 \times 10^6}{2051.828^2 \times 1000} = 1.846 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 1553.97 \times 10^6}{2051.828 \times 180} = 8415.091 \text{ mm}^2$$

Asb = 2569.600 mm²

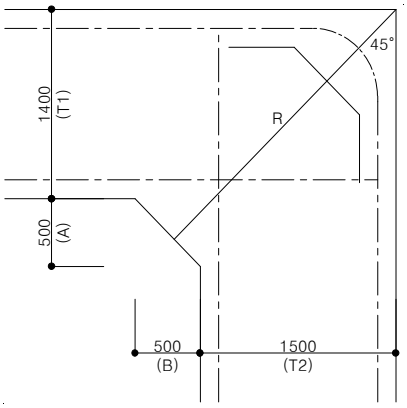
Req'd As = As - Asb
= 8415.091 mm² - 2569.600 mm²
= 5845.491 mm²

- 사용보강철근

Use'd As = H25 - 8EA , H25 - 8EA

∴ Total As = 8107.200 mm² > Req'd As (= 5845.491 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 1307.481 kN.m
- 절점부 휨모멘트 : Mo = 1307.481 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$= 2404.163$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

∴ Total Asb = 3176.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 1307.48 \times 10^6}{2404.163^2 \times 1000} = 1.131 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 1307.48 \times 10^6}{2404.163 \times 180} = 6042.671 \text{ mm}^2$$

Asb = 3176.800 mm²

Req'd As = As - Asb

= 6042.671 mm² - 3176.800 mm²

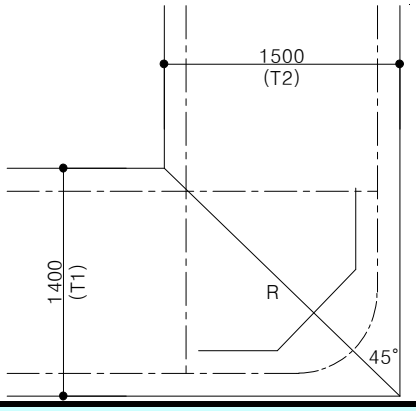
= 2865.871 mm²

- 사용보강철근

Use'd As = H25 - 8EA

∴ Total As = 4053.600 mm² > Req'd As (= 2865.871 mm²) ----------> O.K !!!

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 1554.054 kN.m
- 절점부 휨모멘트 : Mo = 1554.054 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 2051.828$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 2569.600 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 1554.05 \times 10^6}{2051.828^2 \times 1000} = 1.846 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 1554.05 \times 10^6}{2051.828 \times 180} = 8415.551 \text{ mm}^2$$

Asb = 2569.600 mm²

Req'd As = As - Asb
= 8415.551 mm² - 2569.600 mm²
= 5845.951 mm²

- 사용보강철근

Use'd As = H25 - 8EA , H25 - 8EA

∴ Total As = 8107.200 mm² > Req'd As (= 5845.951 mm²) ----------> O.K !!!

19. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	1438	H32 - 8.0EA + H29 - 4.0EA	125	912.693	O.K	7.302
		중앙부	2	1320	H29 - 8.0EA	125	809.989	O.K	6.480
		우측	3	1438	H32 - 8.0EA + H29 - 4.0EA	125	912.693	O.K	7.302
하부슬래브	1경간	좌측	4	1272	H29 - 8.0EA + H25 - 4.0EA	125	470.352	O.K	3.763
		중앙부	5	1320	H29 - 8.0EA	125	237.554	O.K	1.900
		우측	6	1272	H29 - 8.0EA + H25 - 4.0EA	125	470.288	O.K	3.762
좌측벽체	1층	상부	7	1538	H32 - 8.0EA + H29 - 4.0EA	125	611.770	O.K	4.894
		중앙부	8	1371	H32 - 8.0EA + H29 - 4.0EA	125	633.109	O.K	5.065
		중앙부	8	1420	H22 - 8.0EA	-	-	-	-
		하부	9	1372	H29 - 8.0EA + H25 - 4.0EA	125	318.226	O.K	2.546
우측벽체	1층	상부	10	1538	H32 - 8.0EA + H29 - 4.0EA	125	611.770	O.K	4.894
		중앙부	11	1371	H32 - 8.0EA + H29 - 4.0EA	125	633.109	O.K	5.065
		중앙부	11	1420	H22 - 8.0EA	-	-	-	-
		하부	12	1372	H29 - 8.0EA + H25 - 4.0EA	125	318.226	O.K	2.546

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 810.506 x 1000000 / [8923.200 x (1437.870 - 365.938/3)]
= 69.027 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1437.9/(7x8923.200)]
= 365.938 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 69.03) - 2.5 x 84.00 = 930.87 mm
300 x (Kcr / fs) = 300 x (210 / 69.03) = 912.69 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 912.69 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 912.69 mm) ∴ O.K

2) 상부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 491.085 x 1000000 / [5139.200 x (1320.000 - 274.294/3)]
= 77.779 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1320.0/(7x5139.200)]
= 274.294 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 77.78) - 2.5 x 65.50 = 848.74 mm
300 x (Kcr / fs) = 300 x (210 / 77.78) = 809.99 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 809.99 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 809.99 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 810.506 x 1000000 / [8923.200 x (1437.870 - 365.938/3)]
= 69.027 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1437.9/(7x8923.200)]
= 365.938 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 69.03) - 2.5 x 84.00 = 930.87 mm
300 x (Kcr / fs) = 300 x (210 / 69.03) = 912.69 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 912.69 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 912.69 mm) ∴ O.K

4) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 963.665 x 1000000 / [7166.000 x (1271.716 - 310.532/3)]
= 115.114 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7166.000/1000.0 + 7x7166.000/1000.0 x √[(1 + 2x1000.0x1271.7/(7x7166.000)]
= 310.532 mm

사용철근량 = 7166.0 mm² (철근도심 : 128.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 4.0 EA (= 2026.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 115.11) - 2.5 x 85.50 = 470.35 mm
300 x (Kcr / fs) = 300 x (210 / 115.11) = 547.28 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 470.35 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 470.35 mm) ∴ O.K

5) 하부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 1239.002 x 1000000 / [5139.200 x (1320.000 - 274.294/3)]
= 196.235 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1320.0/(7x5139.200)]
= 274.294 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 196.24) - 2.5 x 65.50 = 237.55 mm
300 x (Kcr / fs) = 300 x (210 / 196.24) = 321.04 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 237.55 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 237.55 mm) ∴ O.K

6) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 963.754 x 1000000 / [7166.000 x (1271.716 - 310.532/3)]
= 115.125 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7166.000/1000.0 + 7x7166.000/1000.0 x √[(1 + 2x1000.0x1271.7/(7x7166.000)]
= 310.532 mm

사용철근량 = 7166.0 mm² (철근도심 : 128.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 4.0 EA (= 2026.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 115.13) - 2.5 x 85.50 = 470.29 mm
300 x (Kcr / fs) = 300 x (210 / 115.13) = 547.23 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 470.29 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 470.29 mm) ∴ O.K

7) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 1206.652 x 1000000 / [8923.200 x (1537.870 - 380.279/3)]
= 95.830 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1537.9/(7x8923.200)]
= 380.279 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 95.83) - 2.5 x 84.00 = 611.77 mm
300 x (Kcr / fs) = 300 x (210 / 95.83) = 657.42 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 611.77 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 611.77 mm) ∴ O.K

8) 좌측벽체 중앙부_외측

① 응력 산정

fs = M / [As x (d - χ/3)] = 1043.916 x 1000000 / [8923.200 x (1371.203 - 356.105/3)]
= 93.404 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1371.2/(7x8923.200)]
= 356.105 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 93.40) - 2.5 x 84.00 = 633.11 mm
300 x (Kcr / fs) = 300 x (210 / 93.40) = 674.49 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 633.11 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 633.11 mm) ∴ O.K

9) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 1340.492 x 1000000 / [7166.000 x (1371.716 - 324.180/3)]
= 148.033 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7166.000/1000.0 + 7x7166.000/1000.0 x √[(1 + 2x1000.0x1371.7/(7x7166.000)]
= 324.180 mm

사용철근량 = 7166.0 mm² (철근도심 : 128.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 4.0 EA (= 2026.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 148.03) - 2.5 x 85.50 = 318.23 mm
300 x (Kcr / fs) = 300 x (210 / 148.03) = 425.58 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 318.23 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 318.23 mm) ∴ O.K

10) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 1206.652 x 1000000 / [8923.200 x (1537.870 - 380.279/3)]
= 95.830 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1537.9/(7x8923.200)]
= 380.279 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 95.83) - 2.5 x 84.00 = 611.77 mm
300 x (Kcr / fs) = 300 x (210 / 95.83) = 657.42 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 611.77 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 611.77 mm) ∴ O.K

11) 우측벽체 중앙부_외측

① 응력 산정

fs = M / [As x (d - χ/3)] = 1043.916 x 1000000 / [8923.200 x (1371.203 - 356.105/3)]
= 93.404 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x8923.200/1000.0 + 7x8923.200/1000.0 x √[(1 + 2x1000.0x1371.2/(7x8923.200)]
= 356.105 mm

사용철근량 = 8923.2 mm² (철근도심 : 128.8 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 93.40) - 2.5 x 84.00 = 633.11 mm
300 x (Kcr / fs) = 300 x (210 / 93.40) = 674.49 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 633.11 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 633.11 mm) ∴ O.K

12) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 1340.492 x 1000000 / [7166.000 x (1371.716 - 324.180/3)]
= 148.033 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x7166.000/1000.0 + 7x7166.000/1000.0 x √[(1 + 2x1000.0x1371.7/(7x7166.000)]
= 324.180 mm

사용철근량 = 7166.0 mm² (철근도심 : 128.3 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H25 - 4.0 EA (= 2026.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 148.03) - 2.5 x 85.50 = 318.23 mm
300 x (Kcr / fs) = 300 x (210 / 148.03) = 425.58 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 318.23 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 318.23 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 9.000 m
- fy = 400 MPa
- 부재두께(T) = 1.40 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28

T = 9.000 / 28

T = 0.321 m < 1.400 m ----------> O.K

20. 기초 지지력 검토

(1) 하중산정

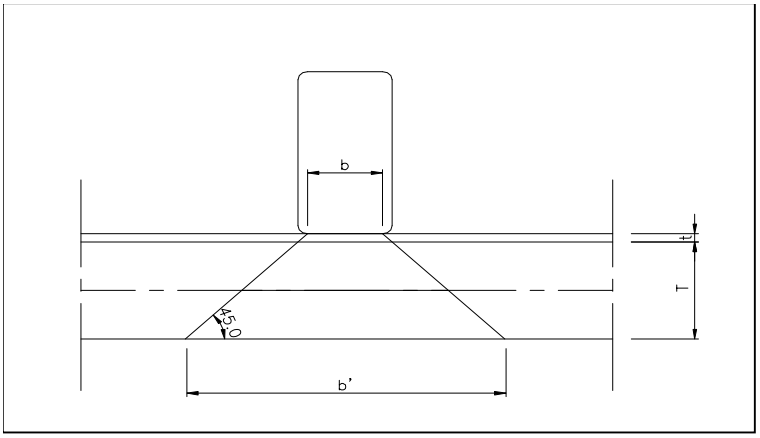
1) 고정하중

- 구체자중 = 1132.750 / 10.500 = 107.881 kN/m²
- 상부연직하중 = 201.500 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.04 × 23.00 = 0.920 kN/m²

2) 활하중

- 도로 노면 활하중 = 10.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중

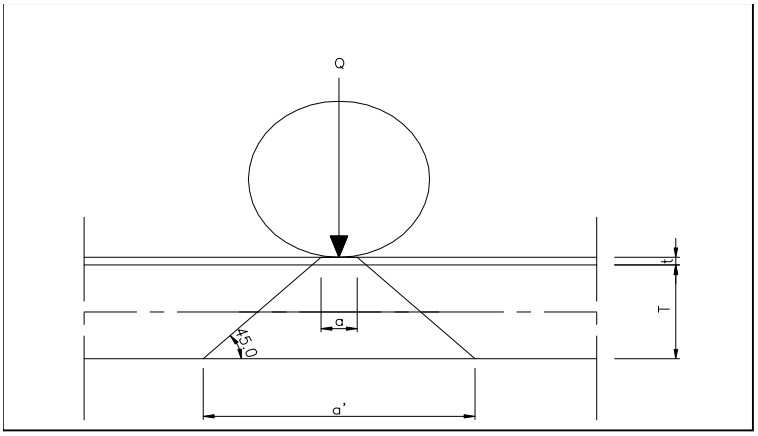


t = 40 mm (암거내부 포장두께)

T = 1400 mm (하부 슬래브 두께)

b' = 0.500 + 2 × (1.400 + 0.040) × cot 45°

= 3.380 m



a' = 0.200 + 2 × (1.400 + 0.040) × cot 45°

= 3.080 m

Qz = 96.0 / (3.380 × 3.080)= 9.222 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 107.88 + 201.50 + 10.00 + 0.92 + 9.22

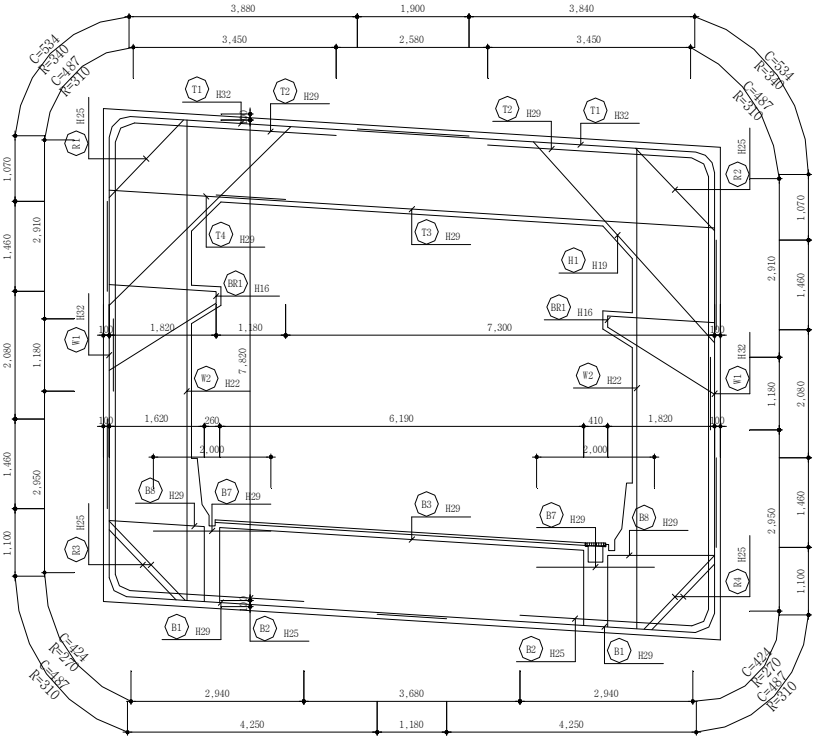
= 329.523 kN/m²

Qa' = 700.000 kN/m² > Qmax = 329.523 kN/m² ..... O.K !!!

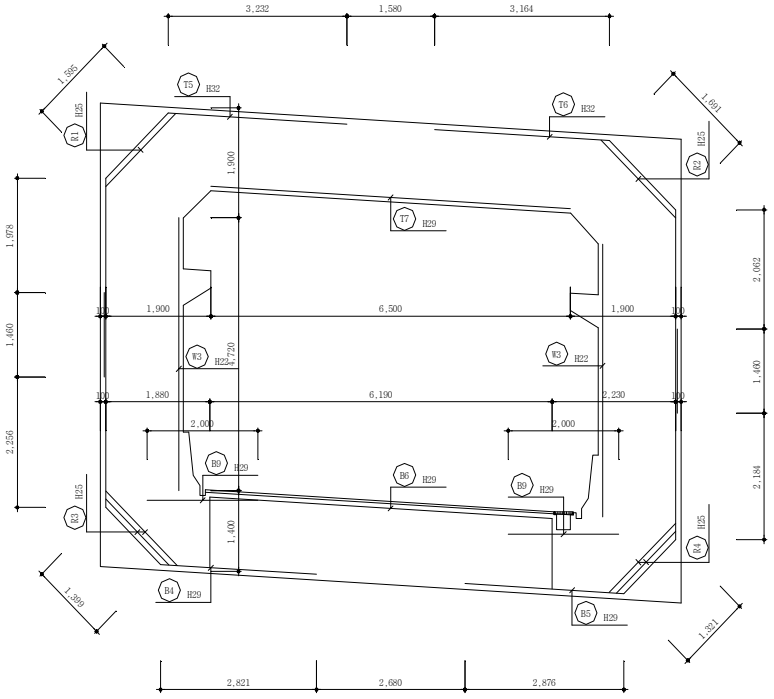
(지반조사 보고서 참조)

21. 주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



1.24 대인용 피난연결통로

국회대로 지하차도

대인용 피난연결통로 (내진)

목 차

1. 설계조건

2. 단면가정

3. 설계지진력 산정

4. 하중재하도

5. 하중조합

6. 단면력도

7. 기능수행수준 부재력집계

8. 붕괴방지수준 부재력집계

1. 설계조건

1.1 적용하중

1) 단위중량

① 철근 콘크리트 : r_c = 25.0 kN/m^3

② 무근 콘크리트 : r_c = 23.5 kN/m^3

③ Ascon Pav. : r_{asp} = 23.0 kN/m^3

④ 토사(지하수위 이상) : r_s = 19.0 kN/m^3

토사(지하수위 이하) : r_{sub} = 10.0 kN/m^3

⑤ 보호몰탈 : r_m = 21.0 kN/m^3

2) 활하중

⊙ 노면활하중(DB-24 기준)에 대한 등가 등분포하중

$D / B_o \geq 0.5$ 인 경우		
토 피 (D, m)	노면의 활하중 P_{vl} (kN/m^2)	비고
1.0	39.0	· 토피의 중간 값은 노면 활하중 상위의 값을 적용
1.5	25.0	
2.0	18.0	
2.5	14.0	
3.0	11.0	
3.5 이상	10.0	
$D / B_o < 0.5$ 인 경우		
토 피 (D, m)	노면의 활하중 P_{vl} (kN/m^2)	비고
0.1	17.0	· D/B_o 의 중간 값은 P_{vl} x D 의 상위 값을 적용 · D/B_o 노면 활하중(P_{vl})은 표의 값을 D로 나누어 구한다.
0.2	27.0	
0.3	33.0	
0.4 이상	36.0	

주1) D : 토피고(m)

2) B_o : ≧10m 이상의 토피에 대한 노면 활하중은 10.0으로 한다.

3) 수 압 (장기실지하수위 : GL - 9.6 m)

⊙ 정수압 : $F = r_w \times h$

4) 토 압

① 정지 토압계수 : $K_o = 1 - \sin \phi$ [ø : 흙의 내부마찰각(°)]

② 설계토압 : $Wq = K_o \times r_s \times h$ (kN/m^2)

5) 지진하중 (응답변위법)

① 붕괴방지수준, 기능수행수준 모두 수행

② 하중형태 : 지반변위에 의한 하중, 주면전단력, 구체 관성력

1.2 탄성계수 ☞ 2012년도 콘크리트구조설계기준

1) 콘크리트

① 설계기준강도 (f_{ck}) = 27 MPa

② 탄성계수 (E_c) = $8{,}500\times(fcu)^{1/3}$, [fcu = fck+4 = 31 MPa]

= 26,702 MPa = 26,702,000 kN/m^2

2) 철 근 (SD40)

① 항복강도 (f_y) = 400 MPa

② 탄성계수 (E_s) = 200,000 MPa = 200,000,000 kN/m^2

1.3 강도감소계수 ☞ 2007년도 개정 콘크리트구조설계기준 p61 (3.3.3)

1) 휨모멘트와 축력을 받는 부재

① 인장지배 단면 : ø = 0.85

2) 전단력과 비틀림모멘트를 받는 부재 : ø = 0.75

1.4 설계피복

단위 : mm

구 분	상부슬래브	하부슬래브	중간슬래브	외측벽체	기둥	거더
상면(벽체외측)	100	80	80	100	90	135
하면(벽체내측)	80	100	80	80	90	90

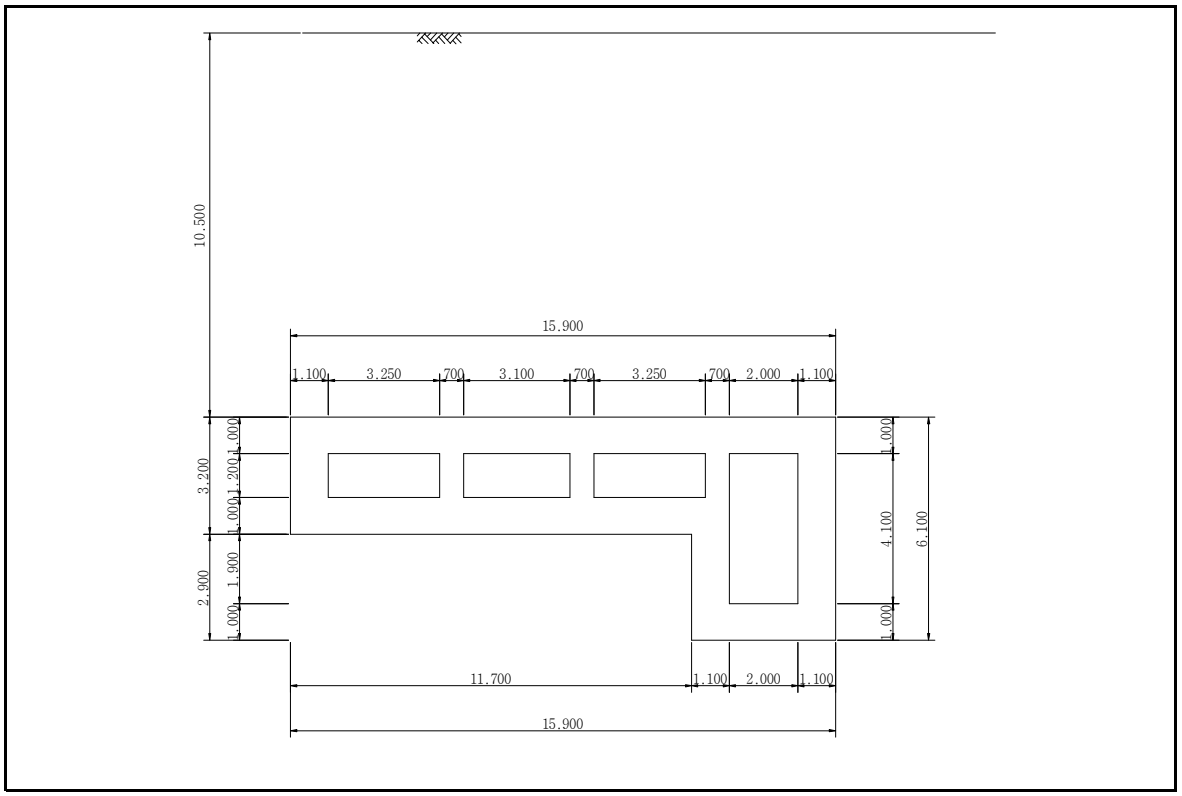
1.5 참고문헌

① 콘크리트설계기준(한국콘크리트학회, 2012) ② 구조물기초설계기준(국토해양부, 2014)

③ 도시철도내진설계기준(국토교통부, 2013)

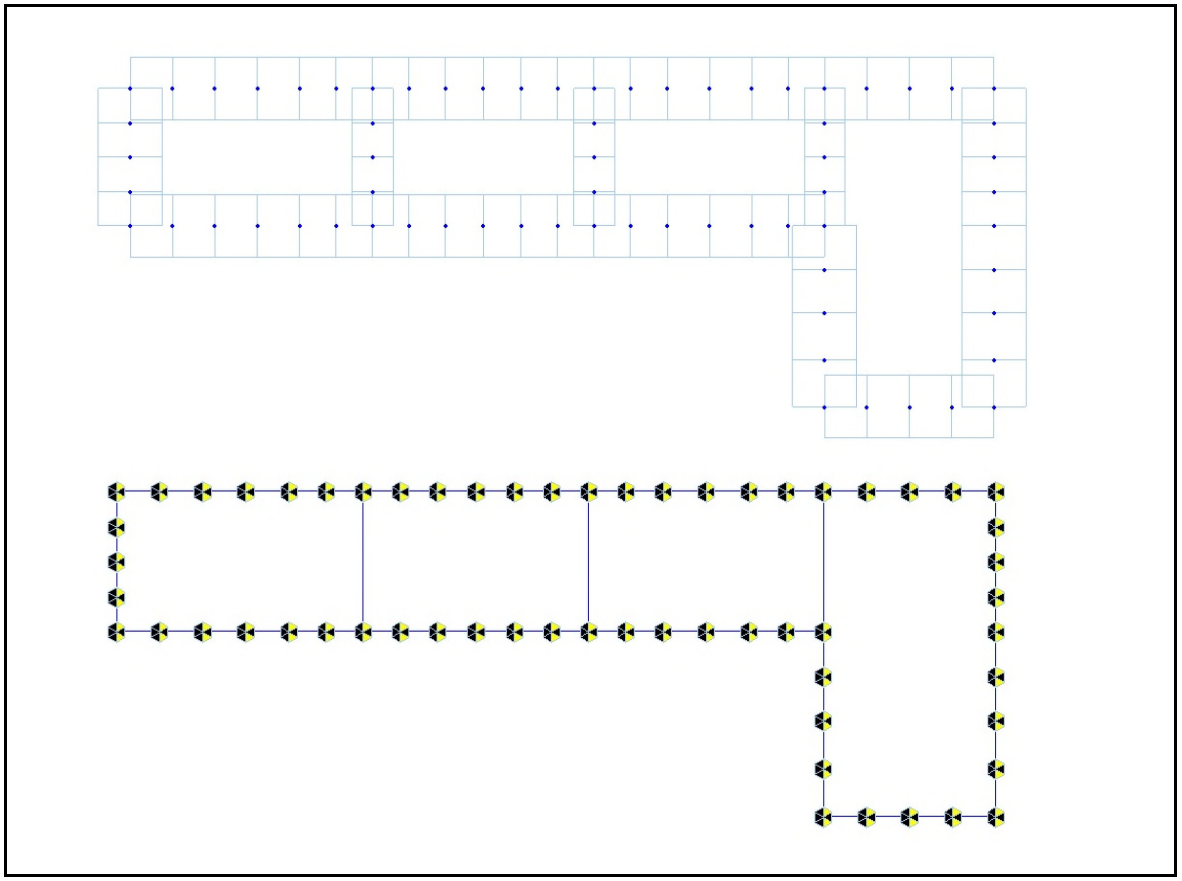
2. 단면가정

2.1 해석단면



2.2 해석모델링

1) 해석모델



2) 지진시 지반반력계수

(1) 동적 지반물성치

* 계산식

- Vo (초기 전단파 속도) : **지반조사 보고서 참고**
- Vs (해당 지층의 전단파 속도) = 0.8 × Vo (m/sec , 기능수행수준)
  = 0.5 × Vo (m/sec , 붕괴방지수준)
- G_D (동적전단탄성계수) = γ_t / g × Vs^2 (kN/m^2) (g = 9.81 m/s^2)
- E_D (동적탄성계수) = 2 ×(1 + υ)× G_D (kN/m^2)

구 분	H	γ_t (kN/m^3)	V_o (m/sec)	υ	기능수행수준			붕괴방지수준		
					V_s (m/sec)	G_D (kN/m^2)	E_D (kN/cm^2)	V_s (m/sec)	G_D (kN/m^2)	E_D (kN/cm^2)
매립층	2.200	18.000	156.000	0.440	125	28,578	82,305	78	11,163	32,150
퇴적층(자갈층)	11.800	19.000	289.000	0.431	231	103,529	296,299	145	40,441	115,742
풍화토	0.000	20.000	424.000	0.408	339	234,570	660,549	212	91,629	258,027
풍화암	16.000	21.000	631.000	0.387	505	545,493	1,513,197	316	213,083	591,093
연 암	0.000	23.000	1216.000	0.280	973	2,218,738	5,679,968	608	866,694	2,218,738
경 암	0.000	26.000	2059.000	0.243	1,647	7,191,128	17,877,144	1,030	2,809,034	6,983,259

단, 지반조사보고서 참조

(2) 지진시 지반반력계수 (기능수행수준, 붕괴방지수준)

* 연직방향 지반반력계수

- B_V = (슬래브의 재하환산폭) = √(V×V) , B_H = (벽체의 재하환산폭) = √(H×H)
  = 11.700 m = 15.900 m = 5.100 m
- $K_{ho(vo)} = 1/0.3 \cdot E_D$

* 연직방향 환산 지반반력계수(압축방향)

- $K_V = K_{vo}\,(B_V/0.3)^{-3/4}$, $K_H = K_{ho}\,(B_H/0.3)^{-3/4}$

* 기초 2 수평방향 지반반력계수(전단방향)

- $K_{SV} = \lambda \times k_V = 1/3 \times k_V$, $K_{SH} = \lambda \times k_H = 1/3 \times k_H$

구 분	기능수행수준					붕괴방지수준				
	$K_{ho(vo)}$ (kN/m^3)	K_V (kN/m^3)	K_H (kN/m^3)	K_{SV} (kN/m^3)	K_{SH} (kN/m^3)	$K_{ho(vo)}$ (kN/m^3)	K_V (kN/m^3)	K_H (kN/m^3)	K_{SV} (kN/m^3)	K_{SH} (kN/m^3)
매립층	274,349	13,967	32,769	4,656	10,923	107,168	5,456	12,801	1,819	4,267
퇴적층(자갈층)	987,663	63,286	117,970	21,095	39,323	385,806	24,721	46,082	8,240	15,361
풍화토	2,201,831	141,087	262,995	47,029	87,665	860,090	55,112	102,732	18,371	34,244
풍화암	5,043,990	323,203	602,473	107,734	200,824	1,970,308	126,251	235,341	42,084	78,447
연 암	18,933,228	1,213,183	2,261,455	404,394	753,818	7,395,792	473,899	883,381	157,966	294,460
보통암	15,536,147	995,508	1,855,695	331,836	618,565	6,068,807	388,870	724,881	129,623	241,627
경 암	59,590,479	3,818,374	7,117,708	1,272,791	2,372,569	23,277,531	1,491,552	2,780,355	497,184	926,785

* 기초 1 수평방향 지반반력계수(전단방향)

- $K_{SV} = \lambda \times k_V = 1/3 \times k_V$, $K_{SH} = \lambda \times k_H = 1/3 \times k_H$

구 분	기능수행수준					붕괴방지수준				
	$K_{ho(vo)}$ (kN/m^3)	K_V (kN/m^3)	K_H (kN/m^3)	K_{SV} (kN/m^3)	K_{SH} (kN/m^3)	$K_{ho(vo)}$ (kN/m^3)	K_V (kN/m^3)	K_H (kN/m^3)	K_{SV} (kN/m^3)	K_{SH} (kN/m^3)
매립층	274,349	13,967	32,769	4,656	10,923	107,168	5,456	12,801	1,819	4,267
퇴적층(자갈층)	987,663	136,462	117,970	45,487	39,323	385,806	53,306	46,082	17,769	15,361
풍화토	2,201,831	304,220	262,995	101,407	87,665	860,090	118,836	102,732	39,612	34,244
풍화암	5,043,990	696,912	602,473	232,304	200,824	1,970,308	272,231	235,341	90,744	78,447
연 암	18,933,228	2,615,945	2,261,455	871,982	753,818	7,395,792	1,021,854	883,381	340,618	294,460
보통암	15,536,147	2,146,581	1,855,695	715,527	618,565	6,068,807	838,508	724,881	279,503	241,627
경 암	59,590,479	8,233,431	7,117,708	2,744,477	2,372,569	23,277,531	3,216,184	2,780,355	1,072,061	926,785

(3) 구간별 지반반력계수

*** 기능수행수준**

[상부슬래브 지진시 지반반력계수 , **매립층** , **퇴적층(자갈층)**]

토층	K_V (kN/m^3)	K_{SV} (kN/m^3)	간격1 (m)	간격2 (m)	연직 지반반력계수 (kN/m)	수평 지반반력계수 (kN/m)	해당절점
퇴적층(자갈층)	63,286	21,095	1.100	0.725	57,749	19,250	47
퇴적층(자갈층)	63,286	21,095	0.725	0.725	45,883	15,294	48 to 50
퇴적층(자갈층)	63,286	21,095	0.725	0.625	42,718	14,239	51
퇴적층(자갈층)	63,286	21,095	0.625	0.625	39,554	13,185	52 to 54
퇴적층(자갈층)	63,286	21,095	0.625	0.650	40,345	13,448	55 57
퇴적층(자갈층)	63,286	21,095	0.650	0.650	41,136	13,712	56
퇴적층(자갈층)	63,286	21,095	0.625	0.625	39,554	13,185	58 to 60
퇴적층(자갈층)	63,286	21,095	0.625	0.725	42,718	14,239	61 63
퇴적층(자갈층)	63,286	21,095	0.725	0.725	45,883	15,294	62
퇴적층(자갈층)	63,286	21,095	0.625	0.625	39,554	13,185	64
퇴적층(자갈층)	63,286	21,095	0.625	0.725	42,718	14,239	65
퇴적층(자갈층)	63,286	21,095	0.725	0.725	45,883	15,294	66 to 68
퇴적층(자갈층)	63,286	21,095	0.725	1.100	57,749	19,250	69

[하부슬래브 지진시 지반반력계수 , **퇴적층(자갈층)** , **매립층** , **풍화암**]

토층	K_V (kN/m^3)	K_{SV} (kN/m^3)	간격1 (m)	간격2 (m)	연직 지반반력계수 (kN/m)	수평 지반반력계수 (kN/m)	해당절점
풍화암	696,912	232,304	1.100	0.725	635,933	211,978	1 5
풍화암	696,912	232,304	0.725	0.725	505,261	168,420	2 4
풍화암	696,912	232,304	0.725	0.725	505,261	168,420	3
퇴적층(자갈층)	63,286	21,095	1.100	0.725	57,749	19,250	12
퇴적층(자갈층)	63,286	21,095	0.725	0.725	45,883	15,294	13 to 15
퇴적층(자갈층)	63,286	21,095	0.725	0.625	42,718	14,239	16
퇴적층(자갈층)	63,286	21,095	0.625	0.625	39,554	13,185	17 to 19
퇴적층(자갈층)	63,286	21,095	0.625	0.650	40,345	13,448	20 22
퇴적층(자갈층)	63,286	21,095	0.650	0.650	41,136	13,712	21
퇴적층(자갈층)	63,286	21,095	0.625	0.625	39,554	13,185	23 to 25
퇴적층(자갈층)	63,286	21,095	0.625	0.725	42,718	14,239	26
퇴적층(자갈층)	63,286	21,095	0.725	0.725	45,883	15,294	27
퇴적층(자갈층)	63,286	21,095	0.725	0.625	42,718	14,239	28
퇴적층(자갈층)	63,286	21,095	0.625	0.625	39,554	13,185	29

[좌측벽체 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암** , **연 암** , **보통암**]

토층	K_H (kN/m^3)	K_{SH} (kN/m^3)	간격1 (m)	간격2 (m)	수평 지반 반력계수 (kN/m)	전단 지반 반력계수 (kN/m)	해당절점
퇴적층(자갈층)	117,970	39,323	1.000	1.000	117,970	39,323	47
퇴적층(자갈층)	117,970	39,323	1.000	0.550	91,427	30,476	42
퇴적층(자갈층)	117,970	39,323	0.550	0.550	64,884	21,628	37
퇴적층(자갈층)	117,970	39,323	0.550	0.550	64,884	21,628	32
퇴적층(자갈층)	117,970	39,323	0.550	0.550	64,884	21,628	12

[우측벽체 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암** , **연 암** , **보통암**]

토층	K_H (kN/m^3)	K_{SH} (kN/m^3)	간격1 (m)	간격2 (m)	수평 지반 반력계수 (kN/m)	전단 지반 반력계수 (kN/m)	해당절점
퇴적층(자갈층)	117,970	39,323	1.000	1.000	117,970	39,323	69
퇴적층(자갈층)	117,970	39,323	1.000	0.550	91,427	30,476	46
퇴적층(자갈층)	117,970	39,323	0.550	0.550	64,884	21,628	41
퇴적층(자갈층)	117,970	39,323	0.550	0.550	64,884	21,628	36
퇴적층(자갈층)	117,970	39,323	0.550	0.550	64,884	21,628	31
퇴적층(자갈층)	117,970	39,323	0.550	0.700	73,731	24,577	11
풍화암	602,473	200,824	0.700	0.700	421,731	140,577	9
풍화암	602,473	200,824	0.700	0.750	436,793	145,598	7
풍화암	602,473	200,824	0.750	0.750	451,855	150,618	5

★ 붕괴방지수준

[상부슬래브 지진시 지반반력계수 , **매립층**]

토층	K_V (kN/m^3)	K_{SV} (kN/m^3)	간격1 (m)	간격2 (m)	연직 지반반력계수 (kN/m)	수평 지반반력계수 (kN/m)	해당절점
퇴적층(자갈층)	24,721	8,240	1.100	0.725	22,558	7,519	47
퇴적층(자갈층)	24,721	8,240	0.725	0.725	17,923	5,974	48 to 50
퇴적층(자갈층)	24,721	8,240	0.725	0.625	16,687	5,562	51
퇴적층(자갈층)	24,721	8,240	0.625	0.625	15,451	5,150	52 to 54
퇴적층(자갈층)	24,721	8,240	0.625	0.650	15,760	5,253	55 57
퇴적층(자갈층)	24,721	8,240	0.650	0.650	16,069	5,356	56
퇴적층(자갈층)	24,721	8,240	0.625	0.625	15,451	5,150	58 to 60
퇴적층(자갈층)	24,721	8,240	0.625	0.725	16,687	5,562	61 63
퇴적층(자갈층)	24,721	8,240	0.725	0.725	17,923	5,974	62
퇴적층(자갈층)	24,721	8,240	0.625	0.625	15,451	5,150	64
퇴적층(자갈층)	24,721	8,240	0.625	0.725	16,687	5,562	65
퇴적층(자갈층)	24,721	8,240	0.725	0.725	17,923	5,974	66 to 68
퇴적층(자갈층)	24,721	8,240	0.725	1.100	22,558	7,519	69

[하부슬래브 지진시 지반반력계수 , **퇴적층(자갈층)** , **매립층**]

토층	K_V (kN/m^3)	K_{SV} (kN/m^3)	간격1 (m)	간격2 (m)	연직 지반반력계수 (kN/m)	수평 지반반력계수 (kN/m)	해당절점
풍화암	272,231	90,744	1.100	0.725	248,411	82,804	1 5
풍화암	272,231	90,744	0.725	0.725	197,368	65,789	2 4
풍화암	272,231	90,744	0.725	0.725	197,368	65,789	3
퇴적층(자갈층)	24,721	8,240	1.100	0.725	22,558	7,519	12
퇴적층(자갈층)	24,721	8,240	0.725	0.725	17,923	5,974	13 to 15
퇴적층(자갈층)	24,721	8,240	0.725	0.625	16,687	5,562	16
퇴적층(자갈층)	24,721	8,240	0.625	0.625	15,451	5,150	17 to 19
퇴적층(자갈층)	24,721	8,240	0.625	0.650	15,760	5,253	20 22
퇴적층(자갈층)	24,721	8,240	0.650	0.650	16,069	5,356	21
퇴적층(자갈층)	24,721	8,240	0.625	0.625	15,451	5,150	23 to 25
퇴적층(자갈층)	24,721	8,240	0.625	0.725	16,687	5,562	26
퇴적층(자갈층)	24,721	8,240	0.725	0.725	17,923	5,974	27
퇴적층(자갈층)	24,721	8,240	0.725	0.625	16,687	5,562	28
퇴적층(자갈층)	24,721	8,240	0.625	0.625	15,451	5,150	29

[좌측벽체 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암** , **연 암** , **보통암**]

토층	K_H (kN/m^3)	K_{SH} (kN/m^3)	간격1 (m)	간격2 (m)	수평 지반 반력계수 (kN/m)	전단 지반 반력계수 (kN/m)	해당절점
퇴적층(자갈층)	46,082	15,361	1.000	1.000	46,082	15,361	47
퇴적층(자갈층)	46,082	15,361	1.000	0.550	35,714	11,905	42
퇴적층(자갈층)	46,082	15,361	0.550	0.550	25,345	8,448	37
퇴적층(자갈층)	46,082	15,361	0.550	0.550	25,345	8,448	32
퇴적층(자갈층)	46,082	15,361	0.550	0.550	25,345	8,448	12

[우측벽체 지진시 지반반력계수 , **퇴적층(자갈층)** , **풍화암** , **연 암** , **보통암**]

토층	K_H (kN/m^3)	K_{SH} (kN/m^3)	간격1 (m)	간격2 (m)	수평 지반 반력계수 (kN/m)	전단 지반 반력계수 (kN/m)	해당절점
퇴적층(자갈층)	46,082	15,361	1.000	1.000	46,082	15,361	69
퇴적층(자갈층)	46,082	15,361	1.000	0.550	35,714	11,905	46
퇴적층(자갈층)	46,082	15,361	0.550	0.550	25,345	8,448	41
퇴적층(자갈층)	46,082	15,361	0.550	0.550	25,345	8,448	36
퇴적층(자갈층)	46,082	15,361	0.550	0.550	25,345	8,448	31
퇴적층(자갈층)	46,082	15,361	0.550	0.700	28,801	9,600	11
풍화암	235,341	78,447	0.700	0.700	164,739	54,913	9
풍화암	235,341	78,447	0.700	0.750	170,622	56,874	7
풍화암	235,341	78,447	0.750	0.750	176,506	58,835	5

3. 설계지진력 산정

1) 설계응답스펙트럼

① 지표면 가속도계수(A)

* 내진성능목표

재 현 주 기	50년	100년	200년	500년	1000년	5000년
기능수행수준	II 등급	I 등급	특등급			
붕괴방지수준				II 등급	I 등급	특등급

* 위험도 계수

재 현 주 기	50년	100년	200년	500년	1000년	5000년
위험도계수(I)	0.40	0.57	0.73	1.00	1.40	2.00

* 기반면, 지표면 : S_B

지 반 종 류		상부 30m에 대한 평균 지반 특성		
		전단파속도 V_{S30}(m.sec)	표준관입시험 N(타격수)	비배수전단강도 (kPa)
S_A	경암지반	1500초과	–	–
S_B	보통암지반	760 ~ 1500		
S_C	매우 조밀한 토사지반 또는 연암지반	360 ~ 760	50초과	100초과
S_D	단단한 토사지반	180 ~ 360	15 ~ 50	50 ~ 100
S_E	연약한 토사지반	180미만	15미만	50미만
S_F	부지 고유의 특성평가가 요구되는 지반			

* 지진계수

지진 구역	지반 종류	지진계수		비고	지진 구역	지반 종류	지진계수		비고
		Ca	Cv				Ca	Cv	
I	S_A	0.09	0.09	기반면, 지표면	II	S_A	0.05	0.05	
	S_B	0.11	0.11			S_B	0.07	0.07	
	S_C	0.13	0.18			S_C	0.08	0.11	
	S_D	0.16	0.23			S_D	0.11	0.16	
	S_E	0.22	0.37			S_E	0.17	0.23	

* 지표면 가속도계수(A)

- 기능수행수준

기반면 : A = I x Ca = 0.57 x 0.09 = 0.051

지표면1 : A = I x Ca = 0.57 x 0.16 = 0.091 ← 토층

지표면2 : A = I x Ca = 0.57 x 0.11 = 0.063 ← 암층

- 붕괴방지수준

기반면 : A = I x Ca = 1.40 x 0.09 = 0.126

지표면1 : A = I x Ca = 1.40 x 0.16 = 0.224 ← 토층

지표면2 : A = I x Ca = 1.40 x 0.11 = 0.154 ← 암층

② 지표면 응답 가속도(Sa)

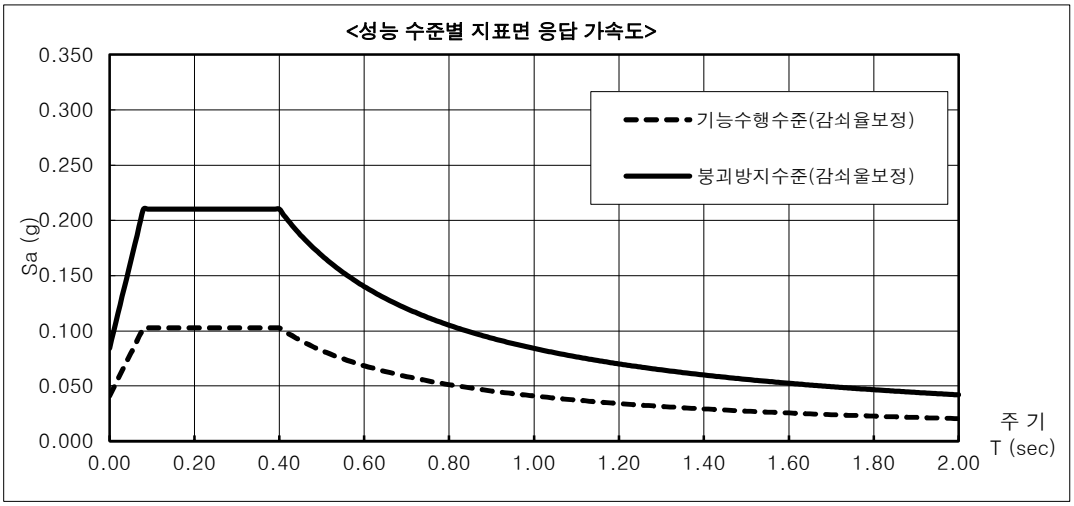
* T'_s = Cv/2.5xCa = 0.400 * T_o = 0.2xT's = 0.080

* 감쇠율에 대한 보정, C_D

C_D = 1.5/(40h+1)+0.5 = 0.800 , 감쇠율, h = 0.1 (기능수행수준)

C_D = 1.5/(40h+1)+0.5 = 0.667 , 감쇠율, h = 0.2 (붕괴방지수준)

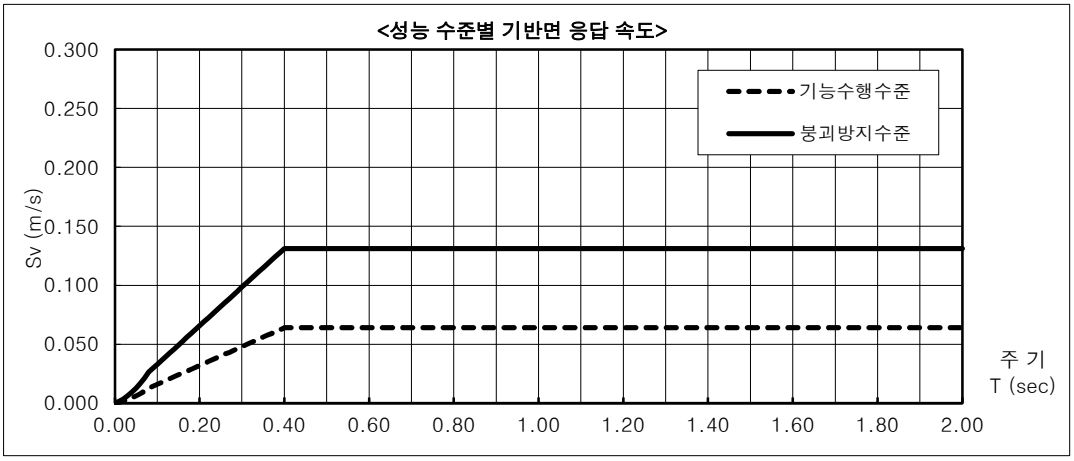
* 성능수준별 지표면 응답 가속도



- $S_{a(at\ T=0)}$ = A x C_D = 0.051 x 0.800 = 0.041 g (기능수행수준)
  = A x C_D = 0.126 x 0.667 = 0.084 g (붕괴방지수준)
- $S_{a(at\ T=0.40)}$ = 2.5 x A x C_D = 2.5 x 0.051 x 0.800 = 0.103 g (기능수행수준)
  = 2.5 x A x C_D = 2.5 x 0.126 x 0.667 = 0.210 g (붕괴방지수준)

③ 기반면 응답 속도(Sv)

* Sv = T/2π×Sa (m/s^2)



- g = 9.81 m/s^2
- $S_{v(at\ T=0.40)}$ = T / 2π x Sa = 0.40 / 2π x 0.103 x g = 0.064 m/s (기능수행수준)
  = T / 2π x Sa = 0.40 / 2π x 0.210 x g = 0.131 m/s (붕괴방지수준)

2) 지반변위

① 표층지반의 특성값 : $T_G = \sum 4Hi / Vsi$

* 기능수행수준

Hi(m)	지반종류	N치	Vsi(m/sec)	T_G(4Hi/Vsi)
2.200	매립층	-	156	0.056
11.800	퇴적층(자갈층)	-	289	0.163
0.000	풍화토	-	424	0.000
16.000	풍화암	-	631	0.101
0.000	연 암	-	1216	0.000
0.000	보통암	-	1050	0.000
0.000	경 암	-	2059	0.000
0.000	0.00	-	0	0.000
30.000	T_G (지반의 특성값, sec)			0.320

* Ts (지반의 고유주기, sec)

= 1.25 × T_G = 1.25 × 0.320 = 0.40 sec

* $S_{a,atT=Ts}$ = 0.103 g = 1.007 m/s²

* $S_{v,at\ T=Ts}$ = 0.064 m/s

* 붕괴방지수준

Hi(m)	지반종류	N치	Vsi(m/sec)	T_G(4Hi/Vsi)
2.200	매립층	-	156	0.056
11.800	퇴적층(자갈층)	-	289	0.163
0.000	풍화토	-	424	0.000
16.000	풍화암	-	631	0.101
0.000	연 암	-	1216	0.000
0.000	보통암	-	1050	0.000
0.000	경 암	-	2059	0.000
0.000	0	-	0	0.000
30.000	T_G (지반의 특성값, sec)			0.320

* Ts (지반의 고유주기, sec)

= 1.25 × T_G = 1.25 × 0.320 = 0.40 sec

* $S_{a,atT=Ts}$ = 0.210 g = 2.061 m/s²

* $S_{v,at\ T=Ts}$ = 0.131 m/s

② 지반변위 (2중코사인)

U_{h1} = 2 / π²·Sv ·T_s ·cos($\omega_0 \cdot x_1 / v_{sod1}$) 제 1층에서의 변위

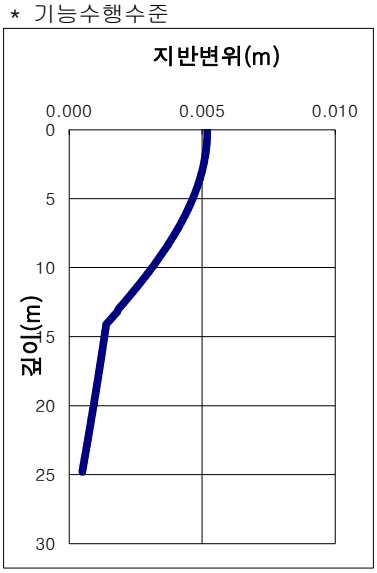
$$U_{h2(x)} = \frac{2}{\pi^2} S_v T_G \cos\left(\frac{\omega_0 H_1}{v_{s0d1}}\right) \cdot \left(\cos\frac{w_0 x_2}{v_{s0d2}} - \frac{\sin\frac{w_0 x_2}{v_{s0d2}}}{\tan\frac{w_0 H_2}{v_{s0d2}}} \right)$$ 제 2층에서의 변위

H_s = 16.10 m, H_1 = 14.0 m, H_2 = 16.0 m, γ_1 = 18.8, γ_2 = 21.0

V_{s0d1} = 268 m/s V_{s0d2} = 631 m/s α = 0.38

ω_0 = 24.890 ⟶ 0.000 *O.K!!*

* 기능수행수준



기반면 깊이

H = 13.200 m

Sv = 0.064 m/s

Ts = 0.40 sec

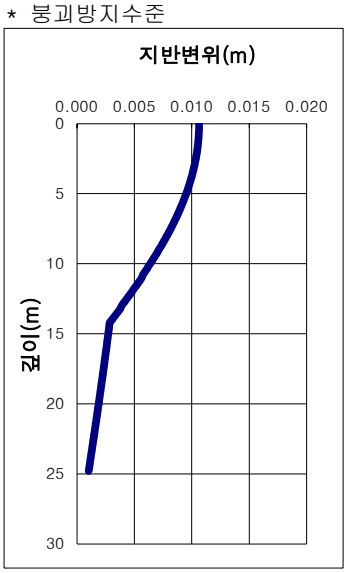
$U(Z_U)$=J(Z=11.000m

= 0.002713 m

$U(Z_B)$=J(Z=13.200m

= 0.001228 m

* 붕괴방지수준



기반면 깊이

H = 13.200 m

Sv = 0.131 m/s

Ts = 0.40 sec

$U(Z_U)$=J(Z=11.000m

= 0.005555 m

$U(Z_B)$=J(Z=16.100m

= 0.002516 m

3) 지진하중

① 지반변위하중

*** 상부슬래브에 작용하는 지반변위하중**

$P_{상부} = K_{SV,기능} \times U(Z_U) = 21,095 \times 0.002713 = \mathbf{57.229}$ kN/m^2 (기능수행수준)

$= K_{SV,붕괴} \times U(Z_U) = 8,240 \times 0.005555 = \mathbf{45.779}$ kN/m^2 (붕괴방지수준)

*** 측벽에 작용하는 지반변위하중**

$P(Z) = K_H \times [\ U(Z) - U(Z_B)\ ]$

1) 기능수행수준 좌측벽체

구분	해당절점	Z	U(Z)	$U(Z_B)$	$U(Z)-U(Z_B)$	K_H	P(Z)
		(m)	(m)	(m)	(m)	(kN/m^3)	(kN/m^2)
기능수행	47	11.000	0.002713	0.001228	0.001484	117,970	175.116
	42	11.550	0.002483	0.001228	0.001255	117,970	148.032
	37	12.100	0.002247	0.001228	0.001019	117,970	120.183
	32	12.650	0.002005	0.001228	0.000777	117,970	91.644
	12	13.200	0.001758	0.001228	0.000530	117,970	62.488

2) 기능수행수준 우측벽체

구분	해당절점	Z	U(Z)	$U(Z_B)$	$U(Z)-U(Z_B)$	K_H	P(Z)
		(m)	(m)	(m)	(m)	(kN/m^3)	(kN/m^2)
기능수행수준	69	11.000	0.002713	0.001228	0.001484	117,970	175.116
	46	11.550	0.002483	0.001228	0.001255	117,970	148.032
	41	12.100	0.002247	0.001228	0.001019	117,970	120.183
	36	12.650	0.002005	0.001228	0.000777	117,970	91.644
	31	13.200	0.001758	0.001228	0.000530	117,970	62.488
	11	13.900	0.001437	0.001228	0.000209	117,970	24.609
	9	14.600	0.001345	0.001228	0.000117	602,473	70.362
	7	15.350	0.001287	0.001228	0.000059	602,473	35.520
	5	16.100	0.001228	0.001228	0.000000	602,473	0.000

3) 붕괴방지수준 좌측벽체

구분	해당절점	Z	U(Z)	$U(Z_B)$	$U(Z)-U(Z_B)$	K_H	P(Z)
		(m)	(m)	(m)	(m)	(kN/m^3)	(kN/m^2)
붕괴방지	47	11.000	0.005555	0.002516	0.003040	46,082	140.080
	42	11.550	0.005085	0.002516	0.002570	46,082	118.414
	37	12.100	0.004602	0.002516	0.002086	46,082	96.138
	32	12.650	0.004106	0.002516	0.001591	46,082	73.308
	12	13.200	0.003600	0.002516	0.001085	46,082	49.986

4) 붕괴방지수준 우측벽체

구분	해당절점	Z	U(Z)	$U(Z_B)$	$U(Z)-U(Z_B)$	K_H	P(Z)
		(m)	(m)	(m)	(m)	(kN/m^3)	(kN/m^2)
붕괴방지수준	69	11.000	0.005555	0.002516	0.003040	46,082	140.080
	46	11.550	0.005085	0.002516	0.002570	46,082	118.414
	41	12.100	0.004602	0.002516	0.002086	46,082	96.138
	36	12.650	0.004106	0.002516	0.001591	46,082	73.308
	31	13.200	0.003600	0.002516	0.001085	46,082	49.986
	11	13.900	0.002943	0.002516	0.000427	46,082	19.685
	9	14.600	0.002755	0.002516	0.000239	235,341	56.284
	7	15.350	0.002636	0.002516	0.000121	235,341	28.414
	5	16.100	0.002516	0.002516	0.000000	235,341	0.000

② 주면전단력

(1) 기초 1

* 기능수행수준

$\tau_u = 2*G_{D,TOP}/(\pi^2)\cdot Sv\cdot T_G\cdot w_0 / v_{sod1}\sin(w_0x_u/v_{s0d1}) = 42.569$ kN/m^2

$$\tau_B = \frac{2G_D}{\pi^2}\cdot S_v\cdot T_G\cdot\frac{w_0}{v_{s0d2}}\cdot\cos\left(\frac{w_0H_1}{v_{sod1}}\right)\cdot\left(\sin\frac{w_0x_2}{v_{s0d2}}+\frac{\cos {w_0x_2}/{v_{s0d2}}}{\tan {w_0H_2}/{v_{s0d2}}}\right) = 43.278 \text{ kN/m}^2$$

$\tau_W = (\tau_u + \tau_B) / 2 = 42.924$ kN/m^2

* 붕괴방지수준

$\tau_u = 2*G_{D,TOP}/(\pi^2)\cdot Sv\cdot T_G\cdot w_0 / v_{sod1}\sin(w_0x_u/v_{s0d1}) = 34.052$ kN/m^2

$$\tau_B = \frac{2G_D}{\pi^2}\cdot S_v\cdot T_G\cdot\frac{w_0}{v_{s0d2}}\cdot\cos\left(\frac{w_0H_1}{v_{sod1}}\right)\cdot\left(\sin\frac{w_0x_2}{v_{s0d2}}+\frac{\cos {w_0x_2}/{v_{s0d2}}}{\tan {w_0H_2}/{v_{s0d2}}}\right) = 34.619 \text{ kN/m}^2$$

$\tau_W = (\tau_u + \tau_B) / 2 = 34.336$ kN/m^2

(2) 기초 2

* 기능수행수준

$\tau_u = 2*G_{D,TOP}/(\pi^2)\cdot Sv\cdot T_G\cdot w_0 / v_{sod1}\sin(w_0x_u/v_{s0d1}) = 42.569$ kN/m^2

$$\tau_B = \frac{2G_D}{\pi^2}\cdot S_v\cdot T_G\cdot\frac{w_0}{v_{s0d2}}\cdot\cos\left(\frac{w_0H_1}{v_{sod1}}\right)\cdot\left(\sin\frac{w_0x_2}{v_{s0d2}}+\frac{\cos {w_0x_2}/{v_{s0d2}}}{\tan {w_0H_2}/{v_{s0d2}}}\right) = 8.214 \text{ kN/m}^2$$

$\tau_W = (\tau_u + \tau_B) / 2 = 25.391$ kN/m^2

* 붕괴방지수준

$\tau_u = 2*G_{D,TOP}/(\pi^2)\cdot Sv\cdot T_G\cdot w_0 / v_{sod1}\sin(w_0x_u/v_{s0d1}) = 34.052$ kN/m^2

$$\tau_B = \frac{2G_D}{\pi^2}\cdot S_v\cdot T_G\cdot\frac{w_0}{v_{s0d2}}\cdot\cos\left(\frac{w_0H_1}{v_{sod1}}\right)\cdot\left(\sin\frac{w_0x_2}{v_{s0d2}}+\frac{\cos {w_0x_2}/{v_{s0d2}}}{\tan {w_0H_2}/{v_{s0d2}}}\right) = 6.570 \text{ kN/m}^2$$

$\tau_W = (\tau_u + \tau_B) / 2 = 20.311$ kN/m^2

③ 관성력

* 기능수행수준 γ_c = 25.0 kN/m^3

- 상부슬래브 관성력 (Vi = 1.000 m^3/m^2 : 단위면적당 부피 , Z = 11.000 m)

f_u = mi × ai = wi × K_{Hi} = Vi × γ_con × A × (1 − 0.015·Z)

= 1.000 × 25.0 × 0.091 × 0.835 = 1.904 kN/m^2 (기능수행수준)

= 1.000 × 25.0 × 0.224 × 0.835 = 4.676 kN/m^2 (붕괴방지수준)

- 하부슬래브(기초 2) 관성력 (Vi = 1.000 m^3/m^2 : 단위면적당 부피 , Z = 13.200 m)

fu = mi × ai = wi × K_{Hi} = Vi × γ_con × A × (1 − 0.015·Z)

= 1.000 × 25.0 × 0.091 × 0.802 = 1.829 kN/m^2 (기능수행수준)

= 1.000 × 25.0 × 0.224 × 0.802 = 4.491 kN/m^2 (붕괴방지수준)

- 하부슬래브(기초 1) 관성력 (Vi = 1.000 m^3/m^2 : 단위면적당 부피 , Z = 16.100 m)

f_B = mi × ai = wi × K_{Hi} = Vi × γ_con × A × (1 − 0.015·Z)

= 1.000 × 25.0 × 0.063 × 0.759 = 1.189 kN/m^2 (기능수행수준)

= 1.000 × 25.0 × 0.154 × 0.759 = 2.920 kN/m^2 (붕괴방지수준)

- 좌측벽체 관성력

구분	해당절점	Z	Vi	γ_con	A (가속도계수)		1-0.015·Z	$f_{u(Z)기능}$	$f_{u(Z)붕괴}$
		(m)	(m^3/m^2)	(kN/m^3)	기능수행	붕괴방지	(m)	(kN/m^2)	(kN/m^2)
외측	47	11.000	1.100	25.0	0.091	0.224	0.835	2.094	5.144
	42	11.550	1.100	25.0	0.091	0.224	0.827	2.073	5.093
	37	12.100	1.100	25.0	0.091	0.224	0.819	2.053	5.042
	32	12.650	1.100	25.0	0.091	0.224	0.810	2.032	4.991
	12	13.200	1.100	25.0	0.091	0.224	0.802	2.011	4.940

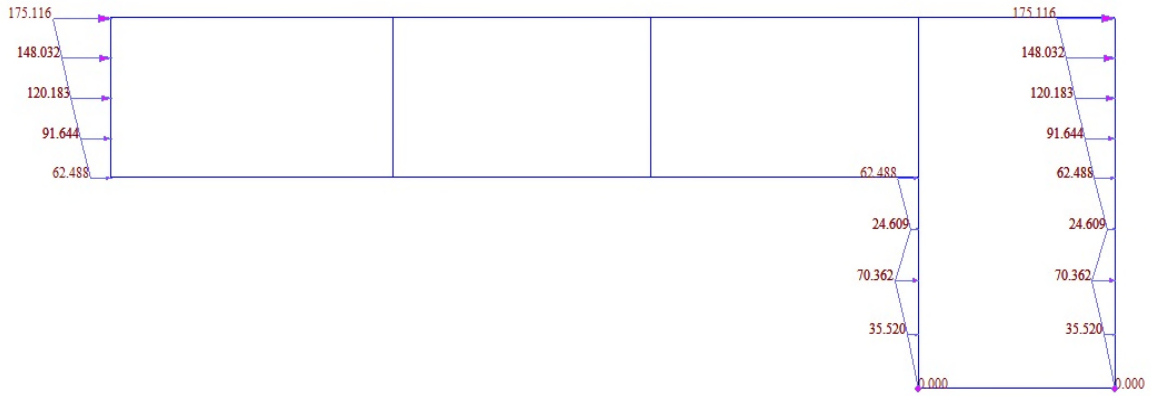
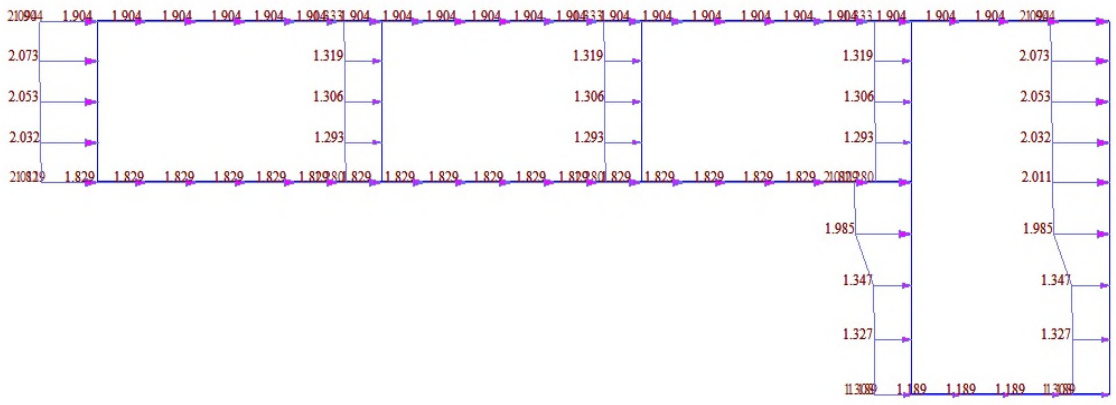
- 우측벽체 관성력

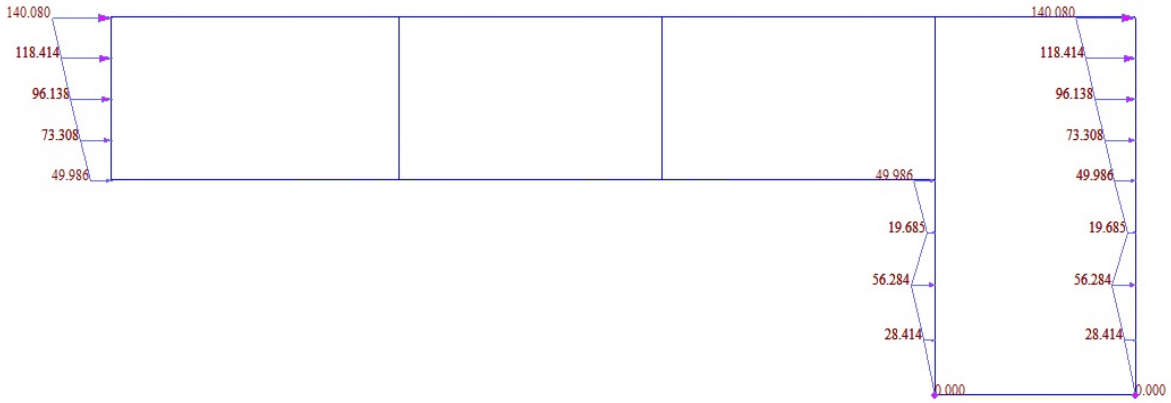
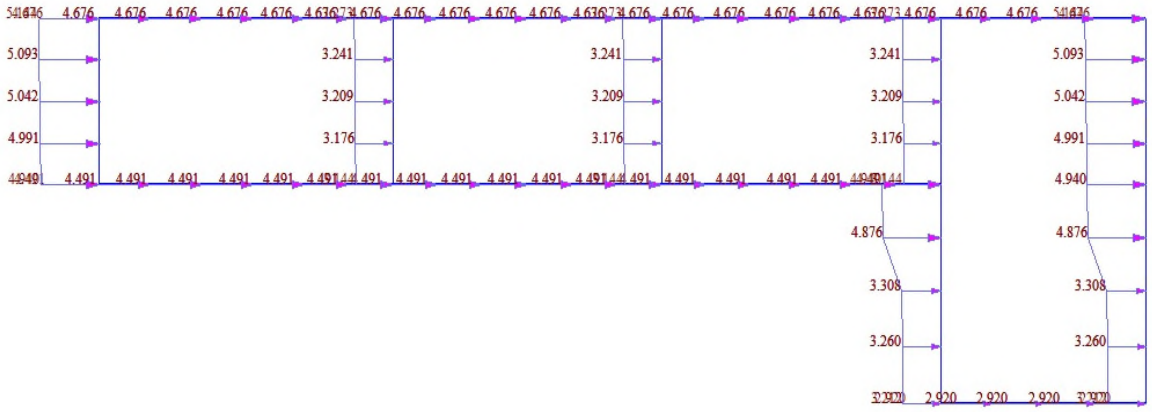
구분	해당절점	Z	Vi	γ_con	A (가속도계수)		1-0.015·Z	$f_{u(Z)기능}$	$f_{u(Z)붕괴}$
		(m)	(m^3/m^2)	(kN/m^3)	기능수행	붕괴방지	(m)	(kN/m^2)	(kN/m^2)
외측	69	11.000	1.100	25.0	0.091	0.224	0.835	2.094	5.144
	46	11.550	1.100	25.0	0.091	0.224	0.827	2.073	5.093
	41	12.100	1.100	25.0	0.091	0.224	0.819	2.053	5.042
	36	12.650	1.100	25.0	0.091	0.224	0.810	2.032	4.991
	31	13.200	1.100	25.0	0.091	0.224	0.802	2.011	4.940
	11	13.900	1.100	25.0	0.091	0.224	0.792	1.985	4.876
	9	14.600	1.100	25.0	0.063	0.154	0.781	1.347	3.308
	7	15.350	1.100	25.0	0.063	0.154	0.770	1.327	3.260
	5	16.100	1.100	25.0	0.063	0.154	0.759	1.308	3.212

- 중간벽체 관성력

구분	해당절점	Z	Vi	ɣ_con	A (가속도계수)		1-0.015·Z	$f_{u(Z)기능}$	$f_{u(Z)붕괴}$
		(m)	(m^3/m^2)	(kN/m^3)	기능수행	붕괴방지	(m)	(kN/m^2)	(kN/m^2)
중간벽체	53	11.000	0.700	25.0	0.091	0.224	0.835	1.333	3.273
	43	11.550	0.700	25.0	0.091	0.224	0.827	1.319	3.241
	38	12.100	0.700	25.0	0.091	0.224	0.819	1.306	3.209
	33	12.650	0.700	25.0	0.091	0.224	0.810	1.293	3.176
	18	13.200	0.700	25.0	0.091	0.224	0.802	1.280	3.144

4. 하중 재하도

구분	기능수행수준
지반변위하중	
주면전단력	
관성력	

구분	붕괴방지수준
지반변위하중	
주면전단력	
관성력	

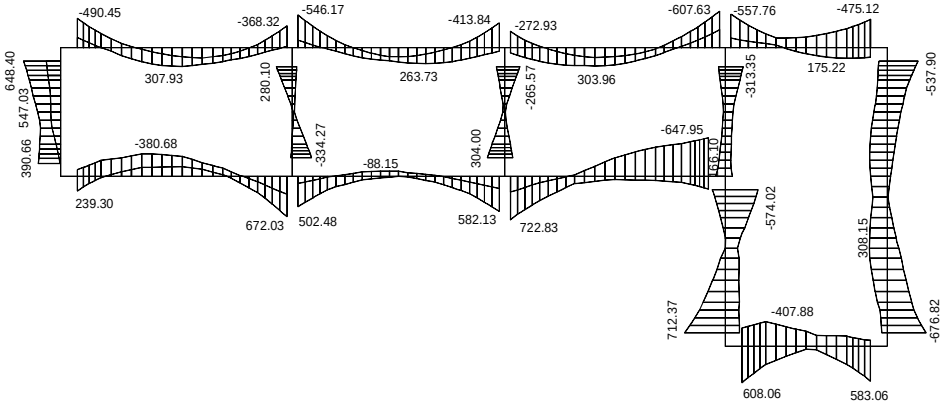
5. 하중조합

1) 콘크리트구조기준(2012)

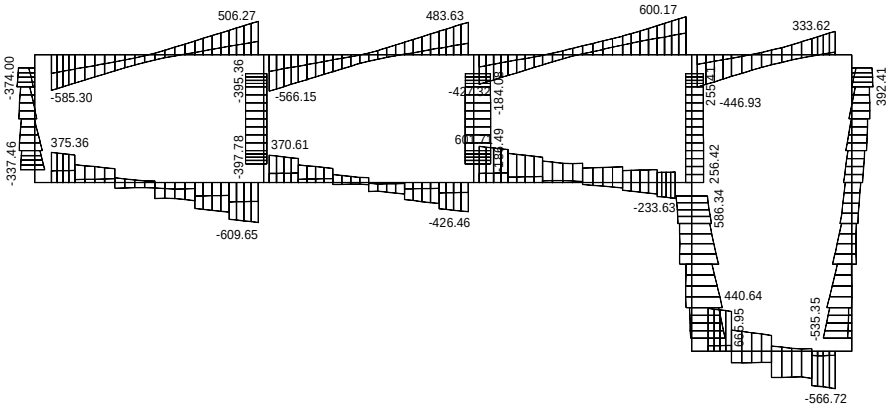
하중조합		고정하중	활하중						토압				수압		지진하중	비고
		자중	연직하중			수평하중			연직하중		수평하중		연직 수압	수평 수압		
			만재하	편재하		만재하	편재하		지하수無	지하수有	지하수無	지하수有				
				좌측	우측		좌측	우측								
		LC01	LC02	LC03	LC04	LC05	LC06	LC07	LC8	LC9	LC10	LC11	LC12	LC13	LC15	
기능수행수준	E1COMB01	1.200	1.000			1.000			1.200		1.000				1.400	
	E1COMB02	1.200		1.000			1.000		1.200		1.000				1.400	
	E1COMB03	1.200			1.000			1.000	1.200		1.000				1.400	
	E1COMB04	1.200	1.000			0.500			1.200		0.500				1.400	
	E1COMB05	1.200		1.000			0.500		1.200		0.500				1.400	
	E1COMB06	1.200			1.000			0.500	1.200		0.500				1.400	
	E1COMB07	0.900							0.900		1.000				1.400	
	E1COMB08	0.900							0.900		0.500				1.400	
	E1COMB09	1.200	1.000			1.000				1.200		1.000	1.200	1.000	1.400	
	E1COMB10	1.200		1.000			1.000			1.200		1.000	1.200	1.000	1.400	
	E1COMB11	1.200			1.000			1.000		1.200		1.000	1.200	1.000	1.400	
	E1COMB12	1.200	1.000			0.500				1.200		0.500	1.200	0.500	1.400	
	E1COMB13	1.200		1.000			0.500			1.200		0.500	1.200	0.500	1.400	
	E1COMB14	1.200			1.000			0.500		1.200		0.500	1.200	0.500	1.400	
	E1COMB15	0.900								0.900		1.000	0.900	1.000	1.400	
	E1COMB16	0.900								0.900		0.500	0.900	0.500	1.400	
붕괴방지수준	E2COMB01	1.200	1.000			1.000			1.200		1.000				1.000	
	E2COMB02	1.200		1.000			1.000		1.200		1.000				1.000	
	E2COMB03	1.200			1.000			1.000	1.200		1.000				1.000	
	E2COMB04	1.200	1.000			0.500			1.200		0.500				1.000	
	E2COMB05	1.200		1.000			0.500		1.200		0.500				1.000	
	E2COMB06	1.200			1.000			0.500	1.200		0.500				1.000	
	E2COMB07	0.900							0.900		1.000				1.000	
	E2COMB08	0.900							0.900		0.500				1.000	
	E2COMB09	1.200	1.000			1.000				1.200		1.000	1.200	1.000	1.000	
	E2COMB10	1.200		1.000			1.000			1.200		1.000	1.200	1.000	1.000	
	E2COMB11	1.200			1.000			1.000		1.200		1.000	1.200	1.000	1.000	
	E2COMB12	1.200	1.000			0.500				1.200		0.500	1.200	0.500	1.000	
	E2COMB13	1.200		1.000			0.500			1.200		0.500	1.200	0.500	1.000	
	E2COMB14	1.200			1.000			0.500		1.200		0.500	1.200	0.500	1.000	
	E2COMB15	0.900								0.900		1.000	0.900	1.000	1.000	
	E2COMB16	0.900								0.900		0.500	0.900	0.500	1.000	

6. 단면력도

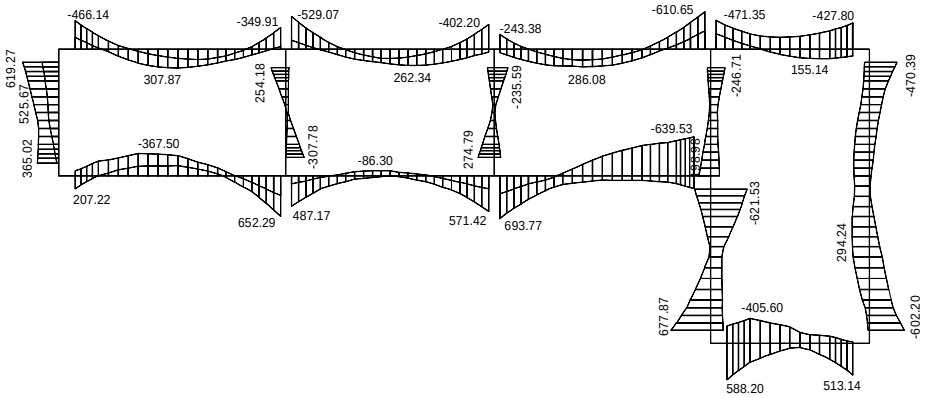
기능수행수준 - 모멘트도(B.M.D)



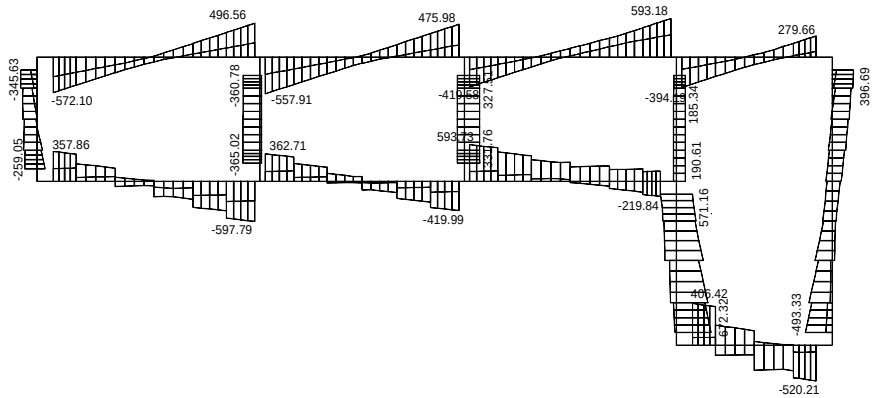
기능수행수준 - 전단력도(S.F.D)



붕괴방지수준 - 모멘트도(B.M.D)



붕괴방지수준 - 전단력도(S.F.D)



7. 기능수행수준 부재력 집계

7.1 기능수행수준 부재력 집계

7.1.1 슬래브

구 분		부재	절점	계 수 하 중			사 용 하 중
				M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
상 부 슬래브	좌측벽체부	51	I[47]	490.450	-	585.300	-
	지간 1 중앙부	53	J[50]	307.930	-	-	-
	지점 1	57	I[53]	546.170	-	506.270	-
	지간 2 중앙부	60	3/4	263.730	-	-	-
	지점 2	62	J[59]	413.840	-	427.320	-
	지간 3 중앙부	65	2/4	303.960	-	-	-
	지점 3	68	J[65]	607.630	-	600.170	-
	지간 4 중앙부	71	J[68]	321.960	-	-	-
	우측벽체부	72	J[69]	475.120	-	333.620	-
하 부 슬래브	좌측벽체부	13	I[12]	239.300	-	373.360	-
	지간 1 중앙부	15	I[14]	380.680	-	-	-
	지점 1	18	J[18]	672.030	-	609.650	-
	지간 2 중앙부	21	3/4	88.150	-	-	-
	지점 2	25	I[24]	722.830	-	601.710	-
	지간 3 중앙부	30	J[30]	647.950	-	-	-
	지점 3	1	I[1]	608.060	-	440.640	-
	지간 4 중앙부	2	I[2]	407.880	-	-	-
	우측벽체부	4	J[5]	583.060	0.000	556.720	-

7.1.2 벽체: 기초 2 (배기 및 배연 통로)

구 분			부재	절점	계 수 하 중			사 용 하 중
					M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
외측 벽체	상단	M_{max}	46	J[47]	648.400	832.020	307.180	
		P_{max}	46	I[42]	547.030	830.270	307.180	
	중앙 부모멘트	M_{max}	41	J[42]	547.030	828.140	-	
		P_{max}	41	I[37]	401.790	838.500	-	
	하단	M_{max}	31	I[12]	390.660	916.240	294.940	
		P_{max}	31	I[12]	390.660	916.240	294.940	
내부 벽체	상단	M_{max}	49	J[65]	313.350	1458.090	255.410	
		P_{max}	49	I[45]	256.160	1469.410	255.410	
	중앙	M_{max}	44	J[45]	256.160	1469.410	-	
		P_{max}	44	I[40]	134.150	1480.740	-	
	하단	M_{max}	34	I[30]	166.100	1503.390	256.420	
		P_{max}	34	I[30]	166.100	1503.390	256.420	

7.1.3 벽체:기초 1 (대인피난연결통로)

구 분			부재	절점	계 수 하 중			사 용 하 중
					M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
좌측 벽체	상단	M_{max}	574	1448	574.020	1447.800	586.340	
		P_{max}	407	1448	407.160	1447.800	586.340	
	하단	M_{max}	712	1658	712.370	1657.600	665.950	
		P_{max}	712	1658	712.370	1657.600	665.950	
우측 벽체	상단	M_{max}	538	586	537.900	586.180	384.670	
		P_{max}	391	571	390.510	570.930	384.670	
	중앙	M_{max}	308	678	308.150	678.420	-	
		P_{max}	290	629	289.660	629.060	-	
	하단	M_{max}	677	844	676.820	844.010	535.350	
		P_{max}	677	844	676.820	844.010	535.350	

8. 붕괴방지수준 부재력 집계

8.1 붕괴방지수준 부재력 집계

8.1.1 슬래브

구 분		부재	절점	계 수 하 중			사 용 하 중
				M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
상 부 슬래브	좌측벽체부	51	I[47]	466.140	-	572.100	-
	지간 1 중앙부	53	J[50]	307.870	-	-	-
	지점 1	57	I[53]	529.070	-	496.560	-
	지간 2 중앙부	60	3/4	262.340	-	-	-
	지점 2	62	J[59]	402.200	-	419.580	-
	지간 3 중앙부	65	2/4	286.080	-	-	-
	지점 3	68	J[65]	610.650	-	593.720	-
	지간 4 중앙부	71	J[68]	298.300	-	-	-
	우측벽체부	72	J[69]	427.800	-	279.660	-
하 부 슬래브	좌측벽체부	13	I[12]	207.220	-	357.420	-
	지간 1 중앙부	15	I[14]	367.500	-	-	-
	지점 1	18	J[18]	652.290	-	597.790	-
	지간 2 중앙부	21	J[21]	86.300	-	-	-
	지점 2	25	I[24]	693.770	-	593.730	-
	지간 3 중앙부	30	J[30]	639.530	-	-	-
	지점 3	1	I[1]	588.200	-	406.420	-
	지간 4 중앙부	2	I[2]	405.600	-	-	-
	우측벽체부	4	J[5]	513.140	-	520.210	-

8.1.2 벽체:기초 2 (배기 및 배연 통로)

구 분			부재	절점	계 수 하 중			사 용 하 중
					M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
외 측 벽체	상단	M_{max}	46	J[47]	619.270	816.940	305.490	
		P_{max}	46	I[42]	525.670	823.570	305.490	
	중앙 부모멘트	M_{max}	41	J[42]	525.670	821.200	-	
		P_{max}	41	I[37]	393.610	837.060	-	
	하단	M_{max}	31	I[12]	365.020	898.370	274.590	
		P_{max}	31	I[12]	365.020	898.370	274.590	
내부 벽체	상단	M_{max}	49	J[65]	246.710	1411.960	187.120	
		P_{max}	49	I[45]	205.090	1423.290	187.120	
	중앙	M_{max}	44	J[45]	205.090	1423.290	-	
		P_{max}	44	I[40]	120.860	1434.610	-	
	하단	M_{max}	34	I[30]	198.980	1457.270	188.870	
		P_{max}	34	I[30]	198.980	1457.270	188.870	

8.1.3 벽체:기초 1 (대인피난연결통로)

구 분			부재	절점	계 수 하 중			사 용 하 중
					M_u(kN·m)	P_u(kN)	S_u(kN)	M(kN·m)
좌측 벽체	상단	M_{max}	622	1461	621.530	1460.860	571.160	
		P_{max}	458	1461	457.840	1460.860	571.160	
	하단	M_{max}	678	1616	677.870	1615.850	672.320	
		P_{max}	678	1616	677.870	1615.850	672.320	
우측 벽체	상단	M_{max}	470	528	470.390	528.260	396.690	
		P_{max}	326	527	326.470	527.170	396.690	
	중앙	M_{max}	294	628	294.240	627.880	-	
		P_{max}	290	615	289.550	614.740	-	
	하단	M_{max}	602	780	602.200	780.270	493.330	
		P_{max}	602	780	602.200	780.270	493.330	

국회대로 지하차도

대인용 피난연결통로

목 차

1. 설계조건
2. 단면가정
3. 부력 검토
4. 해석모델링
5. 지반 반력계수
6. 하중계산
7. 하중재하도
8. 하중조합
9. 단면력도
10. 전산해석결과
11. 단면력 정리
12. 단면설계
13. 우각부 검토
14. 배력철근 검토
15. 처짐검토
16. 지지력검토
17. 주철근조립도

1. 설계조건

1.1 구조형식 : 철근 콘크리트 BOX 구조물

1.2 지반조건

기 초 형 식	계 산 토 피	지 하 수 위	지 지 층	E_O(지반반력계수)	비 고
직접 기초	H = 10.500 m	GL -9.600m	퇴적층, 풍화암	50, 300	지반조사보고서 참고

1.3 재료 중량

철근 콘크리트	25.00 kN/m^3	역청포장	23.00 kN/m^3
Mortar	21.50 kN/m^3	지 하 수	10.00 kN/m^3

1.4 사용재료의 강도

콘크리트	설계강도(fck)	27 MPa	
	탄성계수(Ec)	E_c = 8,500 x $\sqrt[3]{(\ fck + 4\ )}$ = 26702 MPa	
철 근	설계강도(fy)	400 MPa	
	탄성계수(Es)	2.0E+05 MPa	

1.5 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 = 19.00 kN/m^3
- 수 중 = 10.00 kN/m^3

1.6 노면활하중 (DB-24 적용) = 10.000 kN/m^2

1.7 토 사

지 층 분 류	단위중량(kN/m^3)		내부마찰각(Ø)	정지토압(K_0)	비 고
	지하수위 이상	지하수위 이하			
뒷채움흙	19.00	10.00	30.0	0.500	Ko=1-sin Ø

1.8 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력설계법 : 사용성검토 (처짐, 균열, 우각부보강 등)

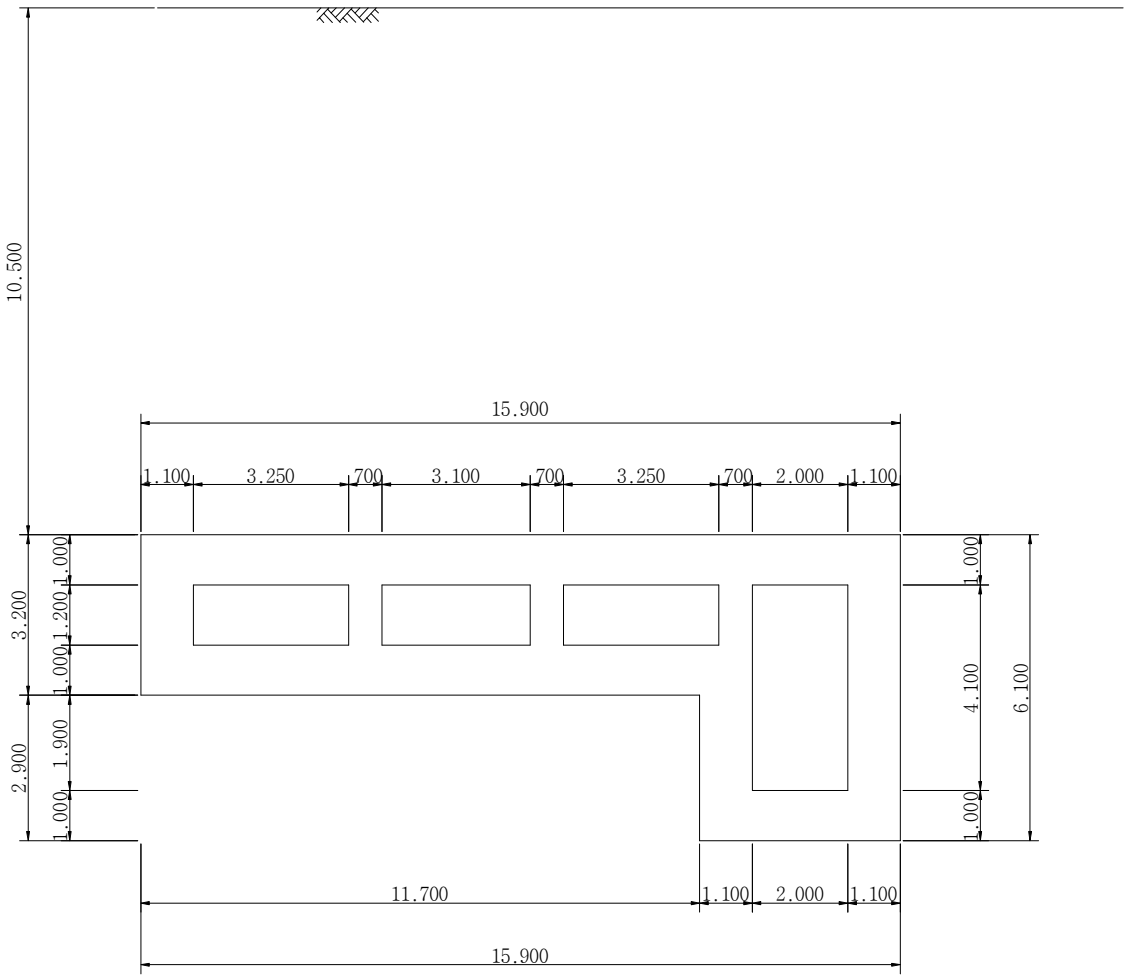
1.9 사용프로그램

- MIDAS Civil 2009

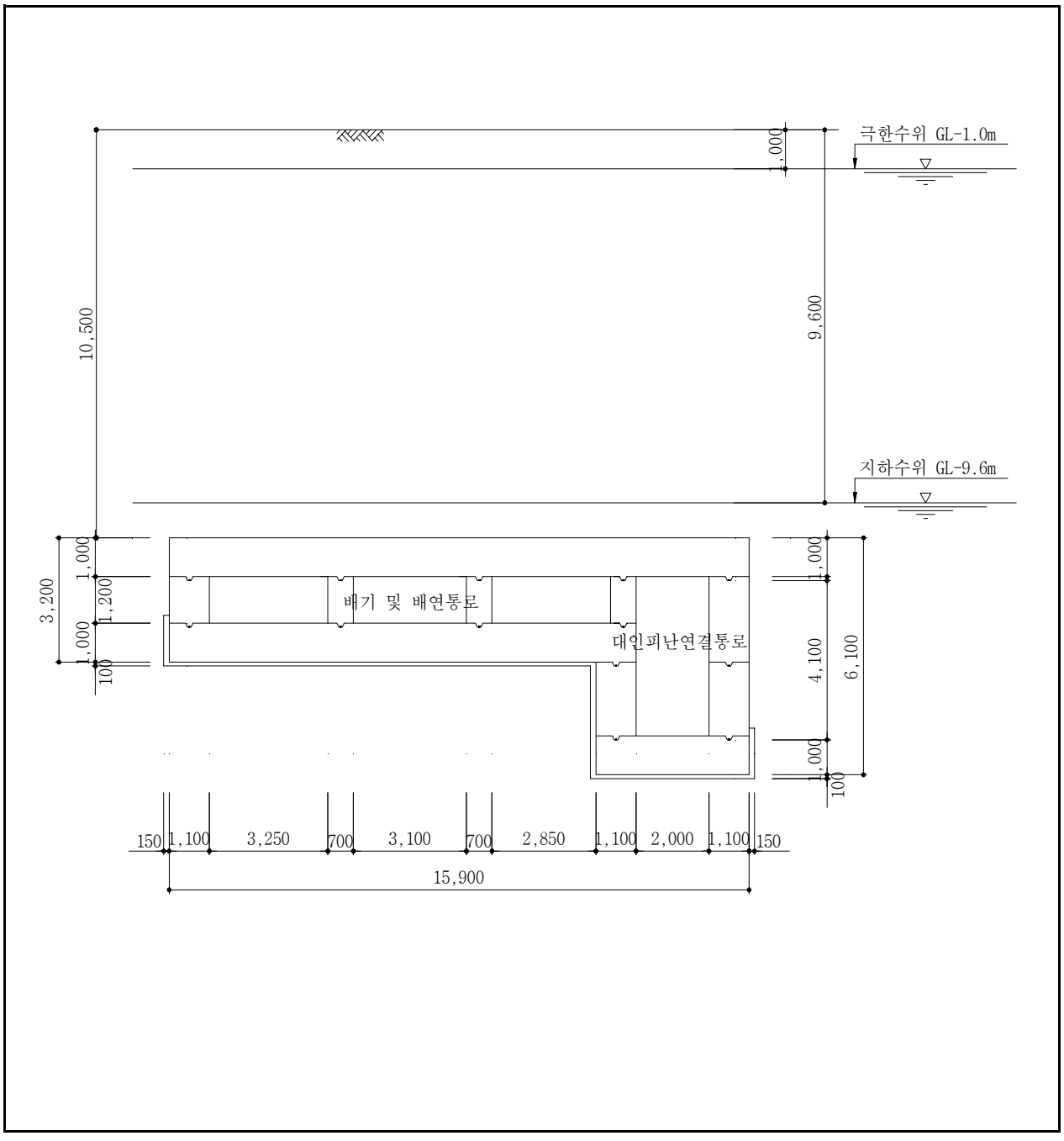
1.10 참고문헌

- 콘크리트구조기준 : 국토해양부(2012)
- 도시철도 내진설계기준 : 국토교통부(2013)

2. 단면가정


10.500
15.900
1.100
3.250
700
3.100
700
3.250
700
2.000
1.100
3.200
1.000
1.200
1.000
2.900
1.900
1.000
1.000
4.100
1.000
6.100
11.700
1.100
2.000
1.100
15.900

3. 부력 검토



3.1 부력 검토 결과

구 분	작용력(kN/m)	저항력(kN/m)	비 고
시 공 중	117.000	713.500	지하수위를 4.079m 이하로 유지
완공후 (지하수위 G.L -9.6m)	773.700	4,722.960	F.S = 6.104 > 1.200 ------ O.K
완공후 (극한수위 G.L-1.0m)	2,141.100	4,697.309	F.S = 2.194 > 1.050 ------ O.K

3.2 시공중 부력 검토(상부슬래브 폐합전 단면 검토)

3.2.1 굴착고 : 16.600 m

3.2.2 부력 작용폭 : 15.900 m

3.2.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × Hw × 11.700 m = 117.000 Hw kN/m

= 10.000 × Hw × 4.20 = 42.000 Hw kN/m

= 159.000 Hw

여기서, U : 부력 (kN/m)

μ : 단위 부력 (kN/m^2)

r_w : 물의 단위 중량 (kN/m^3)

Hw : 지하수위로부터 구조물 바닥슬래브 하면까지의 높이 (m)

B : 부력이 작용하는 구조물의 폭 (m)

3.2.4 작용력

$R = W_1 + W_2 + F$ = 713.500 + 0.000 + 0.000 = 713.500 kN/m

여기서, W_1 : 구체자중 (kN/m)

W_2 : 상재하중 (kN/m)

F : 주면마찰력 (kN/m) ⇒ 구조물 벽체와 주변뒷채움 흙과의 접촉불확실성을 고려하여 무시한다.

(1) W_1 (기초 2 구체자중)

① 기초 2 하부슬래브

(1.000 × 11.700)× 25.000 = 292.500 kN/m

② 벽 체

외측벽체

(1.100 × 1.200)× 1 EA × 25.000 = 33.000 kN/m

중간 벽체

(0.700 × 1.200)× 2 EA × 25.000 = 42.000 kN/m

소 계 = 367.500 kN/m

(2) W2 (기초 1 구체자중)

① 기초 1 하부슬래브

(1.000 × 4.200)× 25.000 = 105.000 kN/m

② 벽 체

좌측 벽체

(1.100 × 3.900)× 1 EA × 25.000 = 107.250 kN/m

우측 벽체

(1.100 × 4.100)× 1 EA × 25.000 = 112.750 kN/m

내측 벽체

(0.700 × 1.200)× 1 EA × 25.000 = 21.000 kN/m

소 계 = 346.000 kN/m

TOTAL = 713.500 kN/m

(2) W_2 (상재하중) : 없음

(3) F (주면마찰력) : 없음

3.2.5 안정검토

$$F_s = \frac{R}{U} = \frac{713.500}{159.000\ Hw} \geq 1.1 \quad \Rightarrow H \leq 4.079\ m$$

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 4.079m이하로 유지.

3.3 완공후 부력 검토 (지하수위 : G.L-9.6m)

3.3.1 굴착고 : 16.600 m

3.3.2 부력 작용폭 : 15.900 m

3.3.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 4.100 × 11.700 = 479.700 KN/m

10.000 × 7.000 × 4.200 = 294.000 KN/m

= 773.700 KN/m

3.3.4 저항력

$R = W_1 + W_2 + F$ = 1111.000 + 3232.073 + 379.887 = 4722.960 KN/m

(1) W_1 (기초 2 구체자중)

① 시공중부력검토 구체자중 = 367.500 KN/m

② 기초 2 상부 슬래브

(1.000 × 11.700)× 25.000 = 292.500 kN/m

소 계 = 660.000 kN/m

(2) W2 (기초 1 구체자중)

① 시공중부력검토 구체자중 = 346.000 KN/m

② 기초 1 상부 슬래브

(1.000 × 4.200)× 25.000 = 105.000 kN/m

소 계 = 451.000 kN/m

TOTAL = 1111.000 kN/m

(3) W3 (상재하중)

① 아스팔트

(0.450 × 15.900)× 23.000 = 164.565 kN/m

② 상재토

지하수위 이상

되메움토 : (9.150 × 15.900)× 19.000 = 2764.215 kN/m

지하수위 이하

되메움토 : (0.900 × 15.900)× 20.000 = 286.200 kN/m

③ 방수몰탈

(0.050 × 15.900)× 21.500 = 17.093 kN/m

TOTAL = 3232.073 kN/m

(4) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로 적

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi = 1 - \sin 30$ = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 9.600 m

지하수위 이하 구간(H_2) = 0.900 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

= 2 × 0.0 × 0.000 + 0.500 ×(19.0 × 9.600 ² + 10.0 × 0.900 ²

+ 2 × 19.0 × 9.600 × 0.900)× tan 20° = 379.887 kN/m

3.3.5 안정검토

$$F_s = \frac{R}{U} = \frac{4722.960}{773.700} = 6.104 \geq 1.200$$ ∴ O.K

3.4 완공후 부력 검토 (극한수위 : G.L - 1.000 m)

3.4.1 굴착고 : 16.600 m

3.4.2 부력 작용폭 : 15.900 m

3.4.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 12.700 × 11.700 = 1485.900 KN/m

10.000 × 15.600 × 4.200 = 655.200 KN/m

= 2141.100 KN/m

3.4.4 저항력

$R = W_1 + W_2 + F$ = 1111.000 + 3352.913 + 233.396 = 4697.309 KN/m

(1) W_1 (구체자중)

① 실수위시부력검토 구체자중 = 1111.000 KN/m

TOTAL = 1111.000 kN/m

(2) W_2 (상재하중)

① 아스팔트

(0.450 × 15.900)× 23.000 = 164.565 kN/m

② 상재토

지하수위 이상

되메움토 : (0.550 × 15.900)× 19.000 = 166.155 kN/m

지하수위 이하

되메움토 : (9.450 × 15.900)× 20.000 = 3005.100 kN/m

③ 방수몰탈

(0.050 × 15.900)× 21.500 = 17.093 kN/m

TOTAL = 3352.913 kN/m

(3) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi = 1 - \sin$ = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 1.000 m

지하수위 이하 구간(H_2) = 9.500 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

= 2 × 30.0 × 0.000 + 0.500 ×(19.0 × 1.000 ² + 10.0 × 9.500 ²

+ 2 × 19.0 × 1.000 × 9.500)× tan 20° = 233.396 kN/m

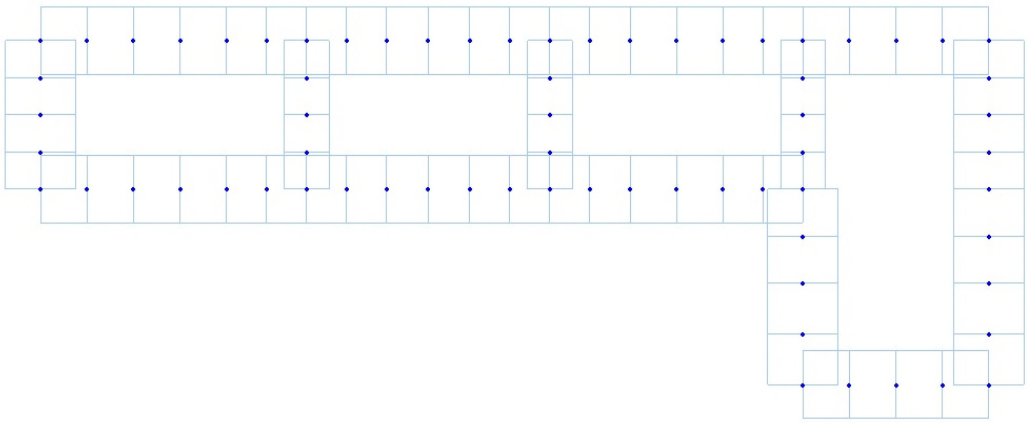
3.4.5 안정검토

$$F_s = \frac{R}{U} = \frac{4697.309}{2141.100} = 2.194 \geq 1.050$$ ∴ O.K

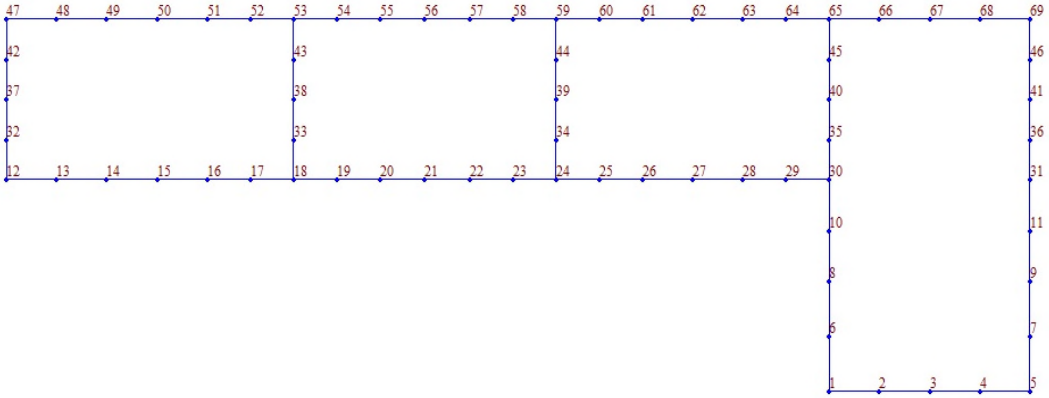
4. 해석모델링

4.1 Modeling

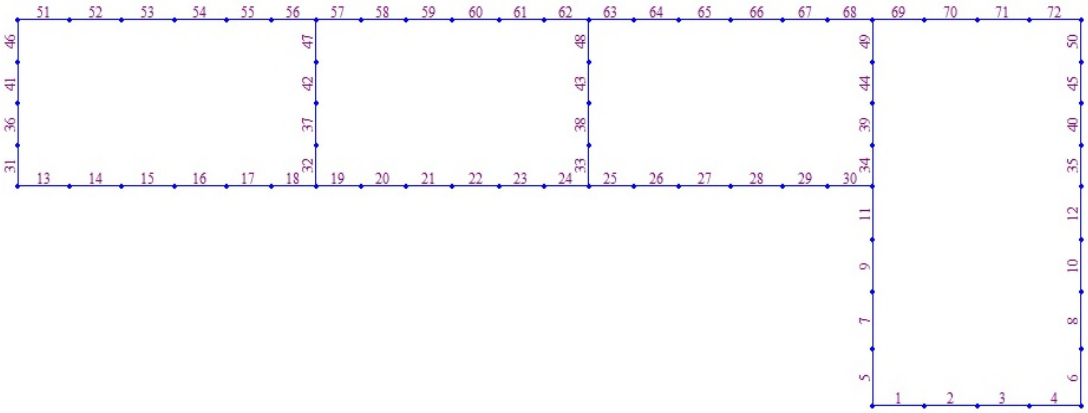
모델링



절점번호



부재번호



4.2 단면제원

구 분		부재폭 (m)	부재두께(m)	단면적 (m2)	단면2차 모멘트(m4)	비 고
슬래브	1	1.000	1.000	1.000	0.0833333	상부슬래브
	2	1.000	1.000	1.000	0.0833333	하부슬래브
벽체	1	1.000	1.100	1.100	0.1109167	외측 벽체
	2	1.000	0.700	0.700	0.0285833	중간 벽체

4.3 강역산정

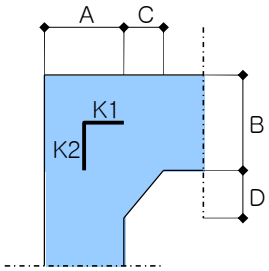
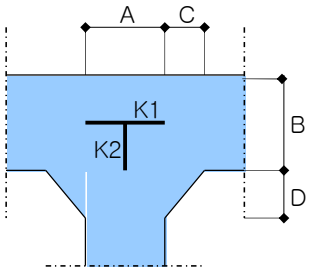
1) 강역설정기준(콘크리트구조기준, 2012)

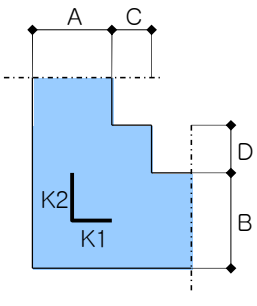
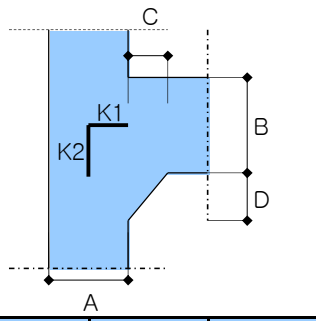
CASE 1 : 부재단부가 다른 부재와 접합할 때는 부재단에서 부재두께의 1/4 안쪽점에서 절점까지

CASE 2 : 부재가 그 축선에 대해 25° 이상 60° 미만인 경사진 헌치를 갖는 경우에는 부재두께가 1.5배가 되는 점에서 부터 절점까지

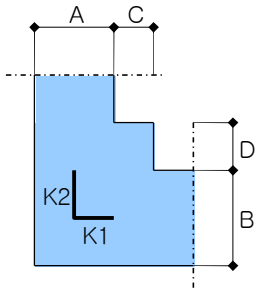
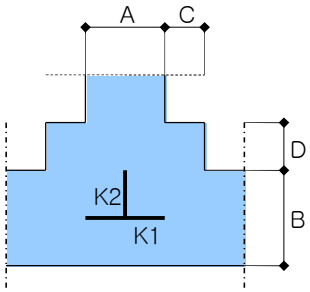
CASE 3 : 헌치의 경사가 60° 이상의 경우는 헌치의 시점에서 부재두께의 1/4 안쪽 점에서부터 절점까지

2) 강역설정

구분	(단부)			(중간부)		
상부슬래브						
	구분	치수	단위	구분	치수	단위
	A	1.100	m	A	0.700	m
	B	1.000	m	B	1.000	m
	C		m	C		m
	D		m	D		m
	Θ1		°	Θ1		°
	Θ2		°	Θ2		°
	K1	0.300	m	K1	0.100	m
	K2	0.225	m	K2	0.325	m

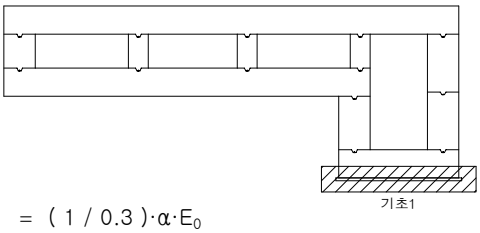
구분	(단부)			(단차부)		
하부슬래브						
	구분	치수	단위	구분	치수	단위
	A	1.100	m	A	1.100	m
	B	1.000	m	B	1.000	m
	C		m	C		m
	D		m	D		m
	Θ1		°	Θ1		°
	Θ2		°	Θ2		°
	K1	0.300	m	K1	0.300	m

	K2	0.225	m	K2	0.225	m

구분	(단부)			(중앙부)		
하부슬래브						
	구분	치수	단위	구분	치수	단위
	A		m	A	0.700	m
	B		m	B	1.000	m
	C		m	C		m
	D		m	D		m
	Θ1		°	Θ1		°
	Θ2		°	Θ2		°
	K1		m	K1	0.100	m
	K2		m	K2	0.325	m

5. 지반 반력계수

5.1 연직 지반반력 계수 : 기초 1 (대인피난연결통로)



$Kv = Kv_0 (Bv / 0.3)^{(-3/4)}$

여기서, Kv : 연직방향 지반반력계수 (kN/㎥)

Kv_0 : 토질시험결과에 의해 구한 지반반력계수 = $(1 / 0.3) \cdot \alpha \cdot E_0$

α , E_0 : 지반반력계수의 추정에 쓰이는 계수 및 지반변형계수 (kN/㎡)로서, 아래의 E_0 와 α의 관계참조

다음의 시험방법에 의한 변형계수 E_0 (kN/㎡)	α	
	평상시	지진시
지름 30cm의 강체원판에 의한 평판재하시험을 반복시킨 곡선에서 구한 변형계수의 1/2	1	2
보링공내에서 측정한 변형계수	4	8
공시체의 1축 또는 3축압축시험에서 구한 변형계수	4	8
표준관입시험의 N값에서 E_0=2800N 으로 추정한 변형계수	1	2

- Bv : 하중 작용 방향에 직교하는 기초의 환산재하폭 (m) = √(Av)
- Av : 연직방향의 재하면적(㎡)
- E_0 = 300000 kN/㎡

Kv_0 = 1/0.3 x α x E_0 = 1/0.3 x 4 x 300000 = 4000000 kN/㎥

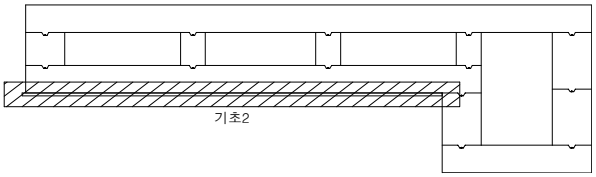
Bv = √(Av) = √(4.20 × 4.20) = 4.20 m

Kv = Kv_0 x (Bv / 0.3) $^{-3/4}$

= 4000000 x (4.20 / 0.3) $^{-3/4}$ = 552,668 kN/㎥

구 분	지 반 반 력 계 수 (kN/㎡)			절 점
1	(1.1000 + 0.7250) / 2 × 552,668	=	504,309	1 5
2	(0.7250 + 0.7250) / 2 × 552,668	=	400,684	2 4
3	(0.7250 + 0.7250) / 2 × 552,668	=	400,684	3
4	(0.0000 + 0.0000) / 2 × 552,668	=	-	
5	(0.0000 + 0.0000) / 2 × 552,668	=	-	
6	(0.0000 + 0.0000) / 2 × 552,668	=	-	
7	(0.0000 + 0.0000) / 2 × 552,668	=	-	
8	(0.0000 + 0.0000) / 2 × 552,668	=	-	
9	(0.0000 + 0.0000) / 2 × 552,668	=	-	
10	(0.0000 + 0.0000) / 2 × 552,668	=	-	
11	(0.0000 + 0.0000) / 2 × 552,668	=	-	
12	(0.0000 + 0.0000) / 2 × 552,668	=	-	
13	(0.0000 + 0.0000) / 2 × 552,668	=	-	
14	(0.0000 + 0.0000) / 2 × 552,668	=	-	
15	(0.0000 + 0.0000) / 2 × 552,668	=	-	
16	(0.0000 + 0.0000) / 2 × 552,668	=	-	

5.2 연직 지반반력 계수 : 기초 2 (배기 및 배연 통로)



$Kv = Kv_0 (Bv / 0.3)^{(-3/4)}$

여기서, Kv : 연직방향 지반반력계수 (kN/㎥)

Kv_0 : 토질시험결과에 의해 구한 지반반력계수 $= (1 / 0.3) \cdot \alpha \cdot E_0$

α , E_0 : 지반반력계수의 추정에 쓰이는 계수 및 지반변형계수 (kN/㎡)로서,

아래의 E_0 와 α의 관계참조

다음의 시험방법에 의한 변형계수 E_0 (kN/㎡)	α	
	평상시	지진시
지름 30cm의 강체원판에 의한 평판재하시험을 반복시킨 곡선에서 구한 변형계수의 1/2	1	2
보링공내에서 측정한 변형계수	4	8
공시체의 1축 또는 3축압축시험에서 구한 변형계수	4	8
표준관입시험의 N값에서 E_0=2800N 으로 추정한 변형계수	1	2

- Bv : 하중 작용 방향에 직교하는 기초의 환산재하폭 (m) $= \sqrt{(Av)}$
- Av : 연직방향의 재하면적(㎡)
- E_0 = 50000 kN/㎡

Kv_0 = 1/0.3 x α x E_0 = 1/0.3 x 4 x 50000 = 666667 kN/㎥

Bv = √(Av) = √(11.70 × 11.70) = 11.70 m

Kv = Kv_0 x (Bv / 0.3) $^{-3/4}$

= 666667 x (11.70 / 0.3) $^{-3/4}$ = 42,718 kN/㎥

구 분	지 반 반 력 계 수 (kN/㎡)			절 점
1	(1.1000 + 0.7250) / 2 × 42,718	=	38,980	12
2	(0.7250 + 0.7250) / 2 × 42,718	=	30,971	13 to 15
3	(0.7250 + 0.6250) / 2 × 42,718	=	28,835	16
4	(0.6250 + 0.6250) / 2 × 42,718	=	26,699	17 to 19
5	(0.6250 + 0.6500) / 2 × 42,718	=	27,233	20 22
6	(0.6500 + 0.6500) / 2 × 42,718	=	27,767	21
7	(0.6250 + 0.6250) / 2 × 42,718	=	26,699	23 to 25
8	(0.6250 + 0.7250) / 2 × 42,718	=	28,835	26
9	(0.7250 + 0.7250) / 2 × 42,718	=	30,971	27
10	(0.7250 + 0.6250) / 2 × 42,718	=	28,835	28
11	(0.6250 + 0.6250) / 2 × 42,718	=	26,699	29

5.3 수평 지반반력 계수 : 절점에 수평방향 무한강성 적용

6. 하중계산

6.1 구체자중 ····· LC01

· PROGRAM 내에서 자동계산

6.2 활하중 ····· LC02~07

(1) 노면 활하중

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

D/B0 < 0.5		
D/B0	Pvl × D, kN/m2	비 고
0.1	17.000	* D/B0의 중간 값은, Pvl × D의 상위값을 적용 *D/B0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

D/B_0 = 10.500 / 15.900 = 0.660

노면활하중 Pvl = 10.000 kN/㎡

노면활하중에 의한 측압 (hl) = 10.000 × 0.500 = 5 kN/㎡

① 상부 슬래브에 작용하는 하중 (W_{L1}) ∴ W_{L1} = **10.000** kN/m^2

② 측벽에 작용하는 하중 (W_{L2})

W_{L2} = 10.000 × 0.500 ∴ W_{L2} = **5.000** kN/m^2

6.3 토압 (연직하중 - 지하수가 없을 경우) ····· LC8

· ASPHALT 포장하중	:	0.450	×	23.00	=	10.350 kN/m^2
· 토 사	:	10.000	×	19.00	=	190.000 kN/m^2
· 방수 Mortar	:	0.050	×	21.50	=	1.075 kN/m^2
				∴ Total W_{D4} =		**201.425** kN/m^2

6.4 토압 (연직하중 - 지하수가 있는 경우 : GL -9.600 m) ····· LC9

· ASPHALT 포장하중	:	0.450	×	23.00	=	10.350 kN/m^2
· 흙 (지하수위 이상)	:	9.150	×	19.00	=	173.850 kN/m^2
· 흙 (지하수위 이하)	:	0.850	×	10.00	=	8.500 kN/m^2
· 방수 Mortar	:	0.050	×	21.50	=	1.075 kN/m^2
				∴ Total W_{D5} =		**193.775** kN/m^2

6.5 토압 (수평하중 - 지하수가 없을경우) ····· LC10

토압 (수평토압)

· W_{h1} = 0.500 × [0.45 × 23.00 + (10.05 + 1.00 / 2) × 19.0]
= **105.400** kN/m²

· W_{h2} = 105.400 + 0.500 × [2.200 x 19.0] = **126.300** kN/m²

· W_{h3} = 126.300 + 0.500 × [2.900 x 19.0] = **153.850** kN/m²

6.6토압 (수평하중 - 지하수가 있을경우) ····· LC11

토압 (수평토압)

· W_{h1} = 0.500 × [0.45 × 23.00 + 0.55 × 19.00 + (9.50 + 1.00 / 2) × 10.0]
= **60.400** kN/m²

· W_{h2} = 60.400 + 0.500 × [2.200 x 10.0] = **71.400** kN/m²

· W_{h3} = 71.400 + 0.500 × [2.900 x 10.0] = **85.900** kN/m²

6.7 지하수압 (연직하중) ····· LC12

① 상부슬래브

· W_{W1} = (0.85 + 0.00 - 0.00) × 10.0 = **8.500** kN/m²

② 기초 2, 하부슬래브에 작용하는 하중 (W_{W2}) : 양수압

· W_{W2} = (10.50 + 3.200 - 9.60) × 10.0 = **41.000** kN/m²

③ 기초 1, 하부슬래브에 작용하는 하중 (W_{W2}) : 양수압

· W_{W2} = (10.50 + 6.100 - 9.60) × 10.0 = **70.000** kN/m²

6.8 지하수압 (수평하중) ····· LC13

① 측벽에 작용하는 하중 (W_{W3}, W_{W4})

· W_{w1} = (10.50 - 9.60 + 1.00 / 2) × 10.0 = **14.000** kN/m²

· W_{w2} = 14.000 + (2.200) x 10.0 = **36.000** kN/m²

· W_{w3} = 36.000 + (2.900) x 10.0 = **65.000** kN/m²

6.9 건조수축 : - 15℃ (상부슬래브만 재하) ····· LC14

건조수축률 ε = 0.00015

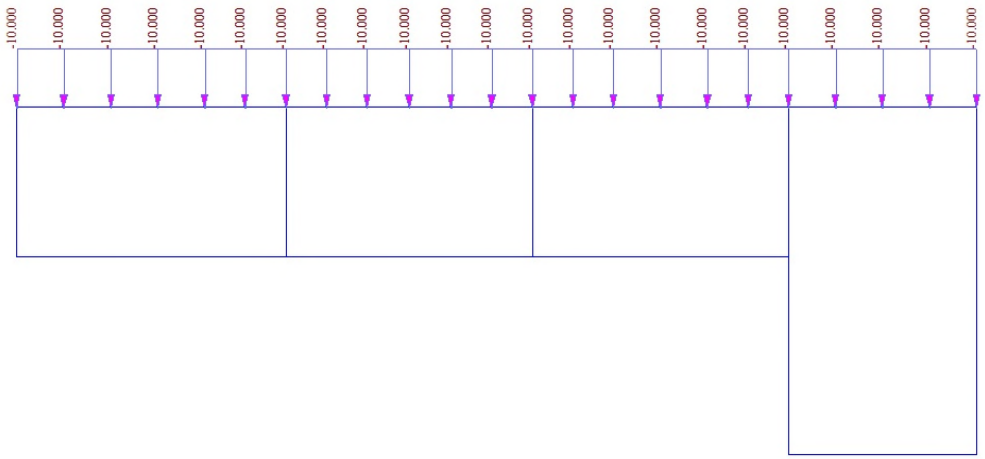
온도선팽창계수 α = 0.00001

7. 하중재하도

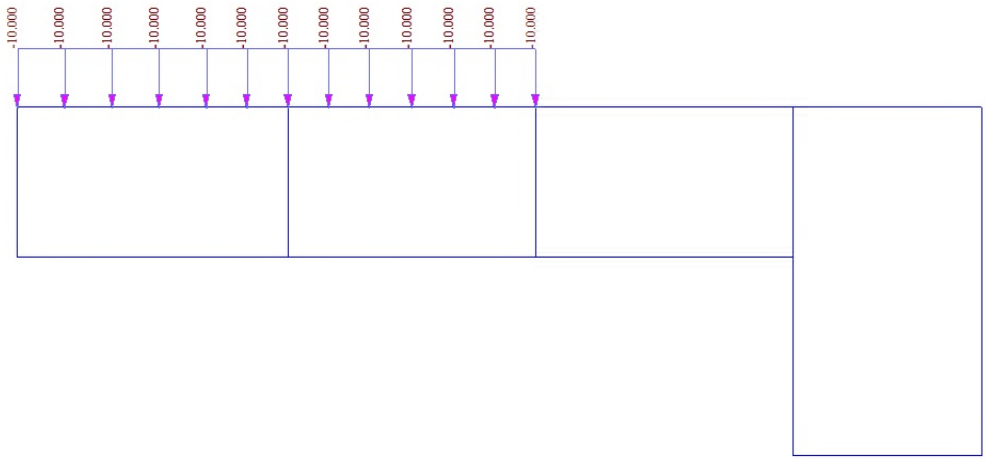
LC1. 고정하중(자중)

프로그램내에서 자동 계산

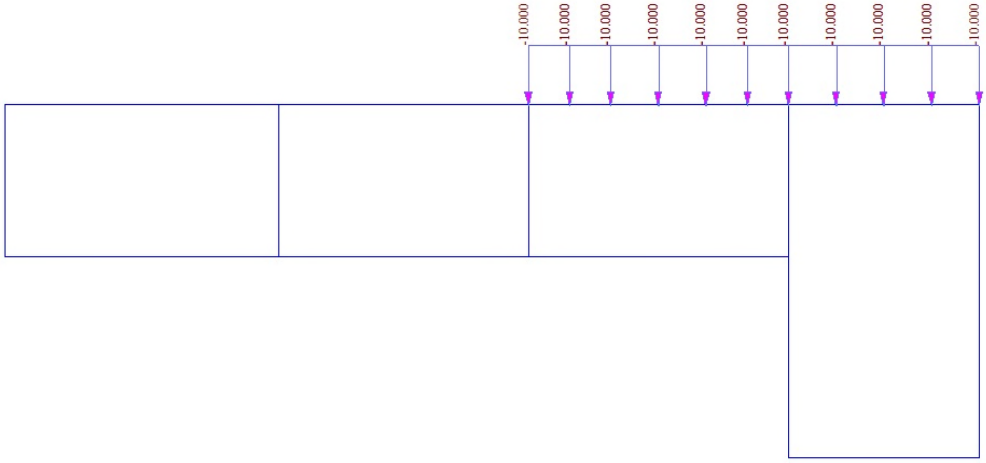
LC2. 활하중(연직하중 만재하시)



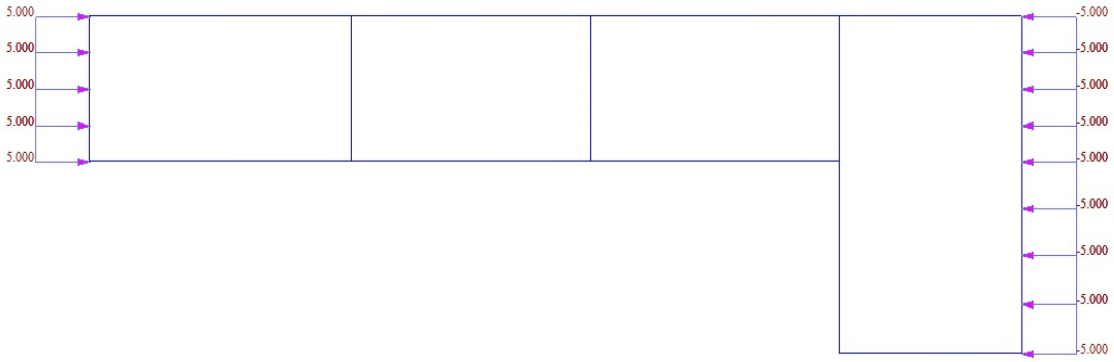
LC3. 활하중(연직하중 좌측편재하시)



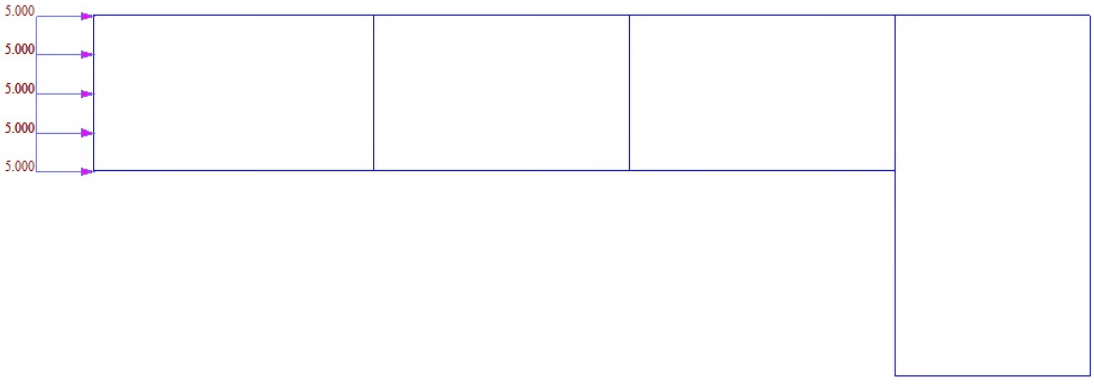
LC4. 활하중(연직하중 우측편재하시)



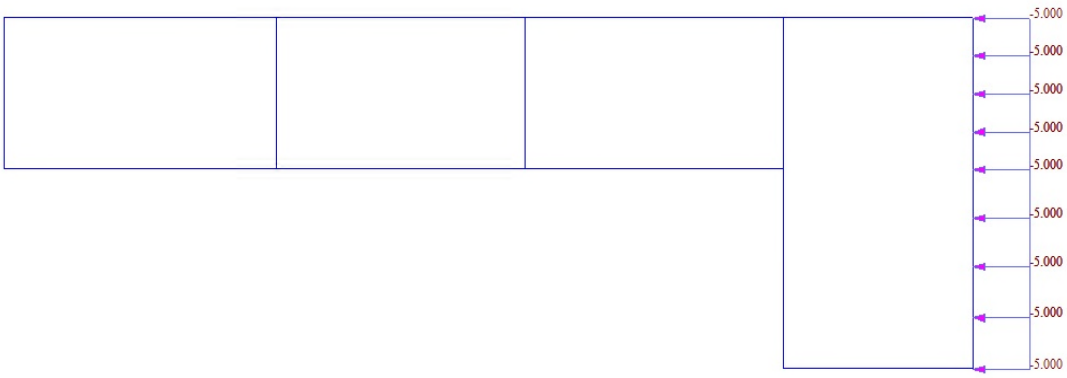
LC5. 활하중(수평하중 만재하시)



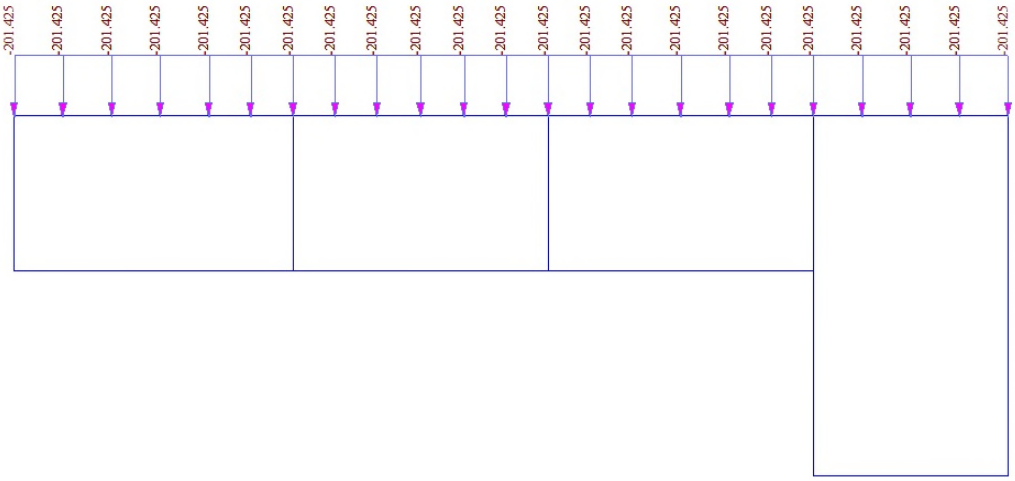
LC6. 활하중(수평하중 좌측편재하시)



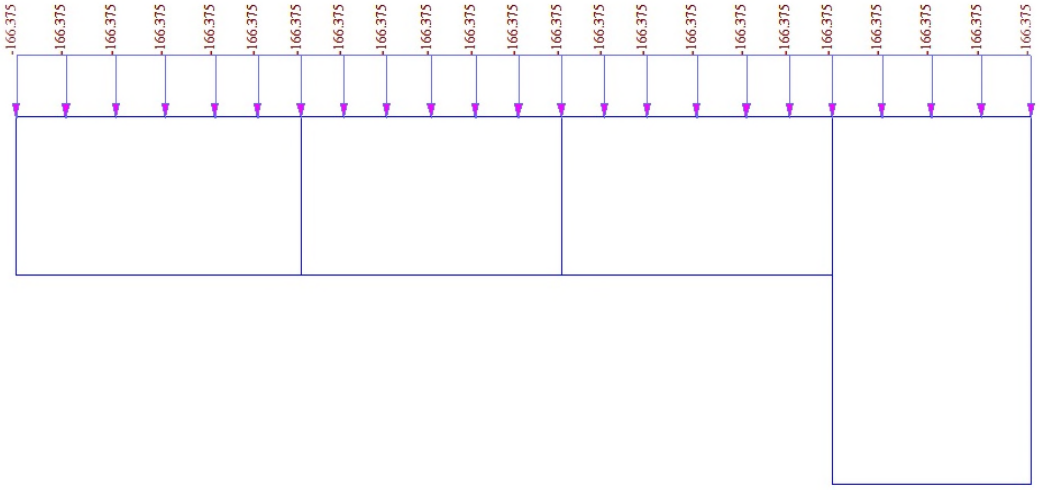
LC7. 활하중(수평하중 우측편재하시)



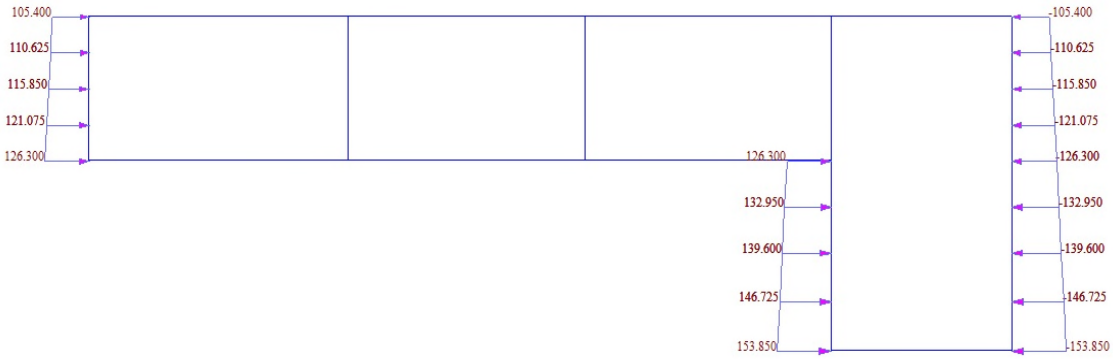
LC8. 토압(연직하중 지하수無)



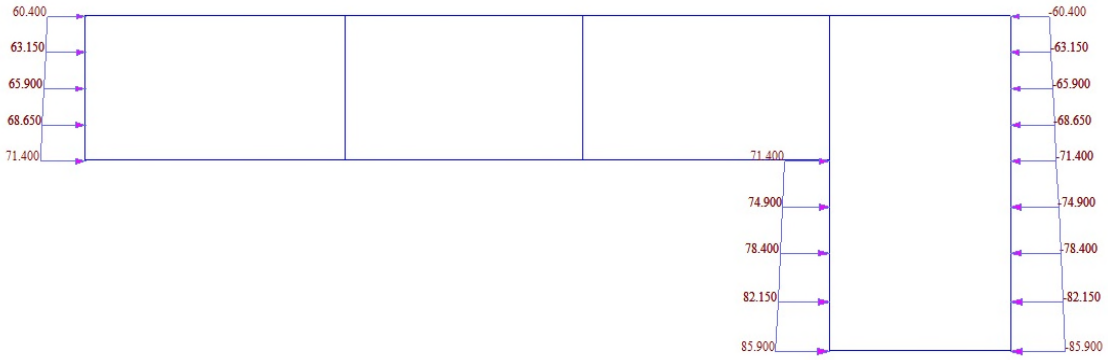
LC9. 토압(연직하중 지하수有)



LC10. 토압(수평하중 지하수無)

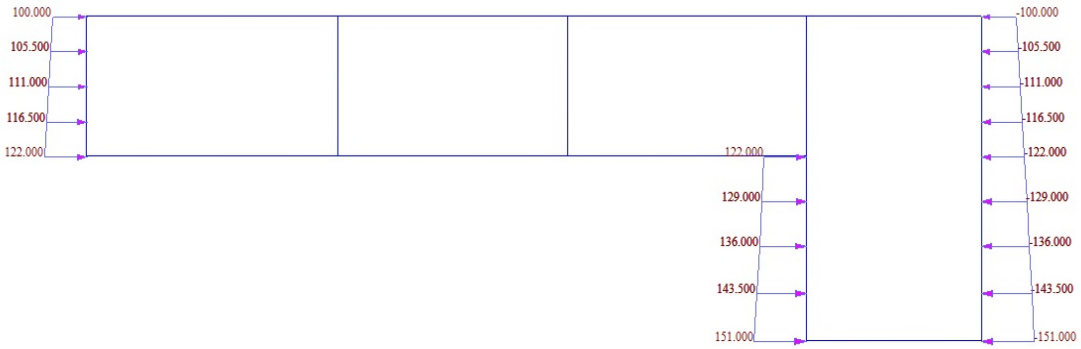


LC11. 토압(수평하중 지하수有)

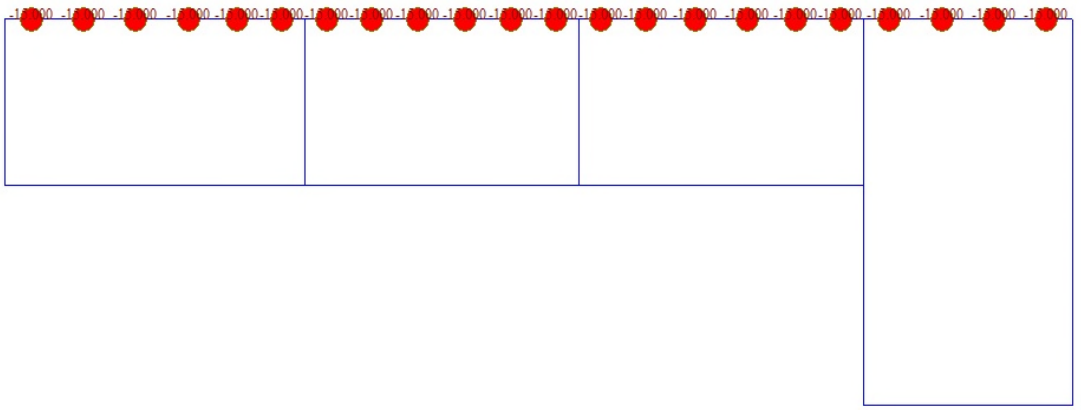


LC12. 수압(연직하중)

LC13. 수압(수평하중)



LC14. 건조수축하중



8. 하중조합

α_H : 토피의 두께에 따른 연직방향 하중 Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, α_H = 1.0

h > 2.0 m 에 대해서, α_H = 1.05 − 0.025h ≥ 0.875

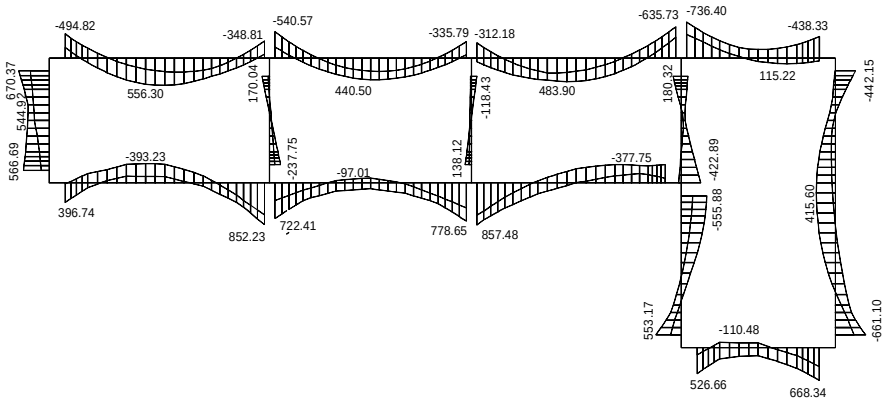
적용토피 = 2.000 m α_H = 1.05 − 0.025 × 2.00

= 1 ≥ 0.875 ∴ α_H = 1

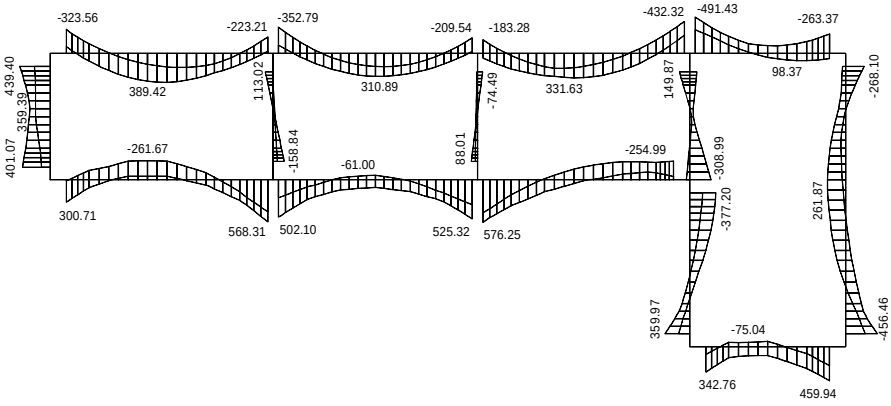
하중조합		고정하중	활하중						토압				수압		건조수축	비고
		자중	연직하중			수평하중			연직하중		수평하중		연직수압	수평수압		
			만재하	편재하		만재하	편재하		지하수無	지하수有	지하수無	지하수有				
				좌측	우측		좌측	우측								
		LC01	LC02	LC03	LC04	LC05	LC06	LC07	LC8	LC9	LC10	LC11	LC12	LC13	LC14	
극한하중조합	UCOMB01	1.20	1.60			1.60			1.60		1.60				1.20	
	UCOMB02	1.20		1.60			1.60		1.60		1.60				1.20	
	UCOMB03	1.20			1.60			1.60	1.60		1.60				1.20	
	UCOMB04	1.20	1.60			1.60				1.60		1.60	1.60	1.60	1.20	
	UCOMB05	1.20		1.60			1.60			1.60		1.60	1.60	1.60	1.20	
	UCOMB06	1.20			1.60			1.60		1.60		1.60	1.60	1.60	1.20	
	UCOMB07	1.20	1.60			0.80			1.60		0.80				1.20	
	UCOMB08	1.20		1.60			0.80		1.60		0.80				1.20	
	UCOMB09	1.20			1.60			0.80	1.60		0.80				1.20	
	UCOMB10	1.20	1.60			0.80				1.60		0.80	1.60	0.80	1.20	
	UCOMB11	1.20		1.60			0.80			1.60		0.80	1.60	0.80	1.20	
	UCOMB12	1.20			1.60			0.80		1.60		0.80	1.60	0.80	1.20	
	UCOMB13	0.90							1.60		1.60					
	UCOMB14	0.90								1.60		1.60	1.60	1.60		
	UCOMB15	0.90							1.60		1.60					
	UCOMB16	0.90								1.60		1.60	1.60	1.60		
사용하중조합	WCOMB01	1.00	1.00			1.00			1.00		1.00				1.00	
	WCOMB02	1.00		1.00			1.00		1.00		1.00				1.00	
	WCOMB03	1.00			1.00			1.00	1.00		1.00				1.00	
	WCOMB04	1.00	1.00			1.00				1.00		1.00	1.00	1.00	1.00	
	WCOMB05	1.00		1.00			1.00			1.00		1.00	1.00	1.00	1.00	
	WCOMB06	1.00			1.00			1.00		1.00		1.00	1.00	1.00	1.00	
	WCOMB07	1.00	1.00			0.50			1.00		0.50				1.00	
	WCOMB08	1.00		1.00			0.50		1.00		0.50				1.00	
	WCOMB09	1.00			1.00			0.50	1.00		0.50				1.00	
	WCOMB10	1.00	1.00			0.50				1.00		0.50	1.00	0.50	1.00	
	WCOMB11	1.00		1.00			0.50			1.00		0.50	1.00	0.50	1.00	
	WCOMB12	1.00			1.00			0.50		1.00		0.50	1.00	0.50	1.00	
	WCOMB13	1.00							1.00		1.00					
	WCOMB14	1.00								1.00		1.00	1.00	1.00		
	WCOMB15	1.00							1.00		1.00					
	WCOMB16	1.00								1.00		1.00	1.00	1.00		

9. 단면력도

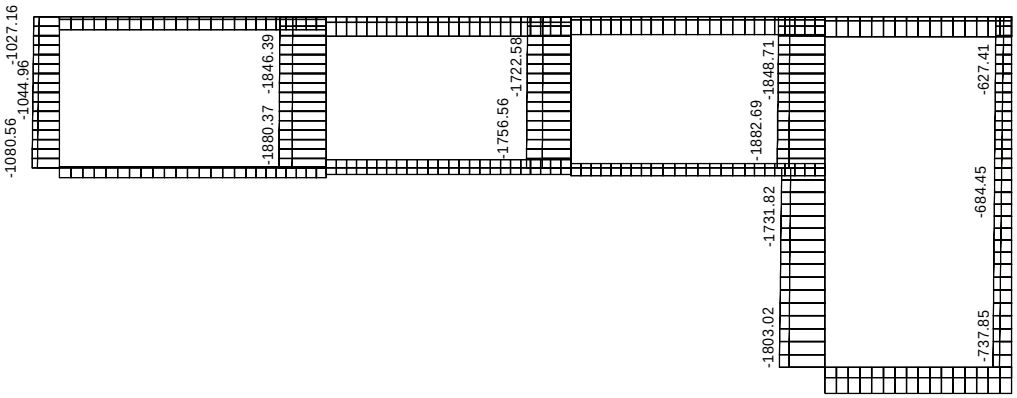
계수하중 – 모멘트도(B.M.D)



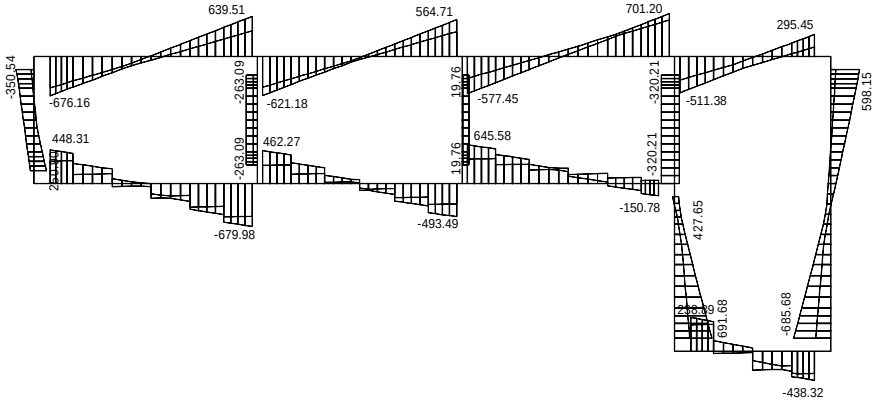
사용하중 – 모멘트도(B.M.D)



계수하중 – 축력도(A.F.D)



계수하중 – 전단력(S.F.D)



10. 전산 해석 결과

10.1 부재력 집계표(부재력도 및 전산 OUTPUT DATA 참조)

※ 상부슬래브

구 분	위 치	상시				지진시			적용하중					
		계수하중			사용하중	MAX(기능수행수준, 붕괴방지수준)			계수하중			사용하중	모멘트	전단
		모멘트	축력	전단력	모멘트	모멘트	축력	전단력	모멘트	축력	전단력	모멘트		
		Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)	Mu(ko.m)	Pu(kN)	Su(kN)	Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)		
상 부 슬래브	좌측벽체부	494.820		676.160	323.560	490.450		585.300	494.820	-	676.160	323.560	상시	상시
	지간 1 중앙부	556.300		0.000	389.420	307.930		0.000	556.300	-	0.000	389.420	상시	상시
	지점 1	540.570		639.510	352.790	546.170		506.270	546.170	-	639.510	352.790	지진시	상시
	지간 2 중앙부	440.500		0.000	310.890	263.730		0.000	440.500	-	0.000	310.890	상시	상시
	지점 2	335.790		577.450	209.540	413.840		427.320	413.840	-	577.450	209.540	지진시	상시
	지간 3 중앙부	483.900		0.000	331.630	303.960		0.000	483.900	-	0.000	331.630	상시	상시
	지점 3	736.400		701.200	491.430	610.650		600.170	736.400	-	701.200	491.430	상시	상시
	지간 4 중앙부	273.070		0.000	160.760	321.960		0.000	321.960	-	0.000	160.760	지진시	상시
	우측벽체부	438.330		295.450	263.370	475.120		333.620	475.120	-	333.620	263.370	지진시	지진시

※ 하부슬래브

구 분	위 치	상시				지진시			적용하중					
		계수하중			사용하중	MAX(기능수행수준, 붕괴방지수준)			계수하중			사용하중	모멘트	전단
		모멘트	축력	전단력	모멘트	모멘트	축력	전단력	모멘트	축력	전단력	모멘트		
		Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)	Mu(kN.m)	Pu(kN)	Su(kN)	Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)		
하 부 슬래브	좌측벽체부	396.740	-	448.310	300.710	239.300	-	373.360	396.740	-	448.310	300.710	상시	상시
	지간 1 중앙부	393.230	-	0.000	261.670	380.680	-	0.000	393.230	-	0.000	261.670	상시	상시
	지점 1	852.230	-	679.980	568.310	672.030	-	609.650	852.230	-	679.980	568.310	상시	상시
	지간 2 중앙부	163.290	-	0.000	133.300	88.150	0.000	0.000	163.290	-	0.000	133.300	상시	상시
	지점 2	857.480	-	645.580	576.250	722.830	0.000	601.710	857.480	-	645.580	576.250	상시	상시
	지간 3 중앙부	377.750	-	0.000	244.860	647.950	0.000	0.000	647.950	-	0.000	244.860	지진시	상시
	지점 3	526.660	-	238.890	342.760	608.060	0.000	440.640	608.060	-	440.640	342.760	지진시	지진시
	지간 4 중앙부	228.150	-	0.000	148.600	407.880	0.000	0.000	407.880	-	0.000	148.600	지진시	상시
	우측벽체부	668.340	-	438.320	459.940	583.060	0.000	556.720	668.340	-	556.720	459.940	상시	지진시

※ 벽체 : 기초 2(배기 및 배연 통로)

구 분	위 치		상시				지진시			적용하중					
			계수하중			사용하중	MAX(기능수행수준, 붕괴방지수준)			계수하중			사용하중	모멘트	전단
			모멘트	축력	전단력	모멘트	모멘트	축력	전단력	모멘트	축력	전단력	모멘트		
			Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)	Mu(kN.m)	Pu(kN)	Su(kN)	Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)		
외측 벽체	상단부	Mmax	670.370	994.770	350.540	439.400	648.400	832.020	307.180	670.370	994.770	350.540	439.400	상시	상시
		Pmax	442.490	1027.160	350.540	439.400	547.030	830.270	307.180	442.490	1027.160	350.540	439.400	상시	상시
	중앙부(-)	Mmax	544.920	1008.120	0.000	359.390	547.030	828.140	0.000	547.030	828.140	0.000	359.390	지진시	상시
		Pmax	413.930	1044.960	0.000	359.390	401.790	838.500	0.000	413.930	1044.960	0.000	359.390	상시	상시
	하단부	Mmax	566.690	1063.130	250.900	401.070	390.660	916.240	294.940	566.690	1063.130	294.940	401.070	상시	지진시
		Pmax	551.550	1080.560	250.900	401.070	390.660	916.240	294.940	551.550	1080.560	294.940	401.070	상시	지진시
내부 벽체	상단부	Mmax	180.320	1713.370	320.210	149.870	313.350	1458.090	255.410	313.350	1458.090	320.210	149.870	지진시	상시
		Pmax	27.610	1848.710	320.210	149.870	256.160	1469.410	255.410	27.610	1848.710	320.210	149.870	상시	상시
	하단부	Mmax	422.890	1805.430	320.210	308.990	198.980	1503.390	256.420	422.890	1805.430	320.210	308.990	상시	상시
		Pmax	253.760	1882.690	320.210	308.990	198.980	1503.390	256.420	253.760	1882.690	320.210	308.990	상시	상시

※ 벽체 : 기초 1(대인피난연결통로)

구 분	위 치		상시				지진시			적용하중					
			계수하중			사용하중	MAX(기능수행수준, 붕괴방지수준)			계수하중			사용하중	모멘트	전단
			모멘트	축력	전단력	모멘트	모멘트	축력	전단력	모멘트	축력	전단력	모멘트		
			Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)	Mu(kN.m)	Pu(kN)	Su(kN)	Mu(kN.m)	Pu(kN)	Su(kN)	Ms(kN.m)		
좌측 벽체	상단부	Mmax	555.880	1731.820	427.650	405.980	621.530	1460.860	586.340	621.530	1460.860	586.340	405.980	지진시	지진시
		Pmax	246.650	1731.820	427.650	405.980	457.840	1460.860	586.340	246.650	1731.820	586.340	405.980	상시	지진시
	하단부	Mmax	553.170	1616.070	691.680	359.970	712.370	1657.600	672.320	712.370	1657.600	691.680	359.970	지진시	상시
		Pmax	251.160	1803.020	691.680	359.970	712.370	1657.600	672.320	251.160	1803.020	691.680	359.970	상시	상시
우측 벽체	상단부	Mmax	442.150	614.060	598.150	268.100	537.900	586.180	396.690	537.900	586.180	598.150	268.100	지진시	상시
		Pmax	233.640	627.410	598.150	268.100	390.510	570.930	396.690	233.640	627.410	598.150	268.100	상시	상시
	중앙부(+)	Mmax	415.600	615.130	0.000	268.100	308.150	678.420	0.000	415.600	615.130	0.000	268.100	상시	상시
		Pmax	375.010	684.450	0.000	268.100	289.660	629.060	0.000	375.010	684.450	0.000	268.100	상시	상시
	하단부	Mmax	661.100	703.320	685.680	456.460	676.820	844.010	535.350	676.820	844.010	685.680	456.460	지진시	상시
		Pmax	494.010	737.850	685.680	456.460	676.820	844.010	535.350	676.820	844.010	685.680	456.460	지진시	상시

11. 단면 설계 정리

※ 상부슬래브

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
상부슬래브	좌측 벽체부	494.82	323.56	-	490.45	494.82	676.16	685.79	1299.53	1.00	1.000 0.900	0.100	H19@250 + H19@250	H16@150 - 2EA	1.39	247.05	125.00
	지간 1 중앙부	556.30	389.42	-	307.93	556.30		940.26		1.00	1.000 0.920	0.080	H22@250 + H22@250		1.69	545.82	125.00
	지점 1	540.57	352.79	-	546.17	546.17	639.51	919.21	1299.53	1.00	1.000 0.900	0.100	H22@250 + H22@250	H16@150 - 2EA	1.68	358.85	125.00
	지간 2 중앙부	440.50	310.89	-	263.73	440.50		701.37		1.00	1.000 0.920	0.080	H19@250 + H19@250		1.59	495.53	125.00
	지점 2	335.79	209.54	-	413.84	413.84	577.45	919.21		1.00	1.000 0.900	0.100	H22@250 + H22@250		2.22	756.28	125.00
	지간 3 중앙부	483.90	331.63	-	303.96	483.90		701.37		1.00	1.000 0.920	0.080	H19@250 + H19@250		1.45	453.52	125.00
	지점 3	736.40	491.43	-	610.65	736.40	701.20	1191.72	1299.53	1.00	1.000 0.900	0.100	H25@250 + H25@250	H16@150 - 2EA	1.62	322.69	125.00
	지간 4 중앙부	273.07	160.76	-	321.96	321.96		701.37		1.00	1.000 0.920	0.080	H19@250 + H19@250		2.18	1039.32	125.00
	우측 벽체부	438.33	263.37	-	475.12	475.12	333.62	685.79		1.00	1.000 0.900	0.100	H19@250 + H19@250		1.44	355.22	125.00

※ 하부슬래브

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
하부슬래브	좌측 벽체부	396.74	300.71		239.30	396.74	448.31	685.79		1.00	1.000 0.900	0.100	H19@250 + H19@250		**1.73**	283.01	125.00
	지간 1 중앙부	393.23	261.67		380.68	393.23		701.37		1.00	1.000 0.920	0.080	H19@250 + H19@250		**1.78**	621.90	125.00
	지점 1	852.23	568.31		672.03	852.23	679.98	1191.72	1299.53	1.00	1.000 0.900	0.100	H25@250 + H25@250	H16@150 - 2EA	**1.40**	249.45	125.00
	지간 2 중앙부	163.29	133.30		88.15	163.29		701.37		1.00	1.000 0.920	0.080	H19@250 + H19@250		**4.30**	1253.42	125.00
	지점 2	857.48	576.25		722.83	857.48	645.58	1191.72	1299.53	1.00	1.000 0.900	0.100	H25@250 + H25@250	H16@150 - 2EA	**1.39**	243.00	125.00
	지간 3 중앙부	377.75	244.86		647.95	647.95		940.26		1.00	1.000 0.920	0.080	H22@250 + H22@250		**1.45**	913.91	125.00
	지점 3	526.66	342.76		608.06	608.06	440.64	919.21		1.00	1.000 0.900	0.100	H22@250 + H22@250		**1.51**	375.86	125.00
	지간 4 중앙부	228.15	148.60		407.88	407.88		701.37		1.00	1.000 0.920	0.080	H19@250 + H19@250		**1.72**	1124.37	125.00
	우측 벽체부	668.34	459.94		583.06	668.34	556.72	919.21		1.00	1.000 0.900	0.100	H22@250 + H22@250		**1.38**	372.05	125.00

※ 벽체 : 기초 2(배기 및 배연 통로)

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
외측 벽체	상단부 Mmax	670.37	439.40	994.77	648.40	670.37	350.54	#NAME?		1.00	1.267 1.167	0.100	H19@250 + H19@250		#NAME?	228.71	125.00
	상단부 Pmax	442.49	439.40	1027.16	547.03	442.49	350.54	#NAME?		1.00	1.267 1.167	0.100	H19@250 + H19@250		#NAME?	228.71	125.00
	중앙부(-) Mmax	544.92	359.39	828.14	547.03	547.03		#NAME?		1.00	1.100 1.000	0.100	H19@250 + H19@250		#NAME?	248.52	125.00
	중앙부(-) Pmax	413.93	359.39	1044.96	401.79	413.93		#NAME?		1.00	1.100 1.000	0.100	H19@250 + H19@250		#NAME?	248.52	125.00
	하단부 Mmax	566.69	401.07	1063.13	390.66	566.69	294.94	#NAME?		1.00	1.100 1.000	0.100	H19@250 + H19@250		#NAME?	199.18	125.00
	하단부 Pmax	551.55	401.07	1080.56	390.66	551.55	294.94	#NAME?		1.00	1.100 1.000	0.100	H19@250 + H19@250		#NAME?	199.18	125.00
내부 벽체	상단부 Mmax	180.32	149.87	1458.09	313.35	313.35	320.21	#NAME?		1.00	0.700 0.620	0.080	H19@250 + H19@250		#NAME?	742.58	125.00
	상단부 Pmax	27.61	149.87	1848.71	256.16	27.61	320.21	#NAME?		1.00	0.700 0.620	0.080	H19@250 + H19@250		#NAME?	742.58	125.00
	중앙부(+) Mmax	122.26	95.31	1469.41	256.16	256.16		#NAME?		1.00	0.700 0.620	0.080	H19@250 + H19@250		#NAME?	1167.67	125.00
	중앙부(+) Pmax	66.18	95.31	1860.04	134.15	66.18		#NAME?		1.00	0.700 0.620	0.080	H19@250 + H19@250		#NAME?	1167.67	125.00
	하단부 Mmax	422.89	308.99	1805.43	198.98	422.89	320.21	#NAME?		1.00	0.700 0.620	0.080	H19@250 + H19@250		#NAME?	273.97	125.00
	하단부 Pmax	253.76	308.99	1882.69	198.98	253.76	320.21	#NAME?		1.00	0.700 0.620	0.080	H19@250 + H19@250		#NAME?	273.97	125.00

※ 벽체 : 기초 1(대인피난연결통로)

구 분		상 시 모멘트 (kN.m)	사 용 모멘트 (kN.m)	축 력 (kN)	지진시 모멘트 (kN.m)	설계적용 모멘트 (kN.m)	설계적용 전단력 (kN)	ΦMn (kN.m)	ΦVn (kN)	b (m)	h(m) / d(m)	d" (m)	사용철근		여유율	균열(mm)	
													휨철근	전단철근		필요간격	배근간격
좌측 벽체	상단부 Mmax	555.88	405.98	1460.86	621.53	621.53	586.34	#NAME?		1.00	1.267 / 1.167	0.100	H22@250 + H19@250		#NAME?	353.92	125.00
	상단부 Pmax	246.65	405.98	1731.82	457.84	246.65	586.34	#NAME?		1.00	1.267 / 1.167	0.100	H22@250 + H19@250		#NAME?	353.92	125.00
	하단부 Mmax	553.17	359.97	1657.60	712.37	712.37	691.68	#NAME?		1.00	1.100 / 1.000	0.100	H22@250 + H22@250		#NAME?	412.52	125.00
	하단부 Pmax	251.16	359.97	1803.02	712.37	251.16	691.68	#NAME?		1.00	1.100 / 1.000	0.100	H22@250 + H22@250		#NAME?	412.52	125.00
우측 벽체	상단부 Mmax	442.15	268.10	586.18	537.90	537.90	598.15	#NAME?	914.69	1.00	0.867 / 0.787	0.080	H19@250 + H19@250	H16@150 - 2EA	#NAME?	487.06	125.00
	상단부 Pmax	233.64	268.10	627.41	390.51	233.64	598.15	#NAME?	916.05	1.00	0.867 / 0.787	0.080	H19@250 + H19@250	H16@150 - 2EA	#NAME?	487.06	125.00
	하단부 Mmax	415.60	268.10	615.13	308.15	415.60		#NAME?		1.00	0.700 / 0.620	0.080	H19@250 + H19@250		#NAME?	342.63	125.00
	하단부 Pmax	375.01	268.10	684.45	289.66	375.01		#NAME?		1.00	0.700 / 0.620	0.080	H19@250 + H19@250		#NAME?	342.63	125.00
	하단부 Mmax	661.10	456.46	844.01	676.82	676.82	685.68	#NAME?	929.91	1.00	0.700 / 0.620	0.080	H22@250 + H22@250	H16@150 - 2EA	#NAME?	235.01	125.00
	하단부 Pmax	494.01	456.46	844.01	676.82	676.82	685.68	#NAME?	929.91	1.00	0.700 / 1.020	0.080	H22@250 + H22@250	H16@150 - 2EA	#NAME?	235.01	125.00

12. 단면설계

12.1 상부슬래브 단면검토

12.1.1 좌측벽체부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
494.820	676.160	323.560	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 28.640 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 494820000 = 0

∴ Required As = 1643.204 ㎟ [p = 0.00183]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 2190.938 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

∴ USE As =	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
		H	19	@	250	=	1146.000	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	2292.000	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 33.694 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 33.694) / 33.694

= 0.0771

· ε_t = 0.0771 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 685.787 kN.m > Mu = 494.820 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 584.567 kN < Vu = 676.160 kN

· 1/2·Øv·Vc = 292.284 kN < Vu = 676.160 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 450 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 50.885 ㎟ [소요 전단철근]

· Required Av = 50.885 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 584.567 kN + 714.960 kN

= 1299.527 kN > Vu = 676.160 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00255

· k = - np + √((np)^2 + 2np) = 0.172

· j = 1 - k / 3 = 0.943

· x = k·d = 154.650 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.932 MPa

· fs = Mo / (As·(D - x/3)) = 166.385 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 166.385 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 247.050 mm

· s_2 = 300·(210 / fst) = 378.640 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 247.050 mn > 125.000 mm ∴ **O.K**

12.1.2 지간 1 중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	920.000	920.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
556.300	0.000	389.420	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 31.538 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 312800.000 As - 556300000 = 0

∴ Required As = 1809.467 ㎟ [p = 0.00197]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20217.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3220.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2987.788 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3220.000 ㎟

4/3·Req As ⇒ MIN As = 2412.623 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
∴ USE As =		H	22	@	250	=	1548.400	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	3096.800	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 37.103 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (920.000 - 37.103) / 37.103

= 0.0714

· ε_t = 0.0714 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 940.264 kN.m > Mu = 556.300 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 597.558 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 298.779 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00337

· k = - np + √((np)^2 + 2np) = 0.195

· j = 1 - k / 3 = 0.935

· x = k·d = 179.212 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.052 MPa

· fs = Mo / (As·(D - x/3)) = 146.175 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 146.175 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 22 / 2 = 69.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 545.816 mm

· s_2 = 300·(280 / fst = 574.652 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 545.816 mn > 125.000 mm ∴ **O.K**

12.1.3 지점 1

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
546.170	639.510	352.790	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 31.666 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 546170000 = 0

∴ Required As = 1816.831 ㎟ [p = 0.00202]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 2422.442 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

		1단	H	22	@	250	=	1548.400	㎟	[4 EA/M]
∴	USE As	=	H	22	@	250	=	1548.400	㎟	[4 EA/M]
		2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	3096.800	㎟	∴ **O.K**

▣ 휨모멘트 검토

· c = a / β1 = 37.254 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 37.254) / 37.254

= 0.0695

· ε_t = 0.0695 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 919.205 kN.m > Mu = 546.170 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 584.567 kN < Vu = 639.510 kN

· 1/2·Øv·Vc = 292.284 kN < Vu = 639.510 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 450 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 30.524 ㎟ [소요 전단철근]

· Required Av = 30.524 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 584.567 kN + 714.960 kN

= 1299.527 kN > Vu = 639.510 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00344

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.197

· j = 1 - k / 3 = 0.934

· x = k·d = 177.042 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.739 MPa

· fs = Mo / (As·(D - x/3)) = 135.461 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 135.461 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 22 / 2 = 89.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 358.848 mm

· s_2 = 300·(210 / fst) = 465.078 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 358.848 mn > 125.000 mm ∴ **O.K**

12.1.4 지간 2 중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	920.000	920.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
440.500	0.000	310.890	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 24.881 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 312800.000 As - 440500000 = 0

∴ Required As = 1427.552 ㎟ [p = 0.00155]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20217.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3220.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2987.788 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3220.000 ㎟

4/3·Req As ⇒ MIN As = 1903.403 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴	USE As	=	H	19	@	250	=	1146.000	㎟	[4 EA/M]
		2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	∴ **O.K**

▣ 휨모멘트 검토

· c = a / β1 = 29.272 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (920.000 - 29.272) / 29.272

= 0.0913

· ε_t = 0.0913 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 701.372 kN.m > Mu = 440.500 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 597.558 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 298.779 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00249

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.170

· j = 1 - k / 3 = 0.943

· x = k·d = 156.520 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.578 MPa

· fs = Mo / (As·(D - x/3)) = 156.300 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 156.300 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 495.535 mm

· s_2 = 300·(280 / fst = 537.428 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 495.535 mn > 125.000 mm ∴ **O.K**

12.1.5 지점 2

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
413.840	577.450	209.540	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 23.889 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 413840000 = 0

∴ Required As = 1370.608 ㎟ [p = 0.00152]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 1827.478 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

		1단	H	22	@	250	=	1548.400	㎟	[4 EA/M]
∴	USE As	=	H	22	@	250	=	1548.400	㎟	[4 EA/M]
		2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	3096.800	㎟	∴ **O.K**

▣ 휨모멘트 검토

· c = a / β1 = 28.104 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 28.104) / 28.104

= 0.0931

· ε_t = 0.0931 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 919.205 kN.m > Mu = 413.840 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 584.567 kN > Vu = 577.450 kN

· 1/2·Øv·Vc = 292.284 kN < Vu = 577.450 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00344

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.197

· j = 1 - k / 3 = 0.934

· x = k·d = 177.042 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 2.815 MPa

· fs = Mo / (As·(D - x/3)) = 80.457 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 80.457 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 22 / 2 = 89.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 756.281 mm

· s_2 = 300·(210 / fst) = 783.025 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 756.281 mn > 125.000 mm ∴ **O.K**

12.1.6 지간 3 중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	920.000	920.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
483.900	0.000	331.630	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 27.370 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 312800.000 As - 483900000 = 0

∴ Required As = 1570.354 ㎟ [p = 0.00171]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20217.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3220.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2987.788 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3220.000 ㎟

4/3·Req As ⇒ MIN As = 2093.805 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴ USE As =		H	19	@	250	=	1146.000	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	2292.000	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 32.200 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (920.000 - 32.200) / 32.200

= 0.0827

· ε_t = 0.0827 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 701.372 kN.m > Mu = 483.900 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 597.558 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 298.779 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00249

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.170

· j = 1 - k / 3 = 0.943

· x = k·d = 156.520 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.883 MPa

· fs = Mo / (As·(D - x/3)) = 166.727 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 166.727 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 453.522 mm

· s_2 = 300·(280 / fst = 503.817 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 453.522 mn > 125.000 mm ∴ **O.K**

12.1.7 지점 3

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
736.400	701.200	491.430	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 42.970 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 736400000 = 0

∴ Required As = 2465.390 ㎟ [p = 0.00274]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 3287.187 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴ USE As =		H	25	@	250	=	2026.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	4053.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 50.553 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 50.553) / 50.553

= 0.0504

· ε_t = 0.0504 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 1191.715 kN.m > Mu = 736.400 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 584.567 kN < Vu = 701.200 kN

· 1/2·Øv·Vc = 292.284 kN < Vu = 701.200 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 450 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 64.796 ㎟ [소요 전단철근]

· Required Av = 64.796 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 584.567 kN + 714.960 kN

= 1299.527 kN > Vu = 701.200 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00450

· k = - np + √((np)^2 + 2np) = 0.222

· j = 1 - k / 3 = 0.926

· x = k·d = 199.398 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.914 MPa

· fs = Mo / (As·(D - x/3)) = 145.445 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 145.445 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 322.694 mm

· s_2 = 300·(210 / fst) = 433.155 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 322.694 mn > 125.000 mm ∴ **O.K**

12.1.8 지간 4 중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	920.000	920.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
321.960	0.000	160.760	80.000	0.85	0.80

· a = As·fy/(0.85·fck·B) = 0.017 As = 18.118 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 312800.000 As - 321960000 = 0

∴ Required As = 1039.520 ㎟ [p = 0.00113]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20217.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3220.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2987.788 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3220.000 ㎟

4/3·Req As ⇒ MIN As = 1386.026 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴ USE As =		H	19	@	250	=	1146.000	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	2292.000	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 21.315 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (920.000 - 21.315) / 21.315

= 0.1265

· ε_t = 0.1265 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 701.372 kN.m > Mu = 321.960 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 637.395 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 318.698 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00249

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.170

· j = 1 - k / 3 = 0.943

· x = k·d = 156.520 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 2.367 MPa

· fs = Mo / (As·(D - x/3)) = 80.822 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 80.822 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 1122.899 mm

· s_2 = 300·(280 / fst = 1039.319 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 1039.319 mn > 125.000 mm ∴ **O.K**

12.1.9 우측벽체부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
475.120	333.620	263.370	100.000	0.85	0.80

· a = As·fy/(0.85·fck·B) = 0.017 As = 27.482 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 475120000 = 0

∴ Required As = 1576.753 ㎟ [p = 0.00175]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 2102.337 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴ USE As =		H	19	@	250	=	1146.000	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	2292.000	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 32.331 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 32.331) / 32.331

= 0.0805

· ε_t = 0.0805 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 685.787 kN.m > Mu = 475.120 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 623.538 kN > Vu = 333.620 kN

· 1/2·Øv·Vc = 311.769 kN < Vu = 333.620 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00255

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.172

· j = 1 - k / 3 = 0.943

· x = k·d = 154.650 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.014 MPa

· fs = Mo / (As·(D - x/3)) = 135.433 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 135.433 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 355.217 mm

· s_2 = 300·(210 / fst) = 465.174 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 355.217 mn > 125.000 mm ∴ **O.K**

12.2 하부슬래브 단면검토

12.2.1 좌측벽체부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
396.740	448.310	300.710	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 22.889 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 396740000 = 0

∴ Required As = 1313.235 ㎟ [p = 0.00146]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 1750.980 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=		H	19	@	250	=	1146.000	㎟	[4 EA/M]
		2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	∴ **O.K**

▣ 휨모멘트 검토

· c = a / β1 = 26.928 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 26.928) / 26.928

= 0.0973

· ε_t = 0.0973 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 685.787 kN.m > Mu = 396.740 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 584.567 kN > Vu = 448.310 kN

· 1/2·Øv·Vc = 292.284 kN < Vu = 448.310 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00255

· k = - np + √((np)^2 + 2np) = 0.172

· j = 1 - k / 3 = 0.943

· x = k·d = 154.650 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.584 MPa

· fs = Mo / (As·(D - x/3)) = 154.635 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 154.635 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 283.015 mm

· s_2 = 300·(210 / fst) = 407.412 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 283.015 mn > 125.000 mm ∴ **O.K**

12.2.2 지간 1 중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	920.000	920.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
393.230	0.000	261.670	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 22.178 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 312800.000 As - 393230000 = 0

∴ Required As = 1272.467 ㎟ [p = 0.00138]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20217.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3220.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2987.788 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3220.000 ㎟

4/3·Req As ⇒ MIN As = 1696.622 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴ USE As =		H	19	@	250	=	1146.000	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	2292.000	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 26.092 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (920.000 - 26.092) / 26.092

= 0.1028

· ε_t = 0.1028 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 701.372 kN.m > Mu = 393.230 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 597.558 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 298.779 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00249

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.170

· j = 1 - k / 3 = 0.943

· x = k·d = 156.520 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 3.853 MPa

· fs = Mo / (As·(D - x/3)) = 131.555 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 131.555 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 621.897 mm

· s_2 = 300·(280 / fst = 638.518 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 621.897 mn > 125.000 mm ∴ **O.K**

12.2.3 지점 1

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
852.230	679.980	568.310	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 49.926 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 852230000 = 0

∴ Required As = 2864.518 ㎟ [p = 0.00318]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 3819.357 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

		1단	H	25	@	250	=	2026.800	㎟	[4 EA/M]
∴ USE As	=		H	25	@	250	=	2026.800	㎟	[4 EA/M]
		2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	4053.600	㎟	∴ **O.K**

▣ 휨모멘트 검토

· c = a / β1 = 58.737 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 58.737) / 58.737

= 0.0430

· ε_t = 0.0430 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 1191.715 kN.m > Mu = 852.230 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 584.567 kN < Vu = 679.980 kN

· 1/2·Øv·Vc = 292.284 kN < Vu = 679.980 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 450 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 53.007 ㎟ [소요 전단철근]

· Required Av = 53.007 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 584.567 kN + 714.960 kN

= 1299.527 kN > Vu = 679.980 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00450

· k = - np + √((np)^2 + 2np) = 0.222

· j = 1 - k / 3 = 0.926

· x = k·d = 199.398 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 6.839 MPa

· fs = Mo / (As·(D - x/3)) = 168.198 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 168.198 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 249.448 mm

· s_2 = 300·(210 / fst) = 374.558 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 249.448 mn > 125.000 mm ∴ **O.K**

12.2.4 지간 2 중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	920.000	920.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
163.290	0.000	133.300	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 9.144 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 312800.000 As - 163290000 = 0

∴ Required As = 524.634 ㎟ [p = 0.00057]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20217.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3220.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2987.788 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3220.000 ㎟

4/3·Req As ⇒ MIN As = 699.512 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴ USE As =		H	19	@	250	=	1146.000	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	2292.000	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 10.758 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (920.000 - 10.758) / 10.758

= 0.2536

· ε_t = 0.2536 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 701.372 kN.m > Mu = 163.290 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 597.558 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 298.779 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00249

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.170

· j = 1 - k / 3 = 0.943

· x = k·d = 156.520 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 1.963 MPa

· fs = Mo / (As·(D - x/3)) = 67.017 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 67.017 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 1390.525 mm

· s_2 = 300·(280 / fst = 1253.420 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 1253.420 mn > 125.000 mm ∴ **O.K**

12.2.5 지점 2

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
857.480	645.580	576.250	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 50.243 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 857480000 = 0

∴ Required As = 2882.686 ㎟ [p = 0.0032]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 3843.581 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	25	@	250	=	2026.800	㎟	[4	EA/M]
∴ USE As =		H	25	@	250	=	2026.800	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	4053.600	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 59.109 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 59.109) / 59.109

= 0.0427

· ε_t = 0.0427 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 1191.715 kN.m > Mu = 857.480 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 584.567 kN < Vu = 645.580 kN

· 1/2·Øv·Vc = 292.284 kN < Vu = 645.580 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mn ≤ 최대간격(600mm,d/2 이하) = 450 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 33.896 ㎟ [소요 전단철근]

· Required Av = 33.896 ㎟

· USE Av = H 16 × 2.0 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 584.567 kN + 714.960 kN

= 1299.527 kN > Vu = 645.580 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00450

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.222

· j = 1 - k / 3 = 0.926

· x = k·d = 199.398 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 6.934 MPa

· fs = Mo / (As·(D - x/3)) = 170.548 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 170.548 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 25 / 2 = 87.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 242.997 mm

· s_2 = 300·(210 / fst) = 369.397 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 242.997 mn > 125.000 mm ∴ **O.K**

12.2.6 지간 3 중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	920.000	920.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
647.950	0.000	244.860	80.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 36.841 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 312800.000 As - 647950000 = 0

∴ Required As = 2113.774 ㎟ [p = 0.0023]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20217.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3220.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2987.788 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3220.000 ㎟

4/3·Req As ⇒ MIN As = 2818.366 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
∴ USE As =		H	22	@	250	=	1548.400	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	3096.800	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 43.343 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (920.000 - 43.343) / 43.343

= 0.0607

· ε_t = 0.0607 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 940.264 kN.m > Mu = 647.950 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 597.558 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 298.779 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00337

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.195

· j = 1 - k / 3 = 0.935

· x = k·d = 179.212 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 3.177 MPa

· fs = Mo / (As·(D - x/3)) = 91.912 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 91.912 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 22 / 2 = 69.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 969.893 mm

· s_2 = 300·(280 / fst = 913.915 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 913.915 mn > 125.000 mm ∴ **O.K**

12.2.7 지점 3

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
608.060	440.640	342.760	100.000	0.85	0.75

· a = As·fy/(0.85·fck·B) = 0.017 As = 35.327 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 608060000 = 0

∴ Required As = 2026.905 ㎟ [p = 0.00225]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 2702.540 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
∴ USE As =		H	22	@	250	=	1548.400	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	3096.800	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 41.562 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 41.562) / 41.562

= 0.0620

· ε_t = 0.0620 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 919.205 kN.m > Mu = 608.060 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 584.567 kN > Vu = 440.640 kN

· 1/2·Øv·Vc = 292.284 kN < Vu = 440.640 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00344

· k = - np + √((np)^2 + 2np) = 0.197

· j = 1 - k / 3 = 0.934

· x = k·d = 177.042 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.604 MPa

· fs = Mo / (As·(D - x/3)) = 131.610 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 131.610 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 22 / 2 = 89.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 375.860 mm

· s_2 = 300·(210 / fst) = 478.688 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 375.860 mn > 125.000 mm ∴ **O.K**

12.2.8 지간 4 중앙부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	920.000	920.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
407.880	0.000	148.600	80.000	0.85	0.80

· a = As·fy/(0.85·fck·B) = 0.017 As = 23.015 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 312800.000 As - 407880000 = 0

∴ Required As = 1320.481 ㎟ [p = 0.00144]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 20217.000 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3220.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2987.788 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3220.000 ㎟

4/3·Req As ⇒ MIN As = 1760.641 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴ USE As =		H	19	@	250	=	1146.000	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	2292.000	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 27.076 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (920.000 - 27.076) / 27.076

= 0.0989

· ε_t = 0.0989 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 701.372 kN.m > Mu = 407.880 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 637.395 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 318.698 kN > Vu = 0.000 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00249

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.170

· j = 1 - k / 3 = 0.943

· x = k·d = 156.520 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 2.188 MPa

· fs = Mo / (As·(D - x/3)) = 74.709 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 74.709 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 1229.209 mm

· s_2 = 300·(280 / fst = 1124.367 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 1124.367 mn > 125.000 mm ∴ **O.K**

12.2.9 우측벽체부

▣ 철근량 검토

fck (MPa)	fy (MPa)	B (mm)	H (mm)	d (mm)	dd (mm)
27	400	1000.000	1000.000	900.000	900.000
Mu (kN.m)	Vu (kN)	Mo (kN.m)	d' (mm)	Øf	Øv
668.340	556.720	459.940	100.000	0.85	0.80

· a = As·fy/(0.85·fck·B) = 0.017 As = 38.908 mm

· Mu = φf·As·fy·(d - a/2) [강도감소계수(Øf) 값은 0.85 로 가정한다]

⇒ - 2.963 As^2 + 306000.000 As - 668340000 = 0

∴ Required As = 2232.372 ㎟ [p = 0.00248]

· β1 = 0.85 ⇒ Pb = 0.85·β1·(fck/fy)·600 / (600 + fy) = 0.0293

· Pmax = 0.75·Pb = 0.02198 ⇒ MAX As = 19777.500 ㎟

· Pmin1 = 1.4 / fy = 0.00350 ⇒ MIN As = 3150.000 ㎟

· Pmin2 = 0.25√fck/fy = 0.00325 ⇒ MIN As = 2922.836 ㎟

· Pmin = MAX(Pmin1,Pmin2) = 0.00350 ⇒ MIN As = 3150.000 ㎟

4/3·Req As ⇒ MIN As = 2976.496 ㎟

∴ P<Pmin CASE ⇒ As=MIN(Pmin,4/3 Req.As) 이상배근

	1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
∴ USE As =		H	22	@	250	=	1548.400	㎟	[4	EA/M]
	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
	3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
		H	0	@	0	=	0.000	㎟	[0	EA/M]
					TOTAL	=	3096.800	㎟	∴	**O.K**

▣ 휨모멘트 검토

· c = a / β1 = 45.775 mm

· ε_t = ε_c × (d - c) / c = 0.003 × (900.000 - 45.775) / 45.775

= 0.0560

· ε_t = 0.0560 ≥ 0.005 이므로 인장지배 단면 ⇒ Øf = 0.85 적용

∴ Ø Mn = Øf·As·fy·(d - a/2) = 919.205 kN.m > Mu = 668.340 kN.m ∴ **O.K**

▣ 전단 검토

· Øv·Vc = Øv·1/6·√fck·B·d = 623.538 kN > Vu = 556.720 kN

· 1/2·Øv·Vc = 311.769 kN < Vu = 556.720 kN

∴ Vu < ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00344

· k = $- np + \sqrt{(np)^2 + 2np}$ = 0.197

· j = 1 - k / 3 = 0.934

· x = k·d = 177.042 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 6.178 MPa

· fs = Mo / (As·(D - x/3)) = 176.604 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 176.604 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 22 / 2 = 89.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 372.052 mm

· s_2 = 300·(280 / fst = 475.642 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 372.052 mn > 125.000 mm ∴ **O.K**

12.3 기초 2-벽체 단면검토(배기 및 배연 통로)

12.3.1 외측 벽체 상단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	670.370	350.540	994.770	439.400
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1266.667	1166.667	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
673.894	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0027] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 700.000 mm

· a = β1·c = 595.000 mm

· Cck = 0.85·fck·B·H = 29070000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 625.604 mm

· d" = X - H + d = 525.604 mm

· Cc = 0.85·fck·a·b = 13655.250 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 13170.549 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 5415.742 kN.m

· eb = Mb / Pb = 411.201 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1199.498 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1166.667 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 994.770 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 670.370 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 685.955 kN > Vu = 350.540 kN

· 1/2·Øv·Vc = 342.978 kN < Vu = 350.540 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00196

· k = - np + √((np)^2 + 2np) = 0.152

· j = 1 - k / 3 = 0.949

· x = k·d = 177.333 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.474 MPa

· fs = Mo / (As·(D - x/3)) = 173.093 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 173.093 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 228.708 mm

· s_2 = 300·(210 / fst) = 363.966 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 228.708 mn > 125.000 mm ∴ **O.K**

12.3.2 외측 벽체 상단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	442.490	350.540	1027.160	439.400
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1266.667	1166.667	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
430.790	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0027] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 700.000 mm

· a = β1·c = 595.000 mm

· Cck = 0.85·fck·B·H = 29070000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 625.604 mm

· d" = X - H + d = 525.604 mm

· Cc = 0.85·fck·a·b = 13655.250 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 13170.549 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 5415.742 kN.m

· eb = Mb / Pb = 411.201 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 956.394 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1166.667 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1027.160 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 442.490 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 687.141 kN > Vu = 350.540 kN

· 1/2·Øv·Vc = 343.571 kN < Vu = 350.540 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00196

· k = - np + √((np)^2 + 2np) = 0.152

· j = 1 - k / 3 = 0.949

· x = k·d = 177.333 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.474 MPa

· fs = Mo / (As·(D - x/3)) = 173.093 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 173.093 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 228.708 mm

· s_2 = 300·(210 / fst) = 363.966 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 228.708 mm > 125.000 mm ∴ **O.K**

12.3.3 외측 벽체 중앙부(-) Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	547.030	0.000	828.140	359.390
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1100.000	1000.000	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
660.553	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0031] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 600.000 mm

· a = β1·c = 510.000 mm

· Cck = 0.85·fck·B·H = 25245000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 542.595 mm

· d" = X - H + d = 442.595 mm

· Cc = 0.85·fck·a·b = 11704.500 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 11219.799 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 4151.557 kN.m

· eb = Mb / Pb = 370.021 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1103.148 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1000.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 828.140 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 547.030 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 684.447 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 342.224 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00229

· k = - np + √((np)^2 + 2np) = 0.164

· j = 1 - k / 3 = 0.945

· x = k·d = 164.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.636 MPa

· fs = Mo / (As·(D - x/3)) = 165.869 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 165.869 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 248.522 mm

· s_2 = 300·(210 / fst) = 379.818 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 248.522 mn > 125.000 mm ∴ **O.K**

12.3.4 외측 벽체 중앙부(-) Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	413.930	0.000	1044.960	359.390
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1100.000	1000.000	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
396.120	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0031] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 600.000 mm

· a = β1·c = 510.000 mm

· Cck = 0.85·fck·B·H = 25245000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 542.595 mm

· d" = X - H + d = 442.595 mm

· Cc = 0.85·fck·a·b = 11704.500 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 11219.799 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 4151.557 kN.m

· eb = Mb / Pb = 370.021 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 838.715 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1000.000 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1044.960 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 413.930 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 693.592 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 346.796 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00229

· k = - np + √((np)^2 + 2np) = 0.164

· j = 1 - k / 3 = 0.945

· x = k·d = 164.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.636 MPa

· fs = Mo / (As·(D - x/3)) = 165.869 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 165.869 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 248.522 mm

· s_2 = 300·(210 / fst) = 379.818 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 248.522 mm > 125.000 mm ∴ **O.K**

12.3.5 외측 벽체 하단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	566.690	294.940	1063.130	401.070
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1100.000	1000.000	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
533.039	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0031] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 600.000 mm

· a = β1·c = 510.000 mm

· Cck = 0.85·fck·B·H = 25245000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 542.595 mm

· d" = X - H + d = 442.595 mm

· Cc = 0.85·fck·a·b = 11704.500 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 11219.799 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 4151.557 kN.m

· eb = Mb / Pb = 370.021 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 975.634 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1000.000 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1063.130 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 566.690 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 694.358 kN > Vu = 294.940 kN

· 1/2·Øv·Vc = 347.179 kN > Vu = 294.940 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00229

· k = - np + √((np)^2 + 2np) = 0.164

· j = 1 - k / 3 = 0.945

· x = k·d = 164.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.174 MPa

· fs = Mo / (As·(D - x/3)) = 185.106 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 185.106 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 199.182 mm

· s_2 = 300·(210 / fst) = 340.346 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 199.182 mm > 125.000 mm ∴ **O.K**

12.3.6 외측 벽체 하단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	551.550	294.940	1080.560	401.070
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1100.000	1000.000	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
510.430	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0031] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 600.000 mm

· a = β1·c = 510.000 mm

· Cck = 0.85·fck·B·H = 25245000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 542.595 mm

· d" = X - H + d = 442.595 mm

· Cc = 0.85·fck·a·b = 11704.500 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 11219.799 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 4151.557 kN.m

· eb = Mb / Pb = 370.021 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 953.025 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1000.000 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1080.560 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 551.550 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 695.093 kN > Vu = 294.940 kN

· 1/2·Øv·Vc = 347.547 kN > Vu = 294.940 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00229

· k = - np + √((np)^2 + 2np) = 0.164

· j = 1 - k / 3 = 0.945

· x = k·d = 164.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.174 MPa

· fs = Mo / (As·(D - x/3)) = 185.106 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 185.106 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 19 / 2 = 90.50 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 199.182 mm

· s_2 = 300·(210 / fst) = 340.346 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 199.182 mm > 125.000 mm ∴ **O.K**

12.3.7 내부 벽체 상단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	313.350	320.210	1458.090	149.870
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	700.000	620.000	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
214.904	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0049] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 372.000 mm

· a = β1·c = 316.200 mm

· Cck = 0.85·fck·B·H = 16065000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 342.378 mm

· d" = X - H + d = 262.378 mm

· Cc = 0.85·fck·a·b = 7256.790 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 6772.089 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1799.756 kN.m

· eb = Mb / Pb = 265.761 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 477.282 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (620.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1458.090 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 313.350 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 462.618 kN > Vu = 320.210 kN

· 1/2·Øv·Vc = 231.309 kN < Vu = 320.210 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00370

· k = - np + √((np)^2 + 2np) = 0.203

· j = 1 - k / 3 = 0.932

· x = k·d = 125.860 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.120 MPa

· fs = Mo / (As·(D - x/3)) = 113.119 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 113.119 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 751.976 mm

· s_2 = 300·(280 / fst = 742.581 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 742.581 mm > 125.000 mm ∴ **O.K**

12.3.8 내부 벽체 상단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	27.610	320.210	1848.710	149.870
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	700.000	620.000	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
14.935	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0049] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 372.000 mm

· a = β1·c = 316.200 mm

· Cck = 0.85·fck·B·H = 16065000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 342.378 mm

· d" = X - H + d = 262.378 mm

· Cc = 0.85·fck·a·b = 7256.790 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 6772.089 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1799.756 kN.m

· eb = Mb / Pb = 265.761 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 277.313 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (620.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1848.710 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 27.610 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 478.669 kN > Vu = 320.210 kN

· 1/2·Øv·Vc = 239.335 kN < Vu = 320.210 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00370

· k = - np + √((np)^2 + 2np) = 0.203

· j = 1 - k / 3 = 0.932

· x = k·d = 125.860 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.120 MPa

· fs = Mo / (As·(D - x/3)) = 113.119 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 113.119 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 751.976 mm

· s_2 = 300·(280 / fst = 742.581 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 742.581 mn > 125.000 mm ∴ **O.K**

12.3.9 내부 벽체 하단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	422.890	320.210	1805.430	308.990
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	700.000	620.000	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
234.232	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0049] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 372.000 mm

· a = β1·c = 316.200 mm

· Cck = 0.85·fck·B·H = 16065000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 342.378 mm

· d" = X - H + d = 262.378 mm

· Cc = 0.85·fck·a·b = 7256.790 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 6772.089 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1799.756 kN.m

· eb = Mb / Pb = 265.761 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ # ∴ ####

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 496.610 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (620.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1805.430 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 422.890 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 476.891 kN > Vu = 320.210 kN

· 1/2·Øv·Vc = 238.446 kN < Vu = 320.210 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00370

· k = - np + √((np)^2 + 2np) = 0.203

· j = 1 - k / 3 = 0.932

· x = k·d = 125.860 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.494 MPa

· fs = Mo / (As·(D - x/3)) = 233.221 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 233.221 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 273.967 mm

· s_2 = 300·(280 / fst = 360.173 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 273.967 mn > 125.000 mm ∴ **O.K**

12.3.10 내부 벽체 하단부 Pmax

3 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	253.760	320.210	1882.690	308.990
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	700.000	620.000	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
134.786	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]
			H	19	@	250	=	1146.000	㎟	[4 EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0 EA/M]
			H	0	@	0	=	0.000	㎟	[0 EA/M]
						TOTAL	=	2292.000	㎟	
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4 EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0049] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 372.000 mm

· a = β1·c = 316.200 mm

· Cck = 0.85·fck·B·H = 16065000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 342.378 mm

· d" = X - H + d = 262.378 mm

· Cc = 0.85·fck·a·b = 7256.790 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 6772.089 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1799.756 kN.m

· eb = Mb / Pb = 265.761 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mm 로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mm ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 397.164 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? # 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (620.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? # ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1882.690 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 253.760 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 480.065 kN > Vu = 320.210 kN

· 1/2·Øv·Vc = 240.033 kN < Vu = 320.210 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토 (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00370

· k = - np + √((np)^2 + 2np) = 0.203

· j = 1 - k / 3 = 0.932

· x = k·d = 125.860 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 8.494 MPa

· fs = Mo / (As·(D - x/3)) = 233.221 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 233.221 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 273.967 mm

· s_2 = 300·(280 / fst = 360.173 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 273.967 mn > 125.000 mm ∴ **O.K**

12.4 기초 1-벽체 단면검토(대인피난연결통로)

12.4.1 좌측 벽체 상단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	621.530	586.340	1460.860	405.980
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1266.667	1166.667	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
425.455	0.850	#NAME?	0.75		

			1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
				H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴	USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
				H	0	@	0	=	0.000	㎟	[0	EA/M]
			3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
				H	0	@	0	=	0.000	㎟	[0	EA/M]
							TOTAL	=	2694.400	㎟		
∴	USE As'	=	1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0033] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 700.000 mm

· a = β1·c = 595.000 mm

· Cck = 0.85·fck·B·H = 29070000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 625.790 mm

· d" = X - H + d = 525.790 mm

· Cc = 0.85·fck·a·b = 13655.250 kN

· Cs = (fs - 0.85·fck)·As' = 583.824 kN

· Ts = fy·As = 1077.760 kN

· Pb = Cc + Cs - Ts = 13161.314 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 5583.023 kN.m

· eb = Mb / Pb = 424.200 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mm로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'
= #NAME? kN
∴ a = #NAME? mn ⇒ # ∴ ####

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 951.245 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ ####

· ε_t = ε_c × (d - c) / c = 0.003 × (1166.667 - #NAME?) / #NAME?
= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1460.860 kN ∴ ####

∴ Ø Mn = #NAME? kN.m #### Mu = 621.530 kN.m ∴ ####

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d
= 703.026 kN > Vu = 586.340 kN

· 1/2·Øv·Vc = 351.513 kN < Vu = 586.340 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00231

· k = - np + $\sqrt{((np)^2 + 2np)}$ = 0.164

· j = 1 - k / 3 = 0.945

· x = k·d = 191.333 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 3.848 MPa

· fs = Mo / (As·(D - x/3)) = 136.619 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 136.619 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2
= 100 - 22 / 2 = 89.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 353.921 mm

· s_2 = 300·(210 / fst) = 461.136 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 353.921 mn > 125.000 mm ∴ **O.K**

12.4.2 좌측 벽체 상단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	246.650	586.340	1731.820	405.980
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1266.667	1166.667	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
142.422	0.850	#NAME?	0.75		

		1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
			H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	2694.400	㎟		
∴	USE As'	= 1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0033] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 700.000 mm

· a = β1·c = 595.000 mm

· Cck = 0.85·fck·B·H = 29070000 N

· X (소성중심) = $\dfrac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 625.790 mm

· d" = X - H + d = 525.790 mm

· Cc = 0.85·fck·a·b = 13655.250 kN

· Cs = (fs - 0.85·fck)·As' = 583.824 kN

· Ts = fy·As = 1077.760 kN

· Pb = Cc + Cs - Ts = 13161.314 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 5583.023 kN.m

· eb = Mb / Pb = 424.200 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 668.212 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1166.667 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1731.820 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 246.650 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 712.950 kN > Vu = 586.340 kN

· 1/2·Øv·Vc = 356.475 kN < Vu = 586.340 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00231

· k = - np + √((np)^2 + 2np) = 0.164

· j = 1 - k / 3 = 0.945

· x = k·d = 191.333 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 3.848 MPa

· fs = Mo / (As·(D - x/3)) = 136.619 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 136.619 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 22 / 2 = 89.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 353.921 mm

· s_2 = 300·(210 / fst) = 461.136 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 353.921 mn > 125.000 mm ∴ **O.K**

12.2.3 좌측 벽체 하단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	712.370	691.680	1657.600	359.970
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1100.000	1000.000	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
429.760	0.850	#NAME?	0.75		

		1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
			H	22	@	250	=	1548.400	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	3096.800	㎟		
∴	USE As'	= 1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0042] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 600.000 mm

· a = β1·c = 510.000 mm

· Cck = 0.85·fck·B·H = 25245000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 540.174 mm

· d" = X - H + d = 440.174 mm

· Cc = 0.85·fck·a·b = 11704.500 kN

· Cs = (fs - 0.85·fck)·As' = 583.824 kN

· Ts = fy·As = 1238.720 kN

· Pb = Cc + Cs - Ts = 11049.604 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 4393.222 kN.m

· eb = Mb / Pb = 397.591 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 869.934 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1000.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1657.600 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 712.370 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 719.431 kN > Vu = 691.680 kN

· 1/2·Øv·Vc = 359.716 kN < Vu = 691.680 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00310

· k = - np + √((np)^2 + 2np) = 0.188

· j = 1 - k / 3 = 0.937

· x = k·d = 188.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.085 MPa

· fs = Mo / (As·(D - x/3)) = 124.011 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 124.011 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 22 / 2 = 89.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 412.524 mm

· s_2 = 300·(210 / fst) = 508.019 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 412.524 mn > 125.000 mm ∴ **O.K**

12.4.4 좌측 벽체 하단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	251.160	691.680	1803.020	359.970
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	1100.000	1000.000	100.000	80.000	1000.000
e (mm)	β1	Øf	Øv		
139.300	0.850	#NAME?	0.75		

		1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
			H	22	@	250	=	1548.400	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	3096.800	㎟		
∴	USE As'	= 1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0042] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 600.000 mm

· a = β1·c = 510.000 mm

· Cck = 0.85·fck·B·H = 25245000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 540.174 mm

· d" = X - H + d = 440.174 mm

· Cc = 0.85·fck·a·b = 11704.500 kN

· Cs = (fs - 0.85·fck)·As' = 583.824 kN

· Ts = fy·As = 1238.720 kN

· Pb = Cc + Cs - Ts = 11049.604 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 4393.222 kN.m

· eb = Mb / Pb = 397.591 mm

∴ e < eb 이므로, **압축파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 579.474 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (1000.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 1803.020 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 251.160 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 725.564 kN > Vu = 691.680 kN

· 1/2·Øv·Vc = 362.782 kN < Vu = 691.680 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (습윤환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00310

· k = - np + √((np)^2 + 2np) = 0.188

· j = 1 - k / 3 = 0.937

· x = k·d = 188.000 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 4.085 MPa

· fs = Mo / (As·(D - x/3)) = 124.011 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 124.011 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 100 - 22 / 2 = 89.00 mm

· s_1 = 375·(210 / fst) - 2.5·Cc = 412.524 mm

· s_2 = 300·(210 / fst) = 508.019 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 412.524 mn > 125.000 mm ∴ **O.K**

12.4.5 우측 벽체 상단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	537.900	598.150	586.180	268.100
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	866.667	786.667	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
917.636	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
			H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	2292.000	㎟		
∴	USE As'	= 1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0040] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 472.000 mm

· a = β1·c = 401.200 mm

· Cck = 0.85·fck·B·H = 19890000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 425.286 mm

· d" = X - H + d = 345.286 mm

· Cc = 0.85·fck·a·b = 9207.540 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 8722.839 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 2681.066 kN.m

· eb = Mb / Pb = 307.362 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1262.922 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (786.667 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 586.180 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 537.900 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 422.157 kN < Vu = 598.150 kN

· 1/2·Øv·Vc = 211.079 kN < Vu = 598.150 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mm ≤ 최대간격(600mm,d/2 이하) = 310 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 141.930 ㎟ [소요 전단철근]

· Required Av = 141.930 ㎟

· USE Av = H 16 × 2 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 422.157 kN + 492.528 kN

= 914.685 kN > Vu = 598.150 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00291

· k = - np + $\sqrt{(np)^2 + 2np}$ = 0.182

· j = 1 - k / 3 = 0.939

· x = k·d = 143.173 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.068 MPa

· fs = Mo / (As·(D - x/3)) = 158.297 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 158.297 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 487.060 mm

· s_2 = 300·(280 / fst = 530.648 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 487.060 mm > 125.000 mm ∴ **O.K**

12.4.6 우측 벽체 상단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	233.640	598.150	627.410	268.100
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	866.667	786.667	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
372.388	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
			H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	2292.000	㎟		
∴	USE As'	= 1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0040] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 472.000 mm

· a = β1·c = 401.200 mm

· Cck = 0.85·fck·B·H = 19890000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 425.286 mm

· d" = X - H + d = 345.286 mm

· Cc = 0.85·fck·a·b = 9207.540 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 8722.839 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 2681.066 kN.m

· eb = Mb / Pb = 307.362 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 717.674 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (786.667 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 627.410 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 233.640 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 423.525 kN < Vu = 598.150 kN

· 1/2·Øv·Vc = 211.763 kN < Vu = 598.150 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mm ≤ 최대간격(600mm,d/2 이하) = 310 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 140.827 ㎟ [소요 전단철근]

· Required Av = 140.827 ㎟

· USE Av = H 16 × 2 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 423.525 kN + 492.528 kN

= 916.053 kN > Vu = 598.150 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00291

· k = - np + √((np)^2 + 2np) = 0.182

· j = 1 - k / 3 = 0.939

· x = k·d = 143.173 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 5.068 MPa

· fs = Mo / (As·(D - x/3)) = 158.297 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 158.297 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 487.060 mm

· s_2 = 300·(280 / fst = 530.648 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 487.060 mn > 125.000 mm ∴ **O.K**

12.4.7 우측 벽체 중앙부(+) Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	415.600	0.000	615.130	268.100
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	700.000	620.000	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
675.630	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
			H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	2292.000	㎟		
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0049] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 372.000 mm

· a = β1·c = 316.200 mm

· Cck = 0.85·fck·B·H = 16065000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 342.378 mm

· d" = X - H + d = 262.378 mm

· Cc = 0.85·fck·a·b = 7256.790 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 6772.089 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1799.756 kN.m

· eb = Mb / Pb = 265.761 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 938.008 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (620.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 615.130 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 415.600 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 427.979 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 213.990 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00370

· k = - np + √((np)^2 + 2np) = 0.203

· j = 1 - k / 3 = 0.932

· x = k·d = 125.860 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.370 MPa

· fs = Mo / (As·(D - x/3)) = 202.357 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 202.357 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 342.635 mm

· s_2 = 300·(280 / fst = 415.108 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 342.635 mn > 125.000 mm ∴ **O.K**

12.4.8 우측 벽체 중앙부(+) Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	375.010	0.000	684.450	268.100
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	700.000	620.000	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
547.900	0.850	#NAME?	0.75		

		1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]
			H	19	@	250	=	1146.000	㎟	[4	EA/M]
∴ USE As	=	2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	2292.000	㎟		
∴ USE As'	=	1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0049] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 372.000 mm

· a = β1·c = 316.200 mm

· Cck = 0.85·fck·B·H = 16065000 N

· X (소성중심) = $\frac{(Cck \cdot H/2 + fy \cdot As' \cdot (H - d') + fy \cdot As \cdot dc)}{(Cck + fy \cdot As' + fy \cdot As)}$ = 342.378 mm

· d" = X - H + d = 262.378 mm

· Cc = 0.85·fck·a·b = 7256.790 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 916.800 kN

· Pb = Cc + Cs - Ts = 6772.089 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1799.756 kN.m

· eb = Mb / Pb = 265.761 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 810.278 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (620.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 684.450 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 375.010 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 430.827 kN > Vu = 0.000 kN

· 1/2·Øv·Vc = 215.414 kN > Vu = 0.000 kN

∴ Vu < 1/2ØVc CASE ⇒ **전단철근 불필요**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00370

· k = - np + √((np)^2 + 2np) = 0.203

· j = 1 - k / 3 = 0.932

· x = k·d = 125.860 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 7.370 MPa

· fs = Mo / (As·(D - x/3)) = 202.357 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 202.357 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 19 / 2 = 70.50 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 342.635 mm

· s_2 = 300·(280 / fst = 415.108 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 342.635 mn > 125.000 mm ∴ **O.K**

12.4.9 우측 벽체 하단부 Mmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	676.820	685.680	844.010	456.460
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	700.000	620.000	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
801.910	0.850	#NAME?	0.75		

		1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
			H	22	@	250	=	1548.400	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	3096.800	㎟		
∴	USE As'	= 1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0061] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 372.000 mm

· a = β1·c = 316.200 mm

· Cck = 0.85·fck·B·H = 16065000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 337.622 mm

· d" = X - H + d = 257.622 mm

· Cc = 0.85·fck·a·b = 7256.790 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 1238.720 kN

· Pb = Cc + Cs - Ts = 6450.169 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1914.897 kN.m

· eb = Mb / Pb = 296.875 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1059.532 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (620.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 844.010 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 676.820 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 437.384 kN < Vu = 685.680 kN

· 1/2·Øv·Vc = 218.692 kN < Vu = 685.680 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mm ≤ 최대간격(600mm,d/2 이하) = 310 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 200.239 ㎟ [소요 전단철근]

· Required Av = 200.239 ㎟

· USE Av = H 16 × 2 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 437.384 kN + 492.528 kN

= 929.912 kN > Vu = 685.680 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00499

· k = - np + √((np)^2 + 2np) = 0.232

· j = 1 - k / 3 = 0.923

· x = k·d = 143.840 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 11.095 MPa

· fs = Mo / (As·(D - x/3)) = 257.664 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 257.664 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 22 / 2 = 69.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 235.007 mm

· s_2 = 300·(280 / fst = 326.006 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 235.007 mn > 125.000 mm ∴ **O.K**

12.4.10 우측 벽체 하단부 Pmax

▣ 휨모멘트 검토

fck (MPa)	fy (MPa)	Mu (kN.m)	Vu (kN)	Pu (kN.m)	Mo (kN.m)
27	400	676.820	685.680	844.010	456.460
B (mm)	H (mm)	d (mm)	dc (mm)	d' (mm)	dd (mm)
1000.000	700.000	620.000	80.000	100.000	620.000
e (mm)	β1	Øf	Øv		
801.910	0.850	#NAME?	0.75		

		1단	H	22	@	250	=	1548.400	㎟	[4	EA/M]
			H	22	@	250	=	1548.400	㎟	[4	EA/M]
∴	USE As	= 2단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
		3단	H	0	@	0	=	0.000	㎟	[0	EA/M]
			H	0	@	0	=	0.000	㎟	[0	EA/M]
						TOTAL	=	3096.800	㎟		
∴	USE As'	= 1단	H	19	@	250	=	1146.000	㎟	[4	EA/M]

□ 철근비 검토

∴ Pmin [0.0015] < Puse [0.0061] < Pmax [0.0800] ∴ **O.K**

□ 평형상태 검토

· c = 600 / (600 + fy)·d = 372.000 mm

· a = β1·c = 316.200 mm

· Cck = 0.85·fck·B·H = 16065000 N

· X (소성중심) = $\dfrac{(Cck\cdot H/2 + fy\cdot As'\cdot(H - d') + fy\cdot As\cdot dc)}{(Cck + fy\cdot As' + fy\cdot As)}$ = 337.622 mm

· d" = X - H + d = 257.622 mm

· Cc = 0.85·fck·a·b = 7256.790 kN

· Cs = (fs - 0.85·fck)·As' = 432.099 kN

· Ts = fy·As = 1238.720 kN

· Pb = Cc + Cs - Ts = 6450.169 kN

· Mb = Cc·(d - a/2 - d") + Cs·(d - d' - d") + Ts·d" = 1914.897 kN.m

· eb = Mb / Pb = 296.875 mm

∴ e > eb 이므로, **인장파괴영역**

□ 공칭강도 검토

· a = #NAME? mn로 가정하여 시산법으로 구한다.

· c = a / β1 = #NAME? mm

· fs = MIN (600·(d - c) / c, 400) = #NAME? MPa

· fs' = MIN (600·(c - d') / c, 400) = #NAME? MPa

· Pn = (0.85·fck·a·B·(d - a/2) + As'·(fs' - 0.85·fck)·(d - d')) / e'

= #NAME? kN

∴ a = #NAME? mn ⇒ **#** ∴ **####**

· Cc = 0.85·fck·a·b = #NAME? kN

· Cs = (fs' - 0.85·fck)·As' = #NAME? kN

· Ts = fs·As = #NAME? kN

· Mn = Cc·(d - a/2) + Cs·(d - d') = #NAME? kN.m

· e' = e + X - dc = 1059.532 mm

· 편심오차 = | e' - Mn / Pn | = #NAME? ## 0.001 ∴ **####**

· ε_t = ε_c × (d - c) / c = 0.003 × (620.000 - #NAME?) / #NAME?

= #NAME?

· ε_t = #NAME? ## ⇒ Øf = #NAME? 적용

∴ Ø Pn = #NAME? kN #### Pu = 844.010 kN ∴ **####**

∴ Ø Mn = #NAME? kN.m #### Mu = 676.820 kN.m ∴ **####**

▣ 전단 검토

· Øv·Vc = Øv·1/6·(1 + Pu / (14·Ag))·√fck·B·d

= 437.384 kN < Vu = 685.680 kN

· 1/2·Øv·Vc = 218.692 kN < Vu = 685.680 kN

∴ Vu > ØVc CASE ⇒ **전단철근 필요**

· 전단철근 간격 s = 150 mm ≤ 최대간격(600mm,d/2 이하) = 310 mm ∴ **O.K**

· 0.35·Bw·s / fyt = 131.250 ㎟ [최소 전단철근]

· (Vu - ØVc)·s / Øv·fyt·d = 200.239 ㎟ [소요 전단철근]

· Required Av = 200.239 ㎟

· USE Av = H 16 × 2 EA/M = 397.200 ㎟ ∴ **O.K**

∴ Ø Vn = Ø Vc + Ø Vs = 437.384 kN + 492.528 kN

= 929.912 kN > Vu = 685.680 kN ∴ **O.K**

▣ 사용성 검토 (균열방지 인장철근 간격검토) (건조환경)

· n = Es / Ec = 200000 / 26702 = 7

· p = As / (B × D) = 0.00499

· k = - np + √((np)^2 + 2np) = 0.232

· j = 1 - k / 3 = 0.923

· x = k·d = 143.840 mm

· fc = 2·Mo / (B·x·(D - x/3)) = 11.095 MPa

· fs = Mo / (As·(D - x/3)) = 257.664 MPa

· fst = fs·(H - dc_min - x)/(D - x) = 257.664 MPa

· Cc (인장철근 표면과 콘크리트 표면사이의 최소두께) = dc_min - 주철근직경 / 2

= 80 - 22 / 2 = 69.00 mm

· s_1 = 375·(280 / fst) - 2.5·Cc = 235.007 mm

· s_2 = 300·(280 / fst = 326.006 mm

∴ 최외단철근 소요중심간격 (s) = MIN (S_1, S_2) = 235.007 mn > 125.000 mm ∴ **O.K**

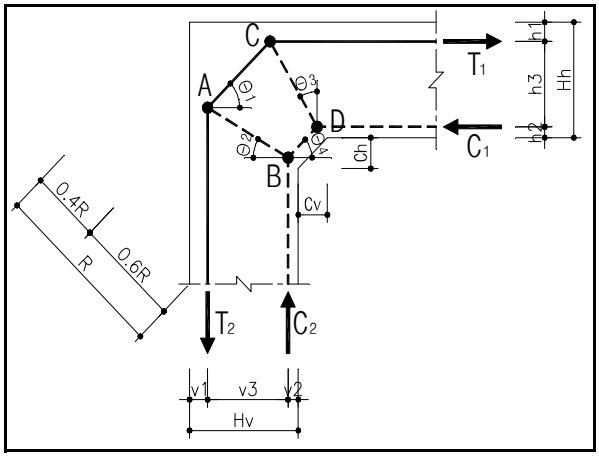
13. 우각부 보강검토

13.1 상부슬래브 (기초 2 - 외측 벽체부) (배기 및 배연 통로)

(1) 계산조건

슬래브두께	H_h	=	1000.00 mm	벽체 높이	H_v	=	1100.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	820.00 mm	벽체측 우력 거리	v_3	=	920.00 mm
수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	670.370 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1486.61 mm

② 사잇각

θ_1 = 45.00°

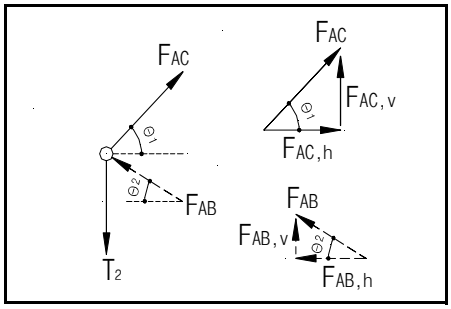
θ_2 = 6.83°

θ_3 = 14.38°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

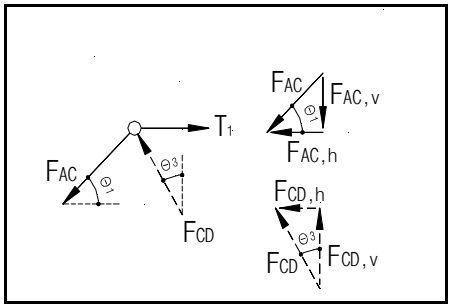
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\theta_2 \Rightarrow \quad F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \frac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$$

$$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\theta = F_{CD} \cdot \cos\theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\theta_1}{\cos\theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\theta_1 + F_{AC} \times \frac{\sin\theta_1}{\cos\theta_3} \times \sin\theta_3$

$= F_{AC}(\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{670.370}{0.820} =$ 817.524 kN

$T_2 = \frac{M_u}{v_3} = \frac{670.370}{0.920} =$ 728.663 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2} =$ 920.285 kN

식 ⑥ 으로부터

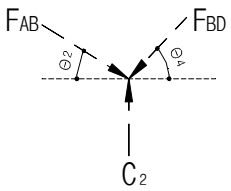
$F_{AC} = \frac{T_1}{\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3} =$ 920.285 kN

따라서 F_{AC} = **920.285** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 655.389 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 920.285 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 671.773 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	920.285	타이
AB	-655.389	스트럿
BD	-920.285	스트럿
CD	-671.773	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 920.285 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{920{,}285.022}{0.85 \times 400} = 2{,}706.72 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	250	=	0.00	mm^2 (1 cycle)
	= H	19	@	250	=	1,146.00	mm^2 (2 cycle)
우각부철근 As	= H	25	@	250	=	2,026.80	mm^2 (1 단)
	= H	0	@	0	=	0.00	mm^2 (2 단)
				합계	=	**3,172.80**	mm^2

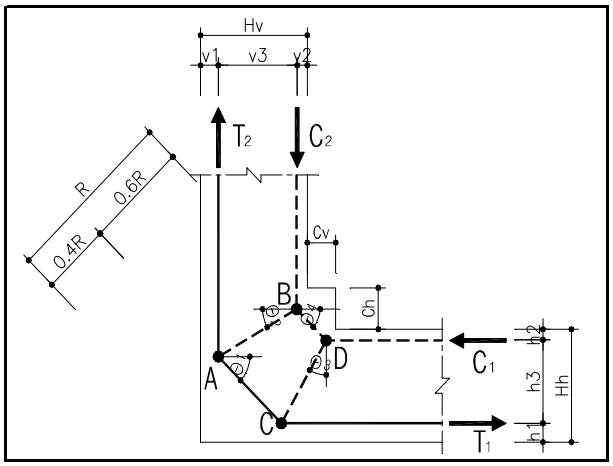
$A_{s,used}$ = 3,172.80 mm^2 > 2,706.72 mm^2 ……O.K

13.2 하부슬래브(기초 2 - 외측 벽체부) (배기 및 배연 통로)

(1) 계산조건

슬래브두께	H_h	=	1000.00 mm	벽체 높이	H_v	=	1100.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	820.00 mm	벽체측 우력 거리	v_3	=	920.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	566.690 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1486.61 mm

② 사잇각

Θ_1 = 45.00°

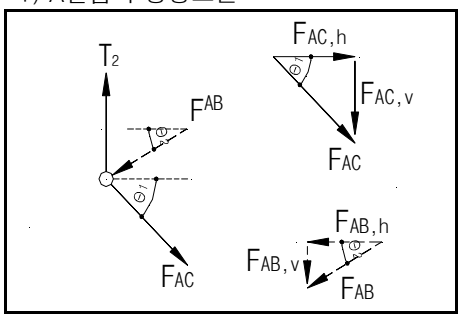
Θ_2 = 9.39°

Θ_3 = 17.10°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

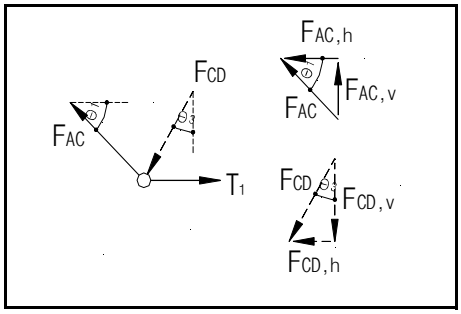
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\Theta_2 \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\theta = F_{CD} \cdot \cos\theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\theta_1 + F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3} \times \sin\theta_3$

$= F_{AC}(\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \dfrac{M_u}{h_3} = \dfrac{566.690}{0.820} =$ 691.085 kN

$T_2 = \dfrac{M_u}{v_3} = \dfrac{566.690}{0.920} =$ 615.967 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \dfrac{T_2}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2} =$ 747.445 kN

식 ⑥ 으로부터

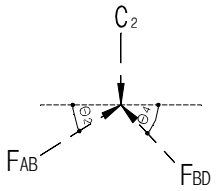
$F_{AC} = \dfrac{T_1}{\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3} =$ 747.445 kN

따라서 $F_{AC} =$ **747.445** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 535.708 \quad kN$$



- 스트럿(BD)의 단면력 산정

$\Sigma V = 0$:

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 747.445 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 552.959 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	**747.445**	타이
AB	**-535.708**	스트럿
BD	**-747.445**	스트럿
CD	**-552.959**	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 747.445 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{747,444.991}{0.85 \times 400} = 2,198.37 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	250	=	0.00	mm^2	(1 cycle)
	= H	19	@	250	=	1,146.00	mm^2	(2 cycle)
우각부철근 As	= H	22	@	250	=	1,548.40	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**2,694.40**	mm^2	

$A_{s,used}$ = 2,694.40 mm^2 > 2,198.37 mm^2 ……O.K

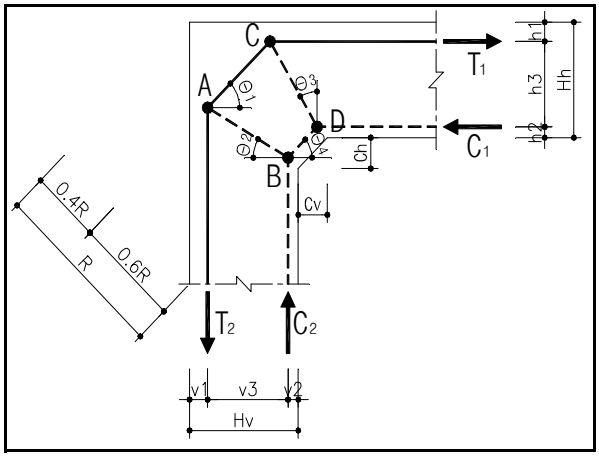
13. 우각부 보강검토

13.3 상부슬래브 (기초 1 - 외측 벽체부) (대인피난연결통로)

(1) 계산조건

슬래브두께	H_h	=	1000.00 mm	벽체 높이	H_v	=	1100.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	820.00 mm	벽체측 우력 거리	v_3	=	920.00 mm
수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	537.900 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1486.61 mm

② 사잇각

θ_1 = 45.00°

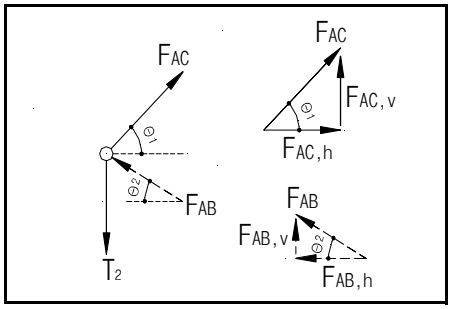
θ_2 = 6.83°

θ_3 = 14.38°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

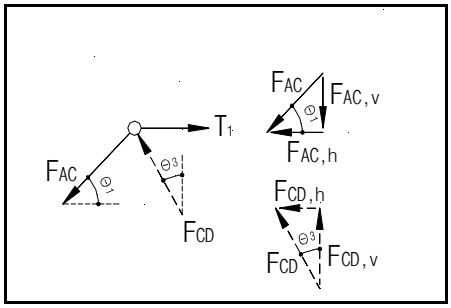
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\theta_2 \Rightarrow \quad F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \frac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$$

$$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\theta = F_{CD} \cdot \cos\theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\theta_1}{\cos\theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\theta_1 + F_{AC} \times \frac{\sin\theta_1}{\cos\theta_3} \times \sin\theta_3$

$= F_{AC}(\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{537.900}{0.820} =$ 655.976 kN

$T_2 = \frac{M_u}{v_3} = \frac{537.900}{0.920} =$ 584.674 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2} =$ 738.430 kN

식 ⑥ 으로부터

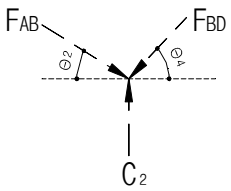
$F_{AC} = \frac{T_1}{\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3} =$ 738.430 kN

따라서 F_{AC} = **738.430** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 525.879 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 738.430 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 539.026 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	738.430	타이
AB	-525.879	스트럿
BD	-738.430	스트럿
CD	-539.026	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 738.430 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{738,429.992}{0.85 \times 400} = 2,171.85 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	250	=	0.00	mm^2	(1 cycle)
	= H	19	@	250	=	1,146.00	mm^2	(2 cycle)
우각부철근 As	= H	25	@	250	=	2,026.80	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**3,172.80**	mm^2	

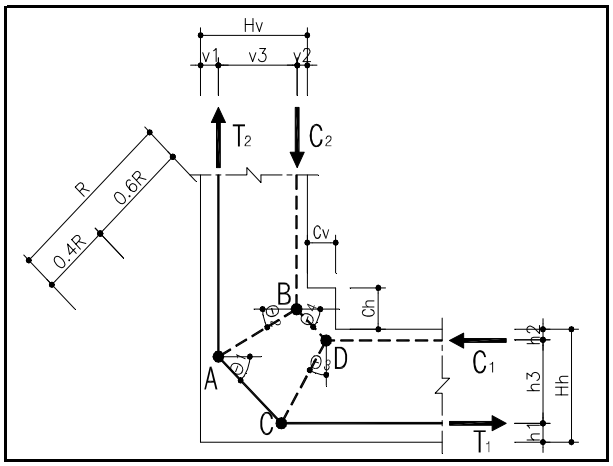
$A_{s,used}$ = 3,172.80 mm^2 > 2,171.85 mm^2 ……O.K

13.4 하부슬래브 (기초 1 - 외측 벽체부) (대인피난연결통로)

(1) 계산조건

슬래브두께	H_h	=	1000.00 mm	벽체 높이	H_v	=	1100.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	820.00 mm	벽체측 우력 거리	v_3	=	920.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	712.370 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1486.61 mm

② 사잇각

Θ_1 = 45.00°

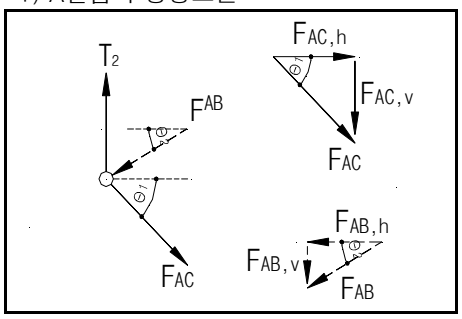
Θ_2 = 9.39°

Θ_3 = 17.10°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

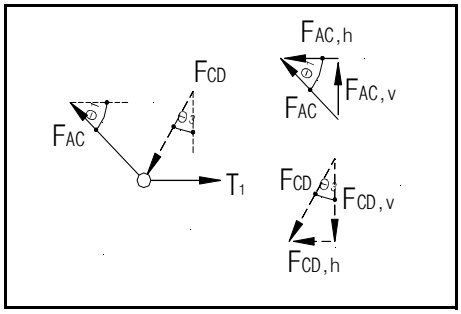
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\Theta_2 \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\theta = F_{CD} \cdot \cos\theta_3$ => $F_{CD} = F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\theta_1 + F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3} \times \sin\theta_3$

$= F_{AC}(\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \dfrac{M_u}{h_3} = \dfrac{712.370}{0.820} =$ 868.744 kN

$T_2 = \dfrac{M_u}{v_3} = \dfrac{712.370}{0.920} =$ 774.315 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \dfrac{T_2}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2} =$ 939.592 kN

식 ⑥ 으로부터

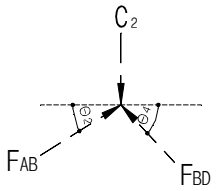
$F_{AC} = \dfrac{T_1}{\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3} =$ 939.592 kN

따라서 F_{AC} = **939.592** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 673.424 \quad kN$$



- 스트럿(BD)의 단면력 산정

$\Sigma V = 0$:

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 939.592 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 695.109 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	**939.592**	타이
AB	**-673.424**	스트럿
BD	**-939.592**	스트럿
CD	**-695.109**	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 939.592 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{939,591.997}{0.85 \times 400} = 2,763.51 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	250	=	0.00	mm^2	(1 cycle)
	= H	22	@	250	=	1,548.40	mm^2	(2 cycle)
우각부철근 As	= H	25	@	250	=	2,026.80	mm^2	(1 단)
	= H		@		=	0.00	mm^2	(2 단)
				합계	=	**3,575.20**	mm^2	

$A_{s,used}$ = 3,575.20 mm^2 > 2,763.51 mm^2 ……O.K

14. 배력철근 검토

(1) 온도, 수축철근

-벽 체 : ρmin = 0.0020

-슬 래 브 : ρmin = 0.0020

- 주철근량 미만

(2) 배력철근

- 주철근의 20%이상

(3) 부재별 온도 / 배력철근

14.1 상부슬래브

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
단부	H	19@	125	=	2292.000	458.400	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중앙부	H	22@	125	=	3096.800	619.360	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
지점부	H	25@	125	=	4053.600	810.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

14.2 하부 슬래브 : 기초 2

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
단부	H	19@	125	=	2292.000	458.400	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
지간 중앙부	H	19@	125	=	2292.000	458.400	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중앙 벽체부	H	25@	125	=	4053.600	810.720	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

14.3 하부 슬래브 : 기초 1

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
단부	H	22@	125	=	3096.800	619.360	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
지간 중앙부	H	19@	125	=	2292.000	458.400	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중앙 기둥부	H	22@	125	=	3096.800	619.360	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

14.4 외측 벽체 : 기초 2

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
상 단	H	19@	125	=	2292.000	458.400	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
중 앙	H	19@	125	=	2292.000	458.400	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
하 단	H	19@	125	=	2292.000	458.400	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

14.5 외측 벽체 : 기초 1

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
상 단	H	22@	125	=	3096.800	619.360	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
하 단	H	22@	125	=	3096.800	619.360	1800.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

14.6 내부 벽체

구 분	사용주철근 (mm^2)					필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)						검토
상 단	H	19@	125	=	2292.000	458.400	1400.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	
하 단	H	19@	125	=	2292.000	458.400	1400.000	인장	H	16@	150	=	1324.000	O.K
								압축	H	16@	300	=	662.000	

15. 사용성 검토

부 재	최소두께 또는 높이 t (mm)			
	단순지지	일단연속	양단연속	캔틸레버
일방향 슬래브	L / 20	L / 24	L / 28	L / 10
보	L / 16	L / 18.5	L / 21	L / 8

부 재	지간 L (mm)	최소두께 t (mm)	사용두께 t (mm)	평 가
상부 슬래브	3250.00	135.42	1000.00	O.K
하부 슬래브	3250.00	135.42	1000.00	O.K
외측 벽체	4100.00	170.83	1100.00	O.K
내부 벽체	1200.00	50.00	700.00	O.K

16. 지지력 검토

16.1 하중 산정 : 기초 2 (배기 및 배연 통로)

16.1.1 고정하중

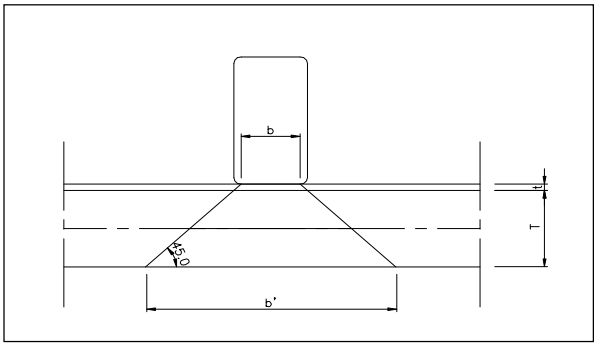
(1) 구체자중(부력검토 참조) = 660.00 / 11.700 = 56.410 kN/m^2

(2) 상부연직하중(하중산정 참조) = 201.425 kN/m^2 (지하수위 미고려시)

(3) 아스콘 포장 = 0.00 x 23.000 = 0.000 kN/m^2

16.1.2 활하중

- 도로 노면 활하중 = 10.0 kN/m^2
- 지하차도 내부 활하중(DB-24)

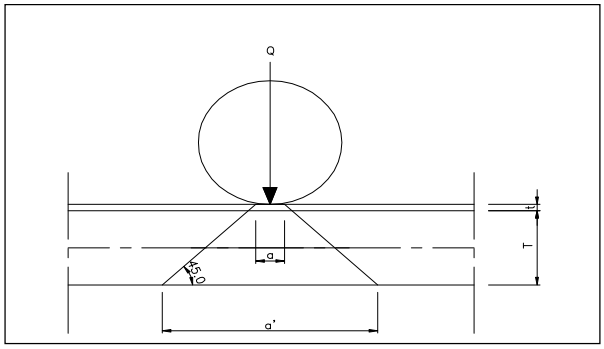


t = 0.0 mm (지하차도내부 포장두께)

T = 1000.0 mm (하부 슬래브 두께)

b' = 0.500 + 2 x (1.000 + 0.000) x cot 45°

= 2.50 m



a' = 0.200 + 2 x (1.000 + 0.000) x cot 45°

= 2.20 m

Qz' = 96.000 / (2.500 x 2.200) = 17.45 kN/m^2

16.2 허용 지지력 검토

(1) 최대 지반반력

Qmax = 56.410 + 201.425 + 0.000 + 10.000 + 17.455

= 285.290 kN/m^2

220

(2) 지반의 허용 지지력

Qmax = 285.290 kN/m^2 < Qa = 700.000 kN/m^2 ∴ **O.K !!**

(지반조사 보고서 참조)

16.3 하중 산정 : 기초 1 (대인피난연결통로)

16.3.1 고정하중

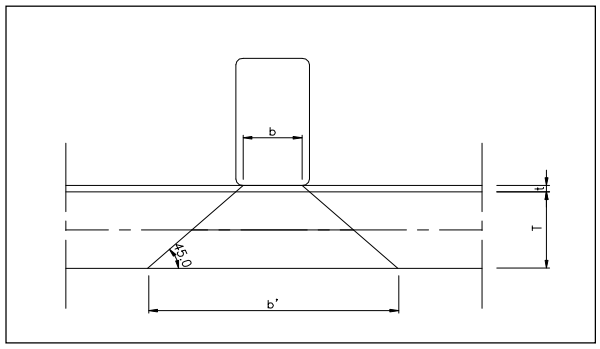
(1) 구체자중(부력검토 참조) = 451.00 / 4.200 = 107.381 kN/m^2

(2) 상부연직하중(하중산정 참조) = 201.425 kN/m^2 (지하수위 미고려시)

(3) 아스콘 포장 = 0.00 x 23.000 = 0.000 kN/m^2

16.3.2 활하중

- 도로 노면 활하중 = 0.0 kN/m^2
- 지하차도 내부 활하중(DB-24)

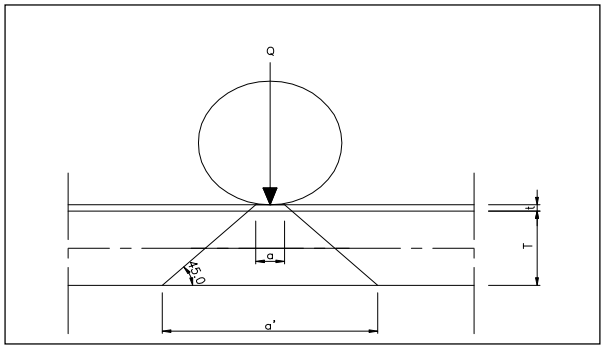


t = 0.0 mm (지하차도내부 포장두께)

T = 1000.0 mm (하부 슬래브 두께)

b' = 0.500 + 2 x (1.000 + 0.000) x cot 45°

= 2.50 m



a' = 0.200 + 2 x (1.000 + 0.000) x cot 45°

= 2.20 m

Qz' = 96.000 / (2.500 x 2.200) = 17.45 kN/m^2

16.4 허용 지지력 검토

(1) 최대 지반반력

Qmax = 107.381 + 201.425 + 0.000 + 0.000 + 17.455

= 326.261 kN/m^2

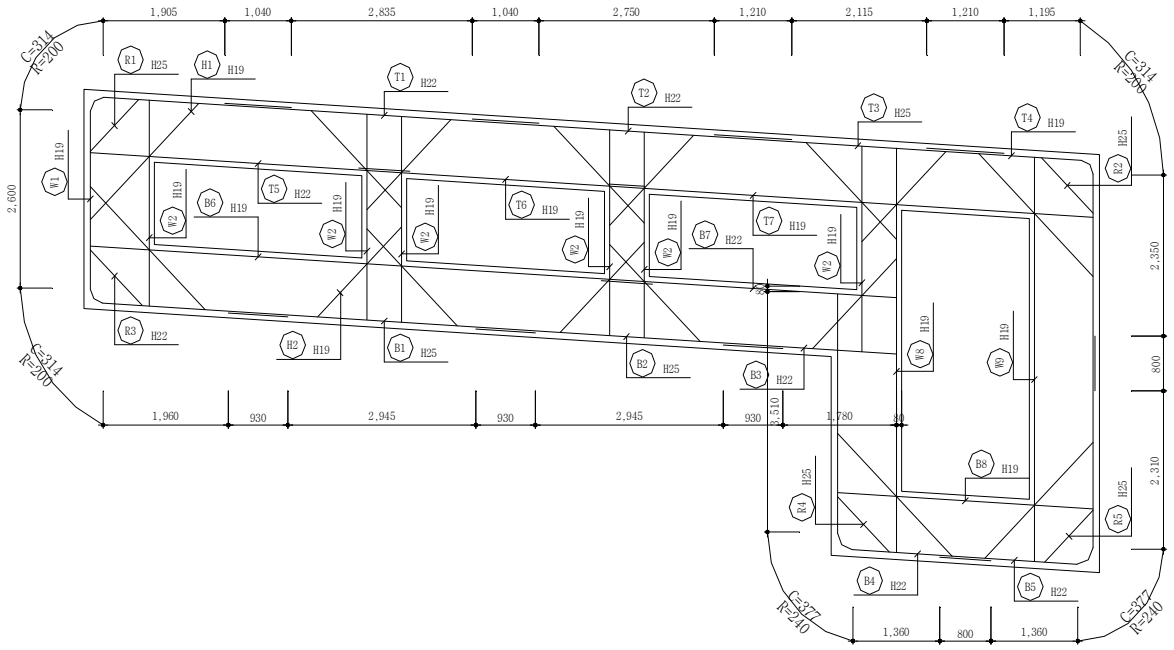
(2) 지반의 허용 지지력

Qmax = 326.261 kN/m^2 < Qa = 700.000 kN/m^2 ∴ **O.K !!**

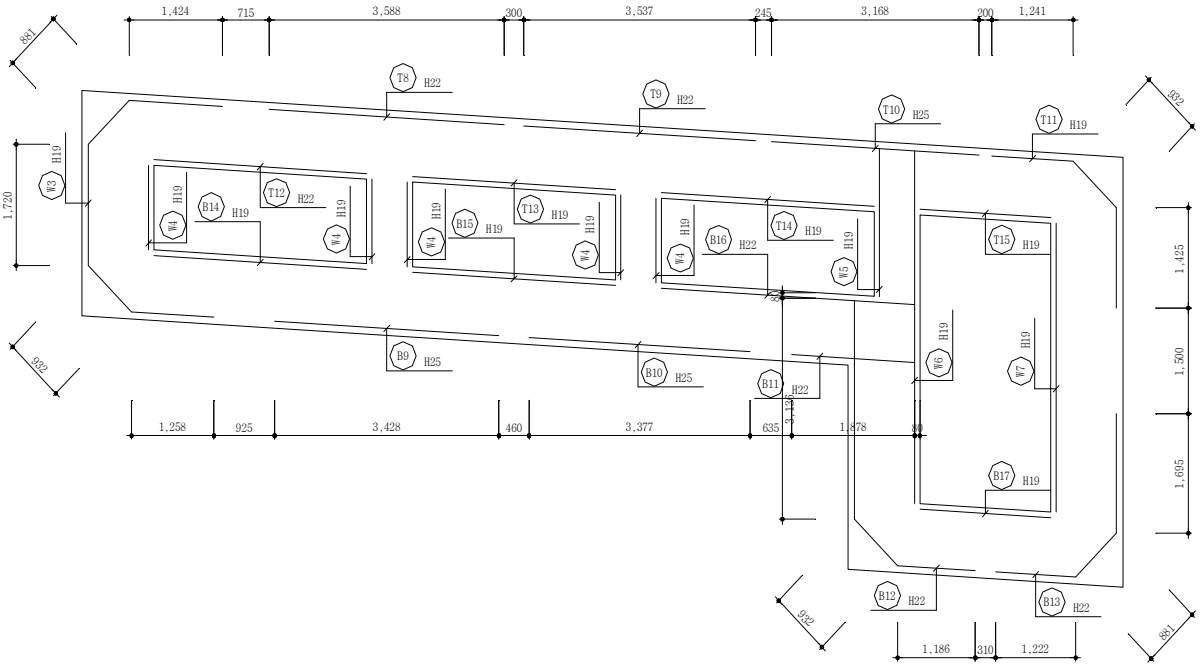
(지반조사 보고서 참조)

17. 주철근조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



1.25 개구부 보강거더

목 차

1. 설계조건

2. 개구부 보강거더 현황

3. 보강거더 검토

4. 기둥 검토

1. 설계조건

1.1 구조형식 : 철근 콘크리트 BOX 구조물

1.2 재료 중량

철근 콘크리트	24.50 kN/m^3	역청포장	23.00 kN/m^3
Mortar	21.00 kN/m^3	지 하 수	10.00 kN/m^3

1.3 사용재료의 강도

콘크리트	설계강도(fck)	27 MPa
	탄성계수(Ec)	$E_c = 8{,}500 \times \sqrt[3]{(fck + 4)} =$ 26702 MPa
철 근	설계강도(fy)	400 MPa
	탄성계수(Es)	2.0E+05 MPa

1.4 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력설계법 : 사용성검토 (처짐, 균열, 우각부보강 등)

1.5 사용프로그램

- MIDAS Civil 2009

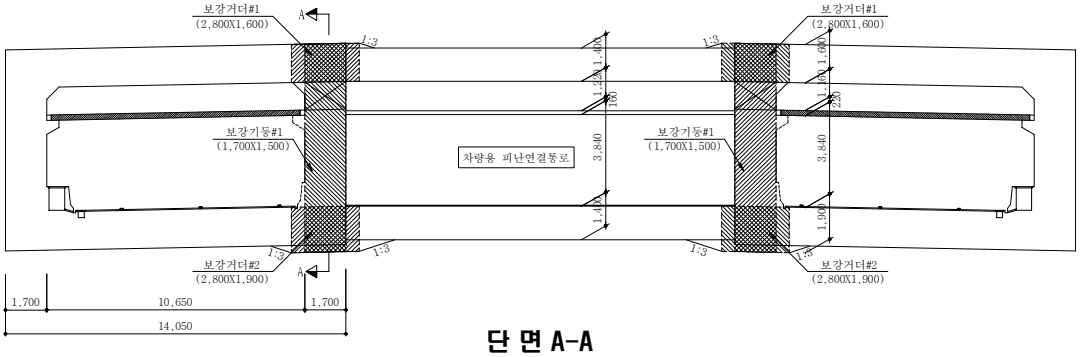
1.6 참고문헌

- 콘크리트 구조설계기준.해설 : 한국콘크리트학회(2012)

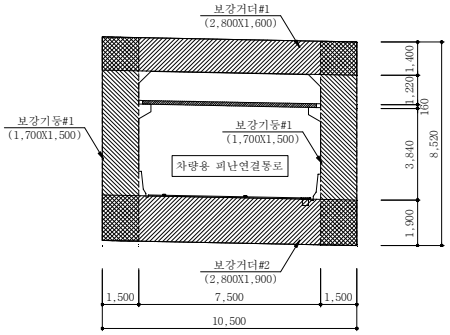
2. 거더현황

2.1 현황

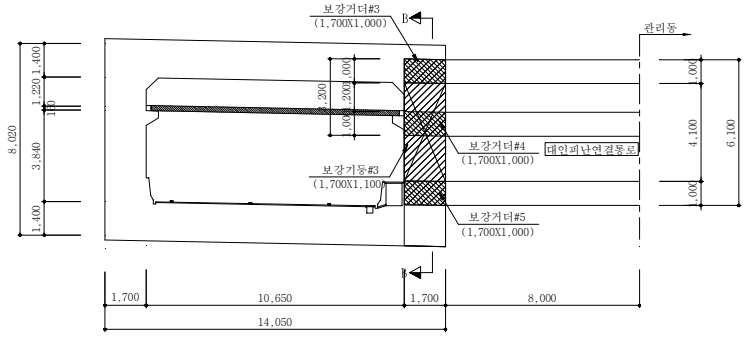
보 강 거 더 및 보 강 기 둥 [차량용 피난연결통로]



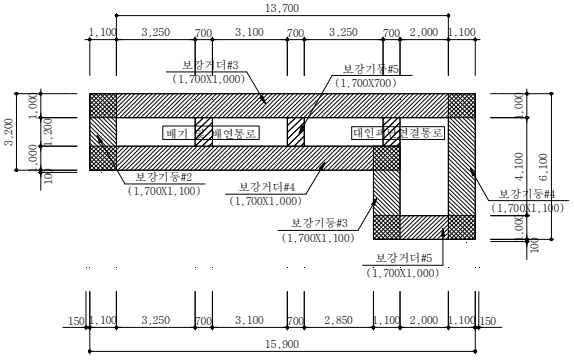
단 면 A-A



보 강 거 더 및 보 강 기 둥 [대인피난연결통로]



단 면 B-B



2.2 보강거더

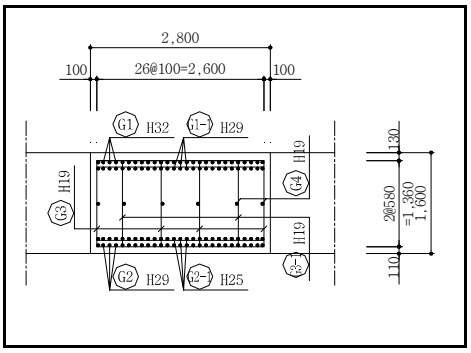
거더 No.	구분	거더제원(mm)		순지간 (m)	등분포하중(kN.m)		비고 (부재력산정위치)
		폭	높이		계수하중	사용하중	
1	차량용 피난연결통로 - 보강거더 #1	2800	1600	7.500	2514.00	1647.43	Ramp(B6) : STA.0+700.00
2	차량용 피난연결통로 - 보강거더 #2	2800	1900	7.500	2805.64	1890.47	Ramp(B6) : STA.0+700.00
3	대인피난연결통로 - 보강거더 #3	1700	1000	3.250	2514.00	1647.43	Ramp(B6) : STA.0+700.00
4	대인피난연결통로 - 보강거더 #4	1700	1000	3.250	2560.86	1761.49	Ramp(B6) : STA.0+700.00
5	대인피난연결통로 - 보강거더 #5	1700	1000	2.000	2805.64	1890.47	Ramp(B6) : STA.0+700.00

2.3 보강기둥

기둥 No.	구분	기둥제원(mm)		기둥지지 지간 (m)	축하중(kN)		비고 (부재력산정위치)
		가로	세로		계수하중	사용하중	
1	차량용 피난연결통로 - 보강기둥 #1	1700	1500	5.250	14729.610	9924.968	Ramp(B6) : STA.0+700.00
2	대인피난연결통로 - 보강기둥 #2	1700	1100	2.725	6978.344	4800.060	Ramp(B6) : STA.0+700.00
3	대인피난연결통로 - 보강기둥 #3	1700	1100	2.100	5891.844	3969.987	Ramp(B6) : STA.0+700.00
4	대인피난연결통로 - 보강기둥 #4	1700	1100	2.100	5891.844	3969.987	Ramp(B6) : STA.0+700.00
5	대인피난연결통로 - 보강기둥 #5	1700	700	3.875	9923.333	6825.774	Ramp(B6) : STA.0+700.00

3. 거더설계

3.1 차량용 피난연결통로 - 벽체 개구부보강거더#1



B = 2,800 mm, H1 = 1,600 mm (정모멘트부)
H2 = 1,600 mm (부모멘트부)

d = 1,441 mm (정모멘트부) d = 1,420 mm (부모멘트부)

d'= 159 mm (정모멘트부) d'= 180 mm (부모멘트부)

Ln= 7,500 mm (연속경간) d = 1,420 mm (전단)

• Ln / d = 5.28 > 4 ☞ 일반보로 설계

• 계수하중 : Wu1 = 2,514.000 kN/m (전산출력결과)

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = Wu1 + 1.4 x Wd = 2,514.000 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	정모멘트부	W × Ln^2 ÷ 14	10,100.893	
	부모멘트부	W × Ln^2 ÷ 12	11,784.375	
전단력 Vu (kN)		W x (Ln - 2 d)/2	5,856.908	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 정모멘트부 : 88,542 ㎟ O.K

• 부모멘트부 : 87,274 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟) 1.4bd/(f_y)	$A_{s.min}$ (㎟) 4A_s/3	$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	∑$A_{s.use}$ (㎟)	ϕM_n (kN·m)
정모멘트	21,628	14,121	28,838	21,628	H 29	27 EA	17,345	31,026	14,181.107
					H 25	27 EA	13,681		
					H 0	0 EA	-		O.K
부모멘트	25,870	13,919	34,494	25,870	H 32	27 EA	21,443	38,788	17,138.590
					H 29	27 EA	17,345		
					H	EA	-		O.K

4) 전단력 검토

• ϕVc = ϕv·1/6·√fck·bw·d= 2,583.003 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : H 19 , N = 6 EA , s1 = 150 mm < d/2또는600mm O.K

Av = 1,719.0 ㎟

Vu = 5,856.908 kN < MIN ΦVn=Φ(Vc+Vs) = 7,465.937 kN
ΦVn=Φ(Vc+Vs(max))= 12,915.015 kN O.K

여기서, Vs : 일반보의 경우 : $Vs = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $Vs = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right)+\frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$

5) 주철근 간격 검토

- 부모멘트

• 주철근 응력, fs

$k = -np + \sqrt{[2np + (np)2]}$ [∵ n = Es / Ec = 7.2 ≒ 7]

$= -7 \times 0.00975 + \sqrt{[2 \times 0.0683 + 0.0683^2]} = 0.308$

$j = 1 - k / 3 = 1 - 0.308 / 3 = 0.897$

$fs = M / [As \cdot d \cdot j] = 156.272$ MPa

$fst = fs\ [H-dt'-kd] / [d-kd] = 163.382$ MPa

• 주철근 간격

$Cc = dt' - d_b/2 = 135 - 31.8 / 2 = 119$ mm (여기서, d_b = 32)

$s_1 = 375\ (210 / fst) - 2.5\ Cc = 184.499$ mm

$s_2 = 300\ (210 / fst) = 385.599$ mm

> s = 100 mm ∴ O.K

- 정모멘트

• 주철근 응력, fs

$k = -np + \sqrt{[2np + (np)2]}$ [∵ n = Es / Ec = 7.2 ≒ 7]

$= -7 \times 0.00769 + \sqrt{[2 \times 0.0538 + 0.0538^2]} = 0.279$

$j = 1 - k / 3 = 1 - 0.279 / 3 = 0.907$

$fs = M / [As \cdot d \cdot j] = 163.244$ MPa

$fst = fs\ [H-dt'-kd] / [d-kd] = 170.1728$ MPa

• 주철근 간격

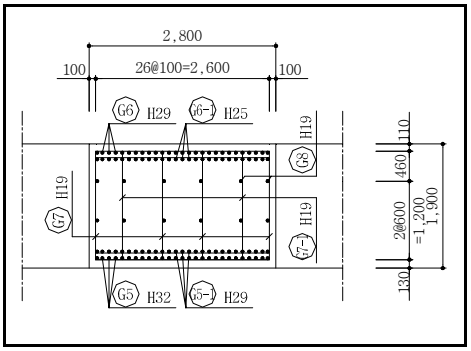
$Cc = dt' - d_b/2 = 115 - 28.6 / 2 = 101$ mm (여기서, d_b = 29)

$s_1 = 375\ (210 / fst) - 2.5\ Cc = 210.265$ mm

$s_2 = 300\ (210 / fst) = 370.212$ mm

> s = 100 mm ∴ O.K

3.2 차량용 피난연결통로 - 벽체 개구부보강거더#2



B = 2,800 mm, H1 = 1,900 mm (정모멘트부)
H2 = 1,900 mm (부모멘트부)

d = 1,741 mm (정모멘트부) d = 1,755 mm (부모멘트부)

d'= 159 mm (정모멘트부) d'= 145 mm (부모멘트부)

Ln= 7,500 mm (연속경간) d = 1,741 mm (전단)

• Ln / d = 4.31 > 4 ☞ 일반보로 설계

• 계수하중 : Wu1 = 2,805.640 kN/m (전산출력결과)

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = Wu1 + 1.4 x Wd = 2,805.640 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	정모멘트부	W × Ln^2 ÷ 14	11,272.661	
	부모멘트부	W × Ln^2 ÷ 12	13,151.438	
전단력 Vu (kN)		W x (Ln - 2 d)/2	5,636.798	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 정모멘트부 : 106,976 ㎟ O.K

• 부모멘트부 : 107,860 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟)		$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
		1.4bd/(f_y)	$4A_s/3$						
정모멘트	19,741	17,061	26,322	19,741	H 29	27 EA	17,345	31,026	17,345.729
					H 25	27 EA	13,681		
					H 0	0 EA	-		O.K
부모멘트	22,972	17,202	30,630	22,972	H 32	27 EA	21,443	38,788	21,556.566
					H 29	27 EA	17,345		
					H	0 EA	-		O.K

4) 전단력 검토

• ϕVc = ϕv·1/6·√fck·bw·d= 3,166.102 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : H 19 , N = 6 EA , s1 = 150 mm < d/2또는600mm O.K

Av = 1,719.0 ㎟

Vu = 5,636.798 kN < MIN ΦVn=Φ(Vc+Vs) = 9,151.332 kN
ΦVn=Φ(Vc+Vs(max))= 15,935.109 kN O.K

여기서, Vs : 일반보의 경우 : $Vs = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $Vs = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right) + \frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$

5) 주철근 간격 검토

- 부모멘트

• 주철근 응력, fs

$k = -np + \sqrt{[2np + (np)2]}$ [∵ n = Es / Ec = 7.2 ≒ 7]

$= -7 \times 0.00789 + \sqrt{[2 \times 0.0552 + 0.0552^2]} = 0.282$

$j = 1 - k / 3 = 1 - 0.282 / 3 = 0.906$

$fs = M / [As \cdot d \cdot j] = 143.66$ MPa

$fst = fs\ [H - dt' - kd] / [d - kd] = 148.7572$ MPa

• 주철근 간격

$Cc = dt' - d_b/2 = 100 - 31.8 / 2 = 84$ mm (여기서, d_b = 32)

$s_1 = 375\ (210 / fst) - 2.5\ Cc = 319.386$ mm

$s_2 = 300\ (210 / fst) = 423.509$ mm

> s = 100 mm ∴ O.K

- 정모멘트

• 주철근 응력, fs

$k = -np + \sqrt{[2np + (np)2]}$ [∵ n = Es / Ec = 7.2 ≒ 7]

$= -7 \times 0.00636 + \sqrt{[2 \times 0.0445 + 0.0445^2]} = 0.257$

$j = 1 - k / 3 = 1 - 0.257 / 3 = 0.914$

$fs = M / [As \cdot d \cdot j] = 153.859$ MPa

$fst = fs\ [H - dt' - kd] / [d - kd] = 159.1041$ MPa

• 주철근 간격

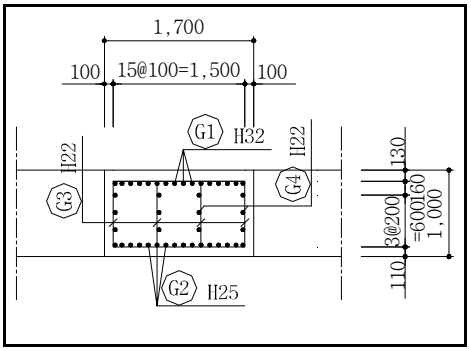
$Cc = dt' - d_b/2 = 115 - 28.6 / 2 = 101$ mm (여기서, d_b = 29)

$s_1 = 375\ (210 / fst) - 2.5\ Cc = 242.459$ mm

$s_2 = 300\ (210 / fst) = 395.967$ mm

> s = 100 mm ∴ O.K

3.3 대인피난연결통로 - 보강거더#3



B = 1,700 mm, H1 = 1,000 mm (정모멘트부)
H2 = 1,000 mm (부모멘트부)

d = 885 mm (정모멘트부) d = 865 mm (부모멘트부)

d'= 115 mm (정모멘트부) d'= 135 mm (부모멘트부)

Ln= 3,250 mm (연속경간) d = 865 mm (전단)

• Ln / d = 3.76 ≤ 4 ☞ 깊은보로 설계

• 계수하중 : Wu1 = 2,514.000 kN/m (전산출력결과)

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = Wu1 + 1.4 x Wd = 2,514.000 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	정모멘트부	W × Ln^2 ÷ 16	1,659.633	
	부모멘트부	W × Ln^2 ÷ 11	2,414.011	
전단력 Vu (kN)		W x (Ln-2x0.15Ln)/2	2,859.675	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 정모멘트부 : 33,018 ㎟ O.K

• 부모멘트부 : 32,272 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟) 1.4bd/(f_y)	$A_{s.min}$ (㎟) 4A_s/3	$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
정모멘트	5,704	5,266	7,605	5,704	H 25	16 EA	8,107	8,107	2,324.900
					H 0	0 EA	-		
					H 0	0 EA	-		O.K
부모멘트	8,652	5,147	11,536	8,652	H 32	16 EA	12,707	12,707	3,455.753
					H 0	0 EA	-		
					H 0	0 EA	-		O.K

4) 전단력 검토

• ϕVc = ϕv·1/6·√fck·bw·d= 955.118 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : H 22 , N = 4 EA , s1 = 150 mm < d/5또는300mm O.K

Av = 1,548.4 ㎟ > Av.min=0.0025·b·s = 638 ㎟ O.K

• 수평전단철근 : H 22 , N = 4 EA , s2 = 200 mm < d/5또는300mm O.K

Ah = 1,548.4 ㎟ > Ah.min=0.0015·b·s = 510 ㎟ O.K

Vu = 2,859.675 kN < MIN ΦVn=Φ(Vc+Vs) = 3,229.653 kN O.K

ΦVnmax=Φ5/6√fck·bo·d= 4,775.589 kN

여기서, Vs : 일반보의 경우 : $V_s = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $V_s = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right) + \frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$

5) 주철근 간격 검토

- 부모멘트

• 주철근 응력, fs

k = − np + √ [2 np + (np)2] [∵ n = Es / Ec = 7.2 ≒ 7]

= −7 × 0.00864 + √ [2 × 0.0605 + 0.0605 ^{2}] = 0.293

j = 1 − k / 3 = 1 − 0.293 / 3 = 0.902

fs = M / [As·d·j] = 159.554 MPa

fst = fs [H−dt'−kd] / [d−kd] = 159.554 MPa

• 주철근 간격

Cc = dt' − d_b/2 = 135 − 31.8 / 2 = 119 mm (여기서, d_b = 32)

s_1 = 375 (210 / fst) − 2.5 Cc = 196.063 mm

s_2 = 300 (210 / fst) = 394.851 mm

> s = 100 mm ∴ O.K

- 정모멘트

• 주철근 응력, fs

k = − np + √ [2 np + (np)2] [∵ n = Es / Ec = 7.2 ≒ 7]

= −7 × 0.00539 + √ [2 × 0.0377 + 0.0377 ^{2}] = 0.239

j = 1 − k / 3 = 1 − 0.239 / 3 = 0.920

fs = M / [As·d·j] = 164.76 MPa

fst = fs [H−dt'−kd] / [d−kd] = 164.76 MPa

• 주철근 간격

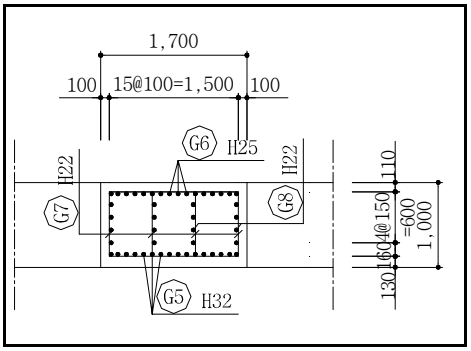
Cc = dt' − d_b/2 = 115 − 25.4 / 2 = 102 mm (여기서, d_b = 25)

s_1 = 375 (210 / fst) − 2.5 Cc = 222.968 mm

s_2 = 300 (210 / fst) = 382.374 mm

> s = 100 mm ∴ O.K

3.4 대인피난연결통로 - 보강거더#4



B = 1,700 mm, H1 = 1,000 mm (정모멘트부)
H2 = 1,000 mm (부모멘트부)

d = 885 mm (정모멘트부) d = 865 mm (부모멘트부)

d'= 115 mm (정모멘트부) d'= 135 mm (부모멘트부)

Ln= 3,250 mm (연속경간) d = 865 mm (전단)

• Ln / d = 3.76 ≤ 4 ☞ 깊은보로 설계

• 계수하중 : Wu1 = 2,560.860 kN/m (전산출력결과)

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = Wu1 + 1.4 x Wd = 2,560.860 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	정모멘트부	W × Ln^2 ÷ 16	1,690.568	
	부모멘트부	W × Ln^2 ÷ 11	2,459.008	
전단력 Vu (kN)		W x (Ln-2x0.15Ln)/2	2,912.978	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 정모멘트부 : 33,018 ㎟ O.K

• 부모멘트부 : 32,272 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟)		$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
		1.4bd/(f_y)	$4A_s/3$						
정모멘트	5,814	5,266	7,752	5,814	H 25	16 EA	8,107	8,107	2,324.900
					H 0	0 EA	-		
					H 0	0 EA	-		O.K
부모멘트	8,822	5,147	11,763	8,822	H 32	16 EA	12,707	12,707	3,455.753
					H 0	0 EA	-		
					H 0	0 EA	-		O.K

4) 전단력 검토

• ϕVc = ϕv·1/6·√fck·bw·d= 955.118 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : H 22 , N = 4 EA , s1 = 150 mm < d/5또는300mm O.K

Av = 1,548.4 ㎟ > Av.min=0.0025·b·s = 638 ㎟ O.K

• 수평전단철근 : H 22 , N = 4 EA , s2 = 150 mm < d/5또는300mm O.K

Ah = 1,548.4 ㎟ > Ah.min=0.0015·b·s = 383 ㎟ O.K

Vu = 2,912.978 kN < MIN ΦVn=Φ(Vc+Vs) = 3,633.850 kN O.K

ΦVnmax=Φ5/6√fck·bo·d= 4,775.589 kN

여기서, Vs : 일반보의 경우 : $V_s = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $V_s = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right) + \frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$

5) 주철근 간격 검토

- 부모멘트

• 주철근 응력, fs

$k = -np + \sqrt{[2np + (np)2]}$ [∵ n = Es / Ec = 7.2 ≒ 7]

$= -7 \times 0.00864 + \sqrt{[2 \times 0.0605 + 0.0605^2]} = 0.293$

$j = 1 - k / 3 = 1 - 0.293 / 3 = 0.902$

$fs = M / [As \cdot d \cdot j] = 170.601$ MPa

$fst = fs\ [H-dt'-kd] / [d-kd] = 170.601$ MPa

• 주철근 간격

$Cc = dt' - d_b/2 = 135 - 31.8 / 2 = 119$ mm (여기서, d_b = 32)

$s_1 = 375\ (210 / fst) - 2.5\ Cc = 164.103$ mm

$s_2 = 300\ (210 / fst) = 369.283$ mm

> s = 100 mm ∴ O.K

- 정모멘트

• 주철근 응력, fs

$k = -np + \sqrt{[2np + (np)2]}$ [∵ n = Es / Ec = 7.2 ≒ 7]

$= -7 \times 0.00539 + \sqrt{[2 \times 0.0377 + 0.0377^2]} = 0.239$

$j = 1 - k / 3 = 1 - 0.239 / 3 = 0.920$

$fs = M / [As \cdot d \cdot j] = 176.167$ MPa

$fst = fs\ [H-dt'-kd] / [d-kd] = 176.167$ MPa

• 주철근 간격

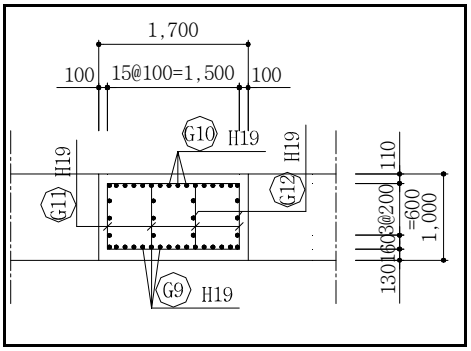
$Cc = dt' - d_b/2 = 115 - 25.4 / 2 = 102$ mm (여기서, d_b = 25)

$s_1 = 375\ (210 / fst) - 2.5\ Cc = 192.019$ mm

$s_2 = 300\ (210 / fst) = 357.615$ mm

> s = 100 mm ∴ O.K

3.5 대인피난연결통로 - 보강거더#5



B = 1,700 mm, H1 = 1,000 mm (정모멘트부)
H2 = 1,000 mm (부모멘트부)

d = 885 mm (정모멘트부) d = 865 mm (부모멘트부)

d'= 115 mm (정모멘트부) d'= 135 mm (부모멘트부)

Ln= 2,000 mm (연속경간) d = 865 mm (전단)

• Ln / d = 2.31 ≤ 4 ☞ 깊은보로 설계

• 계수하중 : Wu1 = 2,805.640 kN/m (전산출력결과)

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = Wu1 + 1.4 x Wd = 2,805.640 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	정모멘트부	W × Ln^2 ÷ 14	801.611	
	부모멘트부	W × Ln^2 ÷ 12	935.213	
전단력 Vu (kN)		W x (Ln-2x0.15Ln)/2	1,963.948	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 정모멘트부 : 33,018 ㎟ O.K

• 부모멘트부 : 32,272 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟) 1.4bd/(f_y)	$A_{s.min}$ (㎟) 4A_s/3	$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
정모멘트	2,706	5,266	3,609	3,609	H 19	16 EA	4,584	4,584	1,342.702
					H 0	0 EA	-		
					H 0	0 EA	-		O.K
부모멘트	3,242	5,147	4,323	4,323	H 19	16 EA	4,584	4,584	1,311.530
					H 0	0 EA	-		
					H 0	0 EA	-		O.K

4) 전단력 검토

• ϕVc = ϕv·1/6·√fck·bw·d= 955.118 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : H 19 , N = 4 EA , s1 = 150 mm < d/5또는300mm O.K

Av = 1,146.0 ㎟ > Av.min=0.0025·b·s = 638 ㎟ O.K

• 수평전단철근 : H 19 , N = 4 EA , s2 = 200 mm < d/5또는300mm O.K

Ah = 1,146.0 ㎟ > Ah.min=0.0015·b·s = 510 ㎟ O.K

Vu = 1,963.948 kN < MIN ΦVn=Φ(Vc+Vs) = 2,578.857 kN

ΦVnmax=Φ5/6√fck·bo·d= 4,775.589 kN O.K

여기서, Vs : 일반보의 경우 : $V_s = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $V_s = \left[\frac{A_v}{s_1}\left(1+\frac{L_n}{d}\right)\frac{1}{12} + \frac{A_h}{s_2}\left(11-\frac{L_n}{d}\right)\frac{1}{12}\right] f_y d$

5) 주철근 간격 검토

- 부모멘트

• 주철근 응력, fs

$k = -np + \sqrt{[2np + (np)2]}$ [∵ n = Es / Ec = 7.2 ≒ 7]

$= -7 \times 0.00312 + \sqrt{[2 \times 0.0218 + 0.0218^2]} = 0.188$

$j = 1 - k / 3 = 1 - 0.188 / 3 = 0.937$

$fs = M / [As \cdot d \cdot j] = 169.609$ MPa

$fst = fs\ [H-dt'-kd] / [d-kd] = 169.609$ MPa

• 주철근 간격

$Cc = dt' - d_b/2 = 135 - 19.1 / 2 = 125$ mm (여기서, d_b = 19)

$s_1 = 375\ (210 / fst) - 2.5\ Cc = 151.803$ mm

$s_2 = 300\ (210 / fst) = 371.443$ mm

> s = 100 mm ∴ O.K

- 정모멘트

• 주철근 응력, fs

$k = -np + \sqrt{[2np + (np)2]}$ [∵ n = Es / Ec = 7.2 ≒ 7]

$= -7 \times 0.00305 + \sqrt{[2 \times 0.0214 + 0.0214^2]} = 0.187$

$j = 1 - k / 3 = 1 - 0.187 / 3 = 0.938$

$fs = M / [As \cdot d \cdot j] = 141.942$ MPa

$fst = fs\ [H-dt'-kd] / [d-kd] = 141.942$ MPa

• 주철근 간격

$Cc = dt' - d_b/2 = 115 - 19.1 / 2 = 105$ mm (여기서, d_b = 19)

$s_1 = 375\ (210 / fst) - 2.5\ Cc = 292.304$ mm

$s_2 = 300\ (210 / fst) = 443.843$ mm

> s = 100 mm ∴ O.K

4. 개구부 보강 기둥 검토

▶ 차량용피난연결통로 보강기둥#1 P - M 상관분석

1) 검토 제목 : 차량용피난연결통로 보강기둥#1

2) 설계조건

설계 기준강도 : fck = 27 MPa, fy = 400 MPa
재료 탄성계수 : Ec = 26680 MPa, Es = 200000 MPa
강도 감소계수 : Øc = 0.65, Øf = 0.85

3) 사각형단면 검토조건

단 면 폭 (B) : 1700.00 mm
단 면 높 이 (H) : 1500.00 mm
철근 피복두께(d') : 90.00 mm
비지지 길이 (Lu) : 5220.00 mm
유효길이계수 (Kx) : 1.00
유효길이계수 (Ky) : 1.00
횡방향 철근 형태 : 띠 철근

4) 사용 강재량

(1) 사용 철근량

-. 1단 철근 : H19 × 56ea = 16044.0 ㎟ (dc = 90.0 mm)
-. 총 사용 철근량 : Ast = 16044.0 ㎟

5) 공칭 강도 검토

(1) Load Case 1

① 작용하중

계수축하중 : Pu = 14729.610 KN

X축 세장비 : λx = 12.1
Y축 세장비 : λy = 10.6

지속 계수하중비 : βdx = 0.000
: βdy = 0.000

X축 확대계수 : δx.ns = 1.000
: δx.s = 1.000
Y축 확대계수 : δy.ns = 1.000
: δy.s = 1.000

X축 확대모멘트 : δMux = 0.000 KN·m
Y축 확대모멘트 : δMuy = 0.000 KN·m
합성 확대모멘트 : δMu = 0.000 KN·m
중립축 회전각 : θrot = 0.000 °

최 소 편 심 : e_min = 150.54 mm
작 용 편 심 : e = 0.00 mm

② 평형상태 계산

중립축 x = εcu / (εcu + εyd) x d = 846.000 mm

Pb = Cc + Cs + Tt = 28055.687 + 2619.651 + -2360.647 = 28314.690 KN
Mb = Mc + Ms + Mt = 10954.343 + 1467.886 + 1439.379 = 13861.608 KN·m

평 형 편 심 : eb = 489.56 mm
최외단철근변형률 : εt = 0.0020
강 도 감 소 계 수 : Ø = 0.6500
평 형 축 하 중 : ØPb = 18404.55 KN
평 형 모 멘 트 : ØMb = 9010.04 KN·m

∴ e ≤ e_min ----> 최소편심 구간

③ 단면강도 검토

사용철근비 : Pused = 0.629 %

αPn = α×{0.85 fck*(Ag-Ast) + fy*Ast} = 51657.513 KN
Mn = αPn × e_min = 7776.311 KN·m

강도 감소 계수 : Ø = 0.650
축력 감소 계수 : α = 0.800
설계축하중강도 : αØPn = 33577.382 KN ≥ Pu = 14729.610 KN ∴ O.K
설 계 휨 강 도 : ØMn = 5054.602 KN·m ≥ Mu = 0.000 KN·m ∴ O.K

▶ 대인피난연결통로 보강기둥#2 P - M 상관분석

1) 검토 제목 : 대인피난연결통로 보강기둥#2

2) 설계조건

설계 기준강도 : fck = 27 MPa, fy = 400 MPa
재료 탄성계수 : Ec = 26680 MPa, Es = 200000 MPa
강도 감소계수 : Øc = 0.65, Øf = 0.85

3) 사각형단면 검토조건

단 면 폭 (B) : 1700.00 mm
단 면 높 이 (H) : 1100.00 mm
철근 피복두께(d') : 90.00 mm
비지지 길이 (Lu) : 1200.00 mm
유효길이계수 (Kx) : 1.00
유효길이계수 (Ky) : 1.00
횡방향 철근 형태 : 띠 철근

4) 사용 강재량

(1) 사용 철근량

-. 1단 철근 : H19 × 48ea = 13752.0 ㎟ (dc = 90.0 mm)
-. 총 사용 철근량 : Ast = 13752.0 ㎟

5) 공칭 강도 검토

(1) Load Case 1

① 작용하중

계수축하중 : Pu = 6978.344 KN

X축 세장비 : λx = 3.8
Y축 세장비 : λy = 2.4

지속 계수하중비 : βdx = 0.000
: βdy = 0.000

X축 확대계수 : δx.ns = 1.000
: δx.s = 1.000
Y축 확대계수 : δy.ns = 1.000
: δy.s = 1.000

X축 확대모멘트 : δMux = 0.000 KN·m
Y축 확대모멘트 : δMuy = 0.000 KN·m
합성 확대모멘트 : δMu = 0.000 KN·m
중립축 회전각 : θrot = 0.000 °

최 소 편 심 : e_min = 110.19 mm
작 용 편 심 : e = 0.00 mm

② 평형상태 계산

중립축 x = εcu / (εcu + εyd) x d = 606.000 mm

Pb = Cc + Cs + Tt = 20096.627 + 2274.578 + -2173.240 = 20197.965 KN
Mb = Mc + Ms + Mt = 5877.258 + 933.679 + 942.109 = 7753.047 KN·m

평 형 편 심 : eb = 383.85 mm
최외단철근변형률 : εt = 0.0020
강 도 감 소 계 수 : Ø = 0.6500
평 형 축 하 중 : ØPb = 13128.68 KN
평 형 모 멘 트 : ØMb = 5039.48 KN·m

∴ e ≤ e_min ----> 최소편심 구간

③ 단면강도 검토

사용철근비 : Pused = 0.735 %

αPn = α×{0.85 fck*(Ag-Ast) + fy*Ast} = 38481.354 KN
Mn = αPn × e_min = 4240.373 KN·m

강도 감소 계수 : Ø = 0.650
축력 감소 계수 : α = 0.800
설계축하중강도 : αØPn = 25012.879 KN ≥ Pu = 6978.344 KN ∴ O.K
설 계 휨 강 도 : ØMn = 2756.242 KN·m ≥ Mu = 0.000 KN·m ∴ O.K

▶ 대인피난연결통로 보강기둥#3 P - M 상관분석

1) 검토 제목 : 대인피난연결통로 보강기둥#3

2) 설계조건

설계 기준강도 : fck = 27 MPa, fy = 400 MPa
재료 탄성계수 : Ec = 26680 MPa, Es = 200000 MPa
강도 감소계수 : Øc = 0.65, Øf = 0.85

3) 사각형단면 검토조건

단 면 폭 (B) : 1700.00 mm
단 면 높 이 (H) : 1100.00 mm
철근 피복두께(d') : 90.00 mm
비지지 길이 (Lu) : 1900.00 mm
유효길이계수 (Kx) : 1.00
유효길이계수 (Ky) : 1.00
횡방향 철근 형태 : 띠 철근

4) 사용 강재량

(1) 사용 철근량

-. 1단 철근 : H19 × 48ea = 13752.0 ㎟ (dc = 90.0 mm)
-. 총 사용 철근량 : Ast = 13752.0 ㎟

5) 공칭 강도 검토

(1) Load Case 1

① 작용하중

계수축하중 : Pu = 5891.844 KN

X축 세장비 : λx = 6.0
Y축 세장비 : λy = 3.9

지속 계수하중비 : βdx = 0.000
: βdy = 0.000

X축 확대계수 : δx.ns = 1.000
: δx.s = 1.000
Y축 확대계수 : δy.ns = 1.000
: δy.s = 1.000

X축 확대모멘트 : δMux = 0.000 KN·m
Y축 확대모멘트 : δMuy = 0.000 KN·m
합성 확대모멘트 : δMu = 0.000 KN·m
중립축 회전각 : θrot = 0.000 °

최 소 편 심 : e_min = 110.19 mm
작 용 편 심 : e = 0.00 mm

② 평형상태 계산

중립축 x = εcu / (εcu + εyd) x d = 606.000 mm

Pb = Cc + Cs + Tt = 20096.627 + 2274.578 + -2173.240 = 20197.965 KN
Mb = Mc + Ms + Mt = 5877.258 + 933.679 + 942.109 = 7753.047 KN·m

평 형 편 심 : eb = 383.85 mm
최외단철근변형률 : εt = 0.0020
강 도 감 소 계 수 : Ø = 0.6500
평 형 축 하 중 : ØPb = 13128.68 KN
평 형 모 멘 트 : ØMb = 5039.48 KN·m

∴ e ≤ e_min ----> 최소편심 구간

③ 단면강도 검토

사용철근비 : Pused = 0.735 %

αPn = α×{0.85 fck*(Ag-Ast) + fy*Ast} = 38481.354 KN
Mn = αPn × e_min = 4240.373 KN·m

강도 감소 계수 : Ø = 0.650
축력 감소 계수 : α = 0.800
설계축하중강도 : αØPn = 25012.879 KN ≥ Pu = 5891.844 KN ∴ O.K
설 계 휨 강 도 : ØMn = 2756.242 KN·m ≥ Mu = 0.000 KN·m ∴ O.K

▶ 대인피난연결통로 보강기둥#4 P - M 상관분석

1) 검토 제목 : 대인피난연결통로 보강기둥#4

2) 설계조건

설계 기준강도 : fck = 27 MPa, fy = 400 MPa
재료 탄성계수 : Ec = 26680 MPa, Es = 200000 MPa
강도 감소계수 : Øc = 0.65, Øf = 0.85

3) 사각형단면 검토조건

단 면 폭 (B) : 1700.00 mm
단 면 높 이 (H) : 1100.00 mm
철근 피복두께(d') : 90.00 mm
비지지 길이 (Lu) : 4100.00 mm
유효길이계수 (Kx) : 1.00
유효길이계수 (Ky) : 1.00
횡방향 철근 형태 : 띠 철근

4) 사용 강재량

(1) 사용 철근량

-. 1단 철근 : H19 × 48ea = 13752.0 ㎟ (dc = 90.0 mm)
-. 총 사용 철근량 : Ast = 13752.0 ㎟

5) 공칭 강도 검토

(1) Load Case 1

① 작용하중

계수축하중 : Pu = 5891.844 KN

X축 세장비 : λx = 12.9
Y축 세장비 : λy = 8.4

지속 계수하중비 : βdx = 0.000
: βdy = 0.000

X축 확대계수 : δx.ns = 1.000
: δx.s = 1.000
Y축 확대계수 : δy.ns = 1.000
: δy.s = 1.000

X축 확대모멘트 : δMux = 0.000 KN·m
Y축 확대모멘트 : δMuy = 0.000 KN·m
합성 확대모멘트 : δMu = 0.000 KN·m
중립축 회전각 : θrot = 0.000 °

최 소 편 심 : e_min = 110.19 mm
작 용 편 심 : e = 0.00 mm

② 평형상태 계산

중립축 x = εcu / (εcu + εyd) x d = 606.000 mm

Pb = Cc + Cs + Tt = 20096.627 + 2274.578 + -2173.240 = 20197.965 KN
Mb = Mc + Ms + Mt = 5877.258 + 933.679 + 942.109 = 7753.047 KN·m

평 형 편 심 : eb = 383.85 mm
최외단철근변형률 : εt = 0.0020
강 도 감 소 계 수 : Ø = 0.6500
평 형 축 하 중 : ØPb = 13128.68 KN
평 형 모 멘 트 : ØMb = 5039.48 KN·m

∴ e ≤ e_min ----> 최소편심 구간

③ 단면강도 검토

사용철근비 : Pused = 0.735 %

αPn = α×{0.85 fck*(Ag-Ast) + fy*Ast} = 38481.354 KN
Mn = αPn × e_min = 4240.373 KN·m

강도 감소 계수 : Ø = 0.650
축력 감소 계수 : α = 0.800
설계축하중강도 : αØPn = 25012.879 KN ≥ Pu = 5891.844 KN ∴ O.K
설 계 휨 강 도 : ØMn = 2756.242 KN·m ≥ Mu = 0.000 KN·m ∴ O.K

▶ 대인피난연결통로 보강기둥#5 P - M 상관분석

1) 검토 제목 : 대인피난연결통로 보강기둥#5

2) 설계조건

설계 기준강도 : fck = 27 MPa, fy = 400 MPa
재료 탄성계수 : Ec = 26680 MPa, Es = 200000 MPa
강도 감소계수 : Øc = 0.65, Øf = 0.85

3) 사각형단면 검토조건

단 면 폭 (B) : 1700.00 mm
단 면 높 이 (H) : 700.00 mm
철근 피복두께(d') : 90.00 mm
비지지 길이 (Lu) : 1200.00 mm
유효길이계수 (Kx) : 1.00
유효길이계수 (Ky) : 1.00
횡방향 철근 형태 : 띠 철근

4) 사용 강재량

(1) 사용 철근량

-. 1단 철근 : H19 × 40ea = 11460.0 ㎟ (dc = 90.0 mm)
-. 총 사용 철근량 : Ast = 11460.0 ㎟

5) 공칭 강도 검토

(1) Load Case 1

① 작용하중

계수축하중 : Pu = 9923.333 KN

X축 세장비 : λx = 5.9
Y축 세장비 : λy = 2.4

지속 계수하중비 : βdx = 0.000
: βdy = 0.000

X축 확대계수 : δx.ns = 1.000
: δx.s = 1.000
Y축 확대계수 : δy.ns = 1.000
: δy.s = 1.000

X축 확대모멘트 : δMux = 0.000 KN·m
Y축 확대모멘트 : δMuy = 0.000 KN·m
합성 확대모멘트 : δMu = 0.000 KN·m
중립축 회전각 : θrot = 0.000 °

최 소 편 심 : e_min = 68.95 mm
작 용 편 심 : e = 0.00 mm

② 평형상태 계산

중립축 x = εcu / (εcu + εyd) x d = 366.000 mm

Pb = Cc + Cs + Tt = 12137.567 + 1935.526 + -1998.925 = 12074.168 KN
Mb = Mc + Ms + Mt = 2360.150 + 475.708 + 499.010 = 3334.868 KN·m

평 형 편 심 : eb = 276.20 mm
최외단철근변형률 : εt = 0.0020
강 도 감 소 계 수 : Ø = 0.6500
평 형 축 하 중 : ØPb = 7848.21 KN
평 형 모 멘 트 : ØMb = 2167.66 KN·m

∴ e ≤ e_min ----> 최소편심 구간

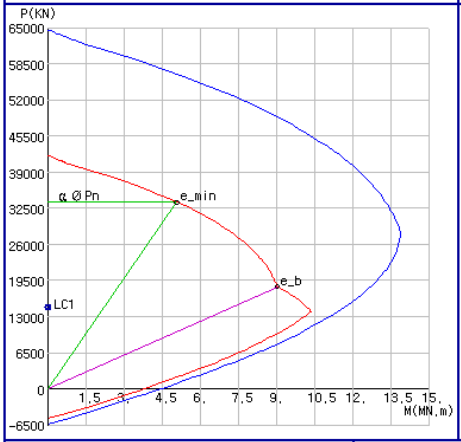
③ 단면강도 검토

사용철근비 : Pused = 0.963 %

αPn = α×{0.85 fck*(Ag-Ast) + fy*Ast} = 25305.195 KN
Mn = αPn × e_min = 1744.738 KN·m

강도 감소 계수 : Ø = 0.650
축력 감소 계수 : α = 0.800
설계축하중강도 : αØPn = 16448.376 KN ≥ Pu = 9923.333 KN ∴ O.K
설 계 휨 강 도 : ØMn = 1134.080 KN·m ≥ Mu = 0.000 KN·m ∴ O.K

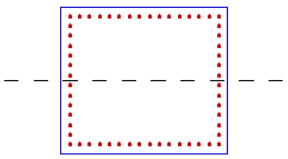
검토단면 : 차량용피난연결통로 보강기둥#1



검 토 조 건

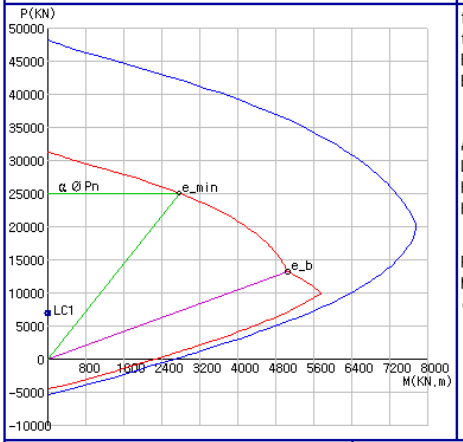
fck	=	27 MPa
fy	=	400 MPa
Ec	=	26680 MPa
Erb	=	200000 MPa
Ix	=	4.781 E+11 mm⁴
Iy	=	6.141 E+11 mm⁴
Ag	=	2.550 E+06 mm²
Lu	=	5220.0 mm
Kx	=	1.00
Ky	=	1.00
ρ	=	0.629 %
Pu	=	14729.610 KN
Mu	=	0.000 KN·m
Θ	=	0.000 °

[검 토 단 면]



▷ 최소 편심 상태
e_min = 150.536 mm
ØP_min = 33577.380 KN
ØM_min = 5054.602 KN·m
▷ 평형 편심 상태
eb = 489.555 mm
ØPb = 18404.550 KN
ØMb = 9010.045 KN·m
▷ 작용편심에서의 설계강도
e < e_min ∴ 최소편심구간
ØPn = 33577.380 KN(=ØPmin)
ØMn = 5054.602 KN·m(=ØMmin)
▷ 사용철근량
A_rebar = 16044.000 mm²

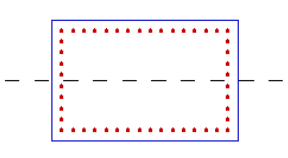
검토단면 : 대인피난연결통로 보강기둥#2



검 토 조 건

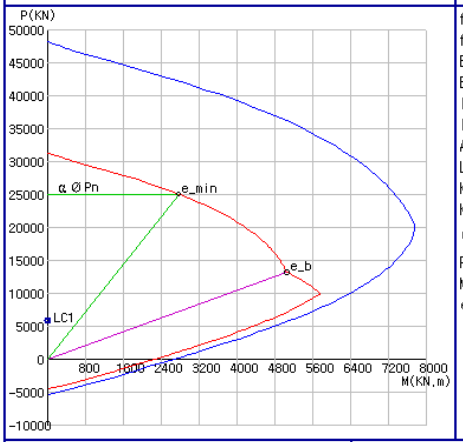
fck	=	27 MPa
fy	=	400 MPa
Ec	=	26680 MPa
Erb	=	200000 MPa
Ix	=	1.886 E+11 mm⁴
Iy	=	4.504 E+11 mm⁴
Ag	=	1.870 E+06 mm²
Lu	=	1200.0 mm
Kx	=	1.00
Ky	=	1.00
ρ	=	0.735 %
Pu	=	6978.344 KN
Mu	=	0.000 KN·m
Θ	=	0.000 °

[검 토 단 면]



▷ 최소 편심 상태
e_min = 110.193 mm
ØP_min = 25012.880 KN
ØM_min = 2756.242 KN·m
▷ 평형 편심 상태
eb = 383.853 mm
ØPb = 13128.680 KN
ØMb = 5039.480 KN·m
▷ 작용편심에서의 설계강도
e < e_min ∴ 최소편심구간
ØPn = 25012.880 KN(=ØPmin)
ØMn = 2756.242 KN·m(=ØMmin)
▷ 사용철근량
A_rebar = 13752.000 mm²

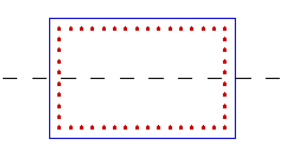
검토단면 : 대인피난연결통로 보강기둥#3



검 토 조 건

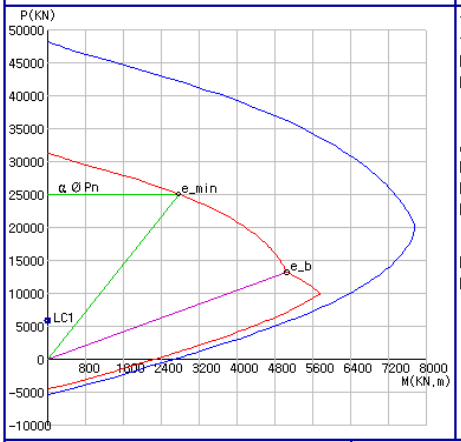
fck	=	27 MPa
fy	=	400 MPa
Ec	=	26680 MPa
Erb	=	200000 MPa
Ix	=	1.886 E+11 mm⁴
Iy	=	4.504 E+11 mm⁴
Ag	=	1.870 E+06 mm²
Lu	=	1900.0 mm
Kx	=	1.00
Ky	=	1.00
ρ	=	0.735 %
Pu	=	5891.844 KN
Mu	=	0.000 KN·m
Θ	=	0.000 °

[검 토 단 면]



▷ 최소 편심 상태
e_min = 110.193 mm
ØP_min = 25012.880 KN
ØM_min = 2756.242 KN·m
▷ 평형 편심 상태
eb = 383.853 mm
ØPb = 13128.680 KN
ØMb = 5039.480 KN·m
▷ 작용편심에서의 설계강도
e < e_min ∴ 최소편심구간
ØPn = 25012.880 KN(=ØPmin)
ØMn = 2756.242 KN·m(=ØMmin)
▷ 사용철근량
A_rebar = 13752.000 mm²

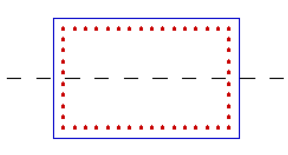
검토단면 : 대인피난연결통로 보강기둥#4



검 토 조 건

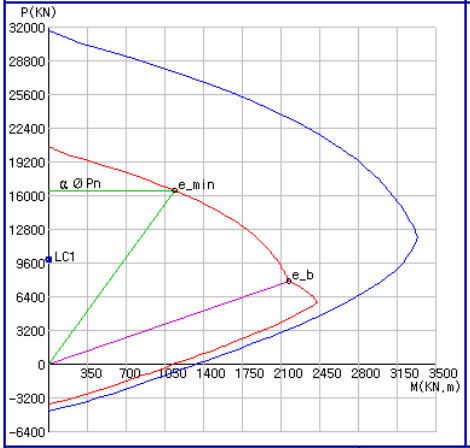
fck	=	27 MPa
fy	=	400 MPa
Ec	=	26680 MPa
Erb	=	200000 MPa
Ix	=	1.886 E+11 mm⁴
Iy	=	4.504 E+11 mm⁴
Ag	=	1.870 E+06 mm²
Lu	=	4100.0 mm
Kx	=	1.00
Ky	=	1.00
ρ	=	0.735 %
Pu	=	5891.844 KN
Mu	=	0.000 KN·m
Θ	=	0.000 °

[검 토 단 면]



▷ 최소 편심 상태
e_min = 110.193 mm
ØP_min = 25012.880 KN
ØM_min = 2756.242 KN·m
▷ 평형 편심 상태
eb = 383.853 mm
ØPb = 13128.680 KN
ØMb = 5039.480 KN·m
▷ 작용편심에서의 설계강도
e < e_min ∴ 최소편심구간
ØPn = 25012.880 KN(=ØPmin)
ØMn = 2756.242 KN·m(=ØMmin)
▷ 사용철근량
A_rebar = 13752.000 mm²

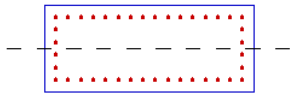
검토단면 : 대인피난연결통로 보강기둥#5



검 토 조 건

fck	=	27 MPa
fy	=	400 MPa
Ec	=	26680 MPa
Erb	=	200000 MPa
Ix	=	4.859 E+10 mm⁴
Iy	=	2.866 E+11 mm⁴
Ag	=	1.190 E+06 mm²
Lu	=	1200.0 mm
Kx	=	1.00
Ky	=	1.00
ρ	=	0.963 %
Pu	=	9923.333 KN
Mu	=	0.000 KN·m
Θ	=	0.000 °

[검 토 단 면]



▷ 최소 편심 상태
- e_min = 68.948 mm
- ØP_min = 16448.380 KN
- ØM_min = 1134.080 KN·m

▷ 평형 편심 상태
- eb = 276.199 mm
- ØPb = 7848.209 KN
- ØMb = 2167.664 KN·m

▷ 작용편심에서의 설계강도
- e < e_min ∴ 최소편심구간
- ØPn = 16448.380 KN(=ØPmin)
- ØMn = 1134.080 KN·m(=ØMmin)

▷ 사용철근량
- A_rebar = 11460.000 mm²

1.26 부반력 앵커

지압식 영구앵커 내적안정 구조계산서

국회대로지하차도 및 상부공원화(1단계-중첩구간) 공사

◈ 제 원

적용구간	지하차도
BLOCK	BLOCK 6 0+325.00 ~ 0+345.00
설계앵커력	500 KN
앵커 조립길이	21.500 m
정착지반	풍화암

앵커의 내적안정성검토

[설계앵커력 P_a = 500 KN , 앵커 간격 D = 5.000 m]

1.설계기준 검토

1.1 앵커 내하체 정착지반 설계조건

구 분	설 계 조 건	비 고
정착지반	풍화암	단위중량 γ = 21 kN/㎥
내부마찰각	Φ = 33°	Φ = 33°
일축압축강도	f_c = 20 MPa	f_c = 200 kgf/㎠
허용인장강도	f_{at} = 0.462 MPa	$f_{at} = 0.0334 \times f_c^{0.9305}$ = 4.622 kgf/㎠

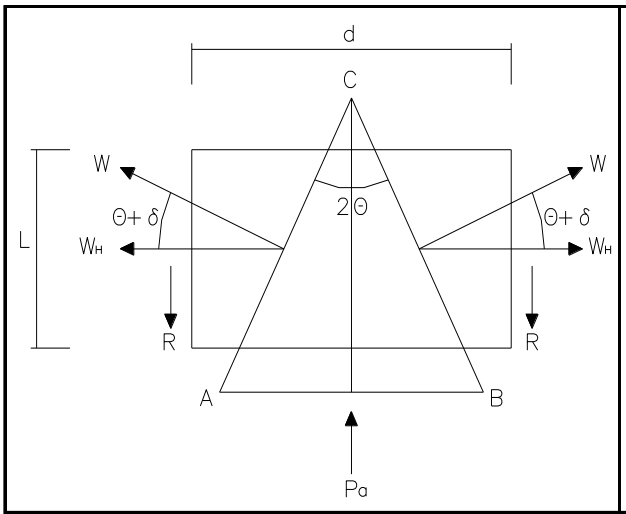
1.2 앵커 내하체 설치조건

구 분	설 계 조 건	비 고
사 용 목 적	부력방지용	지압식 영구앵커
앵커 내하체 전장	여유장 = 1.000 m	
	자유장 = 17.500 m	수압판 두께 포함
	정착근입장 = 3.000 m	
	계 = 21.500 m	앵커 조립장
	수압판두께 = 0.600 m	블럭아웃을 고려한 하부슬래브두께
설 치 간 격	D = 5.000 m	
설 계 앵 커 력	P_a = 500 KN	P_a = 50 tonf
앵커 설계안전율	S.F = 2.5	
앵커 두정각	2Θ = 13°	Θ = 6.5°
앵커 조립직경	d = 95 mm	
앵커 천공직경	d' = 115 mm	
정착지반 근입깊이	$D_{f=}$ 3.000 m	

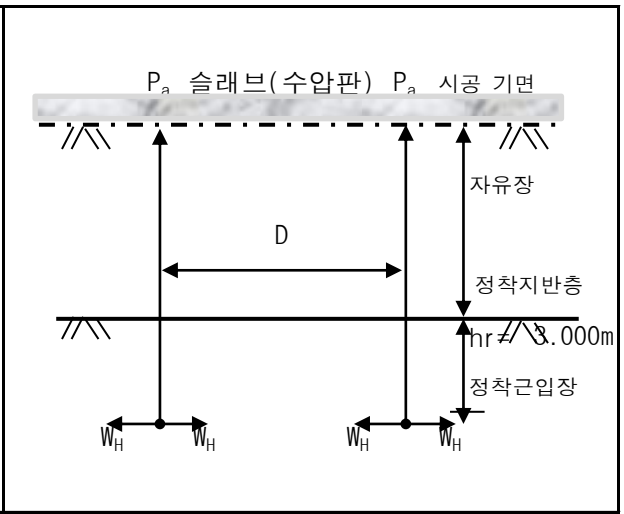
1.3 사용재료의 설계기준

구 분		설 계 조 건	비 고
PS강연선	직경(㎜)	Φ12.7	SWPC7B
	공칭 단면적(㎟)	98.71	Unbonded 강연선
	극한하중	T_{us} = 1.9 KN/㎟	1,900MPa
	항복하중	T_{ys} = 1.6 KN/㎟	1,600MPa
수압판	설계기준강도	f_{ck}= 27 MPa	하부슬래브
	허용압발전단응력	τ_{v3}= 0.950 MPa	도로교설계기준해설(2008) P.906
	허용지압응력	f_{ba}= 13.500 MPa	$f_{ba} = 0.5f_{ck}$
지압판	허용휨/압축응력	$f_{ba}=f_{ca}$= 140 MPa	SS400
	단위중량	γ = 78.50 KN/㎥	

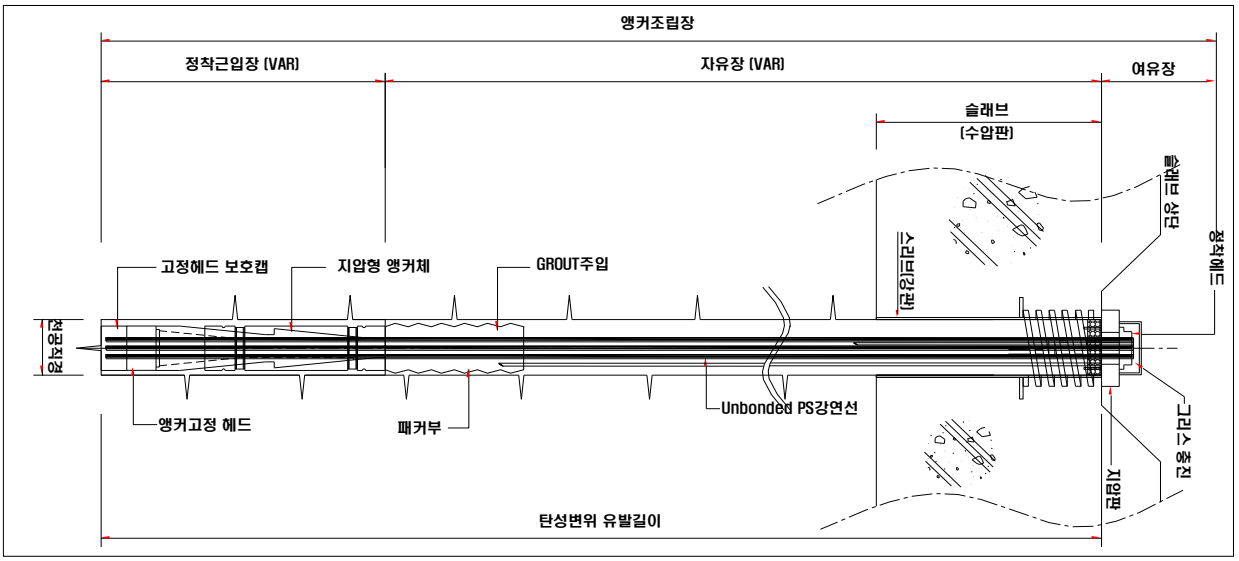
2. 지압식 영구앵커의 정착지반층내 정착근입장검토



< P_a에 의하여 나타나는 WEDGE의 역학관계도 >



< 앵커의 정착조건 >



2.1 앵커내하체의 작용하중 산정

① 쐐기력 $W = \dfrac{P_a}{2 \cdot \sin(\Theta+\delta)}$ ---------- 식1

여기서 sin (6.5 + 22.0) = 0.477

$\dfrac{500}{2 \times 0.477} = 524.109$ KN

② 쐐기수평력 $W_H = W \cdot \cos(\Theta+\delta) = P_a/2 \cdot \cot(\Theta+\delta)$ ---------- 식2

여기서 cos (6.5 + 22.0) = 0.879

524.109 × 0.879 = 460.692 KN

③ 벽면전단저항 $R = f \times W_H$ ---------- 식3

여기서 $f = \tan\Phi$ = tan(33.0)° = 0.649

0.649 × 460.692 = 298.989 KN

식 1, 2, 3 에서

Θ = 앵커 두정각의 1/2 = 6.5 °

δ = 벽면 마찰각 = 2/3 x Φ = 22.0 °

f = 마찰계수 = tan(Φ) = 0.649

2.2 정착지반내 앵커내하체의 최소정착근입장 검토 (L_b)

다음 값중 큰 값으로 적용한다.

① 지반정수와 간격에 따른 최소정착장

최소정착장 $hr_{min} \geq \dfrac{5 \times W_H}{f_{at} \times D} = \dfrac{5 \times 460.692}{462.227 \times 5.000} = 1.00$ m ≒ 1.00 m

② 제품의 특성을 고려한 근입깊이 (내하체, 패커부)

최소정착장 hr_{min} = 3.000 m

∴ 최소정착장 hr_{min} = 3.000 m

2.3 앵커와 앵커사이의 정착지반의 인장파괴에 대한 검토

정착 안정조건 : $1/SF \times f_{at} \times D \times h_r \geq 2 \times W_H$ ---------- 식4

여기에서, f_{at}: 정착지반의 허용인장강도(MPa)

D : 앵커 설치 간격(m)

SF : 정착지반의 인장파괴에 대한 안전율(2.5)

= 1/2.5 × 462.000 × 5.000 × 3.000 = 2772.000KN ≥ 2 × 460.692 = 921.384 KN

2772.000KN ≥ 921.384KN -----→ 0.K

2.4 앵커내하체의 인발에 대한검토

설계앵커력 P_a는 식3에 의한 앵커체 벽면마찰저항 R에대하여 다음을 만족해야 한다.

$P_a \leq 2R = P_a \cdot \tan\Phi \cdot \cot(\Theta+\delta)$ ---------- 식5

$\therefore \tan(\Theta+\delta) \leq \tan\Phi \rightarrow \Theta+\delta \leq \Phi$

6.5 + 22.0 = 28.5 ≤ 33.0 -----→ 0.K

2.5 앵커 내하체 확장시 정착지반의 지압파괴에 대한 검토

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$

$P_{max} / 2.5 \geq 2W_H$

여기에서, P_{max}:심발 폐색공(패커부) 실시 후의 정착지반의 지압파괴하중(kgf)

f_C:정착 지반의 일축압축강도(kgf/㎠)

F:앵커내하체의 지압면적($F = \alpha \cdot \pi \cdot d' \cdot L$, ㎠)

ln:자연대수

d':앵커 천공직경(㎝)

L:앵커체 압착 유효장(㎝)

α:앵커체 유효접지 계수(0.3)

W_H:쐐기 수평력

$F = \alpha \cdot \pi \cdot d' \cdot L$ = 0.3 × π × 11.5 × 36.0 = 390.2 ㎠

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$ = (658.25 × ln 390.2 - 1552.59) × 200.0

= 474,987.93 kgf = 4,749.879 kN

$P_{max} / 2.5$ = 4,749.88 / 2.5 = 1,899.952 kN

≥ $2W_H$ = 921.384 kN -----→ 0.K

3.2 Jacking Force 산정 (P_j)

구 분	설계앵커력	여유장	탄성변위길이		조립길이	수압판	비 고
			근입깊이	자유장			
	(KN)	(m)	(m)	(m)	(m)	(m)	
지압형 앵커	500	1.000	3.000	17.500	21.500	0.600	

1) 프리스트레싱 직후 즉시 손실량 (정착장치의 활동)

Wedge Slip 량 : δ= 6.0 ㎜(쐐기식 정착장치 사용)

$$\Delta P_1 = A_s \times E_s \times \frac{\delta}{L}$$

A_s : 강연선 단면적 (5 x 98.71 = 493.55 ㎟)

E_s : 강연선 탄성계수 (2×10^2 KN/㎟)

L : 탄성변위길이 (20500 ㎜)

δ : Wedge Slip량 (6.0 ㎜)

$$\therefore \Delta P_1 = 493.55 \times 2 \times 10^2 \times \frac{6.0}{20500} = 28.891 \text{ KN}$$

2) 프리스트레싱후 시간 의존적 손실량 (강연선의 Relaxation)

Low - Relaxation 강재사용

$$\Delta P_2 = P_i \times \frac{\log_{10} t}{45} \times \left(\frac{T_{us}}{T_{yS}} - 0.55 \right)$$

P_i : 프리스트레스 도입직후 강연선 긴장력

(설계앵커력 + 즉시손실량 = 500 + 28.9 = 528.891 KN)

t : 프리스트레싱후 손실 계산시까지 시간

(100년 내구연한 : 24 X 365 X 100 = 876,000 hr)

T_{us} : 강연선 극한하중 (187.549 KN)

T_{yS} : 강연선 파단하중 (157.936 KN)

$$\therefore \Delta P_2 = 528.9 \times \frac{\log_{10} 876{,}000}{45} \left(\frac{187.549}{157.936} - 0.55 \right) = 44.525 \text{ KN}$$

3) Jacking Force :

$P_j = P_a + \Delta P1 + \Delta P2$

$= 500 + 28.891 + 44.525 = 573.416$

4) 안정성 검토

(1) 긴장중 허용긴장력

$0.8T_{us}, 0.94T_{ys}$ 중 작은값 = $\begin{cases} 0.8 \times 1.900 = 1.520 & KN/㎟ \\ 0.94 \times 1.600 = 1.504 & KN/㎟ \end{cases}$

허용긴장력= 1.504 × 493.550 = 742.299 KN

∴ JACK에 의해 최대 742.299 KN 까지 긴장가능 ≥ Jacking Force = 573.416 KN --▶ **O.K**

1공당 SWPC7B Φ12.7㎜ 7연선,저릴렉세이션 강연선 5가닥 사용

Φ12.7 × 5EA = 98.71 × 5 = 493.550 ㎟

(2) 긴장직후 허용긴장력

$0.7 \cdot T_{us}$ = 1.33 KN/㎟

허용긴장력= 1.33 × 493.550 = 656.422 KN ≥ 긴장력 도입직후 = 528.891 KN --▶ **O.K**

(3) 손실이 일어난후 유효긴장력작용시 허용긴장력

$0.6T_{us}, 0.75T_{ys}$ 중 작은값 = $\begin{cases} 0.6 \times 1.900 = 1.140 & KN/㎟ \\ 0.75 \times 1.600 = 1.200 & KN/㎟ \end{cases}$

허용긴장력= 1.140 × 493.550 = 562.647 KN ≥ 설계앵커력 P_a = 500 KN --▶ **O.K**

4. 지압판의 설계

4.1 지압판 면적(A) 산정

$$A = \frac{P_j}{f_b} + (\pi \times R^2)$$

여기서, P_j : 긴장하중 (KN)

f_b : 수압판 콘크리트 설계강도의 50% (27 × 0.5 = 13.500 MPa)

R : 지압판 삽입공 (43 mm)

$$A = \frac{573.416}{0.0135} + (\pi \times 42.5^2) = 48149.761 \ mm^2$$

지압판 한 쪽면의 길이(L)은 다음과 같다.

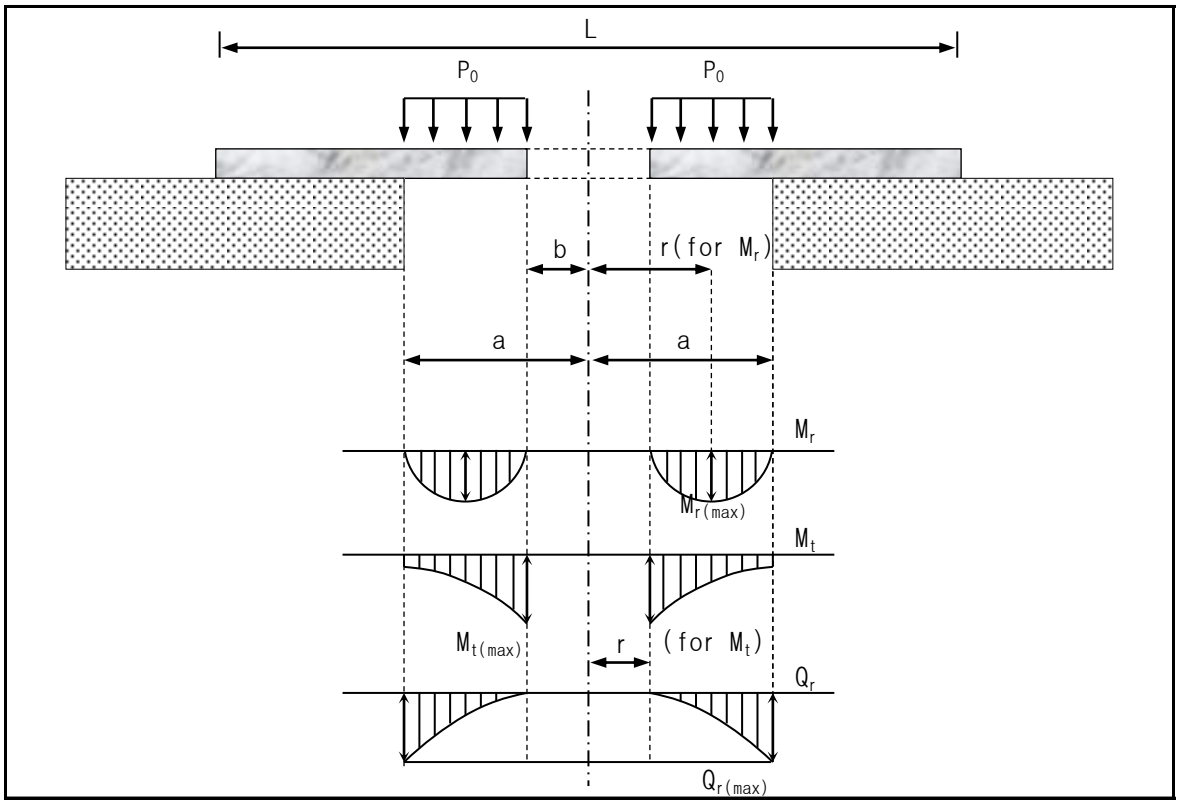
$L = \sqrt{A} = \sqrt{48149.761} = 219$ mm

∴ 규격화를 위해 L= 240 mm , B= 240 mm 적용

4.2 지압판 두께(t) 산정

종래 앵커 지압판의 두께는 지압판을 빔(BEAM)으로 설계는 하는 것이 일반적이였으나 여러 가지 실험결과, 플레이트 판으로서 간주해도 충분히 안전하다는 결과가 얻어지므로 다음과 같이 판으로 간주하여 두께를 산정하였다.

또한, 강두께의 산출에는 안전율 1.5를 보고 그 안전율을 고려한 앵커에 대하여 휨 및 전단에 견딜 수 있도록 강두께를 결정한다.



지압판 두께 산정을 위한 제원 정의도 및 단면력도

1) 단면력 산출

$$M_r = \frac{P_0 a^2}{16}\left[(3+\nu)(1-\rho^2)+k_2\left(1-\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$M_t = \frac{P_0 a^2}{16}\left[2(1-\nu)(1-2X^2)+(1+3\nu)(1-\rho^2)+k_2\left(1+\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$Q_r = -\frac{P_0 A}{2}\left(\rho - X^2\frac{1}{\rho}\right)$$

여기서, M_r : 반경방향의 휨모멘트 (KN · mm/mm)

M_t : 원주방향의 휨모멘트 (KN · mm/mm)

P_0 : 지압판에 작용하는 등분포하중 (KN/mm^2)

$$\frac{1.5 \times Pj}{A} = \frac{1.5 \times 573.416}{48149.761} = 0.018 \quad KN/mm^2$$

ν : 지압판의 포아송비 : (0.3)

r : 지압판 삽입공 중심에서의 거리(mm) { M_r : r = 49.8 mm, M_t : r = 42.5 mm

a : 수압판의 삽입공 반경 (mm) : 57.2 mm

b : 지압판의 삽입공 반경(mm) : 42.5 mm

ρ : r/a (M_r : 0.872 , M_t : 0.744)

K_2 : $X^2[3+\nu+4(1+\nu)\{X^2/(1-X^2)\}\ln X]$ (단, X=b/a) (X= 0.744) (K_2= 0.771)

L : 지압판의 변길이(mm)

ln : 자연대수

(1) $$M_r = \frac{0.018 \times 57.2^2}{16} \times [(3 + 0.3) \times (1 - 0.872^2) + 0.771 \times \left(1 - \frac{1}{0.872^2}\right) + 4 \times (1 + 0.3) \times 0.744^2 \ln(0.872)]$$

$$= 3.647 \times (0.792 + -0.243 + -0.394) = 0.561 \quad KN \cdot mm/mm$$

(2) $M_t = \frac{0.018 \times 57.2^2}{16} \times [2 \times (1 - 0.3) \times (1 - 2 \times 0.744^2)$

$+ (1 + 3 \times 0.3) \times (1 - 0.744^2) + 0.771 \left(1 + \frac{1}{0.744^2}\right)$

$+ 4 \times (1 + 0.3) \times 0.744^2 \times \ln(0.744)]$

$= 3.647 \times (-0.148 + 3.015 + -0.852) = 7.347$ KN · mm/mm

$\therefore M_t = 7.347 > M_r = 0.561$ 이므로 설계휨모멘트 $M_t = 7.347$ 적용

(3) $Q_r = -\frac{0.018 \times 48149.761}{2} \times (1 - 0.744^2 \times 1) = 192.227$ KN

2) 두께산정

(1) M_t에 의한 소요두께 검토

$$t = \left(\frac{6 \times M}{f_{sa}}\right)^{1/2}$$

여기서, M_t : 지압판에 작용하는 휨모멘트 = 7.347 KN · mm/mm

f_{sa} : 지압판의 허용 휨응력 = 140 MPa

$$t \geq \left(\frac{6 \times 7.347}{0.140}\right)^{1/2} = 17.744 \text{ mm}$$

(2) Q_r에 의한 소요두께 검토

$$t \geq \frac{Q_r}{\tau \times \pi d} = \frac{192227}{14363.362} = 13.383 \text{ mm}$$

(3) 강체(Rigid Body)로서의 소요두께 검토

$\beta\lambda \leq 1.0$

여기서 $\beta = \sqrt[4]{\frac{3 \cdot k}{E \cdot h^3}}$ (m^{-1})

K : 수압판의 탄성계수 (= 24,421,916 kN/m^2)

L : 지압판의 길이 (= 0.240 m)

B : 지압판의 폭 (= 0.240 m)

E : 지압판의 탄성계수 (= 210,000,000 kN/m^2)

h : 지압판의 두께 (= 0.019 m) :시산법(Try and Error Method)에 의해 산출

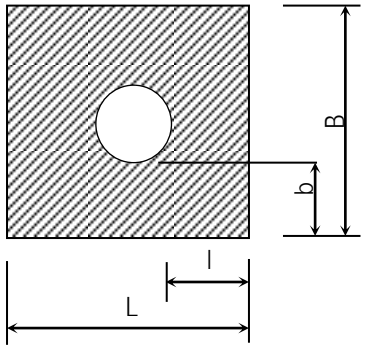
λ : 지압판의 환산 돌출길이 (m)

$\beta = \sqrt[4]{\{(3 \times 24,421,916) / (210,000,000 \times 0.019^3)\}} = 15.018$ (m^{-1})

λ= max(l,b) = max(0.065 , 0.065) = 0.065

다만, l ≥ L/2이면 l = L/2 = 0.120

b ≥ B/2이면 b = B/2 = 0.120



β λ = 15.018 x 0.065 = 0.976 ≤ 1.0 ------► **O.K**

(4) 두께 검토 결과

구분	휨M_t	전단력Q_r	강체검토	최대두께	규격화
소요두께	17.744mm	13.383mm	19.000mm	19.000mm	25mm

3) 응력검토

(1) 휨응력 검토

$$f_{max} = \frac{6 \times Mmax}{h^2} = \frac{6 \times 7.347}{25^2} = 70.528 \quad MPa$$

$f_{max} \leq f_{sa} = 70.528 \leq 140$ ---------► **O.K**

(2) 전단응력 검토

$$\tau_{max} = \frac{3}{2} \times \frac{Q_r}{A} = \frac{3}{2} \times \frac{192227}{8977.101} = 32.120 \quad MPa \qquad (A=\pi 2a \times t)$$

$\tau_{max} \leq \tau_{sa} = 32.120 \leq 80$ ---------► **O.K**

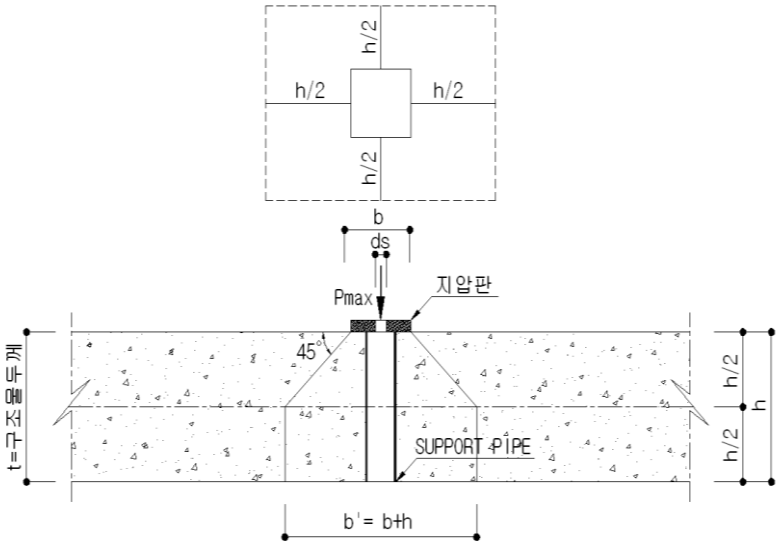
(3) 조합응력 검토

$$\left(\frac{f}{f_a}\right)^2 + \left(\frac{V}{V_a}\right)^2 = \left(\frac{70.528}{140}\right)^2 + \left(\frac{32.120}{80}\right)^2$$

$= 0.415 < 1.2$ ---► **O.K**

∴ 지압판 규격(L × B × t) = 240 mm × 240 mm × 25 mm

5.수압판 콘크리트 응력검토 (지압판 직하 하부슬래브)



5.1 압발 전단응력 검토

$\tau_v = P_{max} / \{4(b+h)\times h\} \leq \tau_{v3}$

여기서, f_{ck} = 27.0 MPa 일때 τ_{v3} = 0.95 MPa

P_{max} : 소요하중 = 573416 KN

b : 지압판 길이 = 240 mm

h : 수압판 유효두께 = 600 mm

τ_v = 573416 / { 4 (240 + 600) × 600 }

= 0.284 MPa ≤ τ_{v3} = 0.950 MPa ----► O.K

5.2 수직 지압응력 검토

$\tau_c = P_{max} / A_b \leq f_{ba}$

여기서, $f_{ba} = 0.5f_{ck}$ = 0.5 × 27 = 13.500 MPa

A_b : 지압판 면적-슬리브 면적

$A_b = L \times B - \pi/4 \times ds^2$

240 x 240 - π/4× 114.3 ² = 47339.174 ㎟

τ_c = 573416 / 47339.174 = 12.113 MPa ≤ f_{ba} = 13.500 MPa ----► O.K

지압식 영구앵커 내적안정 구조계산서

국회대로지하차도 및 상부공원화(1단계-중첩구간) 공사

◈ 제 원

적용구간	지하차도
BLCOK	BLOCK 7 0+345.00 ~ 0+365.00
설계앵커력	500 KN
앵커 조립길이	23.000 m
정착지반	풍화암

앵커의 내적안정성검토

[설계앵커력 P_a = 500 KN , 앵커 간격 D = 5.000 m]

1.설계기준 검토

1.1 앵커 내하체 정착지반 설계조건

구 분	설 계 조 건	비 고
정착지반	풍화암	단위중량 γ = 21 kN/㎥
내부마찰각	Φ = 33°	Φ = 33°
일축압축강도	f_c = 20 MPa	f_c = 200 kgf/㎠
허용인장강도	f_{at} = 0.462 MPa	$f_{at} = 0.0334 \times f_c^{0.9305}$ = 4.622 kgf/㎠

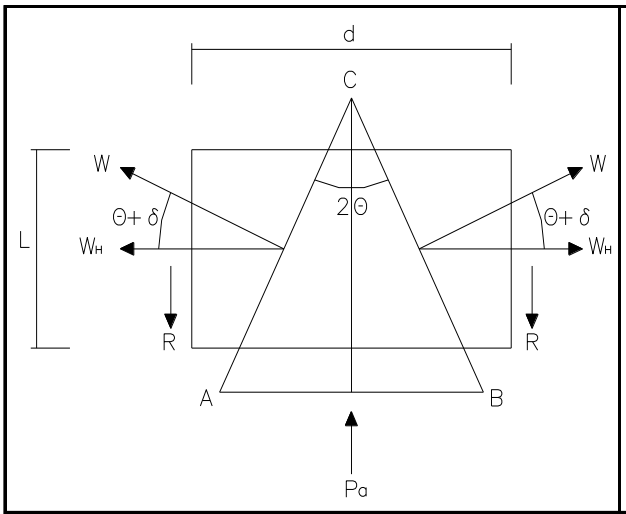
1.2 앵커 내하체 설치조건

구 분	설 계 조 건	비 고
사 용 목 적	부력방지용	지압식 영구앵커
앵커 내하체 전장	여유장 = 1.000 m	
	자유장 = 19.000 m	수압판 두께 포함
	정착근입장 = 3.000 m	
	계 = 23.000 m	앵커 조립장
	수압판두께 = 0.600 m	블럭아웃을 고려한 하부슬래브두께
설 치 간 격	D = 5.000 m	
설 계 앵 커 력	P_a = 500 KN	P_a = 50 tonf
앵커 설계안전율	S.F = 2.5	
앵커 두정각	2Θ = 13°	Θ = 6.5°
앵커 조립직경	d = 95 mm	
앵커 천공직경	d' = 115 mm	
정착지반 근입깊이	$D_{f=}$ 3.000 m	

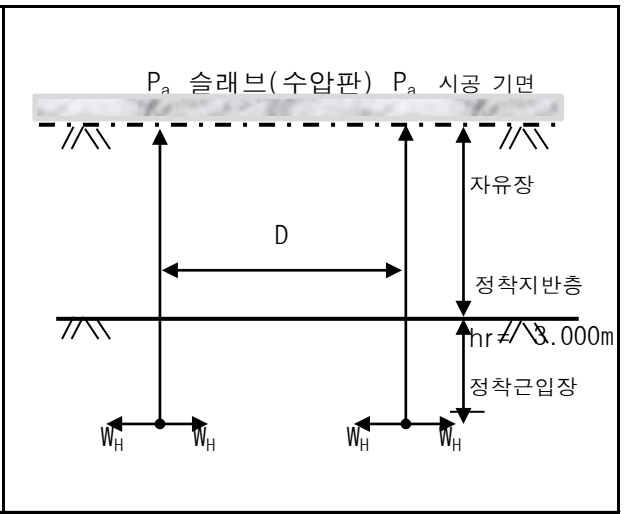
1.3 사용재료의 설계기준

구 분		설 계 조 건	비 고
PS강연선	직경(㎜)	Φ12.7	SWPC7B
	공칭 단면적(㎟)	98.71	Unbonded 강연선
	극한하중	T_{us} = 1.9 KN/㎟	1,900MPa
	항복하중	T_{ys} = 1.6 KN/㎟	1,600MPa
수압판	설계기준강도	f_{ck}= 27 MPa	하부슬래브
	허용압발전단응력	τ_{v3}= 0.950 MPa	도로교설계기준해설(2008) P.906
	허용지압응력	f_{ba}= 13.500 MPa	$f_{ba} = 0.5f_{ck}$
지압판	허용휨/압축응력	$f_{ba}=f_{ca}$= 140 MPa	SS400
	단위중량	γ = 78.50 KN/㎥	

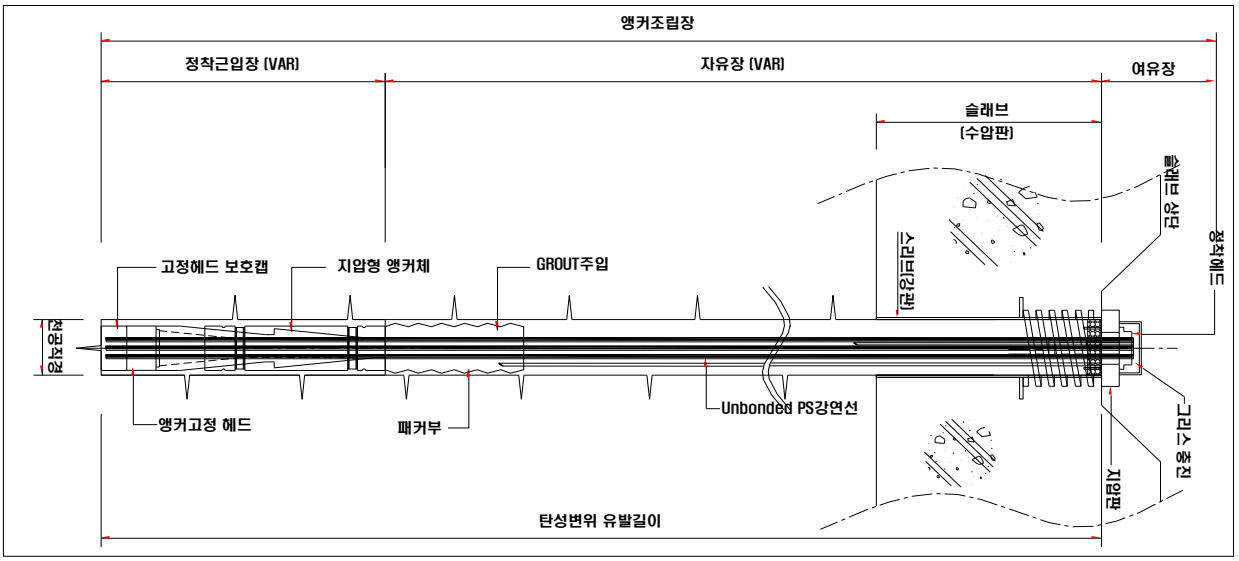
2. 지압식 영구앵커의 정착지반층내 정착근입장검토



< P_a에 의하여 나타나는 WEDGE의 역학관계도 >



< 앵커의 정착조건 >



2.1 앵커내하체의 작용하중 산정

① 쐐기력 $W = \dfrac{P_a}{2 \cdot \sin(\Theta+\delta)}$ ---------- 식1

여기서 sin (6.5 + 22.0) = 0.477

$$\frac{500}{2 \times 0.477} = 524.109 \text{ KN}$$

② 쐐기수평력 $W_H = W \cdot \cos(\Theta+\delta) = P_a/2 \cdot \cot(\Theta+\delta)$ ---------- 식2

여기서 cos (6.5 + 22.0) = 0.879

524.109 × 0.879 = 460.692 KN

③ 벽면전단저항 $R = f \times W_H$ ---------- 식3

여기서 $f = \tan\Phi$ = tan(33.0)° = 0.649

0.649 × 460.692 = 298.989 KN

식 1, 2, 3 에서

Θ = 앵커 두정각의 1/2 = 6.5 °

δ = 벽면 마찰각 = 2/3 x Φ = 22.0 °

f = 마찰계수 = tan(Φ) = 0.649

2.2 정착지반내 앵커내하체의 최소정착근입장 검토 (L_b)

다음 값중 큰 값으로 적용한다.

① 지반정수와 간격에 따른 최소정착장

최소정착장 $hr_{min} \geq \dfrac{5 \times W_H}{f_{at} \times D} = \dfrac{5 \times 460.692}{462.227 \times 5.000} = 1.00 \text{ m} \fallingdotseq 1.00 \text{ m}$

② 제품의 특성을 고려한 근입깊이 (내하체, 패커부)

최소정착장 hr_{min} = 3.000 m

∴ 최소정착장 hr_{min} = 3.000 m

2.3 앵커와 앵커사이의 정착지반의 인장파괴에 대한 검토

정착 안정조건 : $1/SF \times f_{at} \times D \times h_r \geq 2 \times W_H$ ---------- 식4

여기에서, f_{at}: 정착지반의 허용인장강도(MPa)

D : 앵커 설치 간격(m)

SF : 정착지반의 인장파괴에 대한 안전율(2.5)

= 1/2.5 × 462.000 × 5.000 × 3.000 = 2772.000KN ≥ 2 × 460.692 = 921.384 KN

2772.000KN ≥ 921.384KN -----→ 0.K

2.4 앵커내하체의 인발에 대한검토

설계앵커력 P_a는 식3에 의한 앵커체 벽면마찰저항 R에대하여 다음을 만족해야 한다.

$P_a \leq 2R = P_a \cdot \tan\Phi \cdot \cot(\Theta+\delta)$ ---------- 식5

$\therefore \tan(\Theta+\delta) \leq \tan\Phi \rightarrow \Theta+\delta \leq \Phi$

6.5 + 22.0 = 28.5 ≤ 33.0 -----→ 0.K

2.5 앵커 내하체 확장시 정착지반의 지압파괴에 대한 검토

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$

$P_{max} / 2.5 \geq 2W_H$

여기에서, P_{max}:심발 폐색공(패커부) 실시 후의 정착지반의 지압파괴하중(kgf)

f_C:정착 지반의 일축압축강도(kgf/㎠)

F:앵커내하체의 지압면적($F = \alpha \cdot \pi \cdot d' \cdot L$, ㎠)

ln:자연대수

d':앵커 천공직경(㎝)

L:앵커체 압착 유효장(㎝)

α:앵커체 유효접지 계수(0.3)

W_H:쐐기 수평력

$F = \alpha \cdot \pi \cdot d' \cdot L$ = 0.3 × π × 11.5 × 36.0 = 390.2 ㎠

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$ = (658.25 × ln 390.2 - 1552.59) × 200.0

= 474,987.93 kgf = 4,749.879 kN

$P_{max} / 2.5$ = 4,749.88 / 2.5 = 1,899.952 kN

≥ $2W_H$ = 921.384 kN -----→ 0.K

3.2 Jacking Force 산정 (P_j)

구 분	설계앵커력	여유장	탄성변위길이		조립길이	수압판	비 고
			근입깊이	자유장			
	(KN)	(m)	(m)	(m)	(m)	(m)	
지압형 앵커	500	1.000	3.000	19.000	23.000	0.600	

1) 프리스트레싱 직후 즉시 손실량 (정착장치의 활동)

Wedge Slip 량 : δ = 6.0 ㎜(쐐기식 정착장치 사용)

$$\Delta P_1 = A_s \times E_s \times \frac{\delta}{L}$$

A_s : 강연선 단면적 (5 x 98.71 = 493.55 ㎟)

E_s : 강연선 탄성계수 (2×10^2 KN/㎟)

L : 탄성변위길이 (22000 ㎜)

δ : Wedge Slip량 (6.0 ㎜)

$$\therefore \Delta P_1 = 493.55 \times 2 \times 10^2 \times \frac{6.0}{22000} = 26.921 \text{ KN}$$

2) 프리스트레싱후 시간 의존적 손실량 (강연선의 Relaxation)

Low - Relaxation 강재사용

$$\Delta P_2 = P_i \times \frac{\log_{10} t}{45} \times \left(\frac{T_{us}}{T_{yS}} - 0.55 \right)$$

P_i : 프리스트레스 도입직후 강연선 긴장력

(설계앵커력 + 즉시손실량 = 500 + 26.9 = 526.921 KN)

t : 프리스트레싱후 손실 계산시까지 시간

(100년 내구연한 : 24 X 365 X 100 = 876,000 hr)

T_{us} : 강연선 극한하중 (187.549 KN)

T_{yS} : 강연선 파단하중 (157.936 KN)

$$\therefore \Delta P_2 = 526.9 \times \frac{\log_{10} 876{,}000}{45} \left(\frac{187.549}{157.936} - 0.55 \right) = 44.359 \text{ KN}$$

3) Jacking Force :

$P_j = P_a + \Delta P1 + \Delta P2$

$= 500 + 26.921 + 44.359 = 571.280$

4) 안정성 검토

(1) 긴장중 허용긴장력

$0.8T_{us}, 0.94T_{ys}$ 중 작은값 = $\begin{cases} 0.8 \times 1.900 = 1.520 & KN/㎟ \\ 0.94 \times 1.600 = 1.504 & KN/㎟ \end{cases}$

허용긴장력= 1.504 × 493.550 = 742.299 KN

∴ JACK에 의해 최대 742.299 KN 까지 긴장가능 ≥ Jacking Force = 571.280 KN --▶ **O.K**

1공당 SWPC7B Φ12.7㎜ 7연선,저릴렉세이션 강연선 5가닥 사용

Φ12.7 × 5EA = 98.71 × 5 = 493.550 ㎟

(2) 긴장직후 허용긴장력

$0.7 \cdot T_{us}$ = 1.33 KN/㎟

허용긴장력= 1.33 × 493.550 = 656.422 KN ≥ 긴장력 도입직후 = 526.921 KN --▶ **O.K**

(3) 손실이 일어난후 유효긴장력작용시 허용긴장력

$0.6T_{us}, 0.75T_{ys}$ 중 작은값 = $\begin{cases} 0.6 \times 1.900 = 1.140 & KN/㎟ \\ 0.75 \times 1.600 = 1.200 & KN/㎟ \end{cases}$

허용긴장력= 1.140 × 493.550 = 562.647 KN ≥ 설계앵커력 P_a = 500 KN --▶ **O.K**

4. 지압판의 설계

4.1 지압판 면적(A) 산정

$$A = \frac{P_j}{f_b} + (\pi \times R^2)$$

여기서, P_j : 긴장하중 (KN)

f_b : 수압판 콘크리트 설계강도의 50% (27 × 0.5 = 13.500 MPa)

R : 지압판 삽입공 (43 mm)

$$A = \frac{571.280}{0.0135} + (\pi \times 42.5^2) = 47991.539 \ mm^2$$

지압판 한 쪽면의 길이(L)은 다음과 같다.

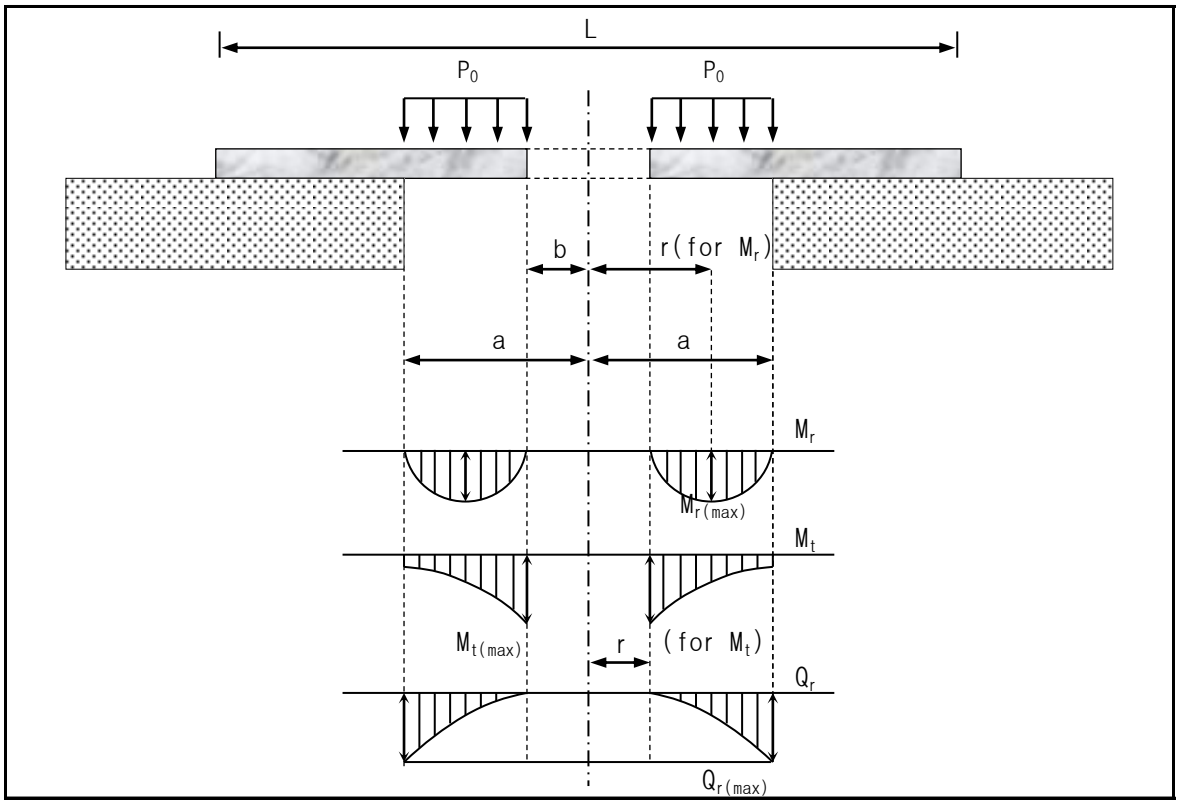
$L = \sqrt{A} = \sqrt{47991.539} = 219$ mm

∴ 규격화를 위해 L= 240 mm , B= 240 mm 적용

4.2 지압판 두께(t) 산정

종래 앵커 지압판의 두께는 지압판을 빔(BEAM)으로 설계는 하는 것이 일반적이였으나 여러 가지 실험결과, 플레이트 판으로서 간주해도 충분히 안전하다는 결과가 얻어지므로 다음과 같이 판으로 간주하여 두께를 산정하였다.

또한, 강두께의 산출에는 안전율 1.5를 보고 그 안전율을 고려한 앵커에 대하여 휨 및 전단에 견딜 수 있도록 강두께를 결정한다.



지압판 두께 산정을 위한 제원 정의도 및 단면력도

1) 단면력 산출

$$M_r = \frac{P_0 a^2}{16}\left[(3+\nu)(1-\rho^2)+k_2\left(1-\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$M_t = \frac{P_0 a^2}{16}\left[2(1-\nu)(1-2X^2)+(1+3\nu)(1-\rho^2)+k_2\left(1+\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$Q_r = -\frac{P_0 A}{2}\left(\rho - X^2\frac{1}{\rho}\right)$$

여기서, M_r : 반경방향의 휨모멘트 (KN · mm/mm)

M_t : 원주방향의 휨모멘트 (KN · mm/mm)

P_0 : 지압판에 작용하는 등분포하중 (KN/mm^2)

$$\frac{1.5 \times Pj}{A} = \frac{1.5 \times 571.280}{47991.539} = 0.018 \quad KN/mm^2$$

ν : 지압판의 포아송비 : (0.3)

r : 지압판 삽입공 중심에서의 거리(mm) { M_r : r = 49.8 mm, M_t : r = 42.5 mm

a : 수압판의 삽입공 반경 (mm) : 57.2 mm

b : 지압판의 삽입공 반경(mm) : 42.5 mm

ρ : r/a (M_r : 0.872 , M_t : 0.744)

K_2 : $X^2[3+\nu+4(1+\nu)\{X^2/(1-X^2)\}\ln X]$ (단, X=b/a) (X= 0.744) (K_2= 0.771)

L : 지압판의 변길이(mm)

ln : 자연대수

(1) $$M_r = \frac{0.018 \times 57.2^{\,2}}{16} \times [(3+0.3) \times (1-0.872^{\,2}) + 0.771 \times \left(1-\frac{1}{0.872^{\,2}}\right) + 4(1+0.3) \times 0.744^{\,2} \ln(0.872)]$$

$$= 3.645 \times (0.792 + -0.243 + -0.394) = 0.561 \quad KN \cdot mm/mm$$

(2) $M_t = \frac{0.018 \times 57.2^2}{16} \times [\,2 \times (1 - 0.3) \times (1 - 2 \times 0.744^2)$

$+ (1 + 3 \times 0.3) \times (1 - 0.744^2) + 0.771 \left(1 + \frac{1}{0.744^2}\right)$

$+ 4 \times (1 + 0.3) \times 0.744^2 \times \ln(0.744)\,]$

$= 3.645 \times (-0.148 + 3.015 + -0.852) = 7.343$ KN · mm/mm

$\therefore M_t = 7.343 > M_r = 0.561$ 이므로 설계휨모멘트 $M_t = 7.343$ 적용

(3) $Q_r = -\frac{0.018 \times 47991.539}{2} \times (1 - 0.744^2 \times 1) = 191.511$ KN

2) 두께산정

(1) M_t에 의한 소요두께 검토

$$t = \left(\frac{6 \times M}{f_{sa}}\right)^{1/2}$$

여기서, M_t : 지압판에 작용하는 휨모멘트 = 7.343 KN · mm/mm

f_{sa} : 지압판의 허용 휨응력 = 140 MPa

$$t \geq \left(\frac{6 \times 7.343}{0.140}\right)^{1/2} = 17.740 \text{ mm}$$

(2) Q_r에 의한 소요두께 검토

$$t \geq \frac{Q_r}{\tau \times \pi d} = \frac{191511}{14363.362} = 13.333 \text{ mm}$$

(3) 강체(Rigid Body)로서의 소요두께 검토

$\beta\lambda \leq 1.0$

여기서 $\beta = \sqrt[4]{\frac{3 \cdot k}{E \cdot h^3}}$ (m^{-1})

K : 수압판의 탄성계수 (= 24,421,916 kN/m^2)

L : 지압판의 길이 (= 0.240 m)

B : 지압판의 폭 (= 0.240 m)

E : 지압판의 탄성계수 (= 210,000,000 kN/m^2)

h : 지압판의 두께 (= 0.019 m) :시산법(Try and Error Method)에 의해 산출

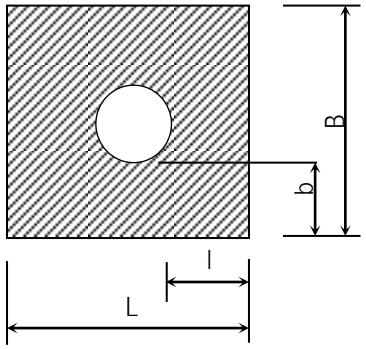
λ : 지압판의 환산 돌출길이 (m)

$\beta = \sqrt[4]{(3 \times 24,421,916) / (210,000,000 \times 0.019^3)} = 15.018$ (m^{-1})

λ= max(l,b) = max(0.065 , 0.065) = 0.065

다만, l ≥ L/2이면 l = L/2 = 0.120

b ≥ B/2이면 b = B/2 = 0.120



β λ = 15.018 x 0.065 = 0.976 ≤ 1.0 ------► **O.K**

(4) 두께 검토 결과

구분	휨M_t	전단력Q_r	강체검토	최대두께	규격화
소요두께	17.740mm	13.333mm	19.000mm	19.000mm	25mm

3) 응력검토

(1) 휨응력 검토

$$f_{max} = \frac{6 \times Mmax}{h^2} = \frac{6 \times 7.343}{25^2} = 70.497 \quad MPa$$

f_{max} ≤ f_{sa} = 70.497 ≤ 140 ---------► **O.K**

(2) 전단응력 검토

$$\tau_{max} = \frac{3}{2} \times \frac{Q_r}{A} = \frac{3}{2} \times \frac{191511}{8977.101} = 32.000 \quad MPa \qquad (A=\pi 2a \times t)$$

τ_{max} ≤ τ_{sa} = 32.000 ≤ 80 ---------► **O.K**

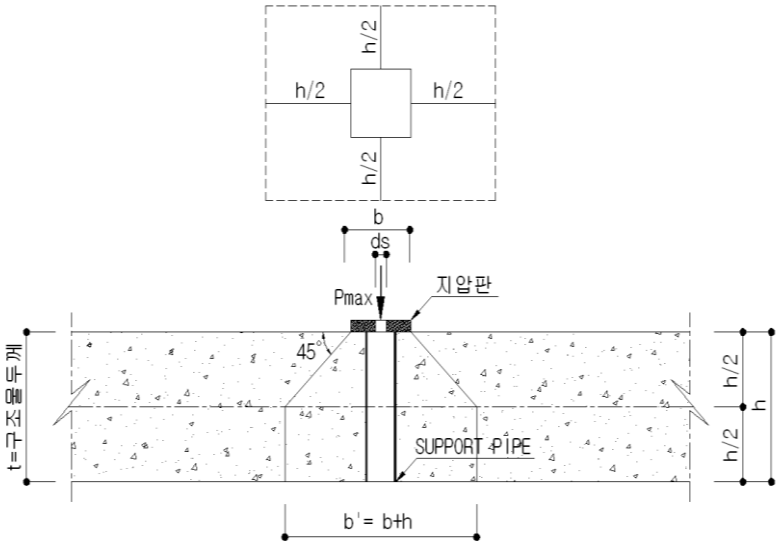
(3) 조합응력 검토

$$\left(\frac{f}{f_a}\right)^2 + \left(\frac{V}{V_a}\right)^2 = \left(\frac{70.497}{140}\right)^2 + \left(\frac{32.000}{80}\right)^2$$

= 0.414 < 1.2 ---► **O.K**

∴ 지압판 규격(L × B × t) = 240 mm × 240 mm × 25 mm

5.수압판 콘크리트 응력검토 (지압판 직하 하부슬래브)



5.1 압발 전단응력 검토

$\tau_v = P_{max} / \{4(b+h)\times h\} \leq \tau_{v3}$

여기서, f_{ck} = 27.0 MPa 일때 τ_{v3} = 0.95 MPa

P_{max} : 소요하중 = 571280 KN

b : 지압판 길이 = 240 mm

h : 수압판 유효두께 = 600 mm

τ_v = 571280 / { 4 (240 + 600) × 600 }

= 0.283 MPa ≤ τ_{v3} = 0.950 MPa ----► O.K

5.2 수직 지압응력 검토

$\tau_c = P_{max} / A_b \leq f_{ba}$

여기서, $f_{ba} = 0.5f_{ck}$ = 0.5 × 27 = 13.500 MPa

A_b : 지압판 면적-슬리브 면적

$A_b = L \times B - \pi/4 \times ds^2$

240 x 240 - π/4× 114.3 ² = 47339.174 ㎟

τ_c = 571280 / 47339.174 = 12.068 MPa ≤ f_{ba} = 13.500 MPa ----► O.K

지압식 영구앵커 내적안정 구조계산서

국회대로지하차도 및 상부공원화(1단계-중첩구간) 공사

◈ 제 원

적용구간	지하차도
BLOCK	BLOCK 8 0+365.00 ~ 0+385.00
설계앵커력	500 KN
앵커 조립길이	25.000 m
정착지반	풍화암

앵커의 내적안정성검토

[설계앵커력 P_a = 500 KN , 앵커 간격 D = 5.000 m]

1.설계기준 검토

1.1 앵커 내하체 정착지반 설계조건

구 분	설 계 조 건	비 고
정착지반	풍화암	단위중량 γ = 21 kN/㎥
내부마찰각	Φ = 33°	Φ = 33°
일축압축강도	f_c = 20 MPa	f_c = 200 kgf/㎠
허용인장강도	f_{at} = 0.462 MPa	$f_{at} = 0.0334 \times f_c^{0.9305}$ = 4.622 kgf/㎠

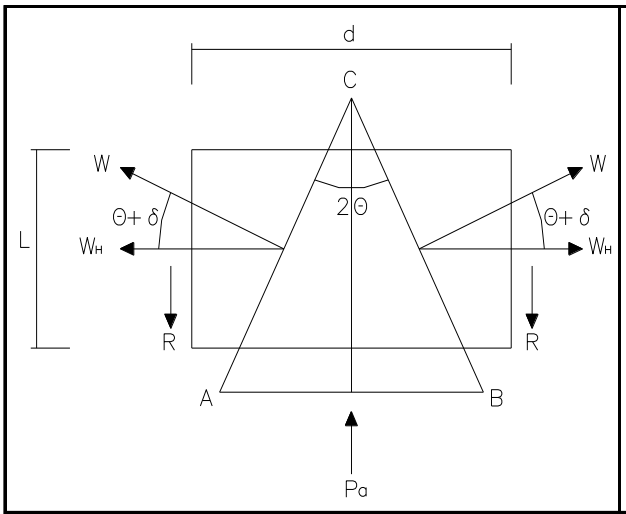
1.2 앵커 내하체 설치조건

구 분	설 계 조 건	비 고
사 용 목 적	부력방지용	지압식 영구앵커
앵커 내하체 전장	여유장 = 1.000 m	
	자유장 = 21.000 m	수압판 두께 포함
	정착근입장 = 3.000 m	
	계 = 25.000 m	앵커 조립장
	수압판두께 = 0.600 m	블럭아웃을 고려한 하부슬래브두께
설 치 간 격	D = 5.000 m	
설 계 앵 커 력	P_a = 500 KN	P_a = 50 tonf
앵커 설계안전율	S.F = 2.5	
앵커 두정각	2Θ = 13°	Θ = 6.5°
앵커 조립직경	d = 95 mm	
앵커 천공직경	d' = 115 mm	
정착지반 근입깊이	$D_{f=}$ 3.000 m	

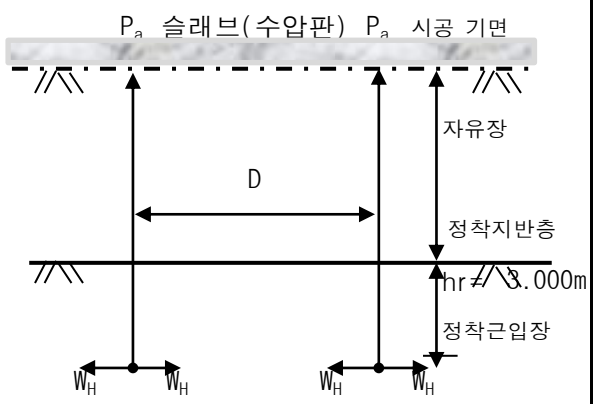
1.3 사용재료의 설계기준

구 분		설 계 조 건	비 고
PS강연선	직경(㎜)	Φ12.7	SWPC7B
	공칭 단면적(㎟)	98.71	Unbonded 강연선
	극한하중	T_{us} = 1.9 KN/㎟	1,900MPa
	항복하중	T_{ys} = 1.6 KN/㎟	1,600MPa
수압판	설계기준강도	f_{ck}= 27 MPa	하부슬래브
	허용압발전단응력	τ_{v3}= 0.950 MPa	도로교설계기준해설(2008) P.906
	허용지압응력	f_{ba}= 13.500 MPa	$f_{ba} = 0.5f_{ck}$
지압판	허용휨/압축응력	$f_{ba}=f_{ca}$= 140 MPa	SS400
	단위중량	γ = 78.50 KN/㎥	

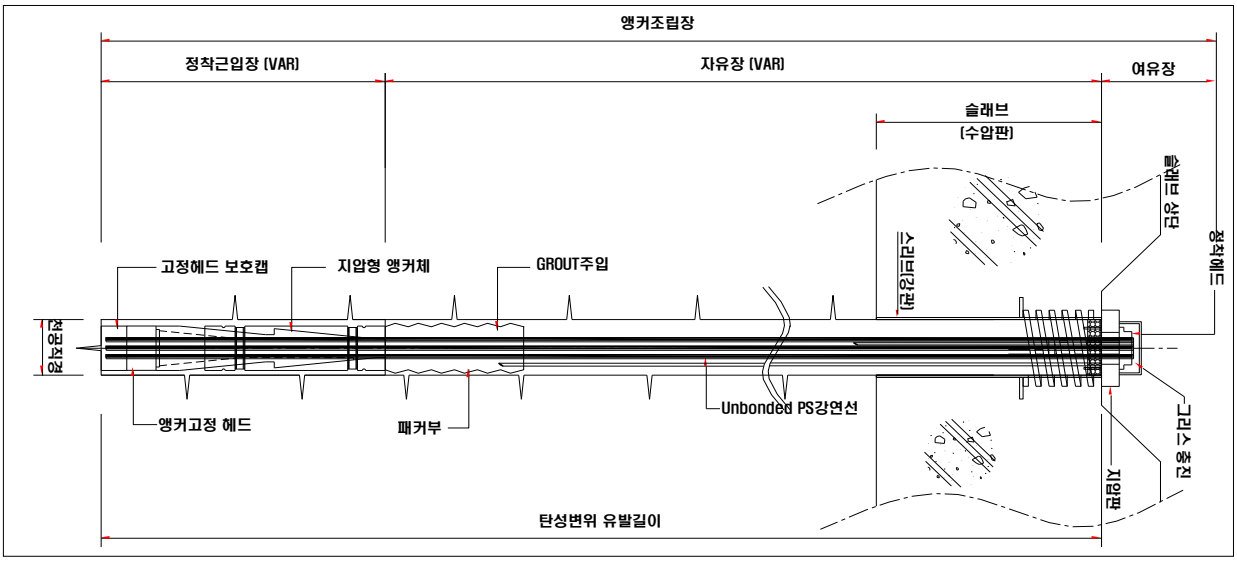
2. 지압식 영구앵커의 정착지반층내 정착근입장검토



< P_a에 의하여 나타나는 WEDGE의 역학관계도 >



< 앵커의 정착조건 >



2.1 앵커내하체의 작용하중 산정

① 쐐기력 $W = \dfrac{P_a}{2 \cdot \sin(\Theta+\delta)}$ ---------- 식1

여기서 sin (6.5 + 22.0) = 0.477

$\dfrac{500}{2 \times 0.477} = 524.109$ KN

② 쐐기수평력 $W_H = W \cdot \cos(\Theta+\delta) = P_a/2 \cdot \cot(\Theta+\delta)$ ---------- 식2

여기서 cos (6.5 + 22.0) = 0.879

524.109 × 0.879 = 460.692 KN

③ 벽면전단저항 $R = f \times W_H$ ---------- 식3

여기서 $f = \tan\Phi$ = tan(33.0)° = 0.649

0.649 × 460.692 = 298.989 KN

식 1, 2, 3 에서

Θ = 앵커 두정각의 1/2 = 6.5 °

δ = 벽면 마찰각 = 2/3 x Φ = 22.0 °

f = 마찰계수 = tan(Φ) = 0.649

2.2 정착지반내 앵커내하체의 최소정착근입장 검토 (L_b)

다음 값중 큰 값으로 적용한다.

① 지반정수와 간격에 따른 최소정착장

최소정착장 $hr_{min} \geq \dfrac{5 \times W_H}{f_{at} \times D} = \dfrac{5 \times 460.692}{462.227 \times 5.000} = 1.00$ m ≒ 1.00 m

② 제품의 특성을 고려한 근입깊이 (내하체, 패커부)

최소정착장 hr_{min} = 3.000 m

∴ 최소정착장 hr_{min} = 3.000 m

2.3 앵커와 앵커사이의 정착지반의 인장파괴에 대한 검토

정착 안정조건 : $1/SF \times f_{at} \times D \times h_r \geq 2 \times W_H$ ---------- 식4

여기에서, f_{at}: 정착지반의 허용인장강도(MPa)

D : 앵커 설치 간격(m)

SF : 정착지반의 인장파괴에 대한 안전율(2.5)

= 1/2.5 × 462.000 × 5.000 × 3.000 = 2772.000KN ≥ 2 × 460.692 = 921.384 KN

2772.000KN ≥ 921.384KN -----→ 0.K

2.4 앵커내하체의 인발에 대한검토

설계앵커력 P_a는 식3에 의한 앵커체 벽면마찰저항 R에대하여 다음을 만족해야 한다.

$P_a \leq 2R = P_a \cdot \tan\Phi \cdot \cot(\Theta+\delta)$ ---------- 식5

$\therefore \tan(\Theta+\delta) \leq \tan\Phi \rightarrow \Theta+\delta \leq \Phi$

6.5 + 22.0 = 28.5 ≤ 33.0 -----→ 0.K

2.5 앵커 내하체 확장시 정착지반의 지압파괴에 대한 검토

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$

$P_{max} / 2.5 \geq 2W_H$

여기에서, P_{max}:심발 폐색공(패커부) 실시 후의 정착지반의 지압파괴하중(kgf)

f_C:정착 지반의 일축압축강도(kgf/㎠)

F:앵커내하체의 지압면적($F = \alpha \cdot \pi \cdot d' \cdot L$, ㎠)

ln:자연대수

d':앵커 천공직경(㎝)

L:앵커체 압착 유효장(㎝)

α:앵커체 유효접지 계수(0.3)

W_H:쐐기 수평력

$F = \alpha \cdot \pi \cdot d' \cdot L$ = 0.3 × π × 11.5 × 36.0 = 390.2 ㎠

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$ = (658.25 × ln 390.2 - 1552.59) × 200.0

= 474,987.93 kgf = 4,749.879 kN

$P_{max} / 2.5$ = 4,749.88 / 2.5 = 1,899.952 kN

≥ $2W_H$ = 921.384 kN -----→ 0.K

3.2 Jacking Force 산정 (P_j)

구 분	설계앵커력	여유장	탄성변위길이		조립길이	수압판	비 고
			근입깊이	자유장			
	(KN)	(m)	(m)	(m)	(m)	(m)	
지압형 앵커	500	1.000	3.000	21.000	25.000	0.600	

1) 프리스트레싱 직후 즉시 손실량 (정착장치의 활동)

Wedge Slip 량 : δ = 6.0 ㎜(쐐기식 정착장치 사용)

$$\Delta P_1 = A_s \times E_s \times \frac{\delta}{L}$$

A_s : 강연선 단면적 (5 x 98.71 = 493.55 ㎟)

E_s : 강연선 탄성계수 (2×10^2 KN/㎟)

L : 탄성변위길이 (24000 ㎜)

δ : Wedge Slip량 (6.0 ㎜)

$$\therefore \Delta P_1 = 493.55 \times 2 \times 10^2 \times \frac{6.0}{24000} = 24.678 \text{ KN}$$

2) 프리스트레싱후 시간 의존적 손실량 (강연선의 Relaxation)

Low - Relaxation 강재사용

$$\Delta P_2 = P_i \times \frac{\log_{10} t}{45} \times \left(\frac{T_{us}}{T_{yS}} - 0.55 \right)$$

P_i : 프리스트레스 도입직후 강연선 긴장력

(설계앵커력 + 즉시손실량 = 500 + 24.7 = 524.678 KN)

t : 프리스트레싱후 손실 계산시까지 시간

(100년 내구연한 : 24 X 365 X 100 = 876,000 hr)

T_{us} : 강연선 극한하중 (187.549 KN)

T_{yS} : 강연선 파단하중 (157.936 KN)

$$\therefore \Delta P_2 = 524.7 \times \frac{\log_{10} 876{,}000}{45} \left(\frac{187.549}{157.936} - 0.55 \right) = 44.170 \text{ KN}$$

3) Jacking Force :

$P_j = P_a + \Delta P1 + \Delta P2$

$= 500 + 24.678 + 44.170 = 568.848$

4) 안정성 검토

(1) 긴장중 허용긴장력

$0.8T_{us}, 0.94T_{ys}$ 중 작은값 = { 0.8 × 1.900 = 1.520 KN/㎟ ; 0.94 × 1.600 = 1.504 KN/㎟ }

허용긴장력= 1.504 × 493.550 = 742.299 KN

∴ JACK에 의해 최대 742.299 KN 까지 긴장가능 ≥ Jacking Force = 568.848 KN --▶ **O.K**

1공당 SWPC7B Φ12.7㎜ 7연선,저릴렉세이션 강연선 5가닥 사용

Φ12.7 × 5EA = 98.71 × 5 = 493.550 ㎟

(2) 긴장직후 허용긴장력

$0.7 \cdot T_{us}$ = 1.33 KN/㎟

허용긴장력= 1.33 × 493.550 = 656.422 KN ≥ 긴장력 도입직후 = 524.678 KN --▶ **O.K**

(3) 손실이 일어난후 유효긴장력작용시 허용긴장력

$0.6T_{us}, 0.75T_{ys}$ 중 작은값 = { 0.6 × 1.900 = 1.140 KN/㎟ ; 0.75 × 1.600 = 1.200 KN/㎟ }

허용긴장력= 1.140 × 493.550 = 562.647 KN ≥ 설계앵커력 P_a = 500 KN --▶ **O.K**

4. 지압판의 설계

4.1 지압판 면적(A) 산정

$$A = \frac{P_j}{f_b} + (\pi \times R^2)$$

여기서, P_j : 긴장하중 (KN)

f_b : 수압판 콘크리트 설계강도의 50% (27 × 0.5 = 13.500 MPa)

R : 지압판 삽입공 (43 mm)

$$A = \frac{568.848}{0.0135} + (\pi \times 42.5^2) = 47811.391 \ mm^2$$

지압판 한 쪽면의 길이(L)은 다음과 같다.

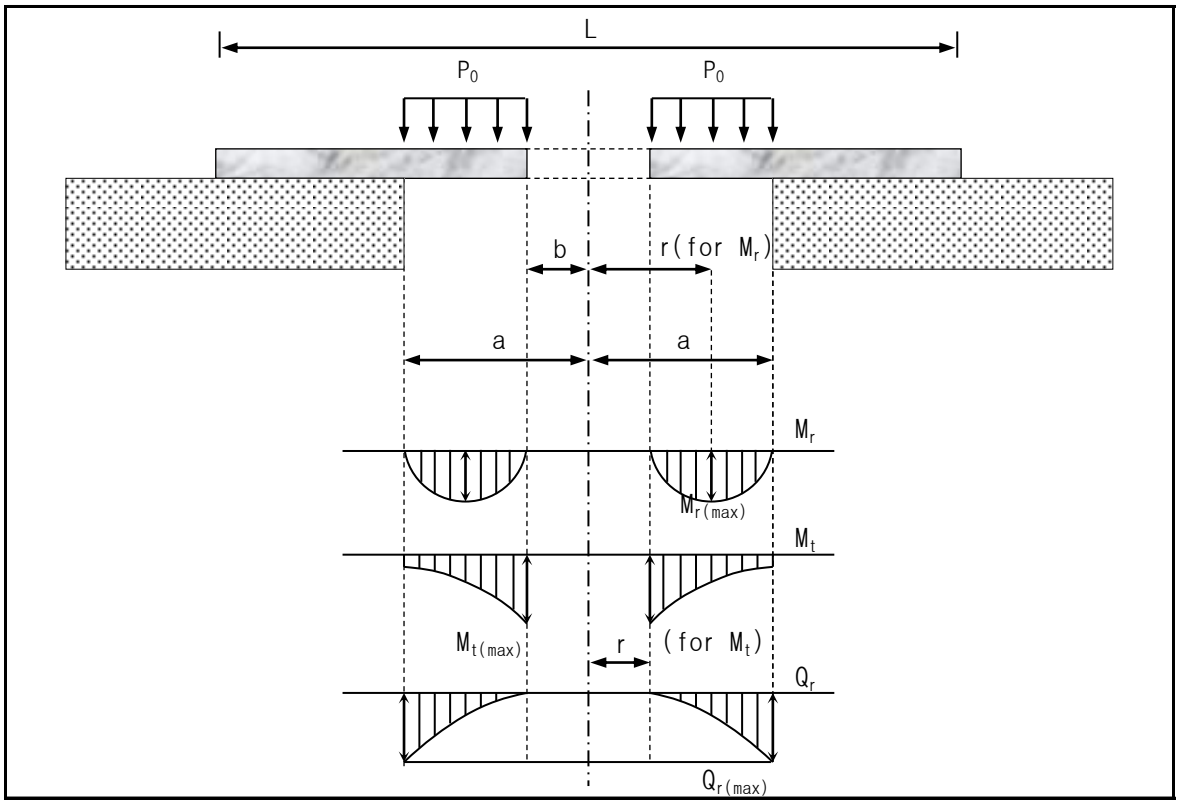
$L = \sqrt{A} = \sqrt{47811.391} = 219$ mm

∴ 규격화를 위해 L= 240 mm , B= 240 mm 적용

4.2 지압판 두께(t) 산정

종래 앵커 지압판의 두께는 지압판을 빔(BEAM)으로 설계는 하는 것이 일반적이였으나 여러 가지 실험결과, 플레이트 판으로서 간주해도 충분히 안전하다는 결과가 얻어지므로 다음과 같이 판으로 간주하여 두께를 산정하였다.

또한, 강두께의 산출에는 안전율 1.5를 보고 그 안전율을 고려한 앵커에 대하여 휨 및 전단에 견딜 수 있도록 강두께를 결정한다.



지압판 두께 산정을 위한 제원 정의도 및 단면력도

1) 단면력 산출

$$M_r = \frac{P_0 a^2}{16}\left[(3+\nu)(1-\rho^2)+k_2\left(1-\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$M_t = \frac{P_0 a^2}{16}\left[2(1-\nu)(1-2X^2)+(1+3\nu)(1-\rho^2)+k_2\left(1+\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$Q_r = -\frac{P_0 A}{2}\left(\rho - X^2\frac{1}{\rho}\right)$$

여기서, M_r : 반경방향의 휨모멘트 (KN · mm/mm)

M_t : 원주방향의 휨모멘트 (KN · mm/mm)

P_0 : 지압판에 작용하는 등분포하중 (KN/mm^2)

$$\frac{1.5 \times Pj}{A} = \frac{1.5 \times 568.848}{47811.391} = 0.018 \quad KN/mm^2$$

ν : 지압판의 포아송비 : (0.3)

r : 지압판 삽입공 중심에서의 거리(mm) { M_r : r = 49.8 mm, M_t : r = 42.5 mm

a : 수압판의 삽입공 반경 (mm) : 57.2 mm

b : 지압판의 삽입공 반경(mm) : 42.5 mm

ρ : r/a (M_r : 0.872 , M_t : 0.744)

K_2 : $X^2[3+\nu+4(1+\nu)\{X^2/(1-X^2)\}\ln X]$ (단, X=b/a) (X= 0.744) (K_2= 0.771)

L : 지압판의 변길이(mm)

ln : 자연대수

(1) $$M_r = \frac{0.018 \times 57.2^2}{16} \times [(3+0.3) \times (1-0.872^2) + 0.771 \times \left(1-\frac{1}{0.872^2}\right) + 4(1+0.3) \times 0.744^2 \ln(0.872)]$$

$$= 3.643 \times (0.792 + -0.243 + -0.394) = 0.561 \quad KN \cdot mm/mm$$

(2) $M_t = \frac{0.018 \times 57.2^2}{16} \times [2 \times (1 - 0.3) \times (1 - 2 \times 0.744^2)$

$+ (1 + 3 \times 0.3) \times (1 - 0.744^2) + 0.771 \left(1 + \frac{1}{0.744^2}\right)$

$+ 4 \times (1 + 0.3) \times 0.744^2 \times \ln(0.744)]$

$= 3.643 \times (-0.148 + 3.015 + -0.852) = 7.340$ KN · mm/mm

$\therefore M_t = 7.340 > M_r = 0.561$ 이므로 설계휨모멘트 $M_t = 7.340$ 적용

(3) $Q_r = -\frac{0.018 \times 47811.391}{2} \times (1 - 0.744^2 \times 1) = 190.695$ KN

2) 두께산정

(1) M_t에 의한 소요두께 검토

$$t = \left(\frac{6 \times M}{f_{sa}}\right)^{1/2}$$

여기서, M_t : 지압판에 작용하는 휨모멘트 = 7.340 KN · mm/mm

f_{sa} : 지압판의 허용 휨응력 = 140 MPa

$$t \geq \left(\frac{6 \times 7.340}{0.140}\right)^{1/2} = 17.736 \text{ mm}$$

(2) Q_r에 의한 소요두께 검토

$$t \geq \frac{Q_r}{\tau \times \pi d} = \frac{190695}{14363.362} = 13.276 \text{ mm}$$

(3) 강체(Rigid Body)로서의 소요두께 검토

$\beta\lambda \leq 1.0$

여기서 $\beta = \sqrt[4]{\frac{3 \cdot k}{E \cdot h^3}}$ (m^{-1})

K : 수압판의 탄성계수 (= 24,421,916 kN/m^2)

L : 지압판의 길이 (= 0.240 m)

B : 지압판의 폭 (= 0.240 m)

E : 지압판의 탄성계수 (= 210,000,000 kN/m^2)

h : 지압판의 두께 (= 0.019 m) :시산법(Try and Error Method)에 의해 산출

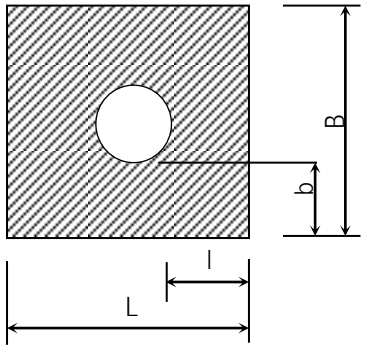
λ : 지압판의 환산 돌출길이 (m)

$\beta = \sqrt[4]{(3 \times 24,421,916) / (210,000,000 \times 0.019^3)} = 15.018$ (m^{-1})

λ= max(l,b) = max(0.065 , 0.065) = 0.065

다만, l ≥ L/2이면 l = L/2 = 0.120

b ≥ B/2이면 b = B/2 = 0.120



β λ = 15.018 x 0.065 = 0.976 ≤ 1.0 ------► **O.K**

(4) 두께 검토 결과

구분	휨M_t	전단력Q_r	강체검토	최대두께	규격화
소요두께	17.736mm	13.276mm	19.000mm	19.000mm	25mm

3) 응력검토

(1) 휨응력 검토

$$f_{max} = \frac{6 \times Mmax}{h^2} = \frac{6 \times 7.340}{25^2} = 70.462 \quad MPa$$

f_{max} ≤ f_{sa} = 70.462 ≤ 140 ---------► **O.K**

(2) 전단응력 검토

$$\tau_{max} = \frac{3}{2} \times \frac{Q_r}{A} = \frac{3}{2} \times \frac{190695}{8977.101} = 31.864 \quad MPa \qquad (A=\pi 2a \times t)$$

τ_{max} ≤ τ_{sa} = 31.864 ≤ 80 ---------► **O.K**

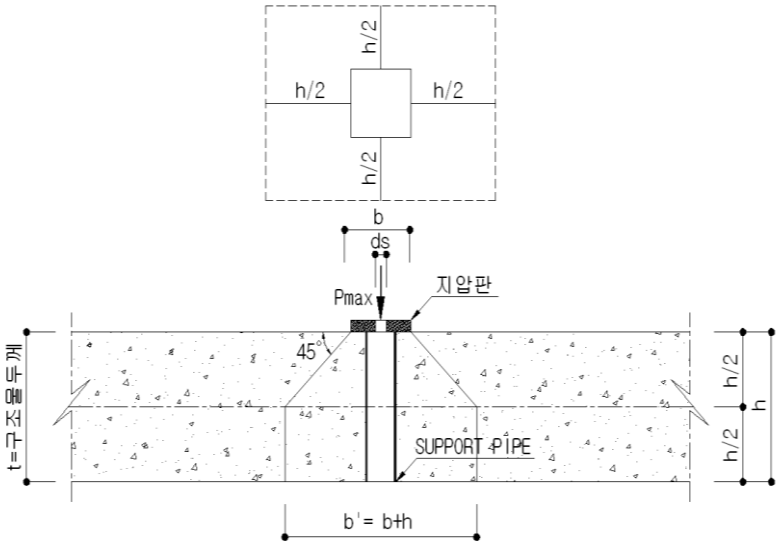
(3) 조합응력 검토

$$\left(\frac{f}{f_a}\right)^2 + \left(\frac{V}{V_a}\right)^2 = \left(\frac{70.462}{140}\right)^2 + \left(\frac{31.864}{80}\right)^2$$

= 0.412 < 1.2 ---► **O.K**

∴ 지압판 규격(L × B × t) = 240 mm × 240 mm × 25 mm

5.수압판 콘크리트 응력검토 (지압판 직하 하부슬래브)



5.1 압발 전단응력 검토

$\tau_v = P_{max} / \{4(b+h)\times h\} \leq \tau_{v3}$

여기서, f_{ck} = 27.0 MPa 일때 τ_{v3} = 0.95 MPa

P_{max} : 소요하중 = 568848 KN

b : 지압판 길이 = 240 mm

h : 수압판 유효두께 = 600 mm

τ_v = 568848 / { 4 (240 + 600) × 600 }

= 0.282 MPa ≤ τ_{v3} = 0.950 MPa ----► O.K

5.2 수직 지압응력 검토

$\tau_c = P_{max} / A_b \leq f_{ba}$

여기서, $f_{ba} = 0.5f_{ck}$ = 0.5 × 27 = 13.500 MPa

A_b : 지압판 면적-슬리브 면적

$A_b = L \times B - \pi/4 \times ds^2$

240 x 240 - π/4× 114.3 ² = 47339.174 ㎟

τ_c = 568848 / 47339.174 = 12.016 MPa ≤ f_{ba} = 13.500 MPa ----► O.K

지압식 영구앵커 내적안정 구조계산서

국회대로지하차도 및 상부공원화(1단계-중첩구간) 공사

◈ **제 원**

적용구간	지하차도
BLCOK	BLOCK 9 0+385.00 ~ 0+405.00
설계앵커력	1000 KN
앵커 조립길이	32.500 m
정착지반	풍화암

앵커의 내적안정성검토

[설계앵커력 P_a = 1,000 KN , 앵커 간격 D = 5.000 m]

1.설계기준 검토

1.1 앵커 내하체 정착지반 설계조건

구 분	설 계 조 건	비 고
정착지반	풍화암	단위중량 γ = 21 kN/㎥
내부마찰각	Φ = 33°	Φ = 33°
일축압축강도	f_c = 20 MPa	f_c = 200 kgf/㎠
허용인장강도	f_{at} = 0.462 MPa	$f_{at} = 0.0334 \times f_c^{0.9305}$ = 4.622 kgf/㎠

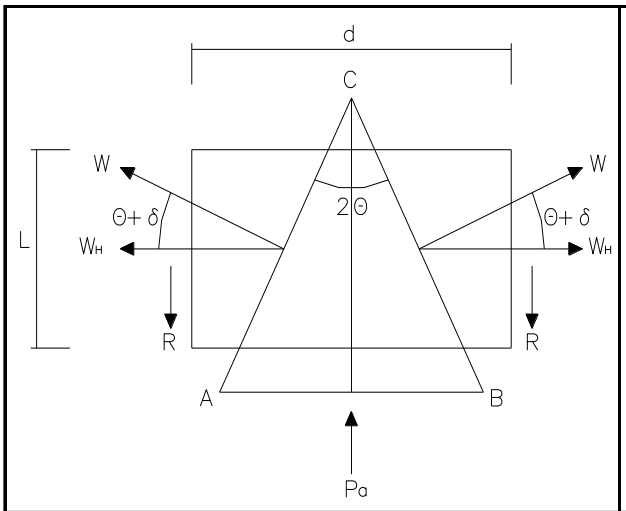
1.2 앵커 내하체 설치조건

구 분	설 계 조 건	비 고
사 용 목 적	부력방지용	지압식 영구앵커
앵커 내하체 전장	여유장 = 1.000 m	
	자유장 = 28.500 m	수압판 두께 포함
	정착근입장 = 3.000 m	
	계 = 32.500 m	앵커 조립장
	수압판두께 = 0.700 m	블럭아웃을 고려한 하부슬래브두께
설 치 간 격	D = 5.000 m	
설 계 앵 커 력	P_a = 1,000 KN	P_a = 100 tonf
앵커 설계안전율	S.F = 2.5	
앵커 두정각	2Θ= 12°	Θ = 6°
앵커 조립직경	d = 120 mm	
앵커 천공직경	d'= 150 mm	
정착지반 근입깊이	$D_{f=}$ 3.000 m	

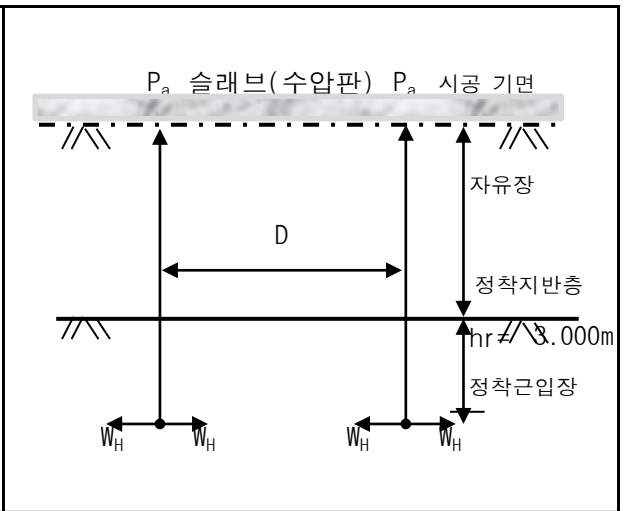
1.3 사용재료의 설계기준

구 분		설 계 조 건	비 고
PS강연선	직경(㎜)	Φ15.2	SWPC7B
	공칭 단면적(㎟)	138.7	Unbonded 강연선
	극한하중	T_{us} = 1.9 KN/㎟	1,900MPa
	항복하중	T_{ys} = 1.6 KN/㎟	1,600MPa
수압판	설계기준강도	f_{ck}= 27 MPa	하부슬래브
	허용압발전단응력	τ_{v3}= 0.950 MPa	도로교설계기준해설(2008) P.906
	허용지압응력	f_{ba}= 13.500 MPa	$f_{ba} = 0.5f_{ck}$
지압판	허용휨/압축응력	$f_{ba}=f_{ca}$= 140 MPa	SS400
	단위중량	γ = 78.50 KN/㎥	

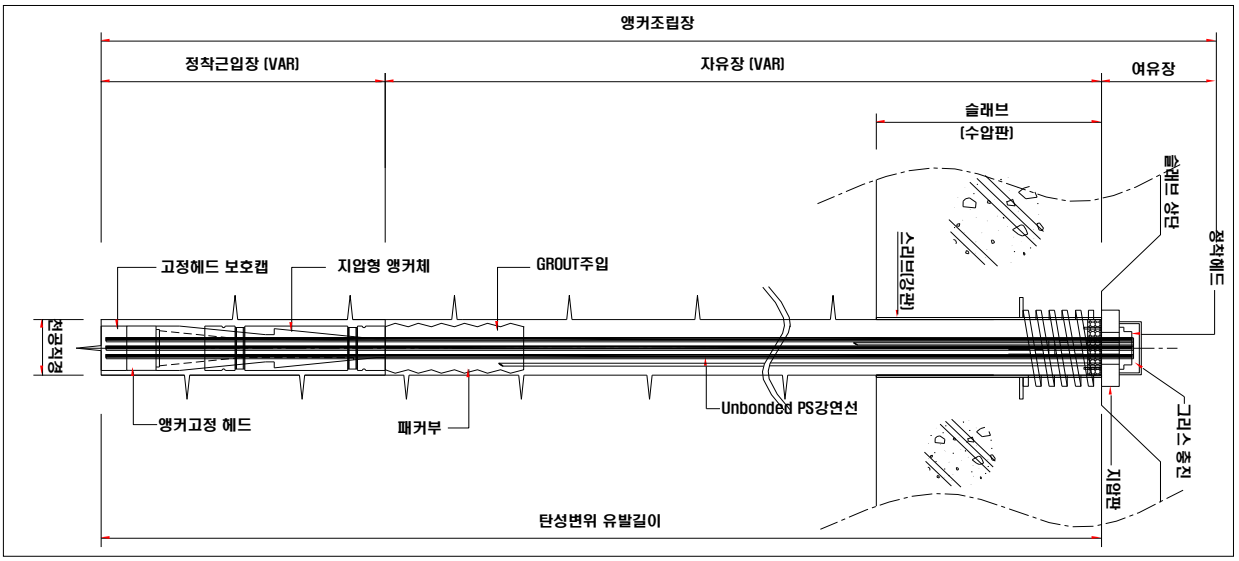
2. 지압식 영구앵커의 정착지반층내 정착근입장검토



< P_a에 의하여 나타나는 WEDGE의 역학관계도 >



< 앵커의 정착조건 >



2.1 앵커내하체의 작용하중 산정

① 쐐기력 $W = \dfrac{P_a}{2 \cdot \sin(\Theta+\delta)}$ ---------- 식1

여기서 sin (6.0 + 22.0) = 0.469

$\dfrac{1,000}{2 \times 0.469} = 1066.098$ KN

② 쐐기수평력 $W_H = W \cdot \cos(\Theta+\delta) = P_a/2 \cdot \cot(\Theta+\delta)$ ---------- 식2

여기서 cos (6 + 22.0) = 0.883

1066.098 × 0.883 = 941.365 KN

③ 벽면전단저항 $R = f \times W_H$ ---------- 식3

여기서 $f=\tan\Phi$ = tan(33.0)° = 0.649

0.649 × 941.365 = 610.946 KN

식 1, 2, 3 에서

Θ = 앵커 두정각의 1/2 = 6.0 °

δ = 벽면 마찰각 = 2/3 x Φ = 22.0 °

f = 마찰계수 = tan(Φ) = 0.649

2.2 정착지반내 앵커내하체의 최소정착근입장 검토 (L_b)

다음 값중 큰 값으로 적용한다.

① 지반정수와 간격에 따른 최소정착장

최소정착장 $hr_{min} \geq \dfrac{5 \times W_H}{f_{at} \times D} = \dfrac{5 \times 941.365}{462.227 \times 5.000} = 2.04$ m ≒ 2.50 m

② 제품의 특성을 고려한 근입깊이 (내하체, 패커부)

최소정착장 hr_{min} = 3.000 m

∴ 최소정착장 hr_{min} = 3.000 m

2.3 앵커와 앵커사이의 정착지반의 인장파괴에 대한 검토

정착 안정조건 : $1/SF \times f_{at} \times D \times h_r \geq 2 \times W_H$ ---------- 식4

여기에서, f_{at}: 정착지반의 허용인장강도(MPa)

D : 앵커 설치 간격(m)

SF : 정착지반의 인장파괴에 대한 안전율(2.5)

= 1/2.5 × 462.000 × 5.000 × 3.000 = 2772.000KN ≥ 2 × 941.365 = 1882.729 KN

2772.000KN ≥ 1882.729KN -----→ 0.K

2.4 앵커내하체의 인발에 대한검토

설계앵커력 P_a는 식3에 의한 앵커체 벽면마찰저항 R에대하여 다음을 만족해야 한다.

$P_a \leq 2R = P_a \cdot \tan\Phi \cdot \cot(\Theta+\delta)$ ---------- 식5

$\therefore \tan(\Theta+\delta) \leq \tan\Phi \rightarrow \Theta+\delta \leq \Phi$

6.0 + 22.0 = 28.0 ≤ 33.0 -----→ 0.K

2.5 앵커 내하체 확장시 정착지반의 지압파괴에 대한 검토

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$

$P_{max} / 2.5 \geq 2W_H$

여기에서, P_{max}:심발 폐색공(패커부) 실시 후의 정착지반의 지압파괴하중(kgf)

f_C:정착 지반의 일축압축강도(kgf/㎠)

F:앵커내하체의 지압면적($F = \alpha \cdot \pi \cdot d' \cdot L$, ㎠)

ln:자연대수

d':앵커 천공직경(㎝)

L:앵커체 압착 유효장(㎝)

α:앵커체 유효접지 계수(0.3)

W_H:쐐기 수평력

$F = \alpha \cdot \pi \cdot d' \cdot L$ = 0.3 × π × 15.0 × 45.0 = 636.2 ㎠

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$ = (658.25 × ln 636.2 - 1552.59) × 200.0

= 539,344.60 kgf = 5,393.446 kN

$P_{max} / 2.5$ = 5,393.45 / 2.5 = 2,157.378 kN

≥ $2W_H$ = 1,882.729 kN -----→ 0.K

3.2 Jacking Force 산정 (P_j)

구 분	설계앵커력	여유장	탄성변위길이		조립길이	수압판	비 고
			근입깊이	자유장			
	(KN)	(m)	(m)	(m)	(m)	(m)	
지압형 앵커	1,000	1.000	3.000	28.500	32.500	0.700	

1) 프리스트레싱 직후 즉시 손실량 (정착장치의 활동)

Wedge Slip 량 : δ = 6.0 ㎜(쐐기식 정착장치 사용)

$$\Delta P_1 = A_s \times E_s \times \frac{\delta}{L}$$

A_s : 강연선 단면적 (7 x 138.70 = 970.9 ㎟)

E_s : 강연선 탄성계수 (2×10^2 KN/㎟)

L : 탄성변위길이 (31500 ㎜)

δ : Wedge Slip량 (6.0 ㎜)

$$\therefore \Delta P_1 = 970.9 \times 2 \times 10^2 \times \frac{6.0}{31500} = 36.987 \text{ KN}$$

2) 프리스트레싱후 시간 의존적 손실량 (강연선의 Relaxation)

Low - Relaxation 강재사용

$$\Delta P_2 = P_i \times \frac{\log_{10} t}{45} \times \left(\frac{T_{us}}{T_{yS}} - 0.55 \right)$$

P_i : 프리스트레스 도입직후 강연선 긴장력

(설계앵커력 + 즉시손실량 = 1,000 + 37.0 = 1,036.987 KN)

t : 프리스트레싱후 손실 계산시까지 시간

(100년 내구연한 : 24 X 365 X 100 = 876,000 hr)

T_{us} : 강연선 극한하중 (263.530 KN)

T_{yS} : 강연선 파단하중 (221.920 KN)

$$\therefore \Delta P_2 = 1{,}037.0 \times \frac{\log_{10} 876{,}000}{45} \left(\frac{263.53}{221.92} - 0.55 \right) = 87.299 \text{ KN}$$

3) Jacking Force :

$P_j = P_a + \Delta P1 + \Delta P2$

$= 1{,}000 + 36.987 + 87.299 = 1{,}124.286$

4) 안정성 검토

(1) 긴장중 허용긴장력

$0.8T_{us}, 0.94T_{ys}$ 중 작은값 = $\begin{cases} 0.8 \times 1.900 = 1.520 & KN/㎟ \\ 0.94 \times 1.600 = 1.504 & KN/㎟ \end{cases}$

허용긴장력= 1.504 × 970.900 = 1460.234 KN

∴ JACK에 의해 최대 1460.234 KN 까지 긴장가능 ≥ Jacking Force = 1124.286 KN --▶ **O.K**

1공당 SWPC7B Φ15.2㎜ 7연선,저릴렉세이션 강연선 7가닥 사용

Φ15.2 × 7EA = 138.70 × 7 = 970.900 ㎟

(2) 긴장직후 허용긴장력

$0.7 \cdot T_{us}$ = 1.33 KN/㎟

허용긴장력= 1.33 × 970.900 = 1291.297 KN ≥ 긴장력 도입직후 = 1036.987 KN --▶ **O.K**

(3) 손실이 일어난후 유효긴장력작용시 허용긴장력

$0.6T_{us}, 0.75T_{ys}$ 중 작은값 = $\begin{cases} 0.6 \times 1.900 = 1.140 & KN/㎟ \\ 0.75 \times 1.600 = 1.200 & KN/㎟ \end{cases}$

허용긴장력= 1.140 × 970.900 = 1106.826 KN ≥ 설계앵커력 P_a = 1,000 KN --▶ **O.K**

4. 지압판의 설계

4.1 지압판 면적(A) 산정

$$A = \frac{P_j}{f_b} + (\pi \times R^2)$$

여기서, P_j : 긴장하중 (KN)

f_b : 수압판 콘크리트 설계강도의 50% (27 × 0.5 = 13.500 MPa)

R : 지압판 삽입공 (55 mm)

$$A = \frac{1124.286}{0.0135} + (\pi \times 55.0^2) = 92783.762 \ mm^2$$

지압판 한 쪽면의 길이(L)은 다음과 같다.

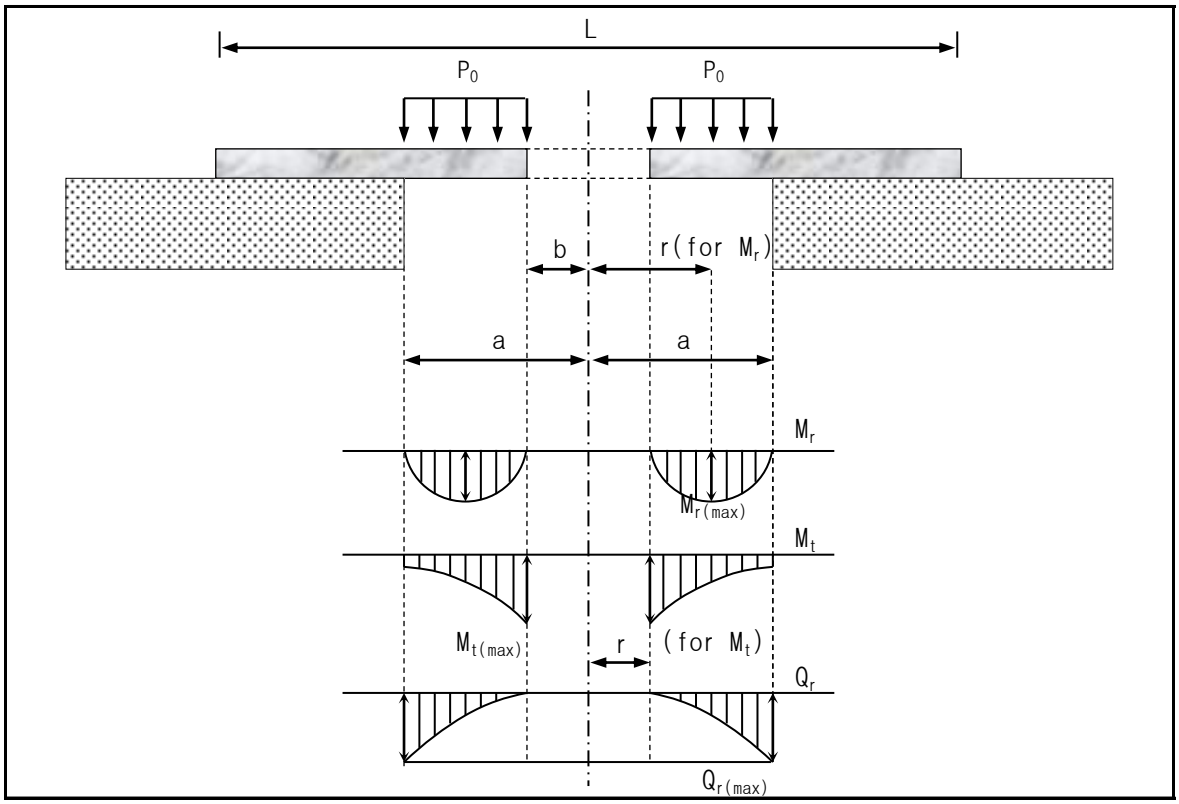
$L = \sqrt{A} = \sqrt{92783.762} = 305$ mm

∴ 규격화를 위해 L= 340 mm , B= 340 mm 적용

4.2 지압판 두께(t) 산정

종래 앵커 지압판의 두께는 지압판을 빔(BEAM)으로 설계는 하는 것이 일반적이였으나 여러 가지 실험결과, 플레이트 판으로서 간주해도 충분히 안전하다는 결과가 얻어지므로 다음과 같이 판으로 간주하여 두께를 산정하였다.

또한, 강두께의 산출에는 안전율 1.5를 보고 그 안전율을 고려한 앵커에 대하여 휨 및 전단에 견딜 수 있도록 강두께를 결정한다.



지압판 두께 산정을 위한 제원 정의도 및 단면력도

1) 단면력 산출

$$M_r = \frac{P_0 a^2}{16}\left[(3+\nu)(1-\rho^2)+k_2\left(1-\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$M_t = \frac{P_0 a^2}{16}\left[2(1-\nu)(1-2X^2)+(1+3\nu)(1-\rho^2)+k_2\left(1+\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$Q_r = -\frac{P_0 A}{2}\left(\rho - X^2\frac{1}{\rho}\right)$$

여기서, M_r : 반경방향의 휨모멘트 (KN · mm/mm)

M_t : 원주방향의 휨모멘트 (KN · mm/mm)

P_0 : 지압판에 작용하는 등분포하중 (KN/mm^2)

$$\frac{1.5 \times Pj}{A} = \frac{1.5 \times 1124.286}{92783.762} = 0.018 \quad KN/mm^2$$

ν : 지압판의 포아송비 : (0.3)

r : 지압판 삽입공 중심에서의 거리(mm) { M_r : r = 56.1 mm, M_t : r = 55.0 mm

a : 수압판의 삽입공 반경 (mm) : 57.2 mm

b : 지압판의 삽입공 반경(mm) : 55.0 mm

ρ : r/a (M_r : 0.981 , M_t : 0.962)

K_2 : $X^2[3+\nu+4(1+\nu)\{X^2/(1-X^2)\}\ln X]$ (단, X=b/a) (X= 0.962) (K_2= 0.739)

L : 지압판의 변길이(mm)

ln : 자연대수

(1) $$M_r = \frac{0.018 \times 57.2^{\,2}}{16} \times [(3 + 0.3) \times (1 - 0.981^{\,2}) + 0.739 \times \left(1 - \frac{1}{0.981^{\,2}}\right) + 4 (1 + 0.3) \times 0.962^{\,2} \ln (0.981)]$$

$$= 3.710 \times (0.123 + -0.029 + -0.091) = 0.011 \quad KN \cdot mm/mm$$

(2) $M_t = \frac{0.018 \times 57.2^2}{16} \times [2 \times (1 - 0.3) \times (1 - 2 \times 0.962^2)$

$+ (1 + 3 \times 0.3) \times (1 - 0.962^2) + 0.739 \left(1 + \frac{1}{0.962^2}\right)$

$+ 4 \times (1 + 0.3) \times 0.962^2 \times \ln(0.962)]$

$= 3.710 \times (-1.193 + 1.678 + -0.185) = 1.114$ KN · mm/mm

$\therefore M_t = 1.114 > M_r = 0.011$ 이므로 설계휨모멘트 $M_t = 1.114$ 적용

(3) $Q_r = -\frac{0.018 \times 92783.762}{2} \times (1 - 0.962^2 \times 1) = 62.251$ KN

2) 두께산정

(1) M_t에 의한 소요두께 검토

$t = \left(\frac{6 \times M}{f_{sa}}\right)^{1/2}$

여기서, M_t : 지압판에 작용하는 휨모멘트 = 1.114 KN · mm/mm

f_{sa} : 지압판의 허용 휨응력 = 140 MPa

$t \geq \left(\frac{6 \times 1.114}{0.140}\right)^{1/2} = 6.909$ mm

(2) Q_r에 의한 소요두께 검토

$t \geq \frac{Q_r}{\tau \times \pi d} = \frac{62251}{14363.362} = 4.334$ mm

(3) 강체(Rigid Body)로서의 소요두께 검토

$\beta\lambda \leq 1.0$

여기서 $\beta = \sqrt[4]{\frac{3 \cdot k}{E \cdot h^3}}$ (m^{-1})

K : 수압판의 탄성계수 (= 24,421,916 kN/m^2)

L : 지압판의 길이 (= 0.340 m)

B : 지압판의 폭 (= 0.340 m)

E : 지압판의 탄성계수 (= 210,000,000 kN/m^2)

h : 지압판의 두께 (= 0.034 m) :시산법(Try and Error Method)에 의해 산출

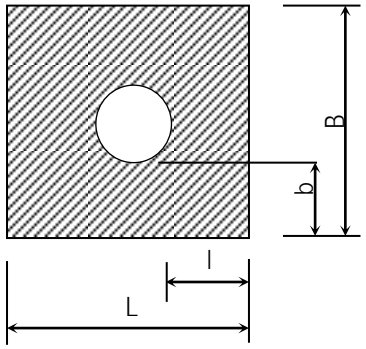
λ : 지압판의 환산 돌출길이 (m)

$\beta = \sqrt[4]{(3 \times 24,421,916) / (210,000,000 \times 0.034^3)} = 9.706$ (m^{-1})

λ= max(l,b) = max(0.100 , 0.100) = 0.100

다만, l ≥ L/2이면 l = L/2 = 0.170

b ≥ B/2이면 b = B/2 = 0.170



β λ = 9.706 x 0.100 = 0.971 ≤ 1.0 ------► 0.K

(4) 두께 검토 결과

구분	휨M_t	전단력Q_r	강체검토	최대두께	규격화
소요두께	6.909mm	4.334mm	34.000mm	34.000mm	35mm

3) 응력검토

(1) 휨응력 검토

$$f_{max} = \frac{6 \times Mmax}{h^2} = \frac{6 \times 1.114}{35^2} = 5.456 \quad MPa$$

$f_{max} \leq f_{sa} = 5.456 \leq 140$ ---------► 0.K

(2) 전단응력 검토

$$\tau_{max} = \frac{3}{2} \times \frac{Q_r}{A} = \frac{3}{2} \times \frac{62251}{12567.941} = 7.430 \quad MPa \quad (A=\pi 2a \times t)$$

$\tau_{max} \leq \tau_{sa} = 7.430 \leq 80$ ---------► 0.K

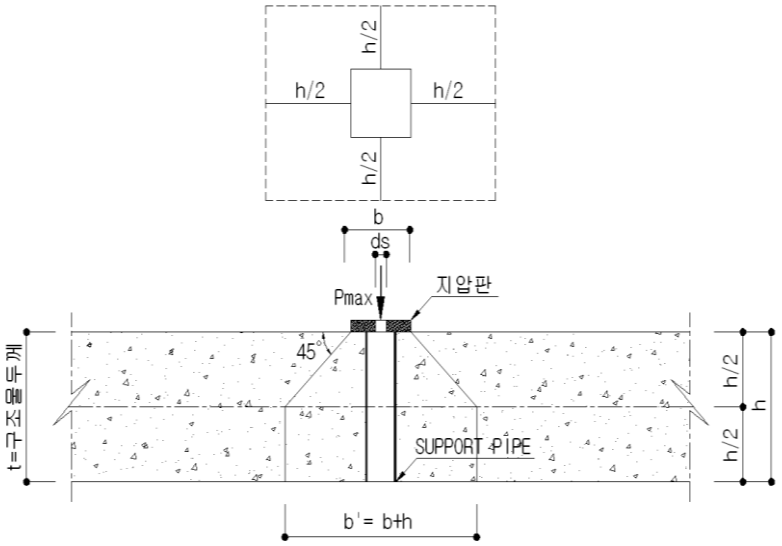
(3) 조합응력 검토

$$\left(\frac{f}{f_a}\right)^2 + \left(\frac{V}{V_a}\right)^2 = \left(\frac{5.456}{140}\right)^2 + \left(\frac{7.430}{80}\right)^2$$

$= 0.010 < 1.2$ ---► 0.K

∴ 지압판 규격(L × B × t) = 340 mm × 340 mm × 35 mm

5.수압판 콘크리트 응력검토 (지압판 직하 하부슬래브)



5.1 압발 전단응력 검토

$\tau_v = P_{max} / \{4(b+h)\times h\} \leq \tau_{v3}$

여기서, f_{ck} = 27.0 MPa 일때 τ_{v3} = 0.95 MPa

P_{max} : 소요하중 = 1124286 KN

b : 지압판 길이 = 340 mm

h : 수압판 유효두께 = 700 mm

τ_v = 1124286 / { 4 (340 + 700) × 700 }

= 0.386 MPa ≤ τ_{v3} = 0.950 MPa ----► O.K

5.2 수직 지압응력 검토

$\tau_c = P_{max} / A_b \leq f_{ba}$

여기서, $f_{ba} = 0.5f_{ck}$ = 0.5 × 27 = 13.500 MPa

A_b : 지압판 면적-슬리브 면적

$A_b = L \times B - \pi/4 \times ds^2$

340 x 340 - π/4× 114.3 ² = 105339.174 ㎟

τ_c = 1124286 / 105339.174 = 10.673 MPa ≤ f_{ba} = 13.500 MPa ----► O.K

지압식 영구앵커 내적안정 구조계산서

국회대로지하차도 및 상부공원화(1단계-중첩구간) 공사

◈ **제 원**

적용구간	지하차도
BLCOK	BLOCK 10 0+405.00 ~ 0+425.00
설계앵커력	1000 KN
앵커 조립길이	35.500 m
정착지반	풍화암

앵커의 내적안정성검토

[설계앵커력 P_a = 1,000 KN , 앵커 간격 D = 5.000 m]

1.설계기준 검토

1.1 앵커 내하체 정착지반 설계조건

구 분	설 계 조 건	비 고
정착지반	풍화암	단위중량 γ = 21 kN/㎥
내부마찰각	Φ = 33°	Φ = 33°
일축압축강도	f_c = 20 MPa	f_c = 200 kgf/㎠
허용인장강도	f_{at} = 0.462 MPa	$f_{at} = 0.0334 \times f_c^{0.9305}$ = 4.622 kgf/㎠

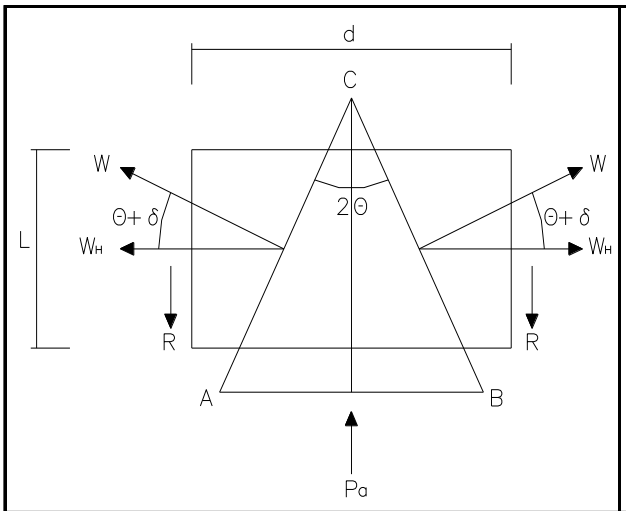
1.2 앵커 내하체 설치조건

구 분	설 계 조 건	비 고
사 용 목 적	부력방지용	지압식 영구앵커
앵커 내하체 전장	여유장 = 1.000 m	
	자유장 = 31.500 m	수압판 두께 포함
	정착근입장 = 3.000 m	
	계 = 35.500 m	앵커 조립장
	수압판두께 = 0.700 m	블럭아웃을 고려한 하부슬래브두께
설 치 간 격	D = 5.000 m	
설 계 앵 커 력	P_a = 1,000 KN	P_a = 100 tonf
앵커 설계안전율	S.F = 2.5	
앵커 두정각	2Θ = 12°	Θ = 6°
앵커 조립직경	d = 120 mm	
앵커 천공직경	d' = 150 mm	
정착지반 근입깊이	$D_{f=}$ 3.000 m	

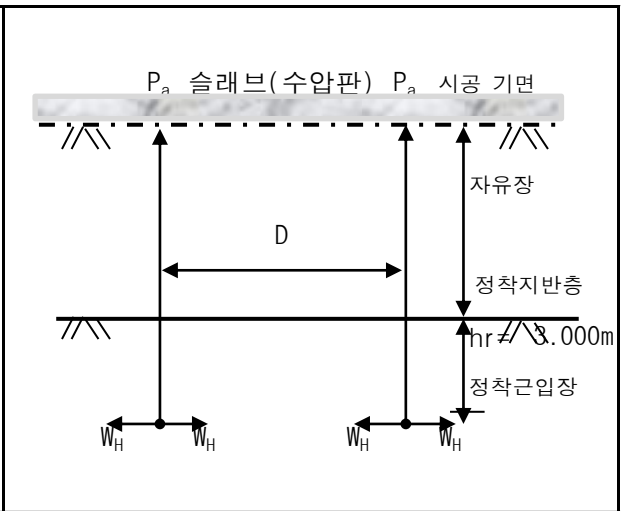
1.3 사용재료의 설계기준

구 분		설 계 조 건	비 고
PS강연선	직경(㎜)	Φ15.2	SWPC7B
	공칭 단면적(㎟)	138.7	Unbonded 강연선
	극한하중	T_{us} = 1.9 KN/㎟	1,900MPa
	항복하중	T_{ys} = 1.6 KN/㎟	1,600MPa
수압판	설계기준강도	f_{ck}= 27 MPa	하부슬래브
	허용압발전단응력	τ_{v3}= 0.950 MPa	도로교설계기준해설(2008) P.906
	허용지압응력	f_{ba}= 13.500 MPa	$f_{ba} = 0.5f_{ck}$
지압판	허용휨/압축응력	$f_{ba}=f_{ca}$= 140 MPa	SS400
	단위중량	ɣ = 78.50 KN/㎥	

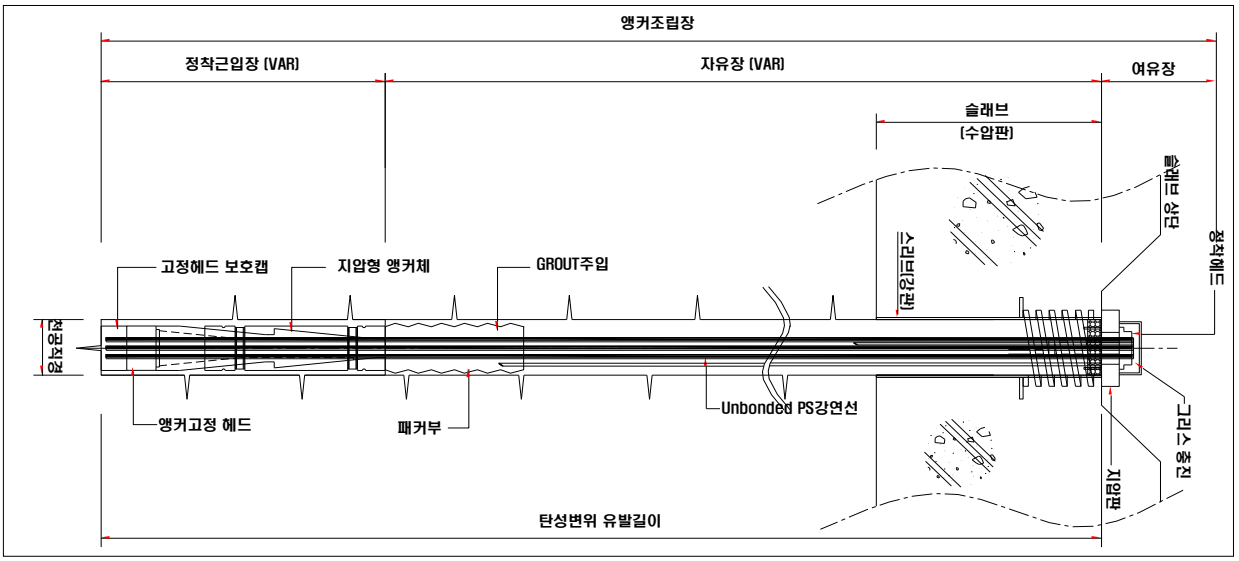
2. 지압식 영구앵커의 정착지반층내 정착근입장검토



< P_a에 의하여 나타나는 WEDGE의 역학관계도 >



< 앵커의 정착조건 >



2.1 앵커내하체의 작용하중 산정

① 쐐기력 $W = \dfrac{P_a}{2 \cdot \sin(\Theta+\delta)}$ ---------- 식1

여기서 sin (6.0 + 22.0) = 0.469

$\dfrac{1,000}{2 \times 0.469} = 1066.098$ KN

② 쐐기수평력 $W_H = W \cdot \cos(\Theta+\delta) = P_a/2 \cdot \cot(\Theta+\delta)$ ---------- 식2

여기서 cos (6 + 22.0) = 0.883

1066.098 × 0.883 = 941.365 KN

③ 벽면전단저항 $R = f \times W_H$ ---------- 식3

여기서 $f=\tan\Phi$ = tan(33.0)° = 0.649

0.649 × 941.365 = 610.946 KN

식 1, 2, 3 에서

Θ = 앵커 두정각의 1/2 = 6.0 °

δ = 벽면 마찰각 = 2/3 x Φ = 22.0 °

f = 마찰계수 = tan(Φ) = 0.649

2.2 정착지반내 앵커내하체의 최소정착근입장 검토 (L_b)

다음 값중 큰 값으로 적용한다.

① 지반정수와 간격에 따른 최소정착장

최소정착장 $hr_{min} \geq \dfrac{5 \times W_H}{f_{at} \times D} = \dfrac{5 \times 941.365}{462.227 \times 5.000} = 2.04$ m ≒ 2.50 m

② 제품의 특성을 고려한 근입깊이 (내하체, 패커부)

최소정착장 hr_{min} = 3.000 m

∴ 최소정착장 hr_{min} = 3.000 m

2.3 앵커와 앵커사이의 정착지반의 인장파괴에 대한 검토

정착 안정조건 : $1/SF \times f_{at} \times D \times h_r \geq 2 \times W_H$ ---------- 식4

여기에서, f_{at}: 정착지반의 허용인장강도(MPa)

D : 앵커 설치 간격(m)

SF : 정착지반의 인장파괴에 대한 안전율(2.5)

= 1/2.5 × 462.000 × 5.000 × 3.000 = 2772.000KN ≥ 2 × 941.365 = 1882.729 KN

2772.000KN ≥ 1882.729KN -----→ 0.K

2.4 앵커내하체의 인발에 대한검토

설계앵커력 P_a는 식3에 의한 앵커체 벽면마찰저항 R에대하여 다음을 만족해야 한다.

$P_a \leq 2R = P_a \cdot \tan\Phi \cdot \cot(\Theta+\delta)$ ---------- 식5

$\therefore \tan(\Theta+\delta) \leq \tan\Phi \rightarrow \Theta+\delta \leq \Phi$

6.0 + 22.0 = 28.0 ≤ 33.0 -----→ 0.K

2.5 앵커 내하체 확장시 정착지반의 지압파괴에 대한 검토

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$

$P_{max} / 2.5 \geq 2W_H$

여기에서, P_{max}:심발 폐색공(패커부) 실시 후의 정착지반의 지압파괴하중(kgf)

f_C:정착 지반의 일축압축강도(kgf/㎠)

F:앵커내하체의 지압면적($F = \alpha \cdot \pi \cdot d' \cdot L$, ㎠)

ln:자연대수

d':앵커 천공직경(㎝)

L:앵커체 압착 유효장(㎝)

α:앵커체 유효접지 계수(0.3)

W_H:쐐기 수평력

$F = \alpha \cdot \pi \cdot d' \cdot L$ = 0.3 × π × 15.0 × 45.0 = 636.2 ㎠

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$ = (658.25 × ln 636.2 - 1552.59) × 200.0

= 539,344.60 kgf = 5,393.446 kN

$P_{max} / 2.5$ = 5,393.45 / 2.5 = 2,157.378 kN

≥ $2W_H$ = 1,882.729 kN -----→ 0.K

3.2 Jacking Force 산정 (P_j)

구 분	설계앵커력	여유장	탄성변위길이		조립길이	수압판	비 고
			근입깊이	자유장			
	(KN)	(m)	(m)	(m)	(m)	(m)	
지압형 앵커	1,000	1.000	3.000	31.500	35.500	0.700	

1) 프리스트레싱 직후 즉시 손실량 (정착장치의 활동)

Wedge Slip 량 : δ = 6.0 ㎜(쐐기식 정착장치 사용)

$$\Delta P_1 = A_s \times E_s \times \frac{\delta}{L}$$

A_s : 강연선 단면적 (7 x 138.70 = 970.9 ㎟)

E_s : 강연선 탄성계수 (2×10^2 KN/㎟)

L : 탄성변위길이 (34500 ㎜)

δ : Wedge Slip량 (6.0 ㎜)

$$\therefore \Delta P_1 = 970.9 \times 2 \times 10^2 \times \frac{6.0}{34500} = 33.770 \text{ KN}$$

2) 프리스트레싱후 시간 의존적 손실량 (강연선의 Relaxation)

Low - Relaxation 강재사용

$$\Delta P_2 = P_i \times \frac{\log_{10} t}{45} \times \left(\frac{T_{us}}{T_{yS}} - 0.55 \right)$$

P_i : 프리스트레스 도입직후 강연선 긴장력

(설계앵커력 + 즉시손실량 = 1,000 + 33.8 = 1,033.770 KN)

t : 프리스트레싱후 손실 계산시까지 시간

(100년 내구연한 : 24 X 365 X 100 = 876,000 hr)

T_{us} : 강연선 극한하중 (263.530 KN)

T_{yS} : 강연선 파단하중 (221.920 KN)

$$\therefore \Delta P_2 = 1{,}033.8 \times \frac{\log_{10} 876{,}000}{45} \left(\frac{263.53}{221.92} - 0.55 \right) = 87.028 \text{ KN}$$

3) Jacking Force :

$P_j = P_a + \Delta P1 + \Delta P2$

$= 1{,}000 + 33.770 + 87.028 = 1{,}120.798$

4) 안정성 검토

(1) 긴장중 허용긴장력

$0.8T_{us}, 0.94T_{ys}$ 중 작은값 = $\begin{cases} 0.8 \times 1.900 = 1.520 & KN/㎟ \\ 0.94 \times 1.600 = 1.504 & KN/㎟ \end{cases}$

허용긴장력= 1.504 × 970.900 = 1460.234 KN

∴ JACK에 의해 최대 1460.234 KN 까지 긴장가능 ≥ Jacking Force = 1120.798 KN --▶ **O.K**

1공당 SWPC7B Φ15.2㎜ 7연선,저릴렉세이션 강연선 7가닥 사용

Φ15.2 × 7EA = 138.70 × 7 = 970.900 ㎟

(2) 긴장직후 허용긴장력

$0.7 \cdot T_{us}$ = 1.33 KN/㎟

허용긴장력= 1.33 × 970.900 = 1291.297 KN ≥ 긴장력 도입직후 = 1033.770 KN --▶ **O.K**

(3) 손실이 일어난후 유효긴장력작용시 허용긴장력

$0.6T_{us}, 0.75T_{ys}$ 중 작은값 = $\begin{cases} 0.6 \times 1.900 = 1.140 & KN/㎟ \\ 0.75 \times 1.600 = 1.200 & KN/㎟ \end{cases}$

허용긴장력= 1.140 × 970.900 = 1106.826 KN ≥ 설계앵커력 P_a = 1,000 KN --▶ **O.K**

4. 지압판의 설계

4.1 지압판 면적(A) 산정

$$A = \frac{P_j}{f_b} + (\pi \times R^2)$$

여기서, P_j : 긴장하중 (KN)

f_b : 수압판 콘크리트 설계강도의 50% (27 × 0.5 = 13.500 MPa)

R : 지압판 삽입공 (55 mm)

$$A = \frac{1120.798}{0.0135} + (\pi \times 55.0^2) = 92525.392 \ mm^2$$

지압판 한 쪽면의 길이(L)은 다음과 같다.

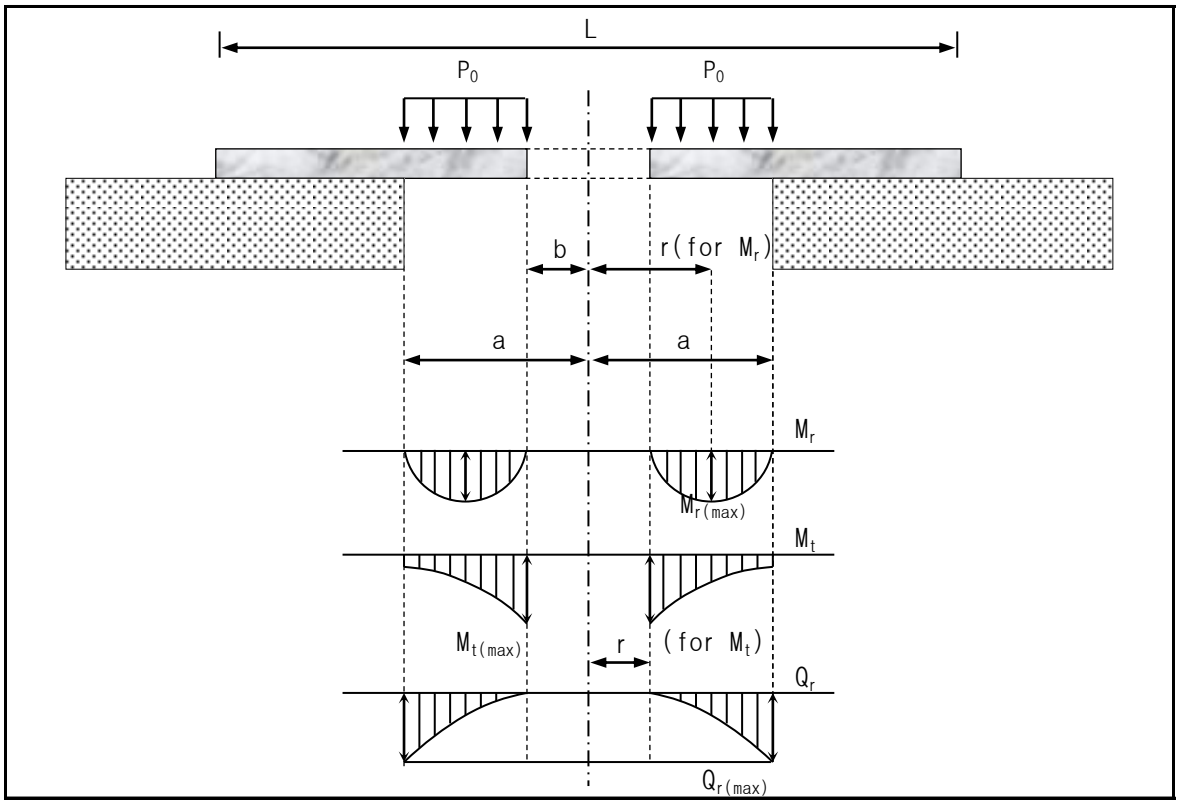
$L = \sqrt{A} = \sqrt{92525.392} = 304$ mm

∴ 규격화를 위해 L= 340 mm , B= 340 mm 적용

4.2 지압판 두께(t) 산정

종래 앵커 지압판의 두께는 지압판을 빔(BEAM)으로 설계는 하는 것이 일반적이였으나 여러 가지 실험결과, 플레이트 판으로서 간주해도 충분히 안전하다는 결과가 얻어지므로 다음과 같이 판으로 간주하여 두께를 산정하였다.

또한, 강두께의 산출에는 안전율 1.5를 보고 그 안전율을 고려한 앵커에 대하여 휨 및 전단에 견딜 수 있도록 강두께를 결정한다.



지압판 두께 산정을 위한 제원 정의도 및 단면력도

1) 단면력 산출

$$M_r = \frac{P_0 a^2}{16}\left[(3+\nu)(1-\rho^2)+k_2\left(1-\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$M_t = \frac{P_0 a^2}{16}\left[2(1-\nu)(1-2X^2)+(1+3\nu)(1-\rho^2)+k_2\left(1+\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$Q_r = -\frac{P_0 A}{2}\left(\rho - X^2\frac{1}{\rho}\right)$$

여기서, M_r : 반경방향의 휨모멘트 (KN · mm/mm)

M_t : 원주방향의 휨모멘트 (KN · mm/mm)

P_0 : 지압판에 작용하는 등분포하중 (KN/mm^2)

$$\frac{1.5 \times Pj}{A} = \frac{1.5 \times 1120.798}{92525.392} = 0.018 \quad KN/mm^2$$

ν : 지압판의 포아송비 : (0.3)

r : 지압판 삽입공 중심에서의 거리(mm) { M_r : r = 56.1 mm, M_t : r = 55.0 mm

a : 수압판의 삽입공 반경 (mm) : 57.2 mm

b : 지압판의 삽입공 반경(mm) : 55.0 mm

ρ : r/a (M_r : 0.981 , M_t : 0.962)

K_2 : $X^2[3+\nu+4(1+\nu)\{X^2/(1-X^2)\}\ln X]$ (단, X=b/a) (X= 0.962) (K_2= 0.739)

L : 지압판의 변길이(mm)

ln : 자연대수

(1) $$M_r = \frac{0.018 \times 57.2^{\,2}}{16} \times [(3 + 0.3) \times (1 - 0.981^{\,2}) + 0.739 \times \left(1 - \frac{1}{0.981^{\,2}}\right) + 4 (1 + 0.3) \times 0.962^{\,2} \ln (0.981)]$$

$$= 3.709 \times (0.123 + -0.029 + -0.091) = 0.011 \quad KN \cdot mm/mm$$

(2) $M_t = \frac{0.018 \times 57.2^2}{16} \times [2 \times (1 - 0.3) \times (1 - 2 \times 0.962^2)$

$+ (1 + 3 \times 0.3) \times (1 - 0.962^2) + 0.739 \left(1 + \frac{1}{0.962^2}\right)$

$+ 4 \times (1 + 0.3) \times 0.962^2 \times \ln(0.962)]$

$= 3.709 \times (-1.193 + 1.678 + -0.185) = 1.114$ KN · mm/mm

$\therefore M_t = 1.114 > M_r = 0.011$ 이므로 설계휨모멘트 $M_t = 1.114$ 적용

(3) $Q_r = -\frac{0.018 \times 92525.392}{2} \times (1 - 0.962^2 \times 1) = 62.057$ KN

2) 두께산정

(1) M_t에 의한 소요두께 검토

$t = \left(\frac{6 \times M}{f_{sa}}\right)^{1/2}$

여기서, M_t : 지압판에 작용하는 휨모멘트 = 1.114 KN · mm/mm

f_{sa} : 지압판의 허용 휨응력 = 140 MPa

$t \geq \left(\frac{6 \times 1.114}{0.140}\right)^{1/2} = 6.908$ mm

(2) Q_r에 의한 소요두께 검토

$t \geq \frac{Q_r}{\tau \times \pi d} = \frac{62057}{14363.362} = 4.321$ mm

(3) 강체(Rigid Body)로서의 소요두께 검토

$\beta\lambda \leq 1.0$

여기서 $\beta = \sqrt[4]{\frac{3 \cdot k}{E \cdot h^3}}$ (m^{-1})

K : 수압판의 탄성계수 (= 24,421,916 kN/m^2)

L : 지압판의 길이 (= 0.340 m)

B : 지압판의 폭 (= 0.340 m)

E : 지압판의 탄성계수 (= 210,000,000 kN/m^2)

h : 지압판의 두께 (= 0.034 m) :시산법(Try and Error Method)에 의해 산출

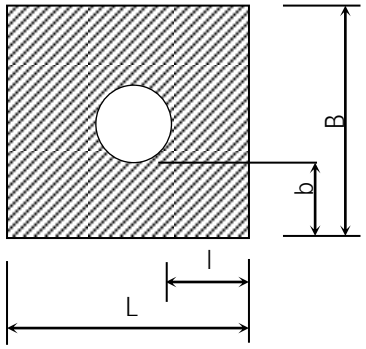
λ : 지압판의 환산 돌출길이 (m)

$\beta = \sqrt[4]{(3 \times 24,421,916) / (210,000,000 \times 0.034^3)} = 9.706$ (m^{-1})

λ= max(l,b) = max(0.100 , 0.100) = 0.100

다만, l ≥ L/2이면 l = L/2 = 0.170

b ≥ B/2이면 b = B/2 = 0.170



β λ = 9.706 x 0.100 = 0.971 ≤ 1.0 ------► **O.K**

(4) 두께 검토 결과

구분	휨M_t	전단력Q_r	강체검토	최대두께	규격화
소요두께	6.908mm	4.321mm	34.000mm	34.000mm	35mm

3) 응력검토

(1) 휨응력 검토

$$f_{max} = \frac{6 \times Mmax}{h^2} = \frac{6 \times 1.114}{35^2} = 5.454 \quad MPa$$

$f_{max} \leq f_{sa} = 5.454 \leq 140$ ---------► **O.K**

(2) 전단응력 검토

$$\tau_{max} = \frac{3}{2} \times \frac{Q_r}{A} = \frac{3}{2} \times \frac{62057}{12567.941} = 7.407 \quad MPa \quad (A=\pi 2a \times t)$$

$\tau_{max} \leq \tau_{sa} = 7.407 \leq 80$ ---------► **O.K**

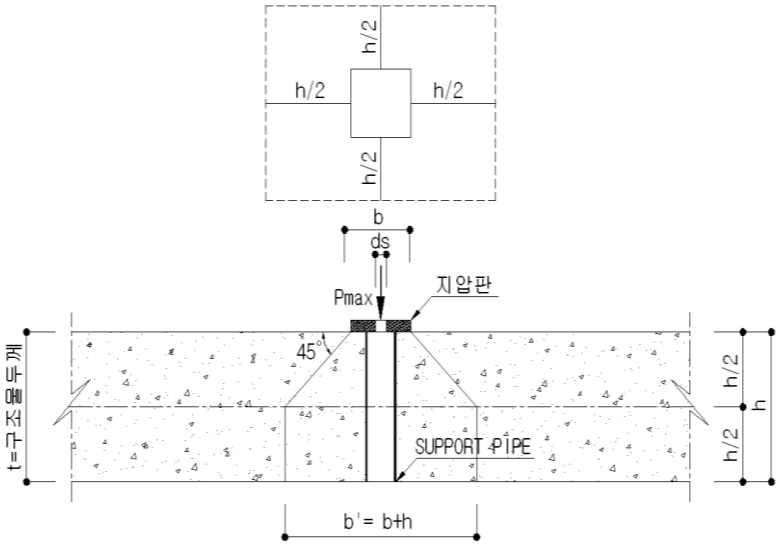
(3) 조합응력 검토

$$\left(\frac{f}{f_a}\right)^2 + \left(\frac{V}{V_a}\right)^2 = \left(\frac{5.454}{140}\right)^2 + \left(\frac{7.407}{80}\right)^2$$

$= 0.010 < 1.2$ ---► **O.K**

∴ 지압판 규격(L × B × t) = 340 mm × 340 mm × 35 mm

5.수압판 콘크리트 응력검토 (지압판 직하 하부슬래브)



5.1 압발 전단응력 검토

$\tau_v = P_{max} / \{4(b+h)\times h\} \leq \tau_{v3}$

여기서, f_{ck} = 27.0 MPa 일때 τ_{v3} = 0.95 MPa

P_{max} : 소요하중 = 1120798 KN

b : 지압판 길이 = 340 mm

h : 수압판 유효두께 = 700 mm

τ_v = 1120798 / { 4 (340 + 700) × 700 }

= 0.385 MPa ≤ τ_{v3} = 0.950 MPa ----► 0.K

5.2 수직 지압응력 검토

$\tau_c = P_{max} / A_b \leq f_{ba}$

여기서, $f_{ba} = 0.5f_{ck}$ = 0.5 × 27 = 13.500 MPa

A_b : 지압판 면적-슬리브 면적

$A_b = L \times B - \pi/4 \times ds^2$

340 x 340 - π/4× 114.3 ² = 105339.174 ㎟

τ_c = 1120798 / 105339.174 = 10.640 MPa ≤ f_{ba} = 13.500 MPa ----► 0.K

지압식 영구앵커 내적안정 구조계산서

국회대로지하차도 및 상부공원화(1단계-중첩구간) 공사

◈ 제 원

적용구간	지하차도
BLCOK	BLOCK 11 0+425.00 ~ 0+445.00
설계앵커력	1000 KN
앵커 조립길이	31.500 m
정착지반	풍화암

앵커의 내적안정성검토

[설계앵커력 P_a = 1,000 KN , 앵커 간격 D = 5.000 m]

1.설계기준 검토

1.1 앵커 내하체 정착지반 설계조건

구 분	설 계 조 건	비 고
정착지반	풍화암	단위중량 γ = 21 kN/㎥
내부마찰각	Φ = 33°	Φ = 33°
일축압축강도	f_c = 20 MPa	f_c = 200 kgf/㎠
허용인장강도	f_{at} = 0.462 MPa	$f_{at} = 0.0334 \times f_c^{0.9305}$ = 4.622 kgf/㎠

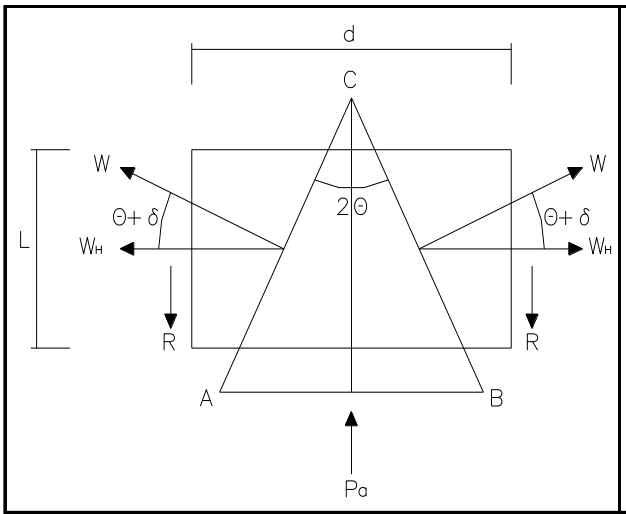
1.2 앵커 내하체 설치조건

구 분	설 계 조 건	비 고
사 용 목 적	부력방지용	지압식 영구앵커
앵커 내하체 전장	여유장 = 1.000 m	
	자유장 = 27.500 m	수압판 두께 포함
	정착근입장 = 3.000 m	
	계 = 31.500 m	앵커 조립장
	수압판두께 = 0.900 m	블럭아웃을 고려한 하부슬래브두께
설 치 간 격	D = 5.000 m	
설 계 앵 커 력	P_a = 1,000 KN	P_a = 100 tonf
앵커 설계안전율	S.F = 2.5	
앵커 두정각	2Θ = 12°	Θ = 6°
앵커 조립직경	d = 120 mm	
앵커 천공직경	d' = 150 mm	
정착지반 근입깊이	$D_{f=}$ 3.000 m	

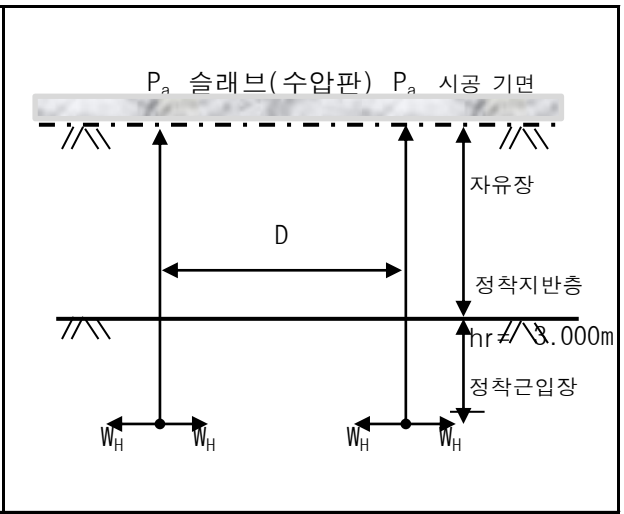
1.3 사용재료의 설계기준

구 분		설 계 조 건	비 고
PS강연선	직경(㎜)	Φ15.2	SWPC7B
	공칭 단면적(㎟)	138.7	Unbonded 강연선
	극한하중	T_{us} = 1.9 KN/㎟	1,900MPa
	항복하중	T_{ys} = 1.6 KN/㎟	1,600MPa
수압판	설계기준강도	f_{ck}= 27 MPa	하부슬래브
	허용압발전단응력	τ_{v3}= 0.950 MPa	도로교설계기준해설(2008) P.906
	허용지압응력	f_{ba}= 13.500 MPa	$f_{ba} = 0.5f_{ck}$
지압판	허용휨/압축응력	$f_{ba}=f_{ca}$= 140 MPa	SS400
	단위중량	γ = 78.50 KN/㎥	

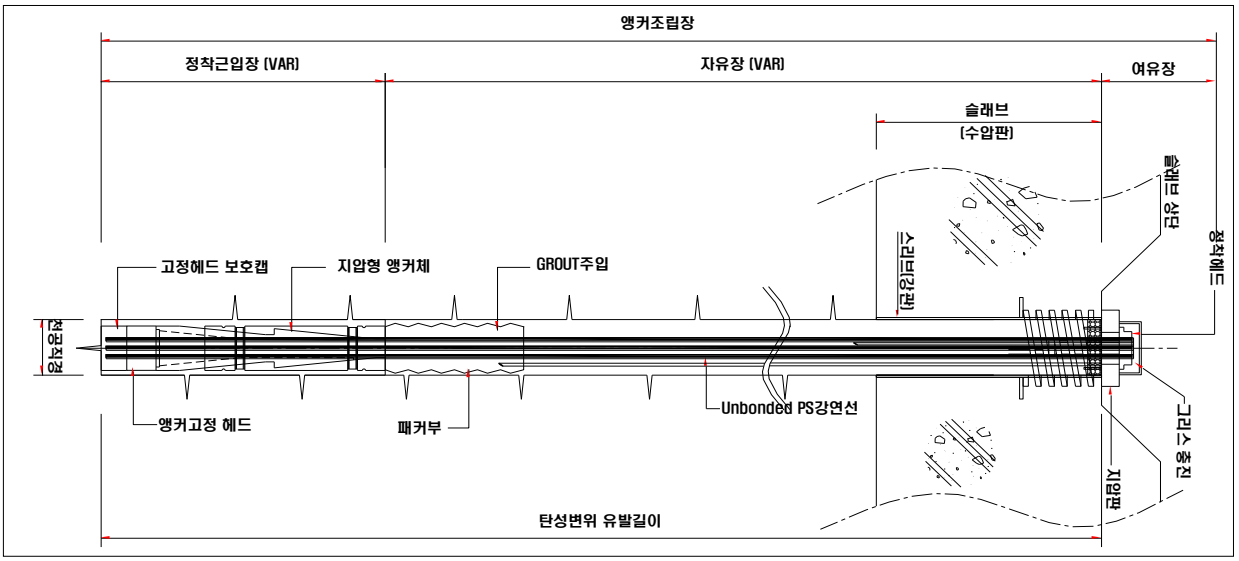
2. 지압식 영구앵커의 정착지반층내 정착근입장검토



< P_a에 의하여 나타나는 WEDGE의 역학관계도 >



< 앵커의 정착조건 >



2.1 앵커내하체의 작용하중 산정

① 쐐기력 $W = \dfrac{P_a}{2 \cdot \sin(\Theta+\delta)}$ ---------- 식1

여기서 sin (6.0 + 22.0) = 0.469

$\dfrac{1,000}{2 \times 0.469} = 1066.098$ KN

② 쐐기수평력 $W_H = W \cdot \cos(\Theta+\delta) = P_a/2 \cdot \cot(\Theta+\delta)$ ---------- 식2

여기서 cos (6 + 22.0) = 0.883

1066.098 × 0.883 = 941.365 KN

③ 벽면전단저항 $R = f \times W_H$ ---------- 식3

여기서 $f=\tan\Phi$ = tan(33.0)° = 0.649

0.649 × 941.365 = 610.946 KN

식 1, 2, 3 에서

Θ = 앵커 두정각의 1/2 = 6.0 °

δ = 벽면 마찰각 = 2/3 x Φ = 22.0 °

f = 마찰계수 = tan(Φ) = 0.649

2.2 정착지반내 앵커내하체의 최소정착근입장 검토 (L_b)

다음 값중 큰 값으로 적용한다.

① 지반정수와 간격에 따른 최소정착장

최소정착장 $hr_{min} \geq \dfrac{5 \times W_H}{f_{at} \times D} = \dfrac{5 \times 941.365}{462.227 \times 5.000} = 2.04$ m ≒ 2.50 m

② 제품의 특성을 고려한 근입깊이 (내하체, 패커부)

최소정착장 hr_{min} = 3.000 m

∴ 최소정착장 hr_{min} = 3.000 m

2.3 앵커와 앵커사이의 정착지반의 인장파괴에 대한 검토

정착 안정조건 : $1/SF \times f_{at} \times D \times h_r \geq 2 \times W_H$ ---------- 식4

여기에서, f_{at}: 정착지반의 허용인장강도(MPa)

D : 앵커 설치 간격(m)

SF : 정착지반의 인장파괴에 대한 안전율(2.5)

= 1/2.5 × 462.000 × 5.000 × 3.000 = 2772.000KN ≥ 2 × 941.365 = 1882.729 KN

2772.000KN ≥ 1882.729KN -----→ 0.K

2.4 앵커내하체의 인발에 대한검토

설계앵커력 P_a는 식3에 의한 앵커체 벽면마찰저항 R에대하여 다음을 만족해야 한다.

$P_a \leq 2R = P_a \cdot \tan\Phi \cdot \cot(\Theta+\delta)$ ---------- 식5

$\therefore \tan(\Theta+\delta) \leq \tan\Phi \rightarrow \Theta+\delta \leq \Phi$

6.0 + 22.0 = 28.0 ≤ 33.0 -----→ 0.K

2.5 앵커 내하체 확장시 정착지반의 지압파괴에 대한 검토

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$

$P_{max} / 2.5 \geq 2W_H$

여기에서, P_{max}:심발 폐색공(패커부) 실시 후의 정착지반의 지압파괴하중(kgf)

f_C:정착 지반의 일축압축강도(kgf/㎠)

F:앵커내하체의 지압면적($F = \alpha \cdot \pi \cdot d' \cdot L$, ㎠)

ln:자연대수

d':앵커 천공직경(㎝)

L:앵커체 압착 유효장(㎝)

α:앵커체 유효접지 계수(0.3)

W_H:쐐기 수평력

$F = \alpha \cdot \pi \cdot d' \cdot L$ = 0.3 × π × 15.0 × 45.0 = 636.2 ㎠

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$ = (658.25 × ln 636.2 - 1552.59) × 200.0

= 539,344.60 kgf = 5,393.446 kN

$P_{max} / 2.5$ = 5,393.45 / 2.5 = 2,157.378 kN

≥ $2W_H$ = 1,882.729 kN -----→ 0.K

3.2 Jacking Force 산정 (P_j)

구 분	설계앵커력	여유장	탄성변위길이		조립길이	수압판	비 고
			근입깊이	자유장			
	(KN)	(m)	(m)	(m)	(m)	(m)	
지압형 앵커	1,000	1.000	3.000	27.500	31.500	0.900	

1) 프리스트레싱 직후 즉시 손실량 (정착장치의 활동)

Wedge Slip 량 : δ = 6.0 ㎜(쐐기식 정착장치 사용)

$$\Delta P_1 = A_s \times E_s \times \frac{\delta}{L}$$

A_s : 강연선 단면적 (7 x 138.70 = 970.9 ㎟)

E_s : 강연선 탄성계수 (2×10^2 KN/㎟)

L : 탄성변위길이 (30500 ㎜)

δ : Wedge Slip량 (6.0 ㎜)

$$\therefore \Delta P_1 = 970.9 \times 2 \times 10^2 \times \frac{6.0}{30500} = 38.199 \text{ KN}$$

2) 프리스트레싱후 시간 의존적 손실량 (강연선의 Relaxation)

Low - Relaxation 강재사용

$$\Delta P_2 = P_i \times \frac{\log_{10} t}{45} \times \left(\frac{T_{us}}{T_{yS}} - 0.55 \right)$$

P_i : 프리스트레스 도입직후 강연선 긴장력

(설계앵커력 + 즉시손실량 = 1,000 + 38.2 = 1,038.199 KN)

t : 프리스트레싱후 손실 계산시까지 시간

(100년 내구연한 : 24 X 365 X 100 = 876,000 hr)

T_{us} : 강연선 극한하중 (263.530 KN)

T_{yS} : 강연선 파단하중 (221.920 KN)

$$\therefore \Delta P_2 = 1{,}038.2 \times \frac{\log_{10} 876{,}000}{45} \left(\frac{263.53}{221.92} - 0.55 \right) = 87.401 \text{ KN}$$

3) Jacking Force :

$P_j = P_a + \Delta P1 + \Delta P2$

$= 1{,}000 + 38.199 + 87.401 = 1{,}125.600$

4) 안정성 검토

(1) 긴장중 허용긴장력

$0.8T_{us}, 0.94T_{ys}$ 중 작은값 = $\begin{cases} 0.8 \times 1.900 = 1.520 & KN/㎟ \\ 0.94 \times 1.600 = 1.504 & KN/㎟ \end{cases}$

허용긴장력= 1.504 × 970.900 = 1460.234 KN

∴ JACK에 의해 최대 1460.234 KN 까지 긴장가능 ≥ Jacking Force = 1125.600 KN --▶ **O.K**

1공당 SWPC7B Φ15.2㎜ 7연선,저릴렉세이션 강연선 7가닥 사용

Φ15.2 × 7EA = 138.70 × 7 = 970.900 ㎟

(2) 긴장직후 허용긴장력

$0.7 \cdot T_{us}$ = 1.33 KN/㎟

허용긴장력= 1.33 × 970.900 = 1291.297 KN ≥ 긴장력 도입직후 = 1038.199 KN --▶ **O.K**

(3) 손실이 일어난후 유효긴장력작용시 허용긴장력

$0.6T_{us}, 0.75T_{ys}$ 중 작은값 = $\begin{cases} 0.6 \times 1.900 = 1.140 & KN/㎟ \\ 0.75 \times 1.600 = 1.200 & KN/㎟ \end{cases}$

허용긴장력= 1.140 × 970.900 = 1106.826 KN ≥ 설계앵커력 P_a = 1,000 KN --▶ **O.K**

4. 지압판의 설계

4.1 지압판 면적(A) 산정

$$A = \frac{P_j}{f_b} + (\pi \times R^2)$$

여기서, P_j : 긴장하중 (KN)

f_b : 수압판 콘크리트 설계강도의 50% (27 × 0.5 = 13.500 MPa)

R : 지압판 삽입공 (55 mm)

$$A = \frac{1125.600}{0.0135} + (\pi \times 55.0^2) = 92881.096 \ mm^2$$

지압판 한 쪽면의 길이(L)은 다음과 같다.

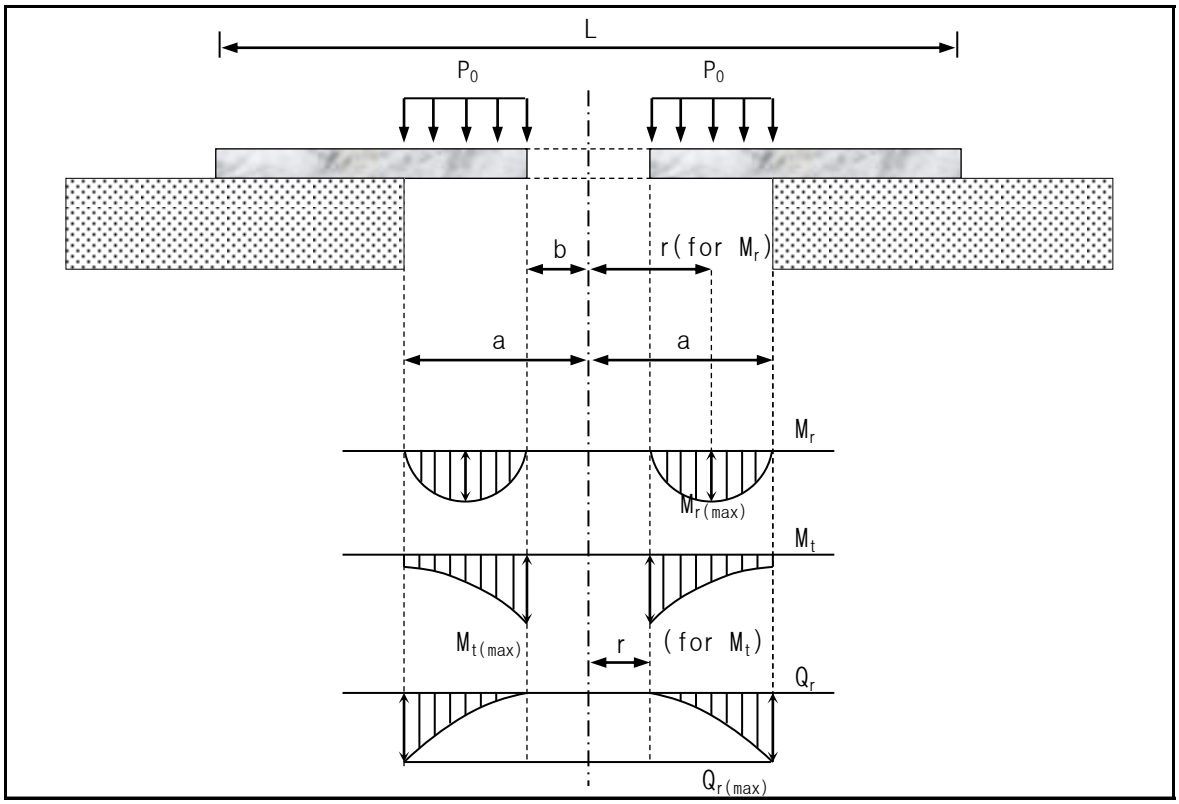
$L = \sqrt{A} = \sqrt{92881.096} = 305$ mm

∴ 규격화를 위해 L= 340 mm , B= 340 mm 적용

4.2 지압판 두께(t) 산정

종래 앵커 지압판의 두께는 지압판을 빔(BEAM)으로 설계는 하는 것이 일반적이였으나 여러 가지 실험결과, 플레이트 판으로서 간주해도 충분히 안전하다는 결과가 얻어지므로 다음과 같이 판으로 간주하여 두께를 산정하였다.

또한, 강두께의 산출에는 안전율 1.5를 보고 그 안전율을 고려한 앵커에 대하여 휨 및 전단에 견딜 수 있도록 강두께를 결정한다.



지압판 두께 산정을 위한 제원 정의도 및 단면력도

1) 단면력 산출

$$M_r = \frac{P_0 a^2}{16}\left[(3+\nu)(1-\rho^2)+k_2\left(1-\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$M_t = \frac{P_0 a^2}{16}\left[2(1-\nu)(1-2X^2)+(1+3\nu)(1-\rho^2)+k_2\left(1+\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$Q_r = -\frac{P_0 A}{2}\left(\rho - X^2\frac{1}{\rho}\right)$$

여기서, M_r : 반경방향의 휨모멘트 (KN · mm/mm)

M_t : 원주방향의 휨모멘트 (KN · mm/mm)

P_0 : 지압판에 작용하는 등분포하중 (KN/mm^2)

$$\frac{1.5 \times Pj}{A} = \frac{1.5 \times 1125.600}{92881.096} = 0.018 \quad KN/mm^2$$

ν : 지압판의 포아송비 : (0.3)

r : 지압판 삽입공 중심에서의 거리(mm) { M_r : r = 56.1 mm, M_t : r = 55.0 mm

a : 수압판의 삽입공 반경 (mm) : 57.2 mm

b : 지압판의 삽입공 반경(mm) : 55.0 mm

ρ : r/a (M_r : 0.981 , M_t : 0.962)

K_2 : $X^2[3+\nu+4(1+\nu)\{X^2/(1-X^2)\}\ln X]$ (단, X=b/a) (X= 0.962) (K_2= 0.739)

L : 지압판의 변길이(mm)

ln : 자연대수

(1) $$M_r = \frac{0.018 \times 57.2^{\,2}}{16} \times [(3 + 0.3) \times (1 - 0.981^{\,2})$$

$$+ 0.739 \times \left(1 - \frac{1}{0.981^{\,2}}\right) + 4 (1 + 0.3) \times 0.962^{\,2} \ln (0.981)]$$

$$= 3.711 \times (0.123 + -0.029 + -0.091) = 0.011 \quad KN \cdot mm/mm$$

(2) $M_t = \frac{0.018 \times 57.2^2}{16} \times [2 \times (1 - 0.3) \times (1 - 2 \times 0.962^2)$

$+ (1 + 3 \times 0.3) \times (1 - 0.962^2) + 0.739 \left(1 + \frac{1}{0.962^2}\right)$

$+ 4 \times (1 + 0.3) \times 0.962^2 \times \ln(0.962)]$

$= 3.711 \times (-1.193 + 1.678 + -0.185) = 1.114$ KN · mm/mm

$\therefore M_t = 1.114 > M_r = 0.011$ 이므로 설계휨모멘트 $M_t = 1.114$ 적용

(3) $Q_r = -\frac{0.018 \times 92881.096}{2} \times (1 - 0.962^2 \times 1) = 62.323$ KN

2) 두께산정

(1) M_t에 의한 소요두께 검토

$t = \left(\frac{6 \times M}{f_{sa}}\right)^{1/2}$

여기서, M_t : 지압판에 작용하는 휨모멘트 = 1.114 KN · mm/mm

f_{sa} : 지압판의 허용 휨응력 = 140 MPa

$t \geq \left(\frac{6 \times 1.114}{0.140}\right)^{1/2} = 6.910$ mm

(2) Q_r에 의한 소요두께 검토

$t \geq \frac{Q_r}{\tau \times \pi d} = \frac{62323}{14363.362} = 4.339$ mm

(3) 강체(Rigid Body)로서의 소요두께 검토

$\beta\lambda \leq 1.0$

여기서 $\beta = \sqrt[4]{\frac{3 \cdot k}{E \cdot h^3}}$ (m^{-1})

K : 수압판의 탄성계수 (= 24,421,916 kN/m^2)

L : 지압판의 길이 (= 0.340 m)

B : 지압판의 폭 (= 0.340 m)

E : 지압판의 탄성계수 (= 210,000,000 kN/m^2)

h : 지압판의 두께 (= 0.034 m) :시산법(Try and Error Method)에 의해 산출

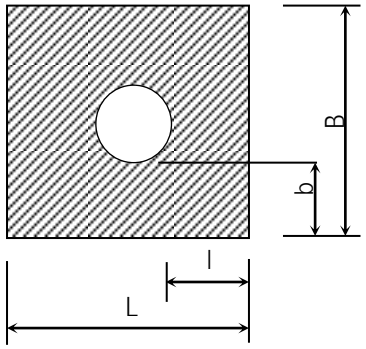
λ : 지압판의 환산 돌출길이 (m)

$\beta = \sqrt[4]{(3 \times 24,421,916) / (210,000,000 \times 0.034^3)} = 9.706$ (m^{-1})

λ= max(l,b) = max(0.100 , 0.100) = 0.100

다만, l ≥ L/2이면 l = L/2 = 0.170

b ≥ B/2이면 b = B/2 = 0.170



β λ = 9.706 x 0.100 = 0.971 ≤ 1.0 ------► **O.K**

(4) 두께 검토 결과

구분	휨M_t	전단력Q_r	강체검토	최대두께	규격화
소요두께	6.910mm	4.339mm	34.000mm	34.000mm	35mm

3) 응력검토

(1) 휨응력 검토

$$f_{max} = \frac{6 \times Mmax}{h^2} = \frac{6 \times 1.114}{35^2} = 5.456 \quad MPa$$

f_{max} ≤ f_{sa} = 5.456 ≤ 140 ---------► **O.K**

(2) 전단응력 검토

$$\tau_{max} = \frac{3}{2} \times \frac{Q_r}{A} = \frac{3}{2} \times \frac{62323}{12567.941} = 7.438 \quad MPa \quad (A=\pi 2a \times t)$$

τ_{max} ≤ τ_{sa} = 7.438 ≤ 80 ---------► **O.K**

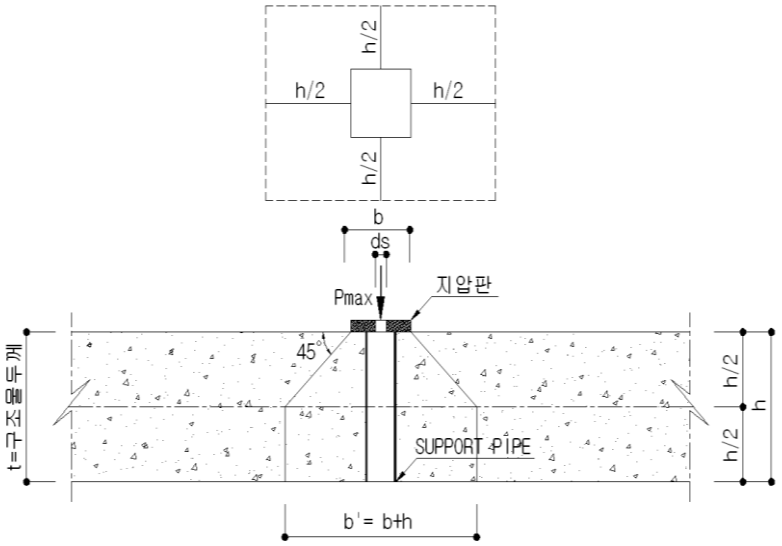
(3) 조합응력 검토

$$\left(\frac{f}{f_a}\right)^2 + \left(\frac{V}{V_a}\right)^2 = \left(\frac{5.456}{140}\right)^2 + \left(\frac{7.438}{80}\right)^2$$

= 0.010 < 1.2 ---► **O.K**

∴ 지압판 규격(L × B × t) = 340 mm × 340 mm × 35 mm

5.수압판 콘크리트 응력검토 (지압판 직하 하부슬래브)



5.1 압발 전단응력 검토

$\tau_v = P_{max} / \{4(b+h)\times h\} \leq \tau_{v3}$

여기서, f_{ck} = 27.0 MPa 일때 τ_{v3} = 0.95 MPa

P_{max} : 소요하중 = 1125600 KN

b : 지압판 길이 = 340 mm

h : 수압판 유효두께 = 900 mm

τ_v = 1125600 / { 4 (340 + 900) × 900 }

= 0.252 MPa ≤ τ_{v3} = 0.950 MPa ----► 0.K

5.2 수직 지압응력 검토

$\tau_c = P_{max} / A_b \leq f_{ba}$

여기서, $f_{ba} = 0.5f_{ck}$ = 0.5 × 27 = 13.500 MPa

A_b : 지압판 면적-슬리브 면적

$A_b = L \times B - \pi/4 \times ds^2$

340 x 340 - π/4× 114.3 ² = 105339.174 ㎟

τ_c = 1125600 / 105339.174 = 10.685 MPa ≤ f_{ba} = 13.500 MPa ----► 0.K

지압식 영구앵커 내적안정 구조계산서

국회대로지하차도 및 상부공원화(1단계-중첩구간) 공사

◈ **제 원**

적용구간	지하차도
BLCOK	BLOCK 12 0+445.00 ~ 0+465.00
설계앵커력	1000 KN
앵커 조립길이	27.000 m
정착지반	풍화암

앵커의 내적안정성검토

[설계앵커력 P_a = 1,000 KN , 앵커 간격 D = 5.000 m]

1.설계기준 검토

1.1 앵커 내하체 정착지반 설계조건

구 분	설 계 조 건	비 고
정착지반	풍화암	단위중량 γ = 21 kN/㎥
내부마찰각	Φ = 33°	Φ = 33°
일축압축강도	f_c = 20 MPa	f_c = 200 kgf/㎠
허용인장강도	f_{at} = 0.462 MPa	$f_{at} = 0.0334 \times f_c^{0.9305}$ = 4.622 kgf/㎠

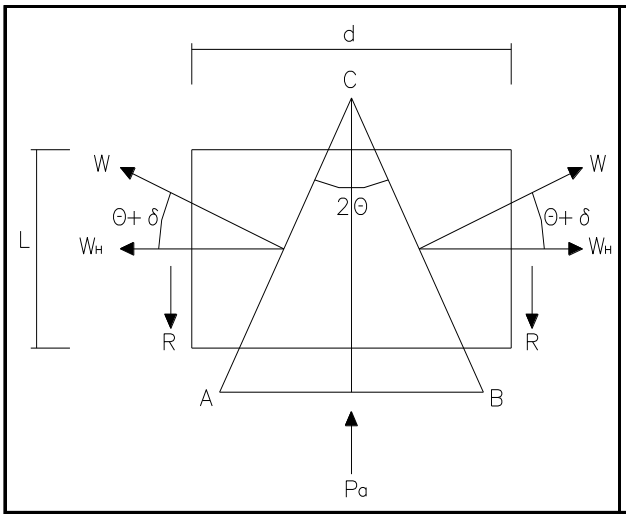
1.2 앵커 내하체 설치조건

구 분	설 계 조 건	비 고
사 용 목 적	부력방지용	지압식 영구앵커
앵커 내하체 전장	여유장 = 1.000 m	
	자유장 = 23.000 m	수압판 두께 포함
	정착근입장 = 3.000 m	
	계 = 27.000 m	앵커 조립장
	수압판두께 = 0.900 m	블럭아웃을 고려한 하부슬래브두께
설 치 간 격	D = 5.000 m	
설 계 앵 커 력	P_a = 1,000 KN	P_a = 100 tonf
앵커 설계안전율	S.F = 2.5	
앵커 두정각	2Θ = 12°	Θ = 6°
앵커 조립직경	d = 120 mm	
앵커 천공직경	d' = 150 mm	
정착지반 근입깊이	$D_{f=}$ 3.000 m	

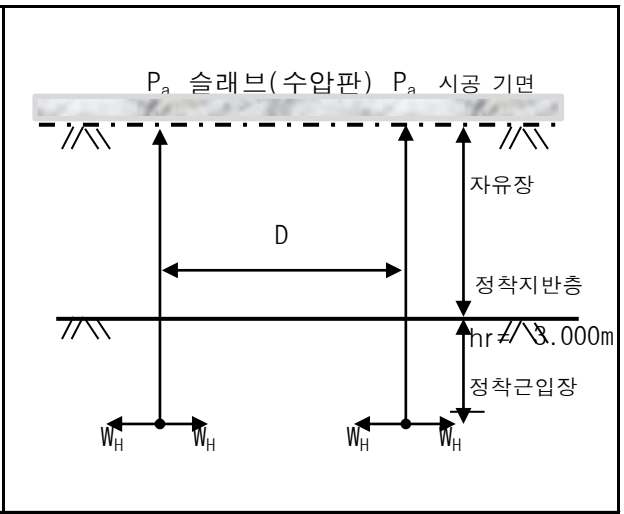
1.3 사용재료의 설계기준

구 분		설 계 조 건	비 고
PS강연선	직경(㎜)	Φ15.2	SWPC7B
	공칭 단면적(㎟)	138.7	Unbonded 강연선
	극한하중	T_{us} = 1.9 KN/㎟	1,900MPa
	항복하중	T_{ys} = 1.6 KN/㎟	1,600MPa
수압판	설계기준강도	f_{ck}= 27 MPa	하부슬래브
	허용압발전단응력	τ_{v3}= 0.950 MPa	도로교설계기준해설(2008) P.906
	허용지압응력	f_{ba}= 13.500 MPa	$f_{ba} = 0.5f_{ck}$
지압판	허용휨/압축응력	$f_{ba}=f_{ca}$= 140 MPa	SS400
	단위중량	γ = 78.50 KN/㎥	

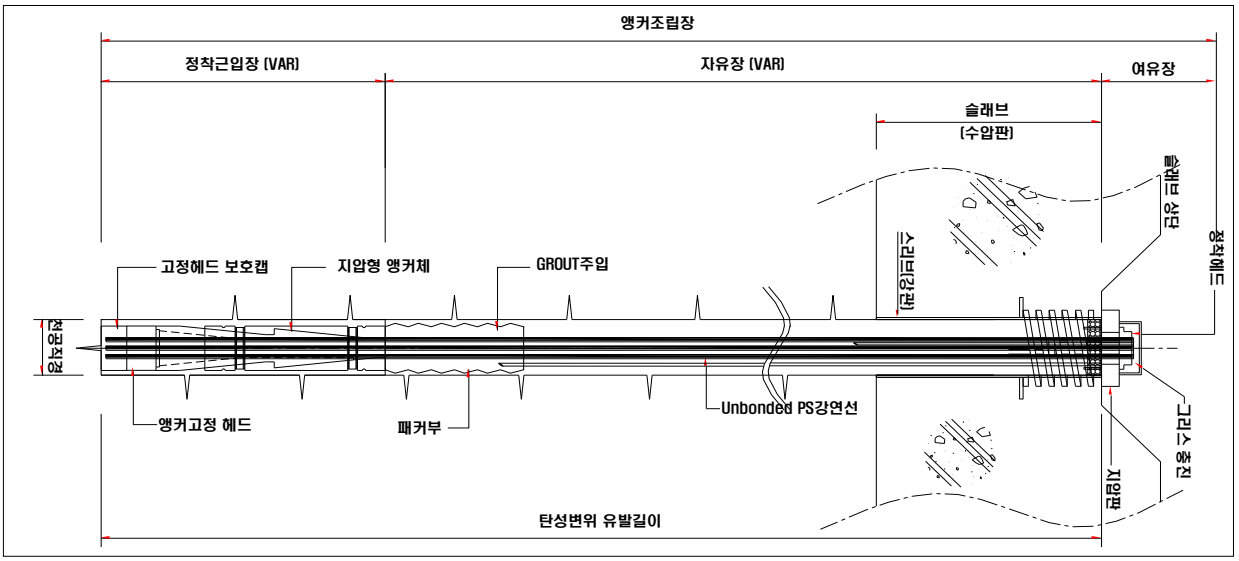
2. 지압식 영구앵커의 정착지반층내 정착근입장검토



< P_a에 의하여 나타나는 WEDGE의 역학관계도 >



< 앵커의 정착조건 >



2.1 앵커내하체의 작용하중 산정

① 쐐기력 $W = \dfrac{P_a}{2 \cdot \sin(\Theta+\delta)}$ ---------- 식1

여기서 sin (6.0 + 22.0) = 0.469

$\dfrac{1,000}{2 \times 0.469} = 1066.098$ KN

② 쐐기수평력 $W_H = W \cdot \cos(\Theta+\delta) = P_a/2 \cdot \cot(\Theta+\delta)$ ---------- 식2

여기서 cos (6 + 22.0) = 0.883

1066.098 × 0.883 = 941.365 KN

③ 벽면전단저항 $R = f \times W_H$ ---------- 식3

여기서 $f=\tan\Phi$ = tan(33.0)° = 0.649

0.649 × 941.365 = 610.946 KN

식 1, 2, 3 에서

Θ = 앵커 두정각의 1/2 = 6.0 °

δ = 벽면 마찰각 = 2/3 x Φ = 22.0 °

f = 마찰계수 = tan(Φ) = 0.649

2.2 정착지반내 앵커내하체의 최소정착근입장 검토 (L_b)

다음 값중 큰 값으로 적용한다.

① 지반정수와 간격에 따른 최소정착장

최소정착장 $hr_{min} \geq \dfrac{5 \times W_H}{f_{at} \times D} = \dfrac{5 \times 941.365}{462.227 \times 5.000} = 2.04$ m ≒ 2.50 m

② 제품의 특성을 고려한 근입깊이 (내하체, 패커부)

최소정착장 hr_{min} = 3.000 m

∴ 최소정착장 hr_{min} = 3.000 m

2.3 앵커와 앵커사이의 정착지반의 인장파괴에 대한 검토

정착 안정조건 : $1/SF \times f_{at} \times D \times h_r \geq 2 \times W_H$ ---------- 식4

여기에서, f_{at}: 정착지반의 허용인장강도(MPa)

D : 앵커 설치 간격(m)

SF : 정착지반의 인장파괴에 대한 안전율(2.5)

= 1/2.5 × 462.000 × 5.000 × 3.000 = 2772.000KN ≥ 2 × 941.365 = 1882.729 KN

2772.000KN ≥ 1882.729KN -----→ 0.K

2.4 앵커내하체의 인발에 대한검토

설계앵커력 P_a는 식3에 의한 앵커체 벽면마찰저항 R에대하여 다음을 만족해야 한다.

$P_a \leq 2R = P_a \cdot \tan\Phi \cdot \cot(\Theta+\delta)$ ---------- 식5

$\therefore \tan(\Theta+\delta) \leq \tan\Phi \rightarrow \Theta+\delta \leq \Phi$

6.0 + 22.0 = 28.0 ≤ 33.0 -----→ 0.K

2.5 앵커 내하체 확장시 정착지반의 지압파괴에 대한 검토

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$

$P_{max} / 2.5 \geq 2W_H$

여기에서, P_{max}:심발 폐색공(패커부) 실시 후의 정착지반의 지압파괴하중(kgf)

f_C:정착 지반의 일축압축강도(kgf/㎠)

F:앵커내하체의 지압면적($F = \alpha \cdot \pi \cdot d' \cdot L$, ㎠)

ln:자연대수

d':앵커 천공직경(㎝)

L:앵커체 압착 유효장(㎝)

α:앵커체 유효접지 계수(0.3)

W_H:쐐기 수평력

$F = \alpha \cdot \pi \cdot d' \cdot L$ = 0.3 × π × 15.0 × 45.0 = 636.2 ㎠

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$ = (658.25 × ln 636.2 - 1552.59) × 200.0

= 539,344.60 kgf = 5,393.446 kN

$P_{max} / 2.5$ = 5,393.45 / 2.5 = 2,157.378 kN

≥ $2W_H$ = 1,882.729 kN -----→ 0.K

3.2 Jacking Force 산정 (P_j)

구 분	설계앵커력	여유장	탄성변위길이		조립길이	수압판	비 고
			근입깊이	자유장			
	(KN)	(m)	(m)	(m)	(m)	(m)	
지압형 앵커	1,000	1.000	3.000	23.000	27.000	0.900	

1) 프리스트레싱 직후 즉시 손실량 (정착장치의 활동)

Wedge Slip 량 : δ = 6.0 ㎜(쐐기식 정착장치 사용)

$$\Delta P_1 = A_s \times E_s \times \frac{\delta}{L}$$

A_s : 강연선 단면적 (7 x 138.70 = 970.9 ㎟)

E_s : 강연선 탄성계수 (2×10^2 KN/㎟)

L : 탄성변위길이 (26000 ㎜)

δ : Wedge Slip량 (6.0 ㎜)

$$\therefore \Delta P_1 = 970.9 \times 2 \times 10^2 \times \frac{6.0}{26000} = 44.811 \text{ KN}$$

2) 프리스트레싱후 시간 의존적 손실량 (강연선의 Relaxation)

Low - Relaxation 강재사용

$$\Delta P_2 = P_i \times \frac{\log_{10} t}{45} \times \left(\frac{T_{us}}{T_{yS}} - 0.55 \right)$$

P_i : 프리스트레스 도입직후 강연선 긴장력

(설계앵커력 + 즉시손실량 = 1,000 + 44.8 = 1,044.811 KN)

t : 프리스트레싱후 손실 계산시까지 시간

(100년 내구연한 : 24 X 365 X 100 = 876,000 hr)

T_{us} : 강연선 극한하중 (263.530 KN)

T_{yS} : 강연선 파단하중 (221.920 KN)

$$\therefore \Delta P_2 = 1{,}044.8 \times \frac{\log_{10} 876{,}000}{45} \left(\frac{263.53}{221.92} - 0.55 \right) = 87.958 \text{ KN}$$

3) Jacking Force :

$P_j = P_a + \Delta P1 + \Delta P2$

$= 1{,}000 + 44.811 + 87.958 = 1{,}132.769$

4) 안정성 검토

(1) 긴장중 허용긴장력

$0.8T_{us}, 0.94T_{ys}$ 중 작은값 = $\begin{cases} 0.8 \times 1.900 = 1.520 & KN/㎟ \\ 0.94 \times 1.600 = 1.504 & KN/㎟ \end{cases}$

허용긴장력= 1.504 × 970.900 = 1460.234 KN

∴ JACK에 의해 최대 1460.234 KN 까지 긴장가능 ≥ Jacking Force = 1132.769 KN --▶ **O.K**

1공당 SWPC7B Φ15.2㎜ 7연선,저릴렉세이션 강연선 7가닥 사용

Φ15.2 × 7EA = 138.70 × 7 = 970.900 ㎟

(2) 긴장직후 허용긴장력

$0.7 \cdot T_{us}$ = 1.33 KN/㎟

허용긴장력= 1.33 × 970.900 = 1291.297 KN ≥ 긴장력 도입직후 = 1044.811 KN --▶ **O.K**

(3) 손실이 일어난후 유효긴장력작용시 허용긴장력

$0.6T_{us}, 0.75T_{ys}$ 중 작은값 = $\begin{cases} 0.6 \times 1.900 = 1.140 & KN/㎟ \\ 0.75 \times 1.600 = 1.200 & KN/㎟ \end{cases}$

허용긴장력= 1.140 × 970.900 = 1106.826 KN ≥ 설계앵커력 P_a = 1,000 KN --▶ **O.K**

4. 지압판의 설계

4.1 지압판 면적(A) 산정

$$A = \frac{P_j}{f_b} + (\pi \times R^2)$$

여기서, P_j : 긴장하중 (KN)

f_b : 수압판 콘크리트 설계강도의 50% (27 × 0.5 = 13.500 MPa)

R : 지압판 삽입공 (55 mm)

$$A = \frac{1132.769}{0.0135} + (\pi \times 55.0^2) = 93412.133 \ mm^2$$

지압판 한 쪽면의 길이(L)은 다음과 같다.

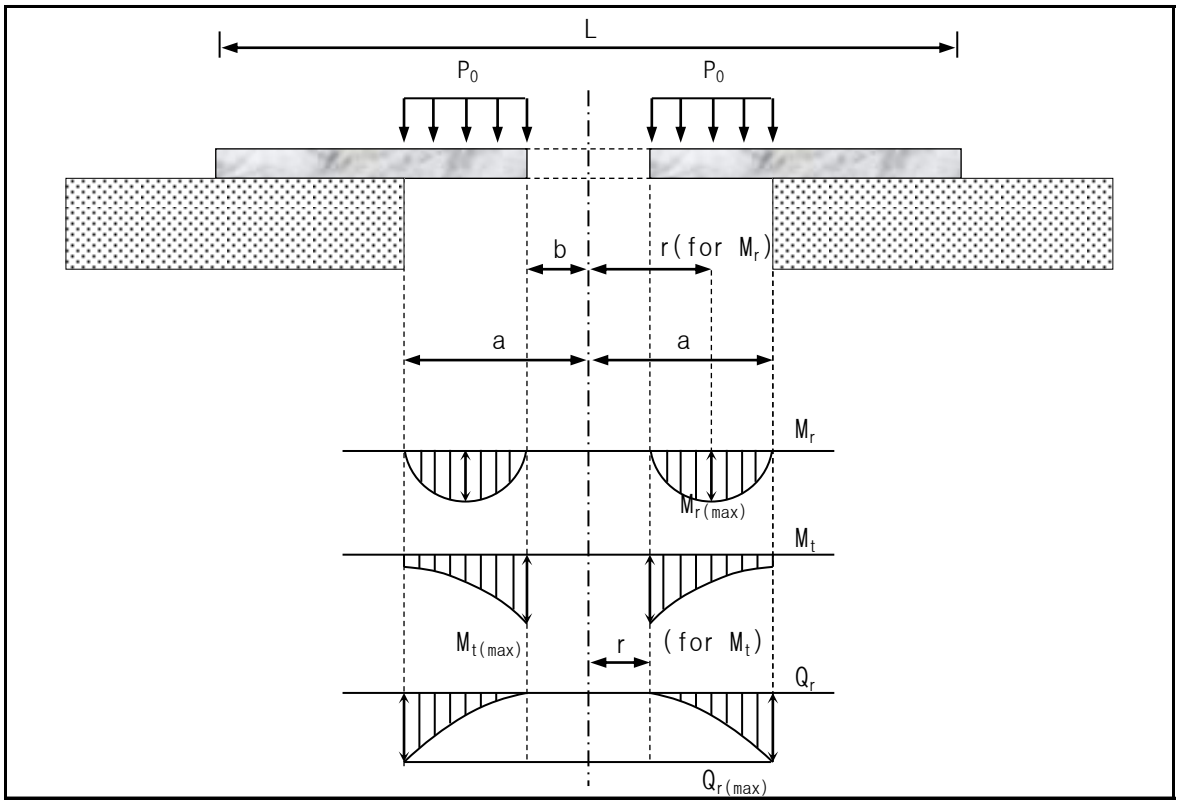
$L = \sqrt{A} = \sqrt{93412.133} = 306$ mm

∴ 규격화를 위해 L= 340 mm , B= 340 mm 적용

4.2 지압판 두께(t) 산정

종래 앵커 지압판의 두께는 지압판을 빔(BEAM)으로 설계는 하는 것이 일반적이였으나 여러 가지 실험결과, 플레이트 판으로서 간주해도 충분히 안전하다는 결과가 얻어지므로 다음과 같이 판으로 간주하여 두께를 산정하였다.

또한, 강두께의 산출에는 안전율 1.5를 보고 그 안전율을 고려한 앵커에 대하여 휨 및 전단에 견딜 수 있도록 강두께를 결정한다.



지압판 두께 산정을 위한 제원 정의도 및 단면력도

1) 단면력 산출

$$M_r = \frac{P_0 a^2}{16}\left[(3+\nu)(1-\rho^2)+k_2\left(1-\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$M_t = \frac{P_0 a^2}{16}\left[2(1-\nu)(1-2X^2)+(1+3\nu)(1-\rho^2)+k_2\left(1+\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$Q_r = -\frac{P_0 A}{2}\left(\rho - X^2\frac{1}{\rho}\right)$$

여기서, M_r : 반경방향의 휨모멘트 (KN · mm/mm)

M_t : 원주방향의 휨모멘트 (KN · mm/mm)

P_0 : 지압판에 작용하는 등분포하중 (KN/mm^2)

$$\frac{1.5 \times Pj}{A} = \frac{1.5 \times 1132.769}{93412.133} = 0.018 \quad KN/mm^2$$

ν : 지압판의 포아송비 : (0.3)

r : 지압판 삽입공 중심에서의 거리(mm) { M_r : r = 56.1 mm, M_t : r = 55.0 mm

a : 수압판의 삽입공 반경 (mm) : 57.2 mm

b : 지압판의 삽입공 반경(mm) : 55.0 mm

ρ : r/a (M_r : 0.981 , M_t : 0.962)

K_2 : $X^2[3+\nu+4(1+\nu)\{X^2/(1-X^2)\}\ln X]$ (단, X=b/a) (X= 0.962) (K_2= 0.739)

L : 지압판의 변길이(mm)

ln : 자연대수

(1) $$M_r = \frac{0.018 \times 57.2^{\,2}}{16} \times [(3+0.3) \times (1-0.981^{\,2}) + 0.739 \times \left(1-\frac{1}{0.981^{\,2}}\right) + 4(1+0.3) \times 0.962^{\,2} \ln(0.981)]$$

$$= 3.713 \times (0.123 + -0.029 + -0.091) = 0.011 \quad KN \cdot mm/mm$$

(2) $M_t = \frac{0.018 \times 57.2^2}{16} \times [2 \times (1 - 0.3) \times (1 - 2 \times 0.962^2)$

$+ (1 + 3 \times 0.3) \times (1 - 0.962^2) + 0.739 \left(1 + \frac{1}{0.962^2}\right)$

$+ 4 \times (1 + 0.3) \times 0.962^2 \times \ln(0.962)]$

$= 3.713 \times (-1.193 + 1.678 + -0.185) = 1.115$ KN · mm/mm

$\therefore M_t = 1.115 > M_r = 0.011$ 이므로 설계휨모멘트 $M_t = 1.115$ 적용

(3) $Q_r = -\frac{0.018 \times 93412.133}{2} \times (1 - 0.962^2 \times 1) = 62.720$ KN

2) 두께산정

(1) M_t에 의한 소요두께 검토

$t = \left(\frac{6 \times M}{f_{sa}}\right)^{1/2}$

여기서, M_t : 지압판에 작용하는 휨모멘트 = 1.115 KN · mm/mm

f_{sa} : 지압판의 허용 휨응력 = 140 MPa

$t \geq \left(\frac{6 \times 1.115}{0.140}\right)^{1/2} = 6.912$ mm

(2) Q_r에 의한 소요두께 검토

$t \geq \frac{Q_r}{\tau \times \pi d} = \frac{62720}{14363.362} = 4.367$ mm

(3) 강체(Rigid Body)로서의 소요두께 검토

$\beta\lambda \leq 1.0$

여기서 $\beta = \sqrt[4]{\frac{3 \cdot k}{E \cdot h^3}}$ (m^{-1})

K : 수압판의 탄성계수 (= 24,421,916 kN/m^2)

L : 지압판의 길이 (= 0.340 m)

B : 지압판의 폭 (= 0.340 m)

E : 지압판의 탄성계수 (= 210,000,000 kN/m^2)

h : 지압판의 두께 (= 0.034 m) :시산법(Try and Error Method)에 의해 산출

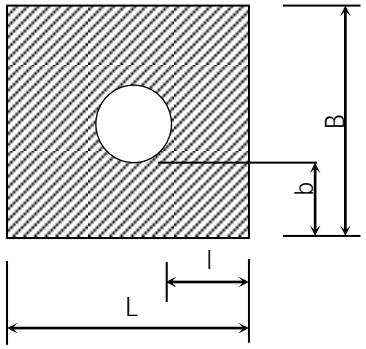
λ : 지압판의 환산 돌출길이 (m)

$\beta = \sqrt[4]{(3 \times 24,421,916) / (210,000,000 \times 0.034^3)} = 9.706$ (m^{-1})

λ= max(l,b) = max(0.100 , 0.100) = 0.100

다만, l ≥ L/2이면 l = L/2 = 0.170

b ≥ B/2이면 b = B/2 = 0.170



β λ = 9.706 x 0.100 = 0.971 ≤ 1.0 ------► **O.K**

(4) 두께 검토 결과

구분	휨M_t	전단력Q_r	강체검토	최대두께	규격화
소요두께	6.912mm	4.367mm	34.000mm	34.000mm	35mm

3) 응력검토

(1) 휨응력 검토

$$f_{max} = \frac{6 \times Mmax}{h^2} = \frac{6 \times 1.115}{35^2} = 5.460 \quad MPa$$

f_{max} ≤ f_{sa} = 5.460 ≤ 140 ---------► **O.K**

(2) 전단응력 검토

$$\tau_{max} = \frac{3}{2} \times \frac{Q_r}{A} = \frac{3}{2} \times \frac{62720}{12567.941} = 7.486 \quad MPa \quad (A=\pi 2a \times t)$$

τ_{max} ≤ τ_{sa} = 7.486 ≤ 80 ---------► **O.K**

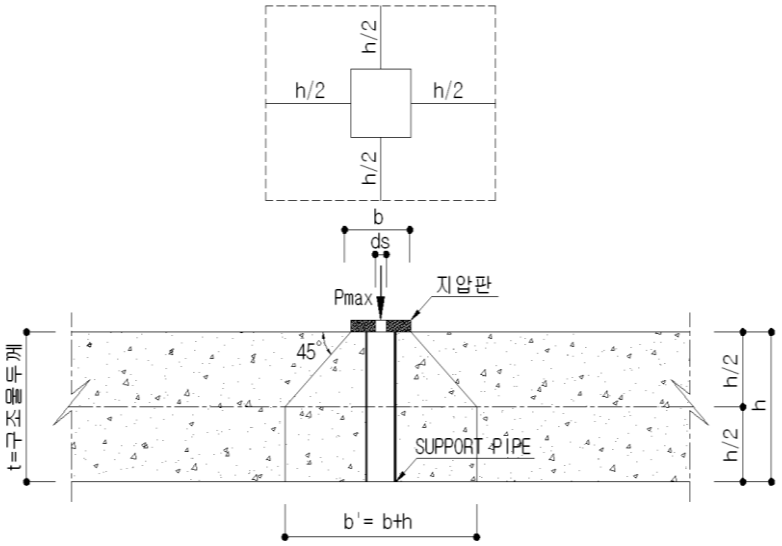
(3) 조합응력 검토

$$\left(\frac{f}{f_a}\right)^2 + \left(\frac{V}{V_a}\right)^2 = \left(\frac{5.460}{140}\right)^2 + \left(\frac{7.486}{80}\right)^2$$

= 0.010 < 1.2 ---► **O.K**

∴ 지압판 규격(L × B × t) = 340 mm × 340 mm × 35 mm

5.수압판 콘크리트 응력검토 (지압판 직하 하부슬래브)



5.1 압발 전단응력 검토

$\tau_v = P_{max} / \{4(b+h)\times h\} \leq \tau_{v3}$

여기서, f_{ck} = 27.0 MPa 일때 τ_{v3} = 0.95 MPa

P_{max} : 소요하중 = 1132769 KN

b : 지압판 길이 = 340 mm

h : 수압판 유효두께 = 900 mm

τ_v = 1132769 / { 4 (340 + 900) × 900 }

= 0.254 MPa ≤ τ_{v3} = 0.950 MPa ----► **O.K**

5.2 수직 지압응력 검토

$\tau_c = P_{max} / A_b \leq f_{ba}$

여기서, $f_{ba} = 0.5f_{ck}$ = 0.5 × 27 = 13.500 MPa

A_b : 지압판 면적-슬리브 면적

$A_b = L \times B - \pi/4 \times ds^2$

340 x 340 - π/4× 114.3 ² = 105339.174 ㎟

τ_c = 1132769 / 105339.174 = 10.754 MPa ≤ f_{ba} = 13.500 MPa ----► **O.K**

지압식 영구앵커 내적안정 구조계산서

국회대로지하차도 및 상부공원화(1단계-중첩구간) 공사

◈ **제 원**

적용구간	지하차도
BLCOK	BLOCK 13 0+465.00 ~ 0+485.00
설계앵커력	1000 KN
앵커 조립길이	25.500 m
정착지반	풍화암

앵커의 내적안정성검토

[설계앵커력 P_a = 1,000 KN , 앵커 간격 D = 5.000 m]

1.설계기준 검토

1.1 앵커 내하체 정착지반 설계조건

구 분	설 계 조 건	비 고
정착지반	풍화암	단위중량 γ = 21 kN/㎥
내부마찰각	Φ = 33°	Φ = 33°
일축압축강도	f_c = 20 MPa	f_c = 200 kgf/㎠
허용인장강도	f_{at} = 0.462 MPa	$f_{at} = 0.0334 \times f_c^{0.9305}$ = 4.622 kgf/㎠

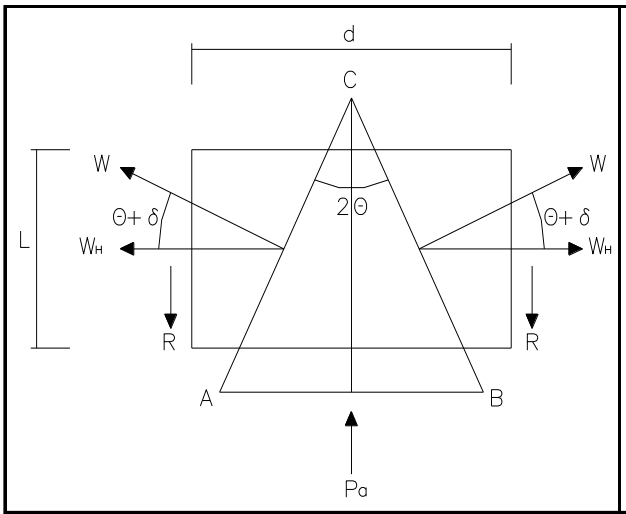
1.2 앵커 내하체 설치조건

구 분	설 계 조 건	비 고
사 용 목 적	부력방지용	지압식 영구앵커
앵커 내하체 전장	여유장 = 1.000 m	
	자유장 = 21.500 m	수압판 두께 포함
	정착근입장 = 3.000 m	
	계 = 25.500 m	앵커 조립장
	수압판두께 = 0.900 m	블럭아웃을 고려한 하부슬래브두께
설 치 간 격	D = 5.000 m	
설 계 앵 커 력	P_a = 1,000 KN	P_a = 100 tonf
앵커 설계안전율	S.F = 2.5	
앵커 두정각	2Θ = 12°	Θ = 6°
앵커 조립직경	d = 120 mm	
앵커 천공직경	d' = 150 mm	
정착지반 근입깊이	$D_{f=}$ 3.000 m	

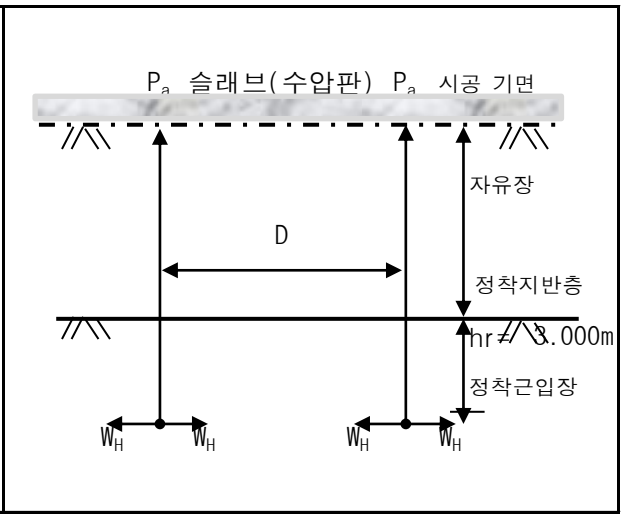
1.3 사용재료의 설계기준

구 분		설 계 조 건	비 고
PS강연선	직경(㎜)	Φ15.2	SWPC7B
	공칭 단면적(㎟)	138.7	Unbonded 강연선
	극한하중	T_{us} = 1.9 KN/㎟	1,900MPa
	항복하중	T_{ys} = 1.6 KN/㎟	1,600MPa
수압판	설계기준강도	f_{ck}= 27 MPa	하부슬래브
	허용압발전단응력	τ_{v3}= 0.950 MPa	도로교설계기준해설(2008) P.906
	허용지압응력	f_{ba}= 13.500 MPa	$f_{ba} = 0.5f_{ck}$
지압판	허용휨/압축응력	$f_{ba}=f_{ca}$= 140 MPa	SS400
	단위중량	γ = 78.50 KN/㎥	

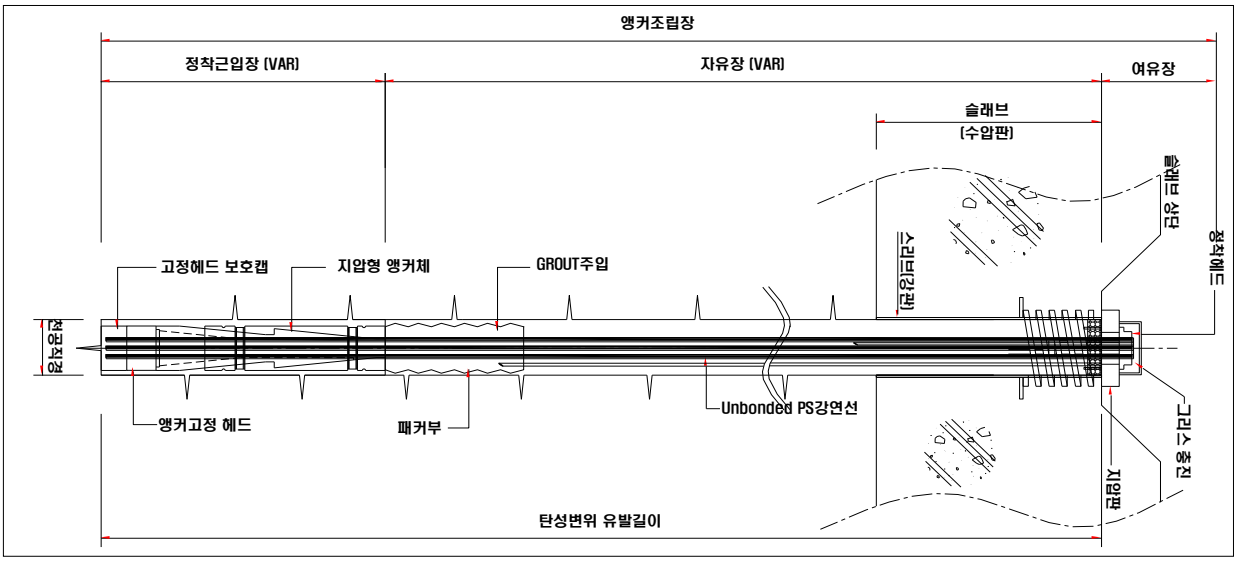
2. 지압식 영구앵커의 정착지반층내 정착근입장검토



< P_a에 의하여 나타나는 WEDGE의 역학관계도 >



< 앵커의 정착조건 >



2.1 앵커내하체의 작용하중 산정

① 쐐기력 $W = \dfrac{P_a}{2 \cdot \sin(\Theta+\delta)}$ ---------- 식1

여기서 sin (6.0 + 22.0) = 0.469

$\dfrac{1,000}{2 \times 0.469} = 1066.098$ KN

② 쐐기수평력 $W_H = W \cdot \cos(\Theta+\delta) = P_a/2 \cdot \cot(\Theta+\delta)$ ---------- 식2

여기서 cos (6 + 22.0) = 0.883

1066.098 × 0.883 = 941.365 KN

③ 벽면전단저항 $R = f \times W_H$ ---------- 식3

여기서 $f=\tan\Phi$ = tan(33.0)° = 0.649

0.649 × 941.365 = 610.946 KN

식 1, 2, 3 에서

Θ = 앵커 두정각의 1/2 = 6.0 °

δ = 벽면 마찰각 = 2/3 x Φ = 22.0 °

f = 마찰계수 = tan(Φ) = 0.649

2.2 정착지반내 앵커내하체의 최소정착근입장 검토 (L_b)

다음 값중 큰 값으로 적용한다.

① 지반정수와 간격에 따른 최소정착장

최소정착장 $hr_{min} \geq \dfrac{5 \times W_H}{f_{at} \times D} = \dfrac{5 \times 941.365}{462.227 \times 5.000} = 2.04$ m ≒ 2.50 m

② 제품의 특성을 고려한 근입깊이 (내하체, 패커부)

최소정착장 hr_{min} = 3.000 m

∴ 최소정착장 hr_{min} = 3.000 m

2.3 앵커와 앵커사이의 정착지반의 인장파괴에 대한 검토

정착 안정조건 : $1/SF \times f_{at} \times D \times h_r \geq 2 \times W_H$ ---------- 식4

여기에서, f_{at}: 정착지반의 허용인장강도(MPa)

D : 앵커 설치 간격(m)

SF : 정착지반의 인장파괴에 대한 안전율(2.5)

= 1/2.5 × 462.000 × 5.000 × 3.000 = 2772.000KN ≥ 2 × 941.365 = 1882.729 KN

2772.000KN ≥ 1882.729KN -----→ 0.K

2.4 앵커내하체의 인발에 대한검토

설계앵커력 P_a는 식3에 의한 앵커체 벽면마찰저항 R에대하여 다음을 만족해야 한다.

$P_a \leq 2R = P_a \cdot \tan\Phi \cdot \cot(\Theta+\delta)$ ---------- 식5

$\therefore \tan(\Theta+\delta) \leq \tan\Phi \rightarrow \Theta+\delta \leq \Phi$

6.0 + 22.0 = 28.0 ≤ 33.0 -----→ 0.K

2.5 앵커 내하체 확장시 정착지반의 지압파괴에 대한 검토

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$

$P_{max} / 2.5 \geq 2W_H$

여기에서, P_{max}:심발 폐색공(패커부) 실시 후의 정착지반의 지압파괴하중(kgf)

f_C:정착 지반의 일축압축강도(kgf/㎠)

F:앵커내하체의 지압면적($F = \alpha \cdot \pi \cdot d' \cdot L$, ㎠)

ln:자연대수

d':앵커 천공직경(㎝)

L:앵커체 압착 유효장(㎝)

α:앵커체 유효접지 계수(0.3)

W_H:쐐기 수평력

$F = \alpha \cdot \pi \cdot d' \cdot L$ = 0.3 × π × 15.0 × 45.0 = 636.2 ㎠

$P_{max} = (658.25 \cdot \ln F - 1552.59) \cdot f_C$ = (658.25 × ln 636.2 - 1552.59) × 200.0

= 539,344.60 kgf = 5,393.446 kN

$P_{max} / 2.5$ = 5,393.45 / 2.5 = 2,157.378 kN

≥ $2W_H$ = 1,882.729 kN -----→ 0.K

3.2 Jacking Force 산정 (P_j)

구 분	설계앵커력	여유장	탄성변위길이		조립길이	수압판	비 고
			근입깊이	자유장			
	(KN)	(m)	(m)	(m)	(m)	(m)	
지압형 앵커	1,000	1.000	3.000	21.500	25.500	0.900	

1) 프리스트레싱 직후 즉시 손실량 (정착장치의 활동)

Wedge Slip 량 : δ = 6.0 ㎜(쐐기식 정착장치 사용)

$$\Delta P_1 = A_s \times E_s \times \frac{\delta}{L}$$

A_s : 강연선 단면적 (7 x 138.70 = 970.9 ㎟)

E_s : 강연선 탄성계수 (2×10^2 KN/㎟)

L : 탄성변위길이 (24500 ㎜)

δ : Wedge Slip량 (6.0 ㎜)

$$\therefore \Delta P_1 = 970.9 \times 2 \times 10^2 \times \frac{6.0}{24500} = 47.554 \text{ KN}$$

2) 프리스트레싱후 시간 의존적 손실량 (강연선의 Relaxation)

Low - Relaxation 강재사용

$$\Delta P_2 = P_i \times \frac{\log_{10} t}{45} \times \left(\frac{T_{us}}{T_{yS}} - 0.55 \right)$$

P_i : 프리스트레스 도입직후 강연선 긴장력

(설계앵커력 + 즉시손실량 = 1,000 + 47.6 = 1,047.554 KN)

t : 프리스트레싱후 손실 계산시까지 시간

(100년 내구연한 : 24 X 365 X 100 = 876,000 hr)

T_{us} : 강연선 극한하중 (263.530 KN)

T_{yS} : 강연선 파단하중 (221.920 KN)

$$\therefore \Delta P_2 = 1{,}047.6 \times \frac{\log_{10} 876{,}000}{45} \left(\frac{263.53}{221.92} - 0.55 \right) = 88.189 \text{ KN}$$

3) Jacking Force :

$P_j = P_a + \Delta P1 + \Delta P2$

$= 1{,}000 + 47.554 + 88.189 = 1{,}135.743$

4) 안정성 검토

(1) 긴장중 허용긴장력

$0.8T_{us}, 0.94T_{ys}$ 중 작은값 = $\begin{cases} 0.8 \times 1.900 = 1.520 & KN/㎟ \\ 0.94 \times 1.600 = 1.504 & KN/㎟ \end{cases}$

허용긴장력= 1.504 × 970.900 = 1460.234 KN

∴ JACK에 의해 최대 1460.234 KN 까지 긴장가능 ≥ Jacking Force = 1135.743 KN --▶ **O.K**

1공당 SWPC7B Φ15.2㎜ 7연선,저릴렉세이션 강연선 7가닥 사용

Φ15.2 × 7EA = 138.70 × 7 = 970.900 ㎟

(2) 긴장직후 허용긴장력

$0.7 \cdot T_{us}$ = 1.33 KN/㎟

허용긴장력= 1.33 × 970.900 = 1291.297 KN ≥ 긴장력 도입직후 = 1047.554 KN --▶ **O.K**

(3) 손실이 일어난후 유효긴장력작용시 허용긴장력

$0.6T_{us}, 0.75T_{ys}$ 중 작은값 = $\begin{cases} 0.6 \times 1.900 = 1.140 & KN/㎟ \\ 0.75 \times 1.600 = 1.200 & KN/㎟ \end{cases}$

허용긴장력= 1.140 × 970.900 = 1106.826 KN ≥ 설계앵커력 P_a = 1,000 KN --▶ **O.K**

4. 지압판의 설계

4.1 지압판 면적(A) 산정

$$A = \frac{P_j}{f_b} + (\pi \times R^2)$$

여기서, P_j : 긴장하중 (KN)

f_b : 수압판 콘크리트 설계강도의 50% (27 × 0.5 = 13.500 MPa)

R : 지압판 삽입공 (55 mm)

$$A = \frac{1135.743}{0.0135} + (\pi \times 55.0^2) = 93632.429 \ mm^2$$

지압판 한 쪽면의 길이(L)은 다음과 같다.

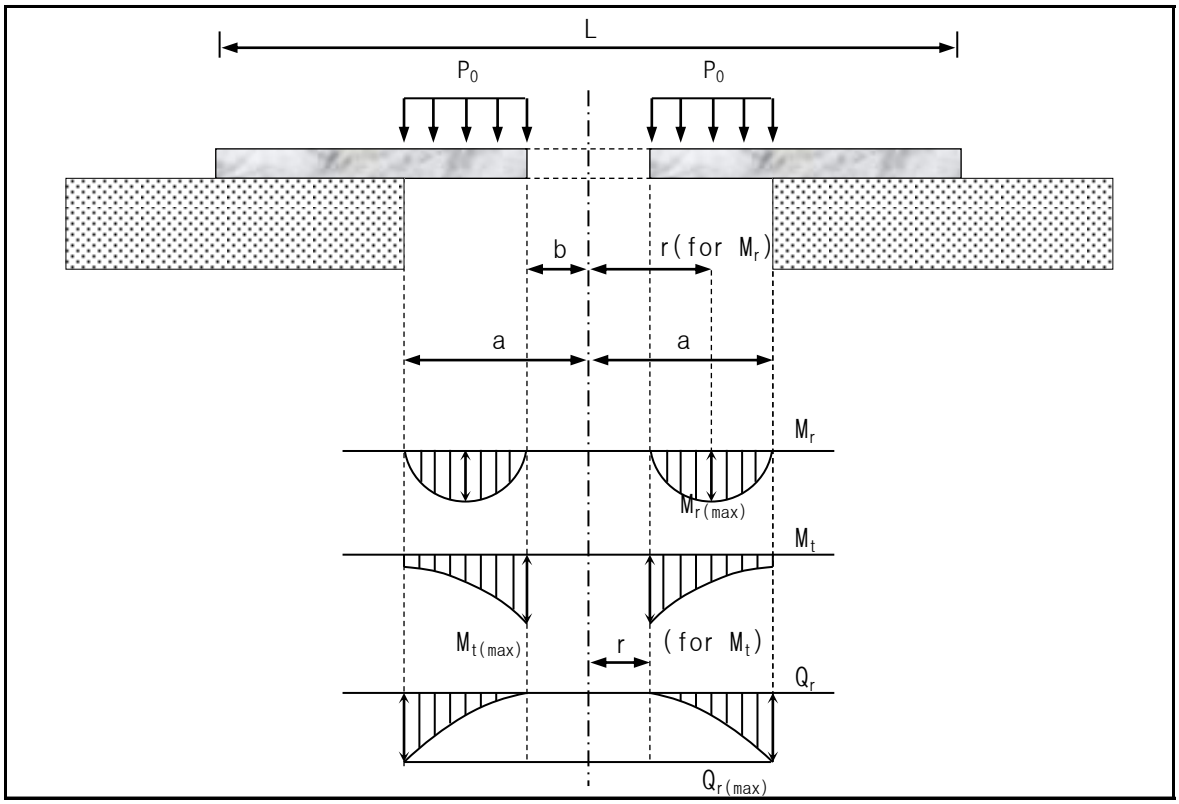
$L = \sqrt{A} = \sqrt{93632.429} = 306$ mm

∴ 규격화를 위해 L= 340 mm , B= 340 mm 적용

4.2 지압판 두께(t) 산정

종래 앵커 지압판의 두께는 지압판을 빔(BEAM)으로 설계는 하는 것이 일반적이였으나 여러 가지 실험결과, 플레이트 판으로서 간주해도 충분히 안전하다는 결과가 얻어지므로 다음과 같이 판으로 간주하여 두께를 산정하였다.

또한, 강두께의 산출에는 안전율 1.5를 보고 그 안전율을 고려한 앵커에 대하여 휨 및 전단에 견딜 수 있도록 강두께를 결정한다.



지압판 두께 산정을 위한 제원 정의도 및 단면력도

1) 단면력 산출

$$M_r = \frac{P_0 a^2}{16}\left[(3+\nu)(1-\rho^2)+k_2\left(1-\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$M_t = \frac{P_0 a^2}{16}\left[2(1-\nu)(1-2X^2)+(1+3\nu)(1-\rho^2)+k_2\left(1+\frac{1}{\rho^2}\right)+4(1+\nu)X^2\ln\rho\right]$$

$$Q_r = -\frac{P_0 A}{2}\left(\rho - X^2\frac{1}{\rho}\right)$$

여기서, M_r : 반경방향의 휨모멘트 (KN · mm/mm)

M_t : 원주방향의 휨모멘트 (KN · mm/mm)

P_0 : 지압판에 작용하는 등분포하중 (KN/mm^2)

$$\frac{1.5 \times Pj}{A} = \frac{1.5 \times 1135.743}{93632.429} = 0.018 \quad KN/mm^2$$

ν : 지압판의 포아송비 : (0.3)

r : 지압판 삽입공 중심에서의 거리(mm) { M_r : r = 56.1 mm, M_t : r = 55.0 mm

a : 수압판의 삽입공 반경 (mm) : 57.2 mm

b : 지압판의 삽입공 반경(mm) : 55.0 mm

ρ : r/a (M_r : 0.981 , M_t : 0.962)

K_2 : $X^2[3+\nu+4(1+\nu)\{X^2/(1-X^2)\}\ln X]$ (단, X=b/a) (X= 0.962) (K_2= 0.739)

L : 지압판의 변길이(mm)

ln : 자연대수

(1) $$M_r = \frac{0.018 \times 57.2^{\,2}}{16} \times [(3 + 0.3) \times (1 - 0.981^{\,2}) + 0.739 \times \left(1 - \frac{1}{0.981^{\,2}}\right) + 4 (1 + 0.3) \times 0.962^{\,2} \ln (0.981)]$$

$$= 3.714 \times (0.123 + -0.029 + -0.091) = 0.011 \quad KN \cdot mm/mm$$

(2) $M_t = \frac{0.018 \times 57.2^2}{16} \times [2 \times (1 - 0.3) \times (1 - 2 \times 0.962^2)$

$+ (1 + 3 \times 0.3) \times (1 - 0.962^2) + 0.739 \left(1 + \frac{1}{0.962^2}\right)$

$+ 4 \times (1 + 0.3) \times 0.962^2 \times \ln(0.962)]$

$= 3.714 \times (-1.193 + 1.678 + -0.185) = 1.115$ KN · mm/mm

$\therefore M_t = 1.115 > M_r = 0.011$ 이므로 설계휨모멘트 $M_t = 1.115$ 적용

(3) $Q_r = -\frac{0.018 \times 93632.429}{2} \times (1 - 0.962^2 \times 1) = 62.885$ KN

2) 두께산정

(1) M_t에 의한 소요두께 검토

$t = \left(\frac{6 \times M}{f_{sa}}\right)^{1/2}$

여기서, M_t : 지압판에 작용하는 휨모멘트 = 1.115 KN · mm/mm

f_{sa} : 지압판의 허용 휨응력 = 140 MPa

$t \geq \left(\frac{6 \times 1.115}{0.140}\right)^{1/2} = 6.913$ mm

(2) Q_r에 의한 소요두께 검토

$t \geq \frac{Q_r}{\tau \times \pi d} = \frac{62885}{14363.362} = 4.378$ mm

(3) 강체(Rigid Body)로서의 소요두께 검토

$\beta\lambda \leq 1.0$

여기서 $\beta = \sqrt[4]{\frac{3 \cdot k}{E \cdot h^3}}$ (m^{-1})

K : 수압판의 탄성계수 (= 24,421,916 kN/m^2)

L : 지압판의 길이 (= 0.340 m)

B : 지압판의 폭 (= 0.340 m)

E : 지압판의 탄성계수 (= 210,000,000 kN/m^2)

h : 지압판의 두께 (= 0.034 m) :시산법(Try and Error Method)에 의해 산출

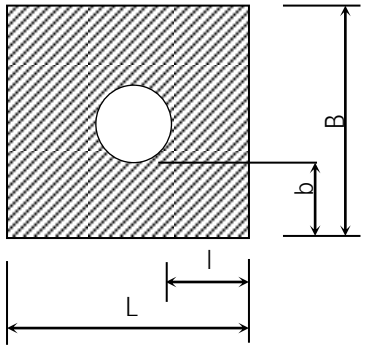
λ : 지압판의 환산 돌출길이 (m)

$\beta = \sqrt[4]{(3 \times 24,421,916) / (210,000,000 \times 0.034^3)} = 9.706$ (m^{-1})

λ= max(l,b) = max(0.100 , 0.100) = 0.100

다만, l ≥ L/2이면 l = L/2 = 0.170

b ≥ B/2이면 b = B/2 = 0.170



βλ = 9.706 x 0.100 = 0.971 ≤ 1.0 ------► **O.K**

(4) 두께 검토 결과

구분	휨M_t	전단력Q_r	강체검토	최대두께	규격화
소요두께	6.913mm	4.378mm	34.000mm	34.000mm	35mm

3) 응력검토

(1) 휨응력 검토

$$f_{max} = \frac{6 \times Mmax}{h^2} = \frac{6 \times 1.115}{35^2} = 5.461 \quad MPa$$

$f_{max} \leq f_{sa} = 5.461 \leq 140$ ---------► **O.K**

(2) 전단응력 검토

$$\tau_{max} = \frac{3}{2} \times \frac{Q_r}{A} = \frac{3}{2} \times \frac{62885}{12567.941} = 7.505 \quad MPa \quad (A=\pi 2a \times t)$$

$\tau_{max} \leq \tau_{sa} = 7.505 \leq 80$ ---------► **O.K**

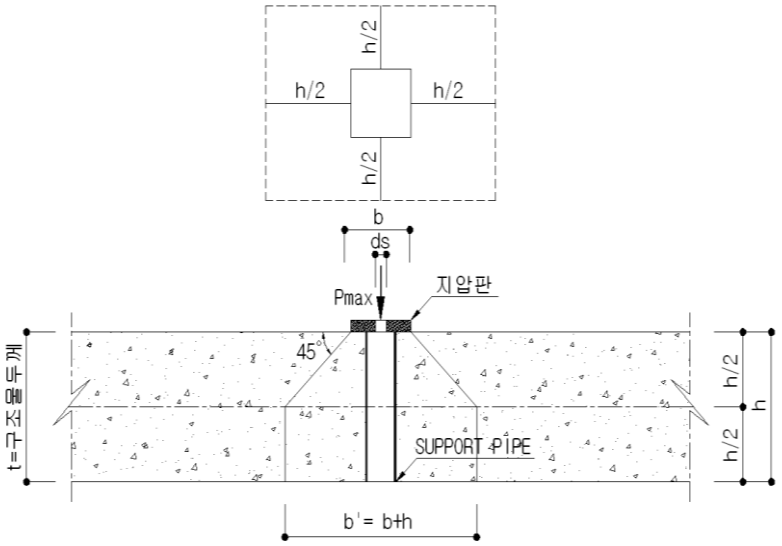
(3) 조합응력 검토

$$\left(\frac{f}{f_a}\right)^2 + \left(\frac{V}{V_a}\right)^2 = \left(\frac{5.461}{140}\right)^2 + \left(\frac{7.505}{80}\right)^2$$

$= 0.010 < 1.2$ ---► **O.K**

∴ 지압판 규격(L × B × t) = 340 mm × 340 mm × 35 mm

5.수압판 콘크리트 응력검토 (지압판 직하 하부슬래브)



5.1 압발 전단응력 검토

$\tau_v = P_{max} / \{4(b+h)\times h\} \leq \tau_{v3}$

여기서, f_{ck} = 27.0 MPa 일때 τ_{v3} = 0.95 MPa

P_{max} : 소요하중 = 1135743 KN

b : 지압판 길이 = 340 mm

h : 수압판 유효두께 = 900 mm

τ_v = 1135743 / { 4 (340 + 900) × 900 }

= 0.254 MPa ≤ τ_{v3} = 0.950 MPa ----► O.K

5.2 수직 지압응력 검토

$\tau_c = P_{max} / A_b \leq f_{ba}$

여기서, $f_{ba} = 0.5f_{ck}$ = 0.5 × 27 = 13.500 MPa

A_b : 지압판 면적-슬리브 면적

$A_b = L \times B - \pi/4 \times ds^2$

340 x 340 - π/4× 114.3 ² = 105339.174 ㎟

τ_c = 1135743 / 105339.174 = 10.782 MPa ≤ f_{ba} = 13.500 MPa ----► O.K

1.27 풍도슬래브 및 브라켓

1.27.1 풍도슬래브 TYPE-1

1. 설계개요

1.1 설계조건

1.1.1 풍도 슬래브 제원

(1) 구 분 : PSC 슬래브

(2) 제작방법 : 프리텐션 방식

(3) 하중조건 : 고정하중, 보도 활하중 및 풍압

(4) 적용지간

① 슬래브전장 : 8.510 m

② 계산지간 : 8.110 m

③ 폭 원 : 1.800 m

④ 콘크리트높이 : 0.180 m

1.1.2 단위중량

(1) 철근 콘크리트 : 25.00 kN/m^3

1.1.3 사용재료 및 허용응력

(1) PS 강재 (15.2mm)

① 인장강도 : f_{pu} = 1,900 MPa

② 항복점 응력 : f_{py} = 1,600 MPa

③ 허용 인장응력

- 초기 인장응력 : $f_{pi} = 0.9f_{py}$ = 1,440 MPa
- 도입 인장응력 : $f_{pt} = 0.7f_{pu}$ = 1,330 MPa
- 사용하중 작용시 : $f_{ps} = 0.9f_{py}$ = 1,440 MPa

④ 탄성계수 : E_p = 200,000 MPa

(2) 프리스트레스트 콘크리트

① 설계기준강도 : f_{ck} = 40 MPa

② PS도입시 압축강도 : f_{ci} = 0.80 X f_{ck} = 32 MPa

③ 허용 휨압축응력

- PS도입 직후 : f_{cat} = 0.6 X f_{ci} = 19.2 MPa
- 사용하중 도입시 : f_{ca} = 0.6 X f_{ck} = 24.0 MPa

④ 허용 휨인장응력

- PS도입 직후 : $f_{cat'}$ = 0.25 X $\sqrt{f_{ci}}$ = 1.41 MPa
- 사용하중 도입시 : f_{ca} = 0.63 X $\sqrt{f_{ck}}$ = 3.98 MPa

⑤ 탄성계수

- PS도입 직후 : E_{ci} = 1.18 X E_c = 35,409 MPa
- 사용하중 도입시 : E_c = 8,500 X $\sqrt[3]{f_{ck} + 4}$ = 30,008 MPa

1.1.4 사용성 한계

(1) 활하중에 의한 허용처짐 : $\delta_L \leq \delta_{La}$ = L / 360

1.2 참고문헌

(1) 콘크리트 구조기준 (한국콘크리트학회, 2012년)

1.3 사용 프로그램

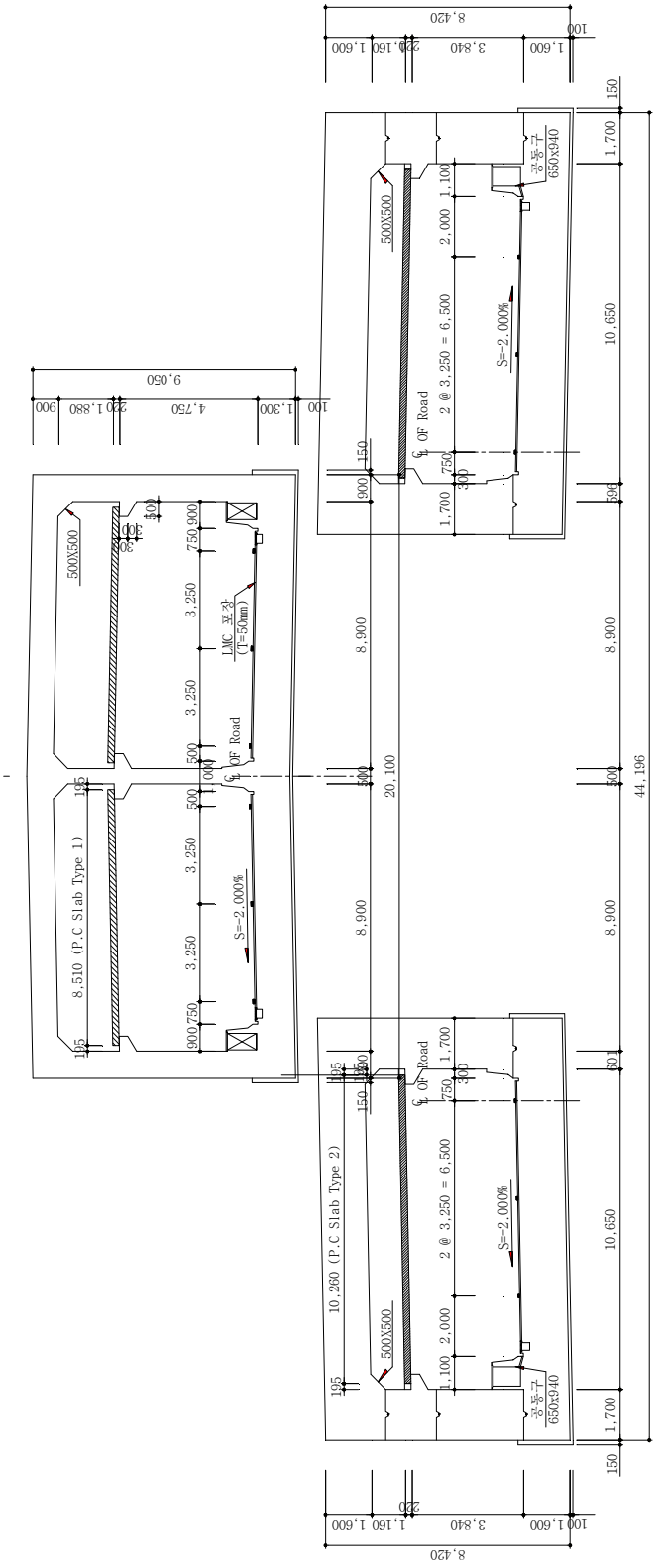
: RM Bridge V10

2. 풍도슬래브 단면도

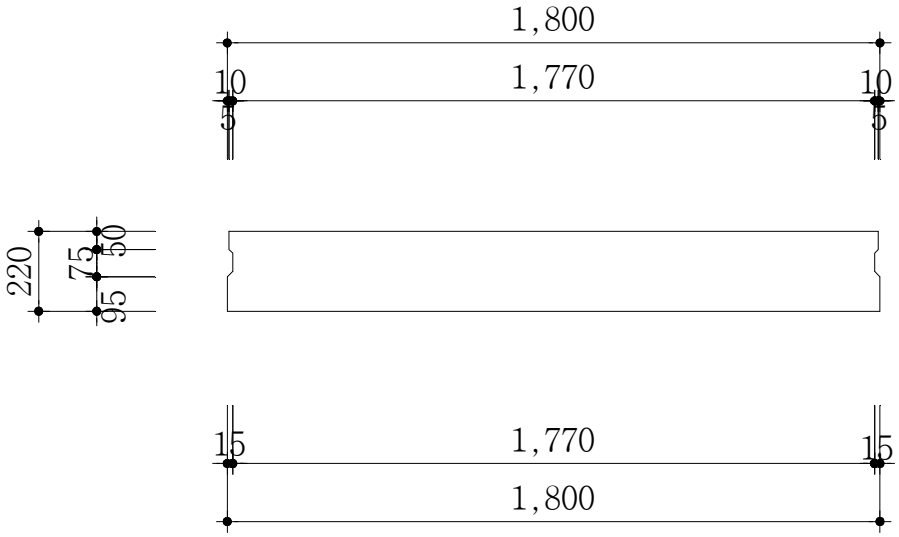
2.1 터널 횡단면도

BOX 단면도 (4) S=1:100

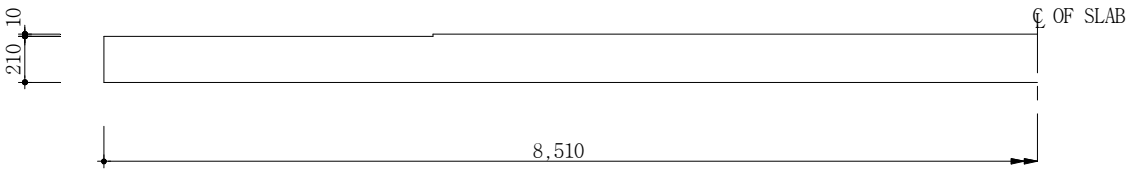
STA.0+660.000 ~ 0+700.000
(B6 , L=40.000m)



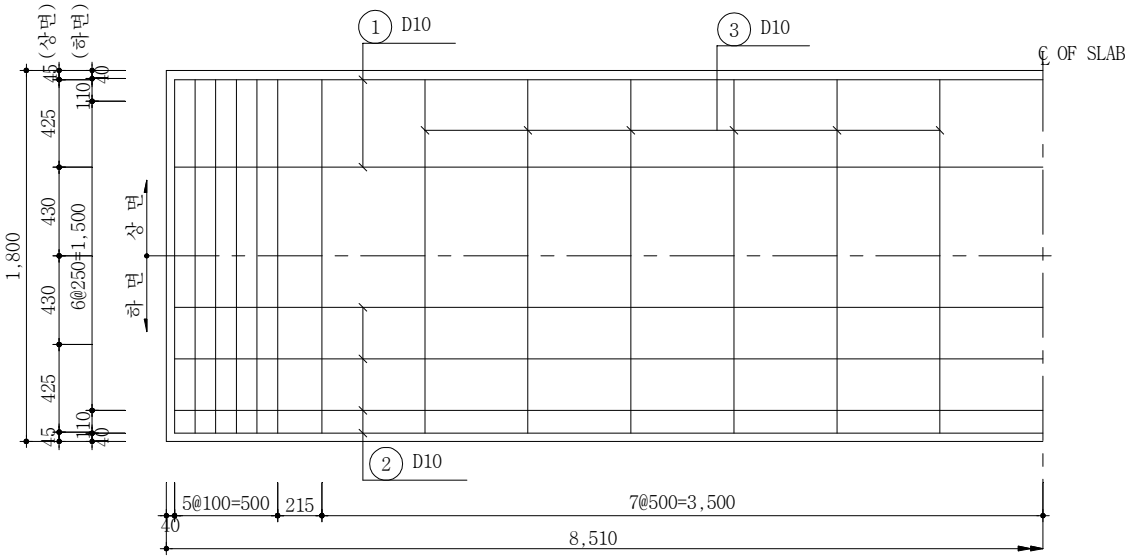
2.2 풍도슬래브 횡단면도



2.3 풍도슬래브 종단면도



2.4 풍도슬래브 강연선 배치도



3. 하중산정

3.1 고정하중

- 단위중량 25kN/m^3으로 고려함
- 풍도슬래브 단면 자중과 현장타설몰탈의 단면을 고려함
- 프로그램에서 자동으로 고려함

3.2 활하중

- 향후 작업하중 및 풍압 등을 고려하여 5.0 kN/m^2 을 재하함

3.3 크리프 및 건조수축

1) 조건

- 시멘트 : 보통(1종) 시멘트
- 지속하중 재하시의 콘크리트 재령 : t_0 = 2 (일)
- 콘크리트가 외기중에 노출되었을 때의 재령 : t_s = 0 (일)
- 상대습도 : 75 % (가정)
- 외기 또는 양생온도 : T = 20 ℃

2) 콘크리트의 크리프

$$\epsilon_{c\sigma}(t, t_o) = f_c(t_o)\left[\frac{1}{E_{ci}(t_o)} + \frac{\phi(t,t_o)}{E_{ci}}\right]$$

- $\varepsilon_{c\sigma}(t,t_0)$: 시간 t_0일에서 작용응력 $f_c(t_0)$에 의한 시간 t일에서의 탄성(순간) 변형율과 크리프 변형율을 포함한 전체 크리프 변형율
- E_{ci} : 28일 재령 콘크리트의 초기 접선탄성계수 (MPa)

$$E_{ci} = 2.15\times10^4\times\sqrt[3]{\frac{f_{cu}}{10}}$$

- $\Phi(t,t_0)$: 크리프 계수

$$\phi(t,t_o) = \phi_0\,\beta_c(t-t_o)$$

- t : 콘크리트의 재령 (일)
- t_0 : 지속하중이 작용할 때의 콘크리트의 재령 (일)

- Φ_0 : 콘크리트의 개념 크리프 계수

$$\phi_o = \phi_{RH}\beta(f_{cu})\beta(t_o)$$

- Φ_{RH} : 외기의 상대습도와 부재 두께에 의해 크리프에 미치는 영향 계수
  아래에서 RH 는 상대습도 (%)

$$\phi_{RH} = 1 + \frac{1 - 0.01RH}{0.10\sqrt[3]{h}}$$

- $\beta(f_{cu})$: 콘크리트 강도에 피해 크리프에 미치는 영향 함수
  아래에서 f_{cu} 는 콘크리트의 28일 평균 압축강도 (MPa) = f_{ck} + 8

$$\beta(f_{cu}) = \frac{16.8}{\sqrt{f_{cu}}}$$

- $\beta(t_0)$: 지속하중이 가해지는 시간 t'에 의해 크리프에 미치는 영향 함수

$$\beta(t_0) = \frac{1}{0.1 + (t_0)^{0.2}}$$

- $\beta_c(t-t_0)$: 재하기간에 따라 크리프에 미치는 영향함수

$$\beta_c(t-t_0) = \left[\frac{(t-t_0)}{\beta_H + (t-t_0)}\right]^{0.3}$$

- β_H : 외기의 상대습도와 부재의 두께에 따른 계수

$$\beta_H = 15\left[1 + (0.012RH)^{18}\right]h + 250 \leq 1500(\text{일})$$

- h : 개념적인 부재치수 (mm), $h = 2A_c/u$
  여기서 A_c는 단면적(mm^2), u는 외기와 접촉하는 단면둘레(mm)

3) 콘크리트의 건조수축 변형률

$$\epsilon_{sh}(t, t_s) = \epsilon_{sho}\beta_s(t-t_s)$$

- $\varepsilon_{sh}(t,t_s)$: 재령 t_s 에서 외기에 노출된 콘크리트의 재령 t에서의 전체 건조수축 변형율
- ε_{sh0} : 개념적인 건조수축계수

$$\epsilon_{sh0} = \epsilon_s(f_{cu})\beta_{RH}$$

- $\beta_s(t-t_s)$: 건조 기간에 따른 건조수축 변형율 함수

$$\beta_s(t-t_s) = \sqrt{\frac{(t-t_s)}{0.035\,h^2+(t-t_s)}}$$

- t_s : 수축이 시작될 때의 콘크리트의 재령 (일)
  아래에서 f_{cu} 는 콘크리트의 28일 평균 압축강도 (MPa)

$$\epsilon_s(f_{cu}) = \left[160 + 10\beta_{sc}\left(9-\frac{f_{cu}}{100}\right)\right]\times 10^{-6}$$

- β_{RH} : 외기습도에 따른 크리프와 건조수축에 미치는 영향계수
  아래에서 RH 는 상대습도 (%)

$$\beta_{RH} = \begin{cases} -1.55\left[1-\left(\frac{RH}{100}\right)^3\right] & 40\% \le RH < 99(\% \\ 0.25 & RH \ge 99\% \end{cases}$$

- h : 개념적인 부재치수 (cm), $h = 2A_c/u$
  여기서 A_c는 단면적(mm^2), u는 외기와 접촉하는 단면둘레(mm)

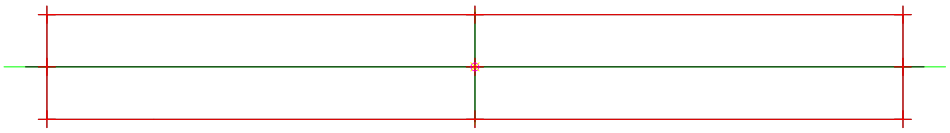
4. 모델링

4.1 단면계수

Cross-section : Standard:rec

Part : 1 Variant : 1

Description : rec



C R O S S - S E C T I O N D A T A

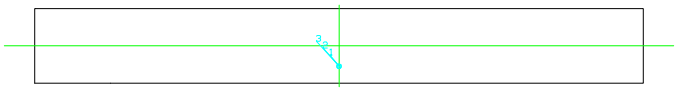
Cross-section area	0.39600E+00 m2
Shear area - Bending about Z-axis	0.39600E+00 m2
Shear area - Bending about Y-axis	0.39600E+00 m2
Torsional moment of inertia I	0.62948E-02 m4
Shear lag factor X (Ax-shear/Ax)	0.10000E+01
Moment of inertia about Y-axis	0.10692E+00 m4
Section moment about Y-axis - min	0.11880E+00 m3
Section moment about Y-axis - max	0.11880E+00 m3
Eccentricity Z (Shear lag)	0.00000E+00 m
Shear lag factor Y	0.10000E+01
Moment of inertia about Y-axis (Shear lag)	0.10692E+00 m4
Moment of inertia about Z-axis	0.15972E-02 m4
Section moment about Z-axis - min	0.14520E-01 m3
Section moment about Z-axis - max	0.14520E-01 m3
Eccentricity Y (Shear lag)	0.00000E+00 m
Shear lag factor Z	0.10000E+01
Moment of inertia about Z-axis (Shear lag)	0.15972E-02 m4
Warping moment of inertia	0.40623E-03 m6
Bending axis origin - Eccentricity ey	0.00000 m
Bending axis origin - Eccentricity ez	0.00000 m
Main axis angle	0.00000 Deg
Shear axis origin - Eccentricity ey	0.00000 m
Shear axis origin - Eccentricity ez	0.00000 m
Main axis angle - Shear	0.00000 Deg
Y-below : Gravity centre - minY	0.11000 m
Y-above : Gravity centre - maxY	0.11000 m
Z-left : Gravity centre - minZ	0.90000 m
Z-right : Gravity centre - maxZ	0.90000 m
Perimeter exposed to drying (outside)	4.04000 m
Perimeter (inside)	0.00000 m

4.2 텐던

Element:116 - Cross-section : Standard:rec - begin

Description : rec

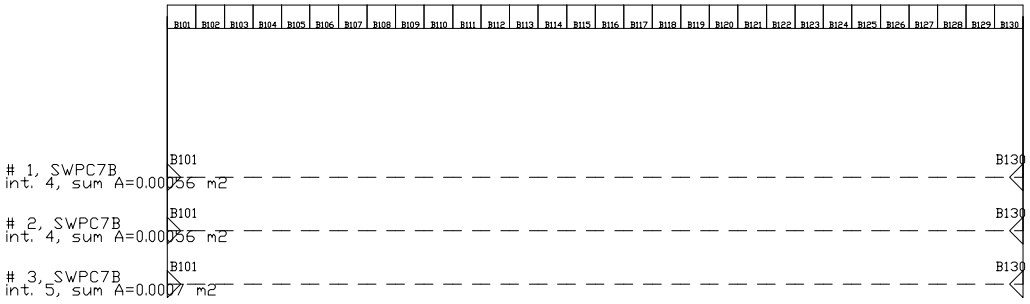
Units : m



C R O S S - S E C T I O N D A T A

Y-below	: Gravity centre - minY	0.11000	m
Y-above	: Gravity centre - maxY	0.11000	m
Z-left	: Gravity centre - minZ	0.90000	m
Z-right	: Gravity centre - maxZ	0.90000	m

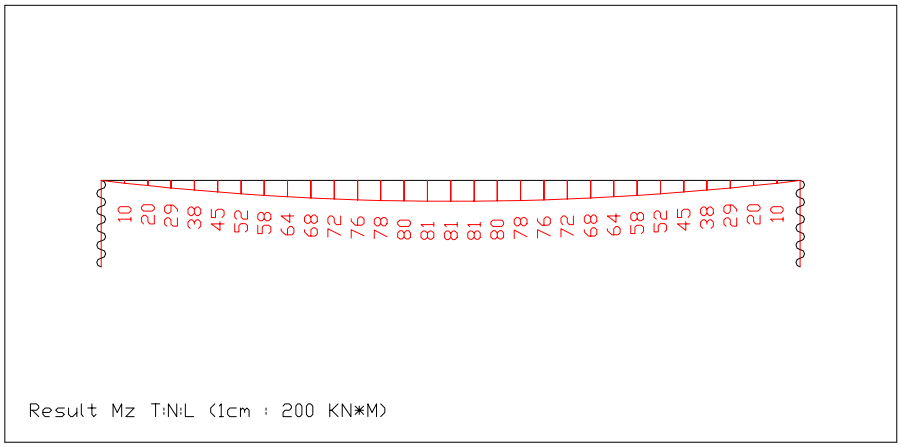
Tendon	Ey	Ez	Tendon	Ey	Ez	Tendon	Ey	Ez	Tendon	Ey	Ez
1	-0.060	-0.000									
2	-0.060	-0.000									
3	-0.060	-0.000									

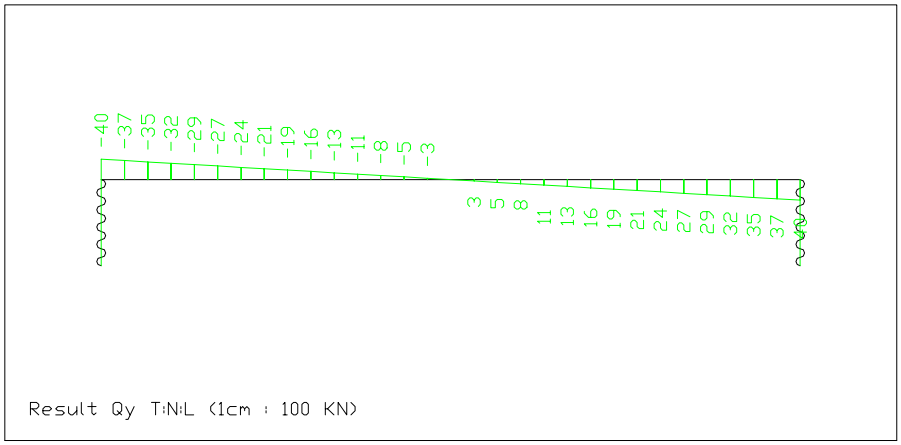


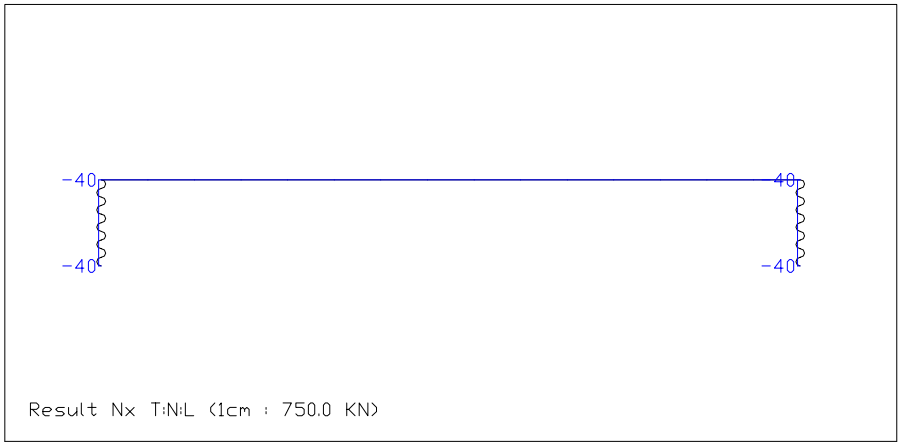
5. 단면력도

5.1 자중(SW)

Results Load Case SW
Stage 1040, elevation view

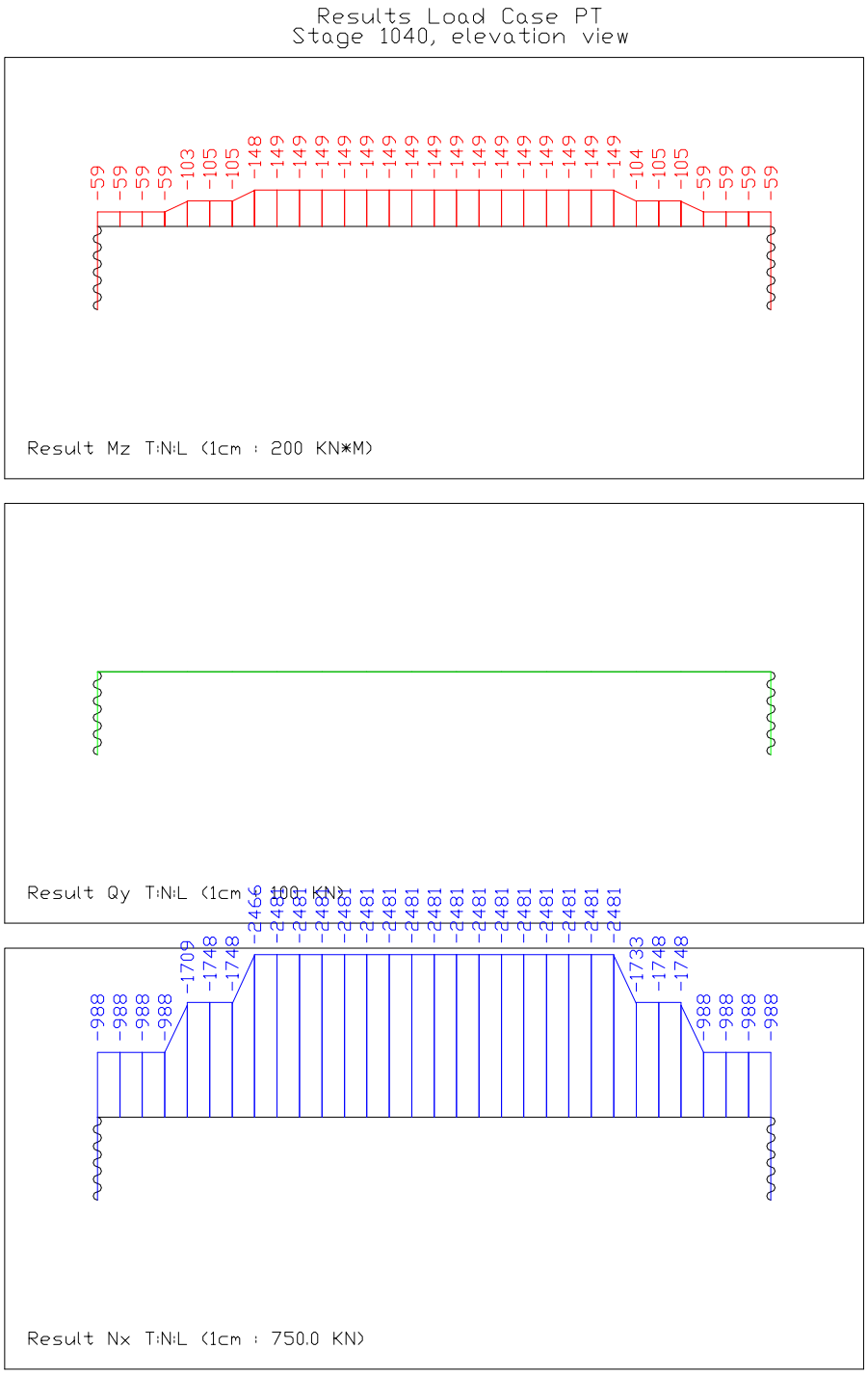






Plot 'pl-lcres-stg1040.pl' from 22 MAY 2017

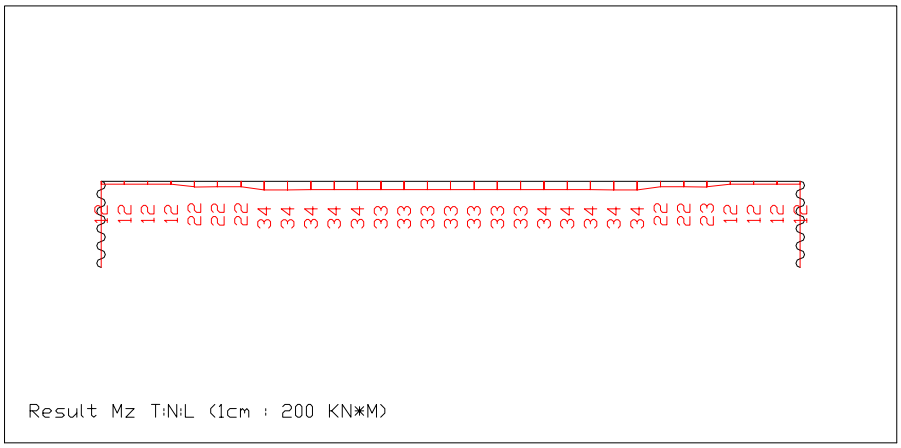
5.2 프리스트레싱 하중(PT)

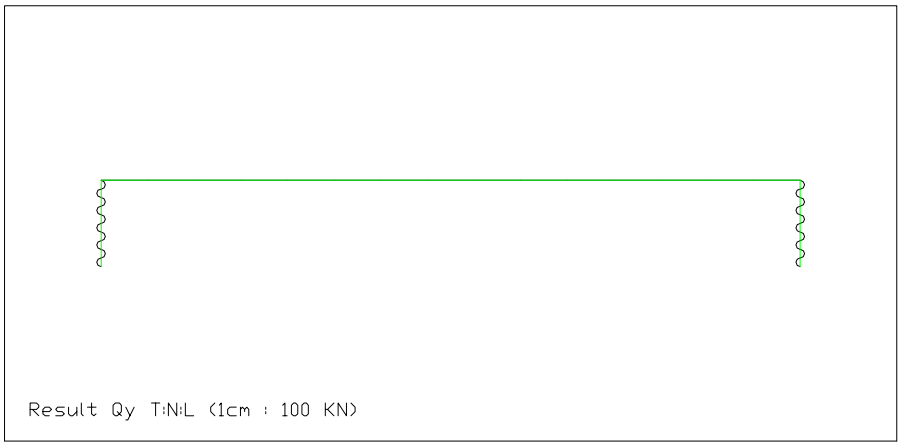


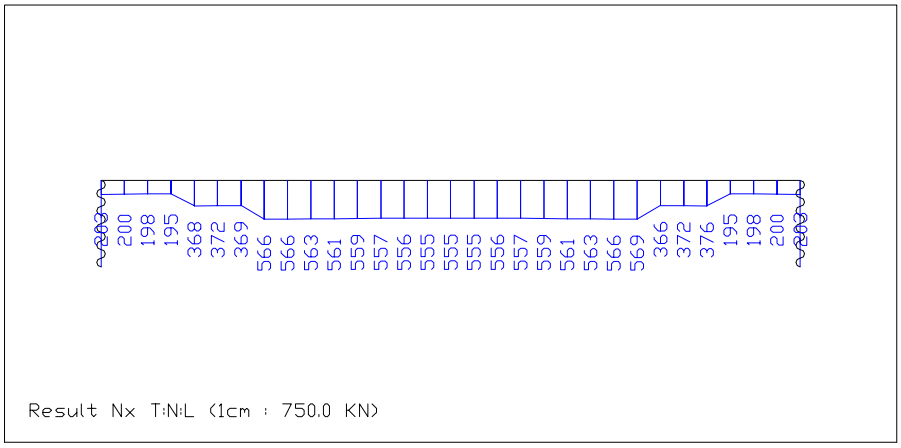
Plot 'pl-lcres-stg1040.pl' from 22 MAY 2017

5.3 크리프 및 건조수축(CS)

Results Load Case CS
Stage 1040, elevation view



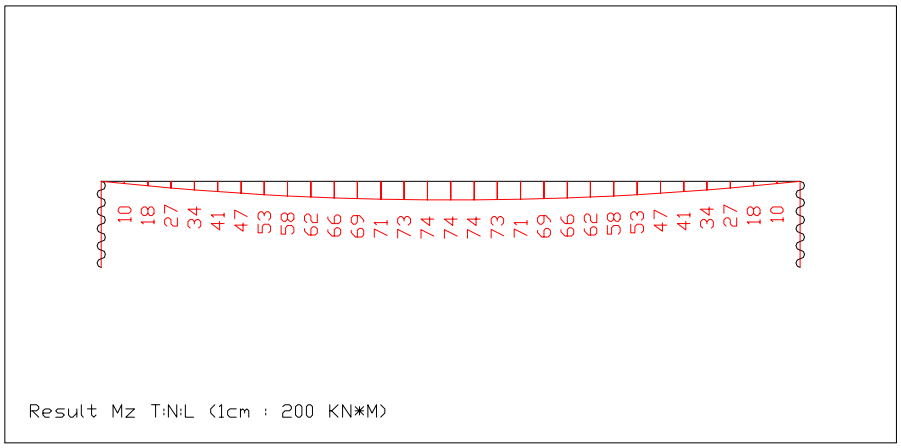


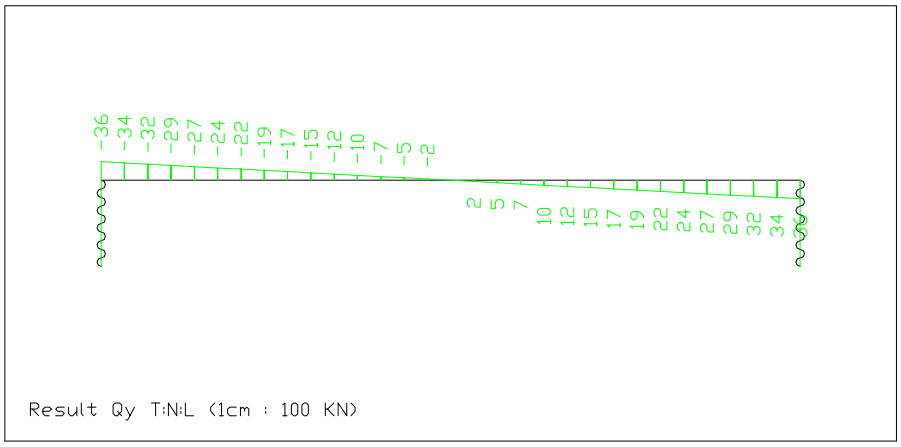


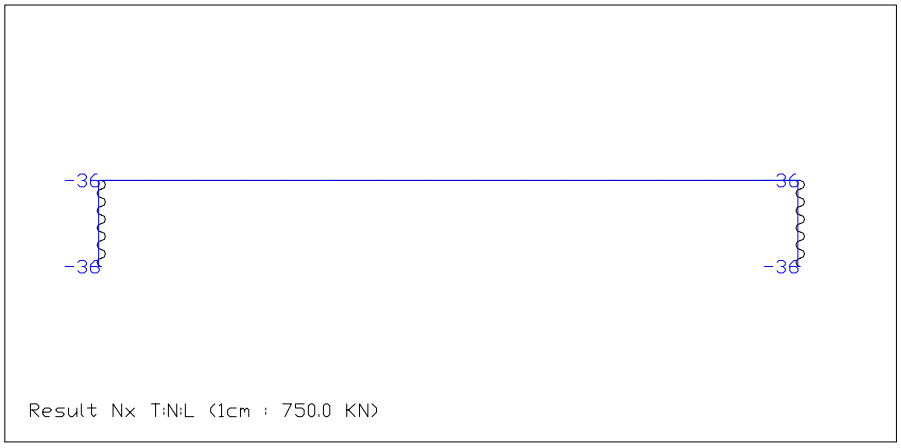
Plot 'pl-lcres-stg1040.pl' from 22 MAY 2017

5.4 활하중(LL)

Results Load Case LL
Stage 1040, elevation view







Plot 'pl-lcres-stg1040.pl' from 22 MAY 2017

6. 하중 조합 검토

6.1 하중 조합

(1) 사용하중 조합

① 1.0 SW + 1.0 PT : 프리스트레스 도입시

② 1.0 SW + 1.0 PT + 1.0 CS : 장기손실 발생시

③ 1.0 SW + 1.0 PT + 1.0 CS + 1.0 LL : 사용하중 재하시

※ SW : 슬래브 자중

PT : 프리스트레스

CS : 크리프 및 건조수축

LL : 활하중

(2) 계수하중 조합

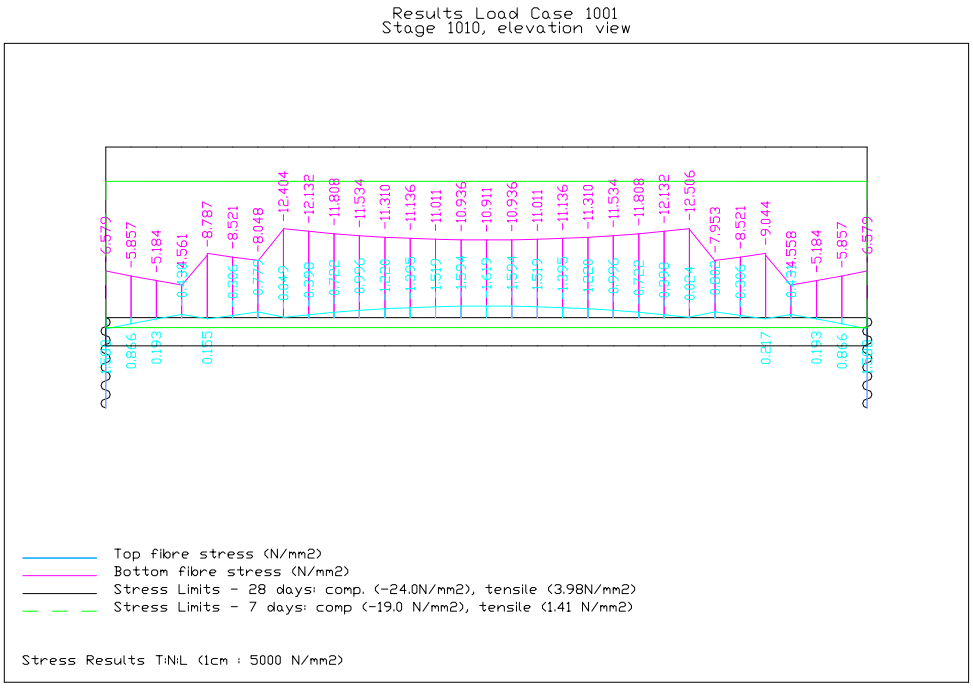
: 1.2 SW + 1.2 CS + 1.6 LL

	SW	CS	LL	계수하중
모멘트(kNm)	81	33	74	188
전단력(kN)	40	0	36	76
위험단면 모멘트(kNm)	0	12	0	12

※ 콘크리트 구조기준 2012 참조

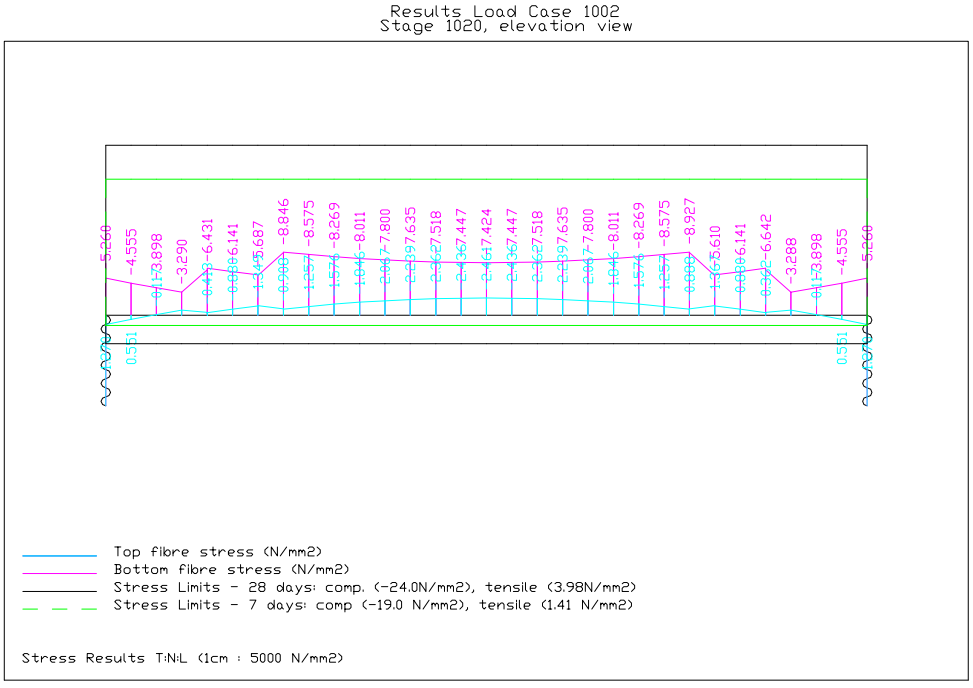
6.2 사용하중 조합에 의한 응력검토

6.2.1 프리스트레싱 도입시: SW+PT



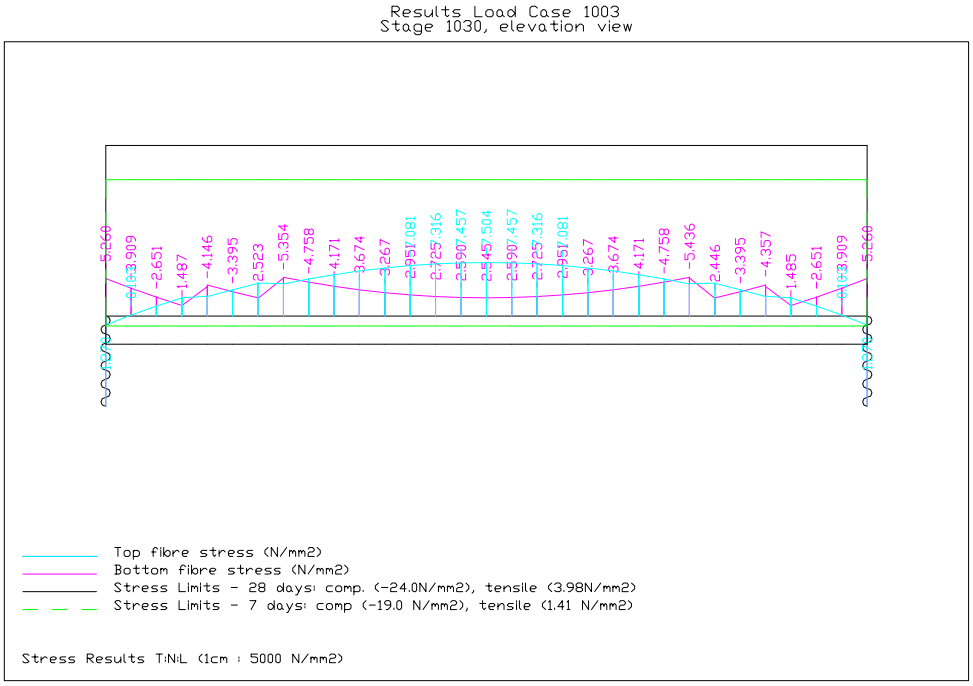
Plot 'lcTLsig-1001.pl' from 22 MAY 2017

6.2.2 장기손실 발생시: SW+PT+CS



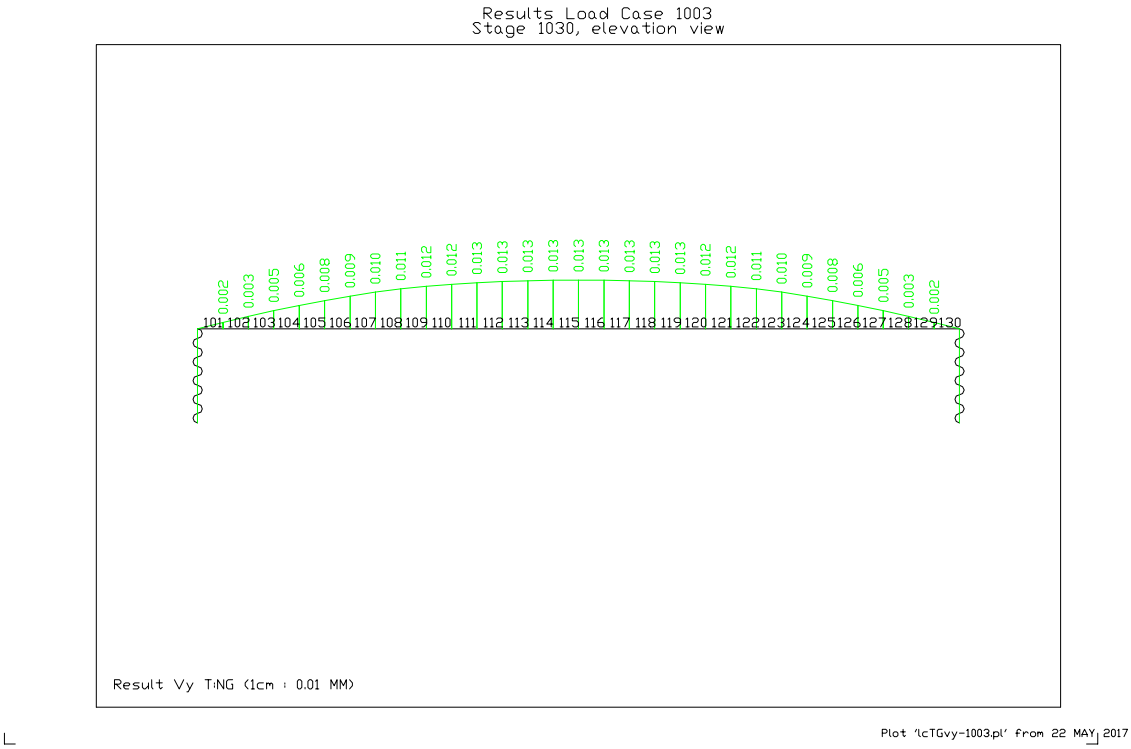
Plot 'lcTLsig-1002.pl' from 22 MAY 2017

6.2.3 사용하중 재하시: SW+PT+CS+LL



Plot 'lcTLsig-1003.pl' from 22 MAY 2017

6.2.4 처짐



최대 처짐 : -13mm　<　(L = 8,110mm) / 360 = 23mm　∴ O.K.

6.3 계수하중 조합에 의한 강도검토

A. 휨강도 검토 (지간 중앙부, 모멘트 최대부)

콘크리트 설계기준강도 $f_{ck} := 40MPa$ 검토단면 폭 $b := 1800mm$ 플랜지 두께 $t_f := 220mm$

철근항복강도 $f_y := 400MPa$ 검토단면 유효깊이 $d := 180mm$

인장철근 단면적 $A_s := 71mm^2 \times 9$

PS강재 극한강도 $f_{pu} := 1900MPa$ PS강재 유효깊이 $d_p := 170mm$

PS강재 종류에 따른 계수 $\gamma_p := 0.28$ PS강재 단면적 $A_p := 138.7mm^2 \times 13$

계수하중 모멘트 $M_u := 188kN \cdot m$

강도감소계수

휨 : $\phi_f := 0.85$

전단 : $\phi_s := 0.75$

유효깊이계수 $\beta_1 := \begin{cases} 0.85 & \text{if } f_{ck} < 28MPa \\ 0.85 - 0.05 \cdot \frac{f_{ck} - 28MPa}{7MPa} & \text{otherwise} \\ 0.65 & \text{if } f_{ck} > 56MPa \end{cases}$ $\beta_1 = 0.7643$

$\rho_p := \frac{A_p}{b \cdot d_p}$ $\rho_p = 0.00589$ $\rho := \frac{A_s}{b \cdot d}$ $\rho = 0.00197$

$f_{ps} := f_{pu} \cdot \left[1 - \frac{\gamma_p}{\beta_1} \cdot \left[\rho_p \cdot \frac{f_{pu}}{f_{ck}} + \frac{d}{d_p} \cdot \left(\rho \cdot \frac{f_y}{f_{ck}}\right)\right]\right]$ $f_{ps} = 1691MPa$

$a := \frac{A_p \cdot f_{ps} + A_s \cdot f_y}{0.85 \cdot f_{ck} \cdot b}$ $a = 54mm$

$\text{if}(a < t_f, \text{"직사각형 단면"}, \text{"T형보 단면"}) = \text{"직사각형 단면"}$

휨강도

$M_n := A_p \cdot f_{ps} \cdot d_p \cdot \left[1 - 0.59\left(\frac{\rho_p \cdot f_{ps}}{f_{ck}} + \frac{d}{d_p} \cdot \frac{\rho \cdot f_y}{f_{ck}}\right)\right] + A_s \cdot f_y \cdot d \cdot \left[1 - 0.59 \cdot \left(\frac{d_p}{d} \cdot \frac{\rho_p \cdot f_{ps}}{f_{ck}} + \frac{\rho \cdot f_y}{f_{ck}}\right)\right]$

$M_n = 475kN \cdot m$ $\phi_f \cdot M_n = 404kN \cdot m$

$c := \frac{a}{\beta_1}$ $c = 71mm$ $\varepsilon_t := 0.003 \cdot \frac{d - c}{c}$ $\varepsilon_t = 0.0046$

$\phi'_f := \begin{cases} 0.65 & \text{if } \varepsilon_t < 0.002 \\ 0.65 + (\varepsilon_t - 0.002) \cdot \frac{200}{3} & \text{otherwise} \\ 0.85 & \text{if } \varepsilon_t > 0.005 \end{cases}$ $\phi'_f = 0.8263$

$\phi'_f \cdot M_n = 392.3187kN \cdot m$ $M_u = 188kN \cdot m$

$\text{if}(M_u < \phi'_f \cdot M_n, \text{"O.K"}, \text{"N.G"}) = \text{"O.K"}$ $\frac{M_u}{\phi'_f \cdot M_n} = 0.4792$

최소 강재량 검토

$I_{zz} := 1597000000mm^4$ $y_{below} := 110mm$ $y_{above} := 110mm$ $A := 396000mm^2$

$Z_{zz} := \frac{I_{zz}}{y_{below}}$ $Z_{zz} = 14518182mm^3$

$f_{ru} := 0.5\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa$ $f_{ru} = 3.162\,MPa$

$f_{pcc} := 7.424MPa$ (손실완료후 유효프리스트레스에 의한 콘크리트 압축응력)

$M'_{cr} := (f_{ru} + f_{pcc})\cdot Z_{zz}$ (콘크리트의 휨인장강도에 기초한 단면의 최소 강재 균열모멘트)

$M'_{cr} = 154\,kN\cdot m$ $1.2\cdot M'_{cr} = 184\,kN\cdot m$ $\phi_f\cdot M_n = 404\,kN\cdot m$

$if(1.2\cdot M'_{cr} \le \phi_f\cdot M_n, "O.K", "N.G") = "O.K"$

B. 전단력 검토 (시점부, 전단력 최대부)

1) 휨전단 강도 계산: V_{ci}

복부 폭 $b_w := 1800mm$ $M_{us} := 10.911kN\cdot m$

단면의 계수전단력 $V_u := 76kN$

사용 고정하중에 의해 발생하는 단면의 전단력 $V_d := 40kN$

하중계수를 고려하지 않은 고정하중 모멘트 $M_d := 0kN\cdot m$

M_{max}를 발생시키는 외부 작용하중에 의한 단면의 계수전단력 $V_i := V_u - V_d$ $V_i = 36\,kN$

외부 작용하중에 의해 발생하는 단면의 최대계수모멘트 $M_{max} := M_{us} - M_d$ $M_{max} = 10.9\,kN\cdot m$

손실이 일어난 후 강재의 유효프리스트레스에 의한 응력 $f_{pe} := (6.579 - 1.320)MPa$

단면의 최외연에서 사용고정하중에 의한 응력 $f_d := 0MPa$

$M_{cr} := Z_{zz}\cdot\left[0.5\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right) + f_{pe} - f_d\right]$ $M_{cr} = 122\,kN\cdot m$

외부하중에 의해 발생하는 단면의 휨균열모멘트

$V_{ci.1} := 0.05\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right)\cdot b_w\cdot d + V_d + \frac{V_i\cdot M_{cr}}{M_{max}}$ $V_{ci.1} = 546\,kN$

$V_{ci.2} := 0.14\cdot\left[\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right)\cdot b_w\cdot d\right]$ $V_{ci.2} = 287\,kN$

$V_{ci} := \max(V_{ci.1}, V_{ci.2})$ $V_{ci} = 546\,kN$

2) 복부전단 강도 계산: V_{cw}

유효프리스트레스에 의한 도심에서의 응력 $f_{pc} := -\left(\frac{-6.579 + 1.588}{2} + \frac{-0.319 + 1.320}{2}\right)\cdot MPa$

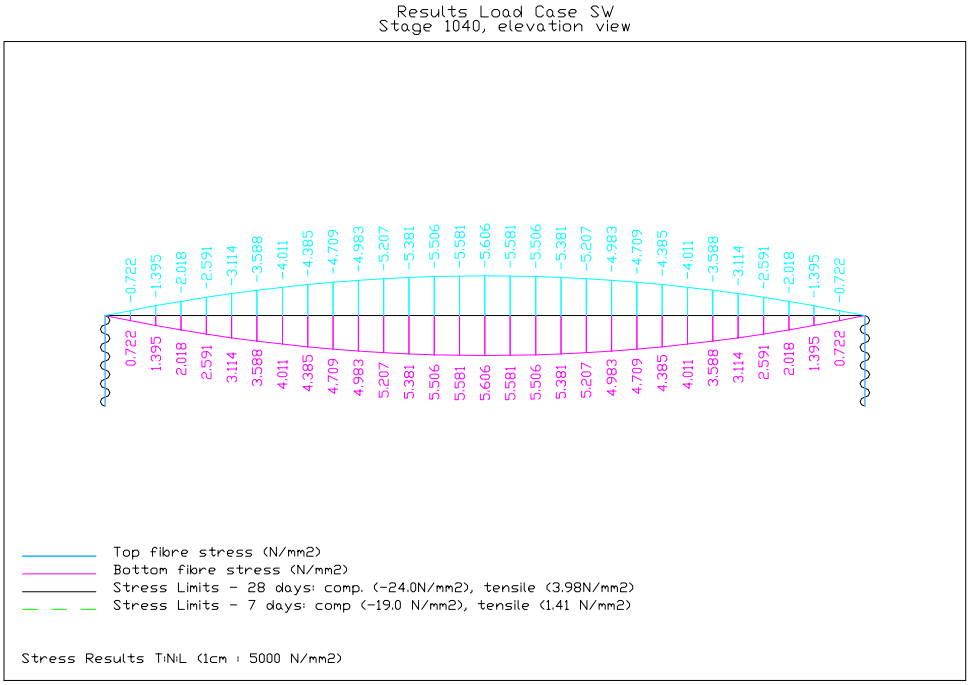
유효프리스트레스힘의 수직분력 $V_p := 0kN$

$V_{cw} := \left[0.29\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right) + 0.3\cdot f_{pc}\right]\cdot b_w\cdot d + V_p$ $V_{cw} = 788\,kN$

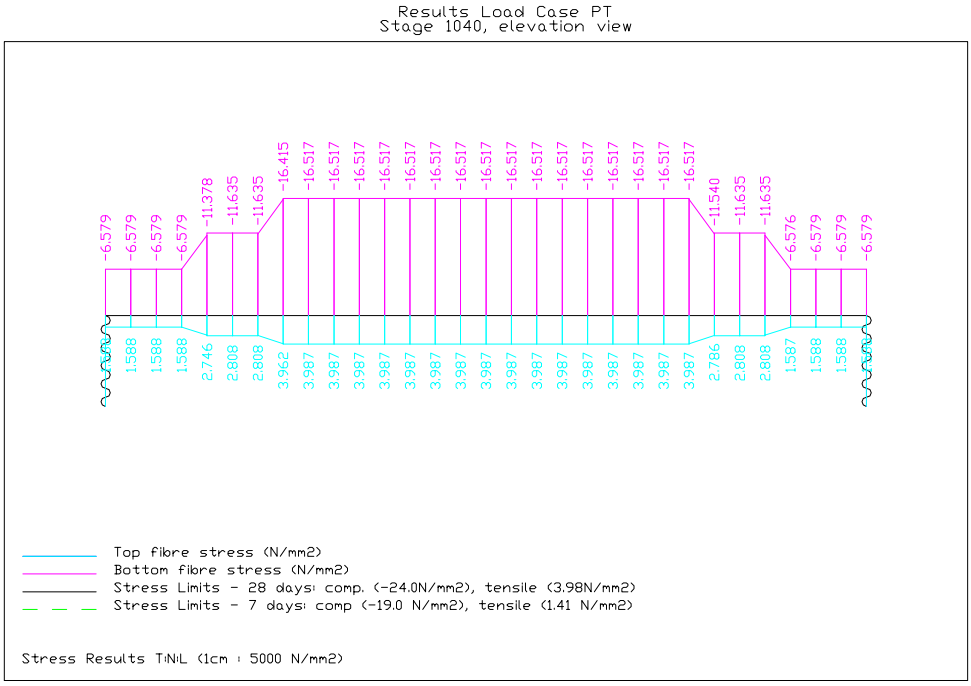
$V_c := \min(V_{ci}, V_{cw})$ $V_c = 546\,kN$ $\phi_s\cdot V_c = 409\,kN$ $\frac{V_u}{\phi_s\cdot V_c} = 0.1856$

$if(\phi_s\cdot V_c > V_u, "전단보강 필요없음", "전단보강 필요") = "전단보강 필요없음"$

6.4 하중별 응력

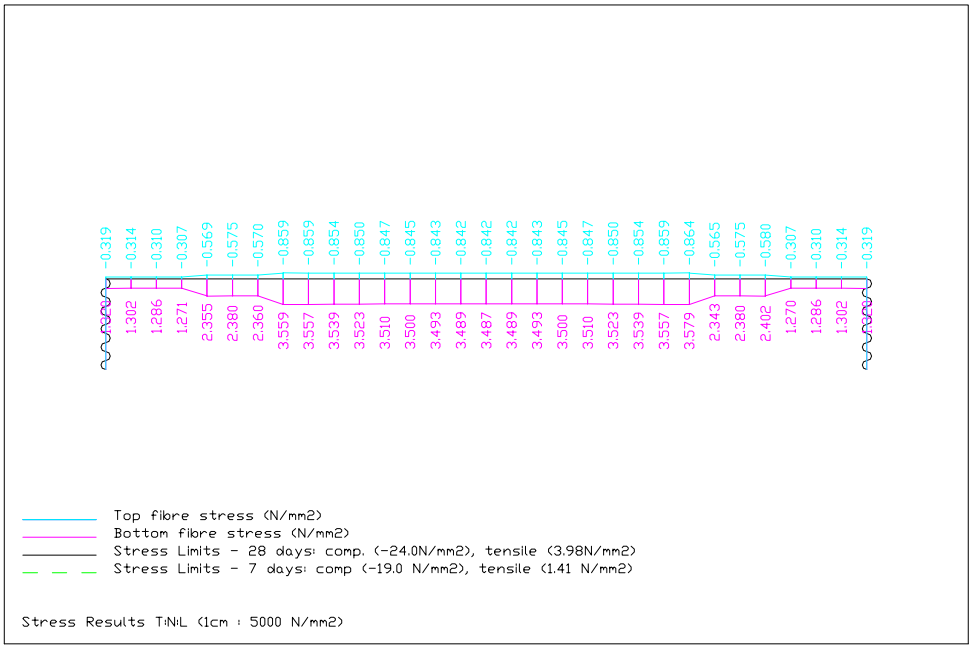


Plot 'lcTLsig-SW.pl' from 22 MAY 2017



Plot 'lcTLsig-PT.pl' from 22 MAY 2017

Results Load Case CS
Stage 1040, elevation view



Plot 'lcTLsig-CS.pl' from 22 MAY 2017

1.27.2 풍도슬래브 TYPE-2

1. 설계개요

1.1 설계조건

1.1.1 풍도 슬래브 제원

(1) 구 분 : PSC 슬래브

(2) 제작방법 : 프리텐션 방식

(3) 하중조건 : 고정하중, 보도 활하중 및 풍압

(4) 적용지간

① 슬래브전장 : 10.260 m

② 계산지간 : 9.860 m

③ 폭 원 : 1.800 m

④ 콘크리트높이 : 0.220 m

1.1.2 단위중량

(1) 철근 콘크리트 : 25.00 kN/m^3

1.1.3 사용재료 및 허용응력

(1) PS 강재 (15.2mm)

① 인장강도 : f_{pu} = 1,900 MPa

② 항복점 응력 : f_{py} = 1,600 MPa

③ 허용 인장응력

- 초기 인장응력 : $f_{pi} = 0.9f_{py}$ = 1,440 MPa
- 도입 인장응력 : $f_{pt} = 0.7f_{pu}$ = 1,330 MPa
- 사용하중 작용시 : $f_{ps} = 0.9f_{py}$ = 1,440 MPa

④ 탄성계수 : E_p = 200,000 MPa

(2) 프리스트레스트 콘크리트

① 설계기준강도 : f_{ck} = 40 MPa

② PS도입시 압축강도 : f_{ci} = 0.80 X f_{ck} = 32 MPa

③ 허용 휨압축응력

- PS도입 직후 : f_{cat} = 0.6 X f_{ci} = 19.2 MPa
- 사용하중 도입시 : f_{ca} = 0.6 X f_{ck} = 24.0 MPa

④ 허용 휨인장응력

- PS도입 직후 : $f_{cat'}$ = 0.25 X $\sqrt{f_{ci}}$ = 1.41 MPa
- 사용하중 도입시 : f_{ca} = 0.63 X $\sqrt{f_{ck}}$ = 3.98 MPa

⑤ 탄성계수

- PS도입 직후 : E_{ci} = 1.18 X E_c = 35,409 MPa
- 사용하중 도입시 : E_c = 8,500 X $\sqrt[3]{f_{ck} + 4}$ = 30,008 MPa

1.1.4 사용성 한계

(1) 활하중에 의한 허용처짐 : $\delta_L \leq \delta_{La}$ = L / 360

1.2 참고문헌

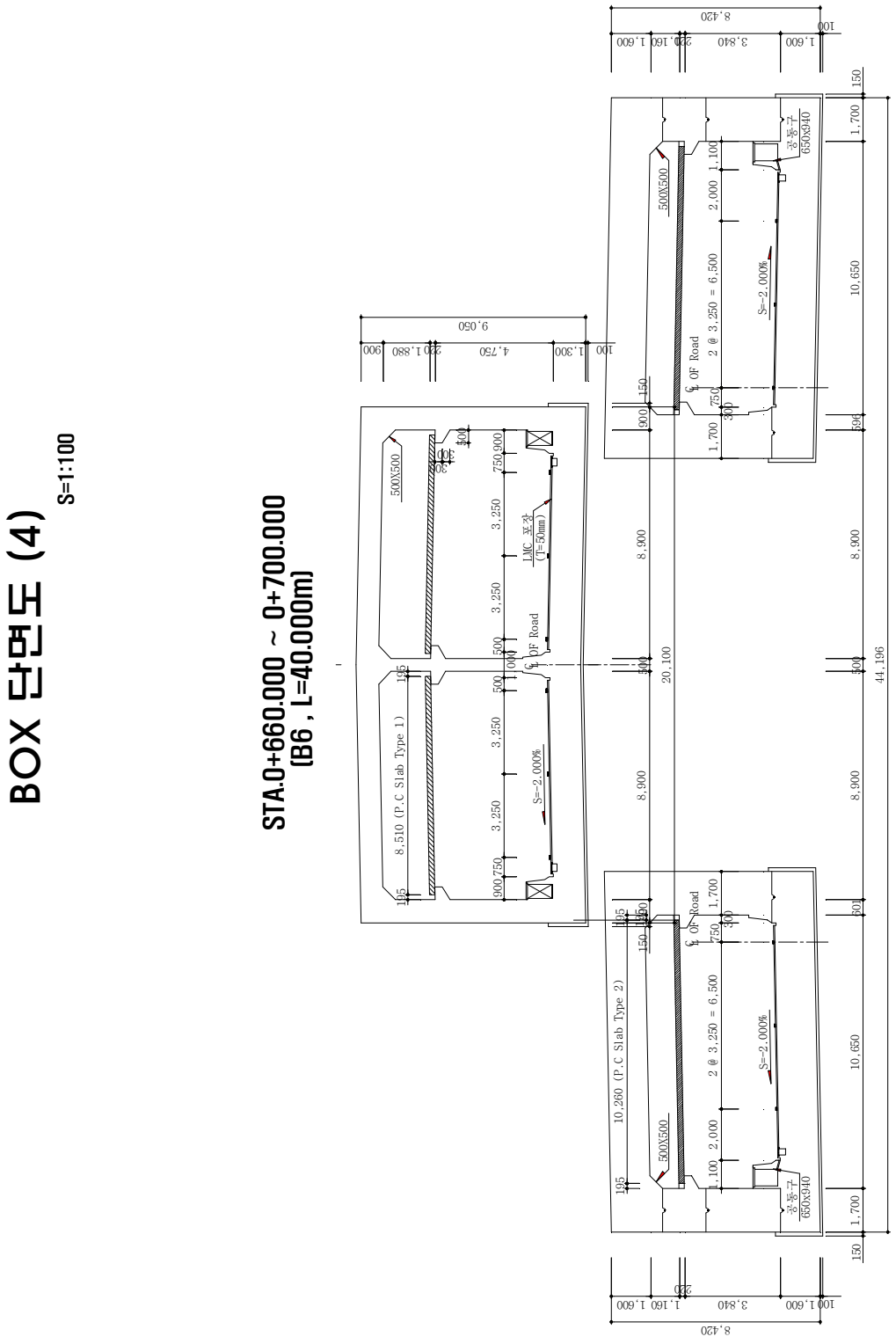
(1) 콘크리트 구조기준 (한국콘크리트학회, 2012년)

1.3 사용 프로그램

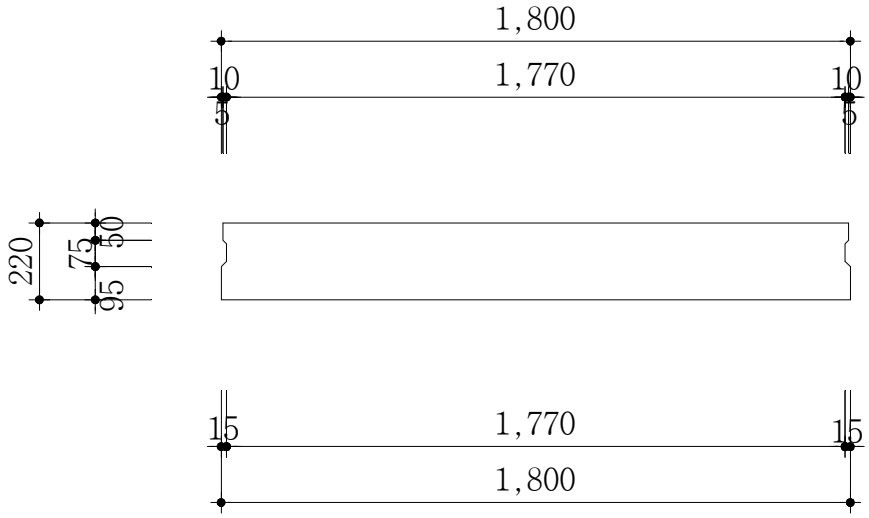
: RM Bridge V10

2. 풍도슬래브 단면도

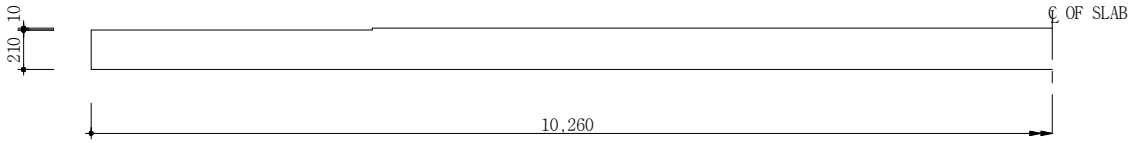
2.1 터널 횡단면도



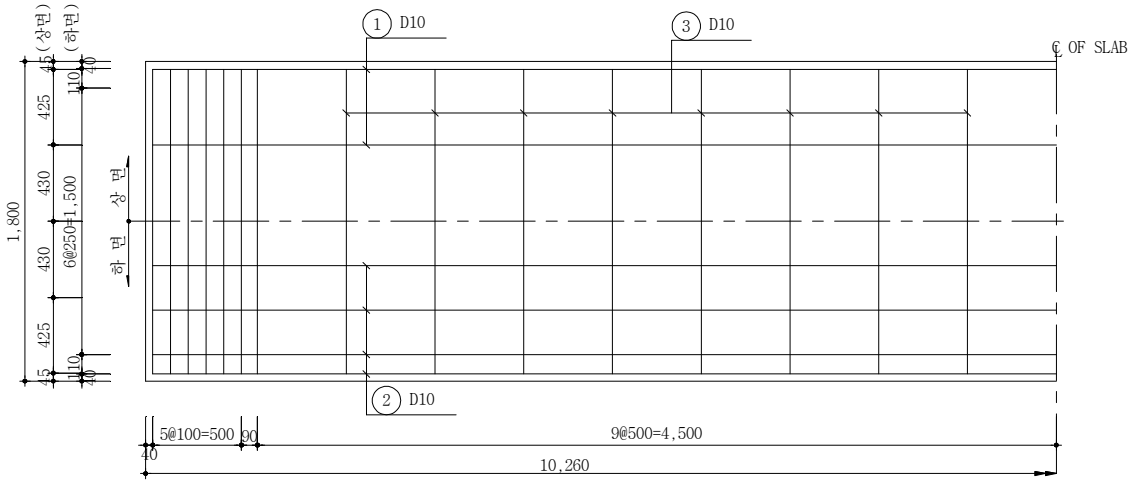
2.2 풍도슬래브 횡단면도



2.3 풍도슬래브 종단면도



2.4 풍도슬래브 강연선 배치도



3. 하중산정

3.1 고정하중

- 단위중량 25kN/m^3으로 고려함
- 풍도슬래브 단면 자중과 현장타설몰탈의 단면을 고려함
- 프로그램에서 자동으로 고려함

3.2 활하중

- 향후 작업하중 및 풍압 등을 고려하여 5.0 kN/m^2 을 재하함

3.3 크리프 및 건조수축

1) 조건

- 시멘트 : 보통(1종) 시멘트
- 지속하중 재하시의 콘크리트 재령 : t_0 = 2 (일)
- 콘크리트가 외기중에 노출되었을 때의 재령 : t_s = 0 (일)
- 상대습도 : 75 % (가정)
- 외기 또는 양생온도 : T = 20 ℃

2) 콘크리트의 크리프

$$\epsilon_{c\sigma}(t, t_o) = f_c(t_o)\left[\frac{1}{E_{ci}(t_o)} + \frac{\phi(t,t_o)}{E_{ci}}\right]$$

- $\varepsilon_{c\sigma}(t,t_0)$: 시간 t_0일에서 작용응력 $f_c(t_0)$에 의한 시간 t일에서의 탄성(순간) 변형율과 크리프 변형율을 포함한 전체 크리프 변형율
- E_{ci} : 28일 재령 콘크리트의 초기 접선탄성계수 (MPa)

$$E_{ci} = 2.15\times10^4\times\sqrt[3]{\frac{f_{cu}}{10}}$$

- $\Phi(t,t_0)$: 크리프 계수

$$\phi(t,t_o) = \phi_0\,\beta_c(t-t_o)$$

- t : 콘크리트의 재령 (일)
- t_0 : 지속하중이 작용할 때의 콘크리트의 재령 (일)

- Φ_0 : 콘크리트의 개념 크리프 계수

$$\phi_o = \phi_{RH}\beta(f_{cu})\beta(t_o)$$

- Φ_{RH} : 외기의 상대습도와 부재 두께에 의해 크리프에 미치는 영향 계수
  아래에서 RH 는 상대습도 (%)

$$\phi_{RH} = 1 + \frac{1 - 0.01RH}{0.10\sqrt[3]{h}}$$

- $\beta(f_{cu})$: 콘크리트 강도에 피해 크리프에 미치는 영향 함수
  아래에서 f_{cu} 는 콘크리트의 28일 평균 압축강도 (MPa) = f_{ck} + 8

$$\beta(f_{cu}) = \frac{16.8}{\sqrt{f_{cu}}}$$

- $\beta(t_0)$: 지속하중이 가해지는 시간 t'에 의해 크리프에 미치는 영향 함수

$$\beta(t_0) = \frac{1}{0.1 + (t_0)^{0.2}}$$

- $\beta_c(t-t_0)$: 재하기간에 따라 크리프에 미치는 영향함수

$$\beta_c(t-t_0) = \left[\frac{(t-t_0)}{\beta_H + (t-t_0)}\right]^{0.3}$$

- β_H : 외기의 상대습도와 부재의 두께에 따른 계수

$$\beta_H = 15\left[1 + (0.012RH)^{18}\right]h + 250 \leq 1500(\text{일})$$

- h : 개념적인 부재치수 (mm), $h = 2A_c/u$
  여기서 A_c는 단면적(mm^2), u는 외기와 접촉하는 단면둘레(mm)

3) 콘크리트의 건조수축 변형률

$$\epsilon_{sh}(t, t_s) = \epsilon_{sho}\beta_s(t-t_s)$$

- $\varepsilon_{sh}(t,t_s)$: 재령 t_s 에서 외기에 노출된 콘크리트의 재령 t에서의 전체 건조수축 변형율
- ε_{sh0} : 개념적인 건조수축계수

$$\epsilon_{sh0} = \epsilon_s(f_{cu})\beta_{RH}$$

- $\beta_s(t-t_s)$: 건조 기간에 따른 건조수축 변형율 함수

$$\beta_s(t-t_s) = \sqrt{\frac{(t-t_s)}{0.035\,h^2+(t-t_s)}}$$

- t_s : 수축이 시작될 때의 콘크리트의 재령 (일)
  아래에서 f_{cu} 는 콘크리트의 28일 평균 압축강도 (MPa)

$$\epsilon_s(f_{cu}) = \left[160 + 10\beta_{sc}\left(9-\frac{f_{cu}}{100}\right)\right]\times 10^{-6}$$

- β_{RH} : 외기습도에 따른 크리프와 건조수축에 미치는 영향계수
  아래에서 RH 는 상대습도 (%)

$$\beta_{RH} = \begin{cases} -1.55\left[1-\left(\frac{RH}{100}\right)^3\right] & 40\% \le RH < 99(\% \\ 0.25 & RH \ge 99\% \end{cases}$$

- h : 개념적인 부재치수 (cm), $h = 2A_c/u$
  여기서 A_c는 단면적(mm^2), u는 외기와 접촉하는 단면둘레(mm)

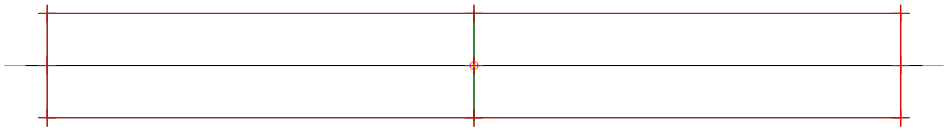
4. 모델링

4.1 단면계수

Cross-section : Standard:rec

Part : 1 Variant : 1

Description : rec



C R O S S - S E C T I O N D A T A

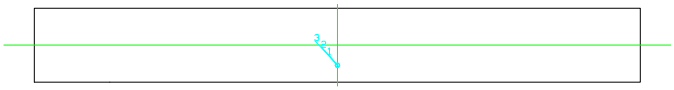
Cross-section area	0.39600E+00 m2
Shear area - Bending about Z-axis	0.39600E+00 m2
Shear area - Bending about Y-axis	0.39600E+00 m2
Torsional moment of inertia I	0.62948E-02 m4
Shear lag factor X (Ax-shear/Ax)	0.10000E+01
Moment of inertia about Y-axis	0.10692E+00 m4
Section moment about Y-axis - min	0.11880E+00 m3
Section moment about Y-axis - max	0.11880E+00 m3
Eccentricity Z (Shear lag)	0.00000E+00 m
Shear lag factor Y	0.10000E+01
Moment of inertia about Y-axis (Shear lag)	0.10692E+00 m4
Moment of inertia about Z-axis	0.15972E-02 m4
Section moment about Z-axis - min	0.14520E-01 m3
Section moment about Z-axis - max	0.14520E-01 m3
Eccentricity Y (Shear lag)	0.00000E+00 m
Shear lag factor Z	0.10000E+01
Moment of inertia about Z-axis (Shear lag)	0.15972E-02 m4
Warping moment of inertia	0.40623E-03 m6
Bending axis origin - Eccentricity ey	0.00000 m
Bending axis origin - Eccentricity ez	0.00000 m
Main axis angle	0.00000 Deg
Shear axis origin - Eccentricity ey	0.00000 m
Shear axis origin - Eccentricity ez	0.00000 m
Main axis angle - Shear	0.00000 Deg
Y-below : Gravity centre - minY	0.11000 m
Y-above : Gravity centre - maxY	0.11000 m
Z-left : Gravity centre - minZ	0.90000 m
Z-right : Gravity centre - maxZ	0.90000 m
Perimeter exposed to drying (outside)	4.04000 m
Perimeter (inside)	0.00000 m

4.2 텐던

Element:116 - Cross-section : Standard:rec - begin

Description : rec

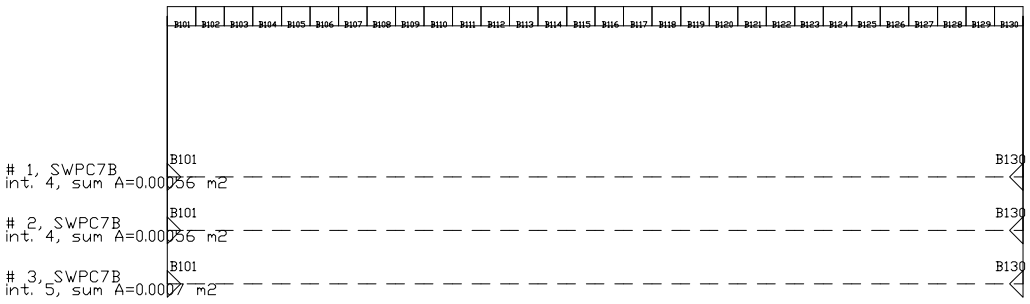
Units : m



C R O S S - S E C T I O N D A T A

Y-below	: Gravity centre - minY	0.11000 m
Y-above	: Gravity centre - maxY	0.11000 m
Z-left	: Gravity centre - minZ	0.90000 m
Z-right	: Gravity centre - maxZ	0.90000 m

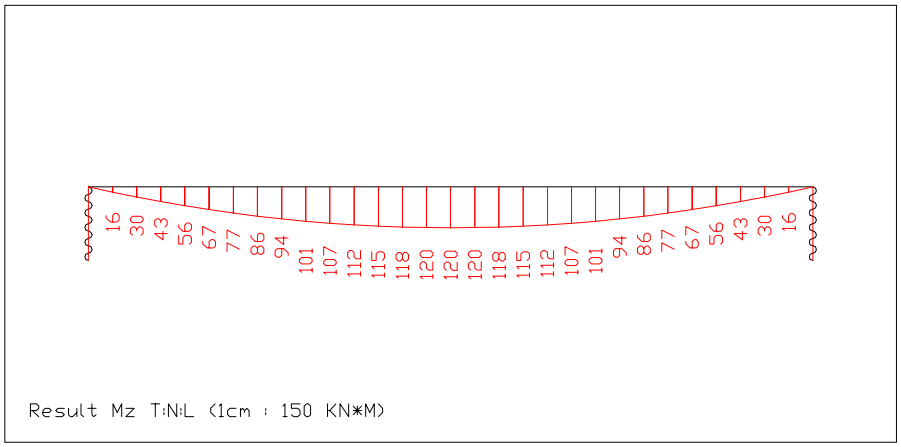
Tendon	Ey	Ez	Tendon	Ey	Ez	Tendon	Ey	Ez	Tendon	Ey	Ez
1	-0.060	-0.000									
2	-0.060	-0.000									
3	-0.060	-0.000									

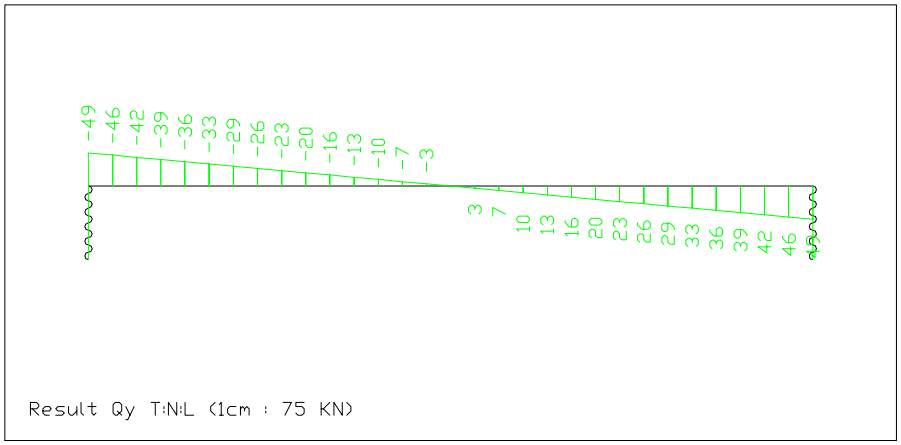


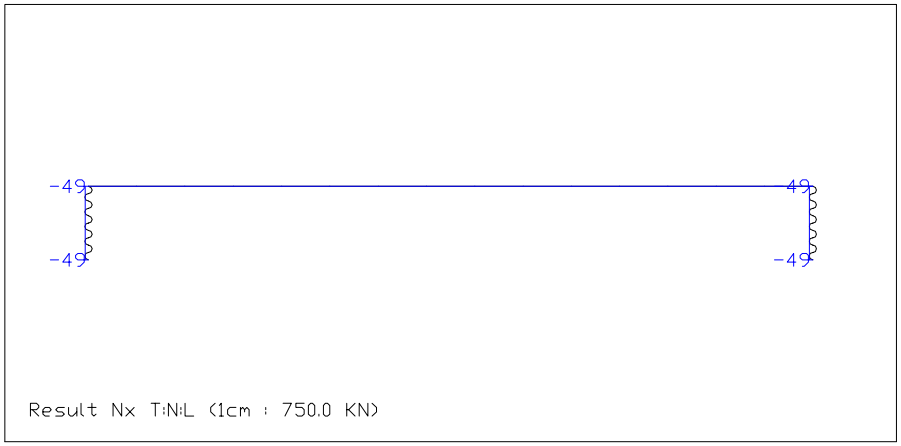
5. 단면력도

5.1 자중(SW)

Results Load Case SW
Stage 1040, elevation view

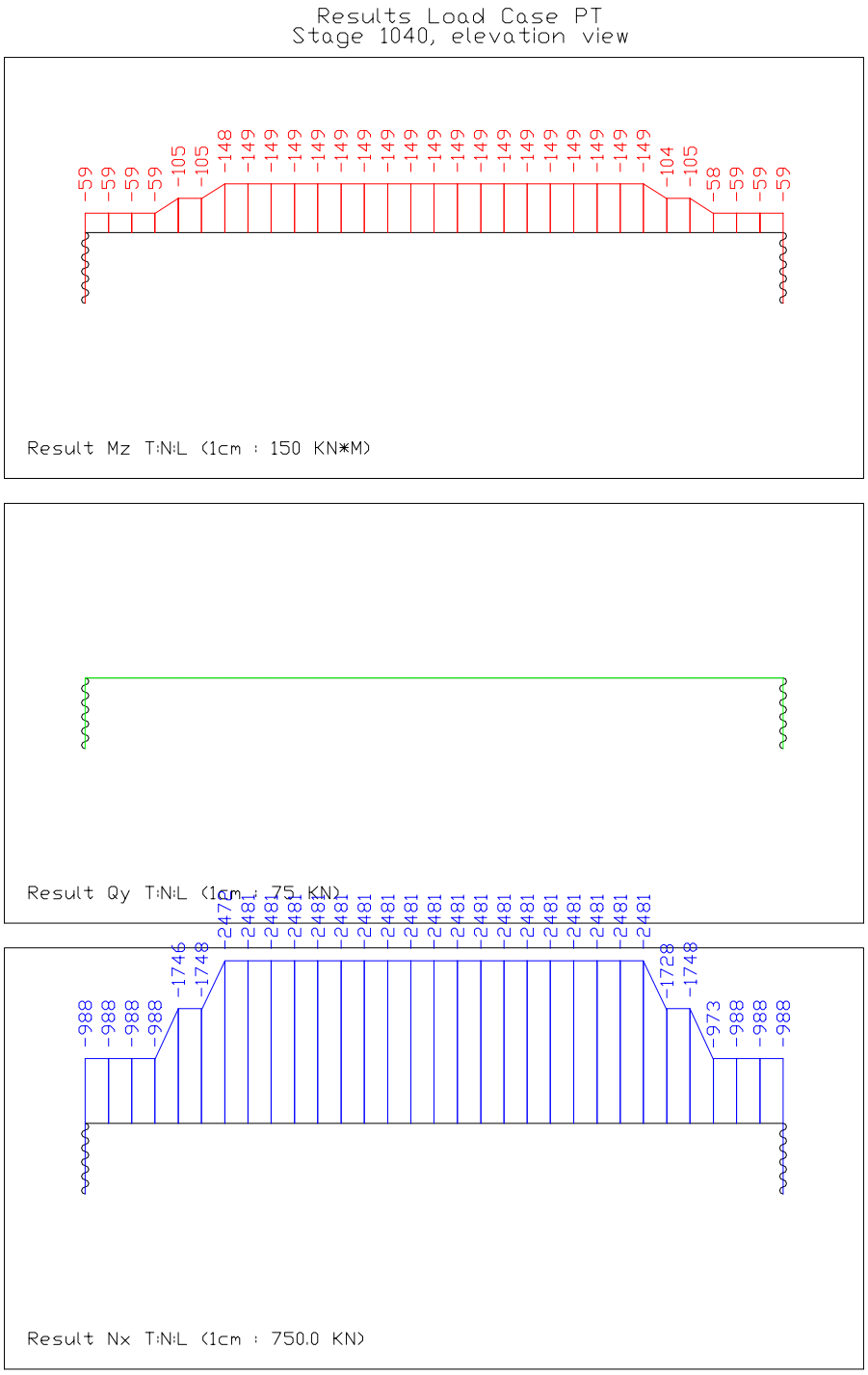






Plot 'pl-lcres-stg1040.pl' from 23 MAY 2017

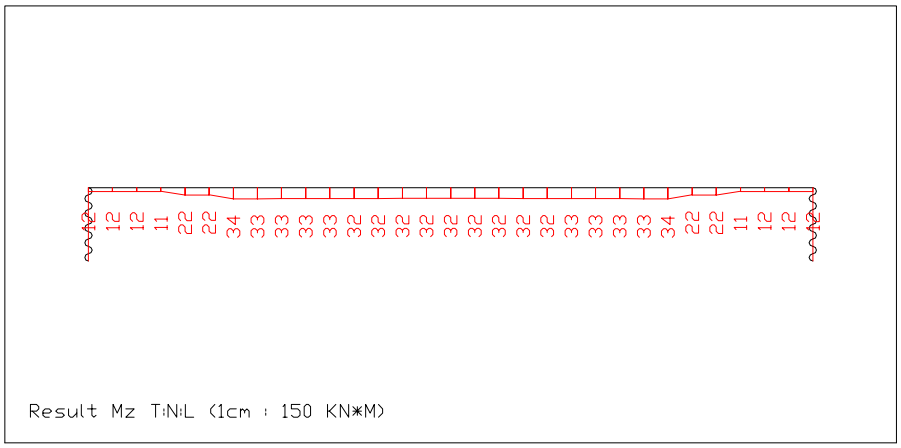
5.2 프리스트레싱 하중(PT)

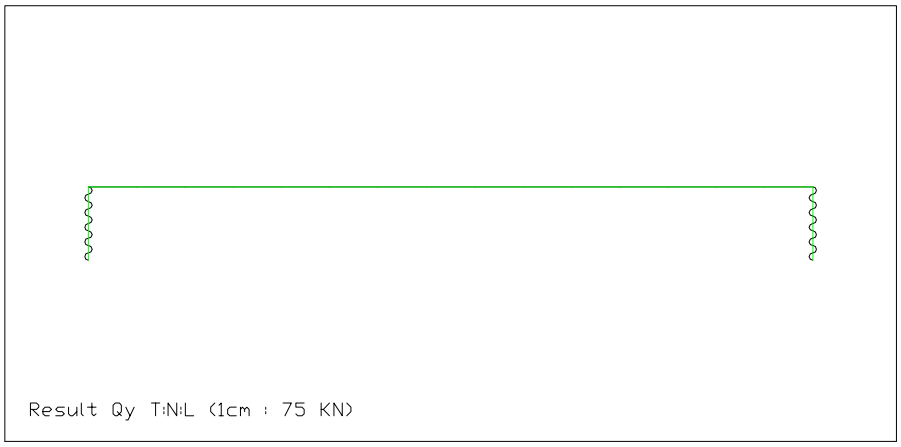


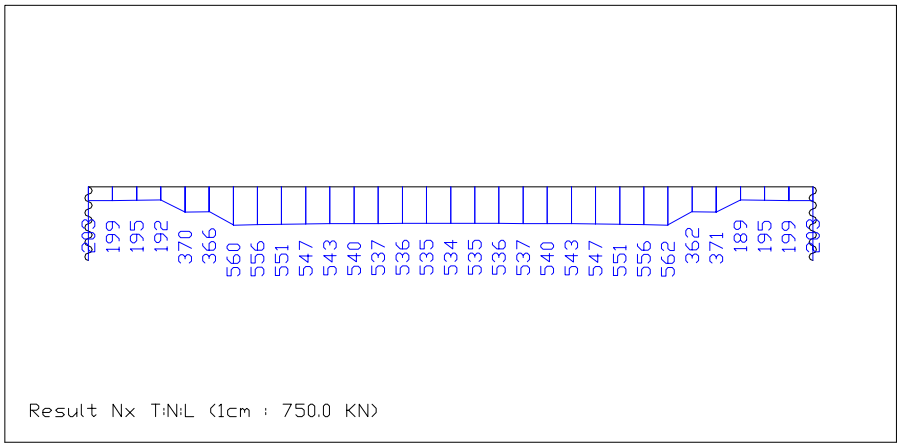
Plot 'pl-lcres-stg1040.pl' from 23 MAY 2017

5.3 크리프 및 건조수축(CS)

Results Load Case CS
Stage 1040, elevation view



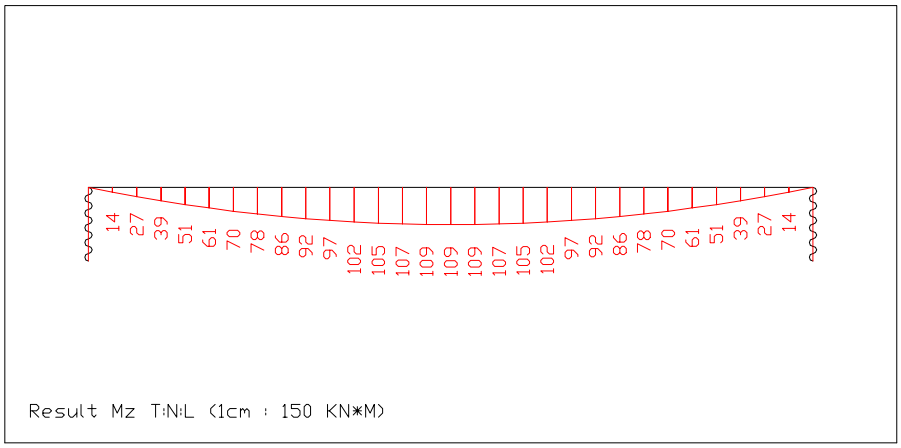


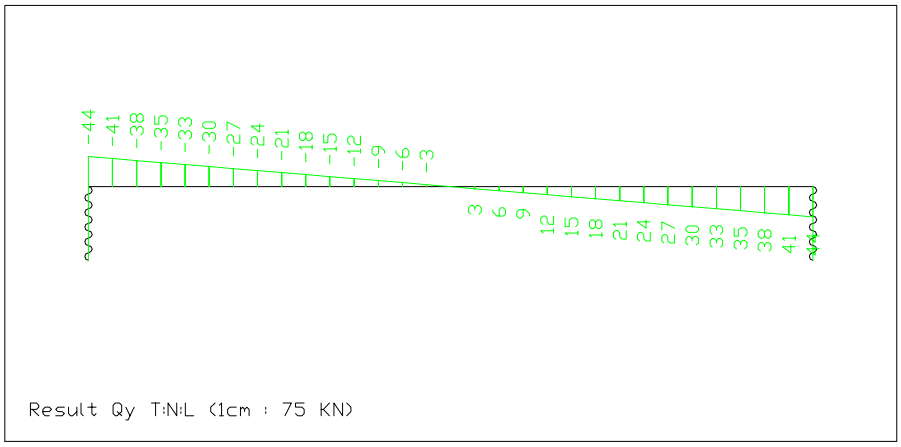


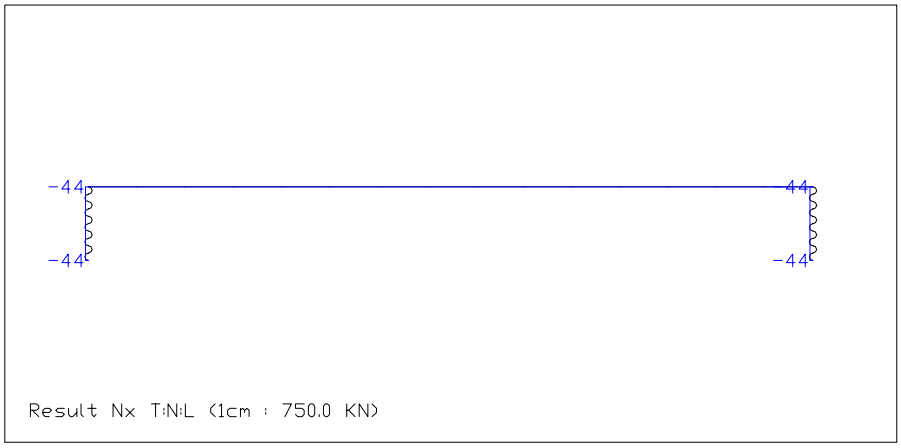
Plot 'pl-lcres-stg1040.pl' from 23 MAY 2017

5.4 활하중(LL)

Results Load Case LL
Stage 1040, elevation view







Plot 'pl-lcres-stg1040.pl' from 23 MAY 2017

6. 하중 조합 검토

6.1 하중 조합

(1) 사용하중 조합

① 1.0 SW + 1.0 PT : 프리스트레스 도입시

② 1.0 SW + 1.0 PT + 1.0 CS : 장기손실 발생시

③ 1.0 SW + 1.0 PT + 1.0 CS + 1.0 LL : 사용하중 재하시

※ SW : 슬래브 자중

PT : 프리스트레스

CS : 크리프 및 건조수축

LL : 활하중

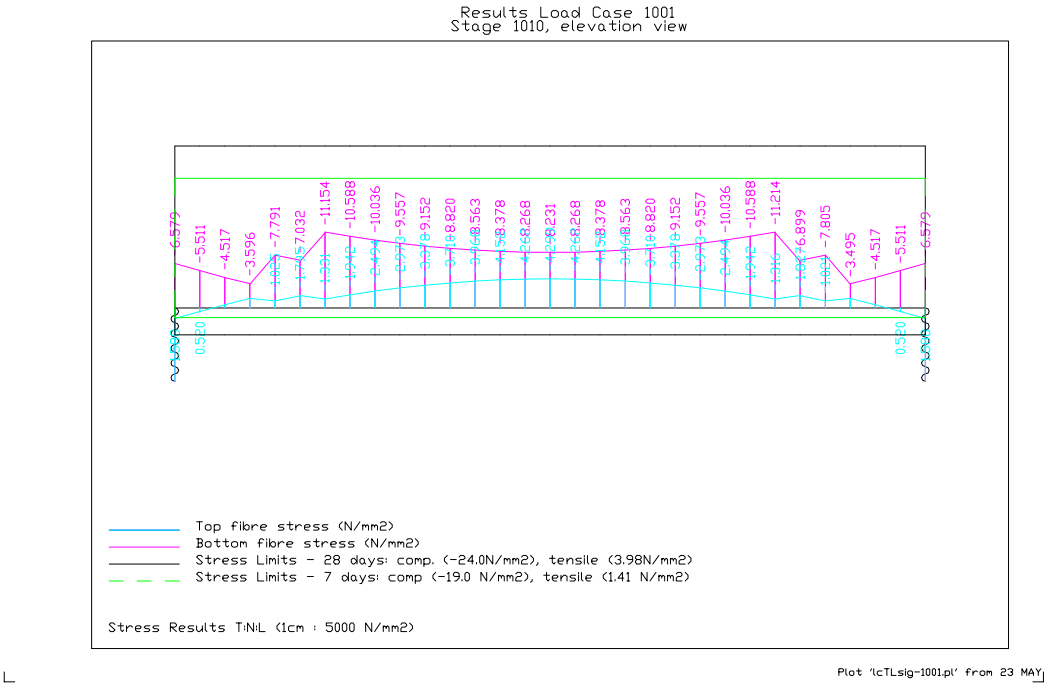
(2) 계수하중 조합

: 1.2 SW + 1.2 CS + 1.6 LL

	SW	CS	LL	계수하중
모멘트(kNm)	149	32	109	290
전단력(kN)	49	0	44	93
위험단면 모멘트(kNm)	0	12	0	1

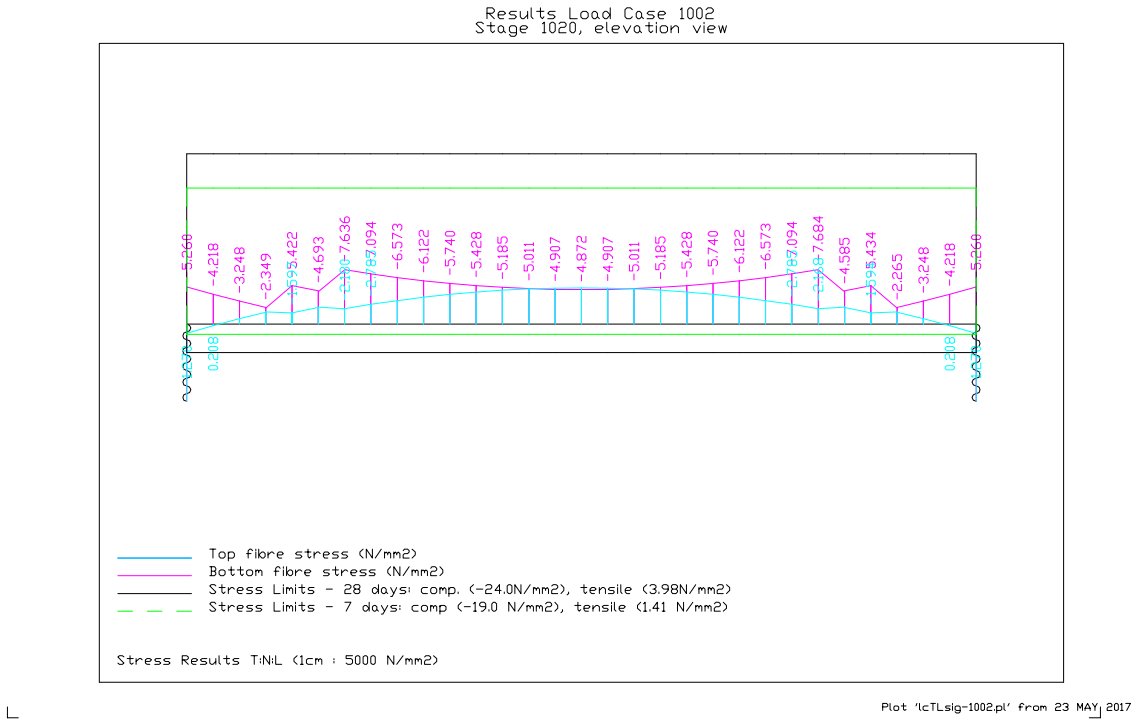
※ 콘크리트 구조기준 2012 참조

6.2 사용하중 조합

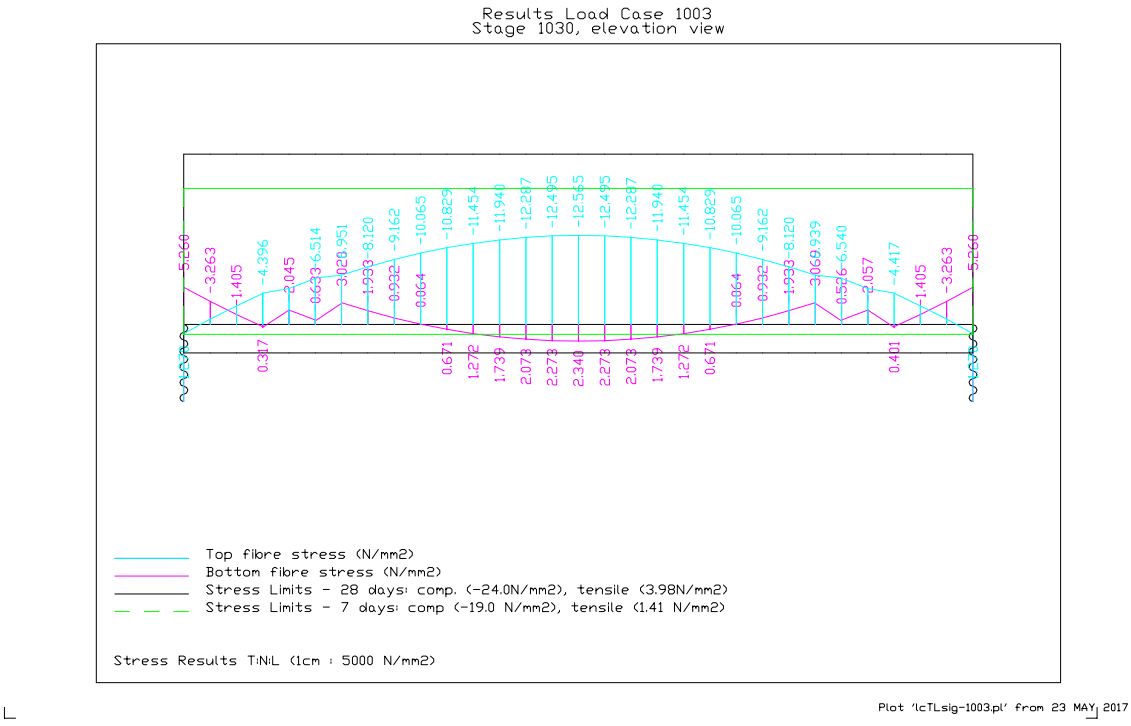


6.2.1 프리스트레싱 도입시: SW+PT

6.2.2 장기손실 발생시: SW+PT+CS

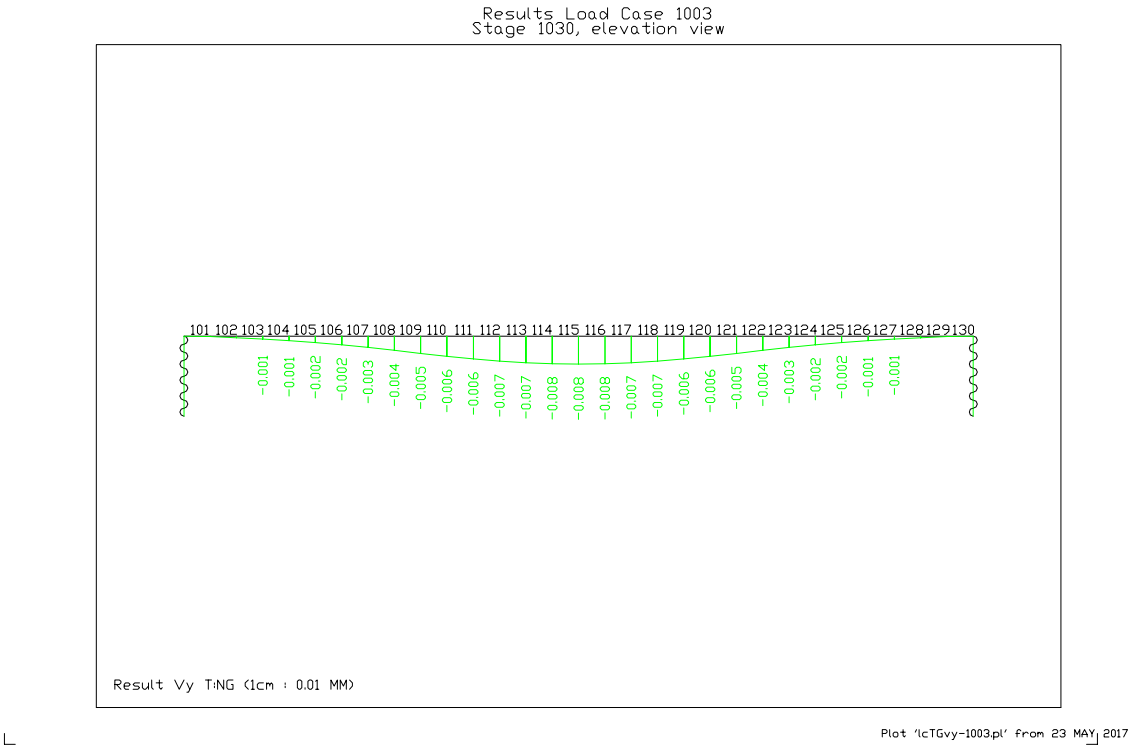


6.2.3 사용하중 재하시: SW+PT+CS+LL



Plot 'lcTLsig-1003.pl' from 23 MAY 2017

6.2.4 처짐



최대 처짐 : 8mm < (L = 9,860mm) / 360 = 27.4mm ∴ O.K.

6.3 계수하중 조합에 의한 강도검토

A. 휨강도 검토 (지간 중앙부, 모멘트 최대부)

콘크리트 설계기준강도 $f_{ck} := 40MPa$ 검토단면 폭 $b := 1800mm$ 플랜지 두께

철근항복강도 $f_y := 400MPa$ 검토단면 유효깊이 $d := 180mm$ $t_f := 220mm$

인장철근 단면적 $A_s := 71mm^2 \times 9$

PS강재 극한강도 $f_{pu} := 1900MPa$ PS강재 유효깊이 $d_p := 170mm$

PS강재 종류에 따른 계수 $\gamma_p := 0.28$ PS강재 단면적 $A_p := 138.7mm^2 \times 13$

계수하중 모멘트 $M_u := 290kN \cdot m$

강도감소계수

휨 : $\phi_f := 0.85$

전단 : $\phi_s := 0.75$

유효깊이계수 $\beta_1 := \begin{cases} 0.85 & \text{if } f_{ck} < 28MPa \\ 0.85 - 0.05 \cdot \dfrac{f_{ck} - 28MPa}{7MPa} & \text{otherwise} \\ 0.65 & \text{if } f_{ck} > 56MPa \end{cases}$ $\beta_1 = 0.7643$

$\rho_p := \dfrac{A_p}{b \cdot d_p}$ $\rho_p = 0.00589$ $\rho := \dfrac{A_s}{b \cdot d}$ $\rho = 0.00197$

$f_{ps} := f_{pu} \cdot \left[1 - \dfrac{\gamma_p}{\beta_1} \cdot \left[\rho_p \cdot \dfrac{f_{pu}}{f_{ck}} + \dfrac{d}{d_p} \cdot \left(\rho \cdot \dfrac{f_y}{f_{ck}}\right)\right]\right]$ $f_{ps} = 1691MPa$

$a := \dfrac{A_p \cdot f_{ps} + A_s \cdot f_y}{0.85 \cdot f_{ck} \cdot b}$ $a = 54mm$

$\text{if}(a < t_f, \text{"직사각형 단면"}, \text{"T형보 단면"}) = \text{"직사각형 단면"}$

휨강도

$M_n := A_p \cdot f_{ps} \cdot d_p \cdot \left[1 - 0.59\left(\dfrac{\rho_p \cdot f_{ps}}{f_{ck}} + \dfrac{d}{d_p} \cdot \dfrac{\rho \cdot f_y}{f_{ck}}\right)\right] + A_s \cdot f_y \cdot d \cdot \left[1 - 0.59 \cdot \left(\dfrac{d_p}{d} \cdot \dfrac{\rho_p \cdot f_{ps}}{f_{ck}} + \dfrac{\rho \cdot f_y}{f_{ck}}\right)\right]$

$M_n = 475kN \cdot m$ $\phi_f \cdot M_n = 404kN \cdot m$

$c := \dfrac{a}{\beta_1}$ $c = 71mm$ $\varepsilon_t := 0.003 \cdot \dfrac{d - c}{c}$ $\varepsilon_t = 0.0046$

$\phi_f := \begin{cases} 0.65 & \text{if } \varepsilon_t < 0.002 \\ 0.65 + (\varepsilon_t - 0.002) \cdot \dfrac{200}{3} & \text{otherwise} \\ 0.85 & \text{if } \varepsilon_t > 0.005 \end{cases}$ $\phi_f = 0.8263$

$\phi_f \cdot M_n = 392.3187kN \cdot m$ $M_u = 290kN \cdot m$

$\text{if}(M_u < \phi_f \cdot M_n, \text{"O.K"}, \text{"N.G"}) = \text{"O.K"}$ $\dfrac{M_u}{\phi_f \cdot M_n} = 0.7392$

최소 강재량 검토

$I_{zz} := 1597200000mm^4$ $y_{below} := 110mm$ $y_{above} := 110mm$ $A := 396000mm^2$

$Z_{zz} := \dfrac{I_{zz}}{y_{below}}$ $Z_{zz} = 14520000mm^3$

$f_{ru} := 0.5\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa$ $f_{ru} = 3.162\,MPa$

$f_{pcc} := 4.907MPa$ (손실완료후 유효프리스트레스에 의한 콘크리트 압축응력)

$M'_{cr} := (f_{ru} + f_{pcc})\cdot Z_{zz}$ (콘크리트의 휨인장강도에 기초한 단면의 최소 강재 균열모멘트)

$M'_{cr} = 117\,kN\cdot m$ $1.2\cdot M'_{cr} = 141\,kN\cdot m$ $\phi_f\cdot M_n = 404\,kN\cdot m$

$if(1.2\cdot M'_{cr} \le \phi_f\cdot M_n, "O.K", "N.G") = "O.K"$

B. 전단력 검토 (시점부, 전단력 최대부)

1) 휨전단 강도 계산: V_{ci}

복부 폭 $b_w := 1800mm$ $M_{us} := 8.231kN\cdot m$

단면의 계수전단력 $V_u := 93kN$

사용 고정하중에 의해 발생하는 단면의 전단력 $V_d := 49kN$

하중계수를 고려하지 않은 고정하중 모멘트 $M_d := 0kN\cdot m$

M_{max}를 발생시키는 외부 작용하중에 의한 단면의 계수전단력 $V_i := V_u - V_d$ $V_i = 44\,kN$

외부 작용하중에 의해 발생하는 단면의 최대계수모멘트 $M_{max} := M_{us} - M_d$ $M_{max} = 8.2\,kN\cdot m$

손실이 일어난 후 강재의 유효프리스트레스에 의한 응력 $f_{pe} := (6.579 - 1.319)MPa$

단면의 최외연에서 사용고정하중에 의한 응력 $f_d := 0MPa$

$M_{cr} := Z_{zz}\cdot\left[0.5\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right) + f_{pe} - f_d\right]$ $M_{cr} = 122\,kN\cdot m$

외부하중에 의해 발생하는 단면의 휨균열모멘트

$V_{ci.1} := 0.05\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right)\cdot b_w\cdot d + V_d + \frac{V_i\cdot M_{cr}}{M_{max}}$ $V_{ci.1} = 805\,kN$

$V_{ci.2} := 0.14\cdot\left[\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right)\cdot b_w\cdot d\right]$ $V_{ci.2} = 287\,kN$

$V_{ci} := \max(V_{ci.1}, V_{ci.2})$ $V_{ci} = 805\,kN$

2) 복부전단 강도 계산: V_{cw}

유효프리스트레스에 의한 도심에서의 응력 $f_{pc} := -\left(\frac{-6.579 + 1.588}{2} + \frac{-0.318 + 1.319}{2}\right)\cdot MPa$

유효프리스트레스힘의 수직분력 $V_p := 0kN$

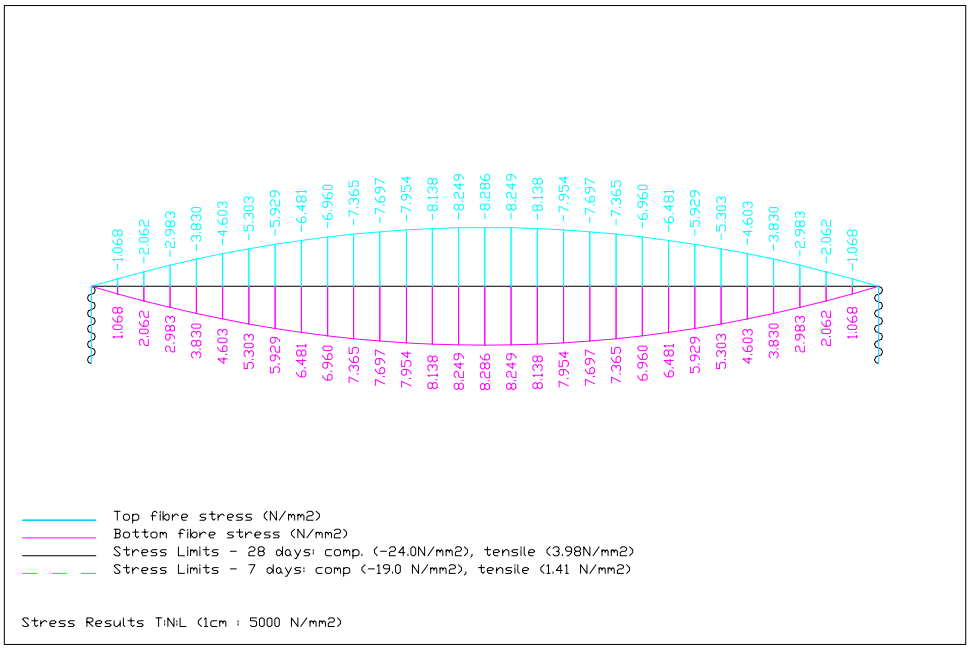
$V_{cw} := \left[0.29\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right) + 0.3\cdot f_{pc}\right]\cdot b_w\cdot d + V_p$ $V_{cw} = 788\,kN$

$V_c := \min(V_{ci}, V_{cw})$ $V_c = 788\,kN$ $\phi_s\cdot V_c = 591\,kN$ $\frac{V_u}{\phi_s\cdot V_c} = 0.1573$

$if(\phi_s\cdot V_c > V_u, "전단보강\ 필요없음", "전단보강\ 필요") = "전단보강\ 필요없음"$

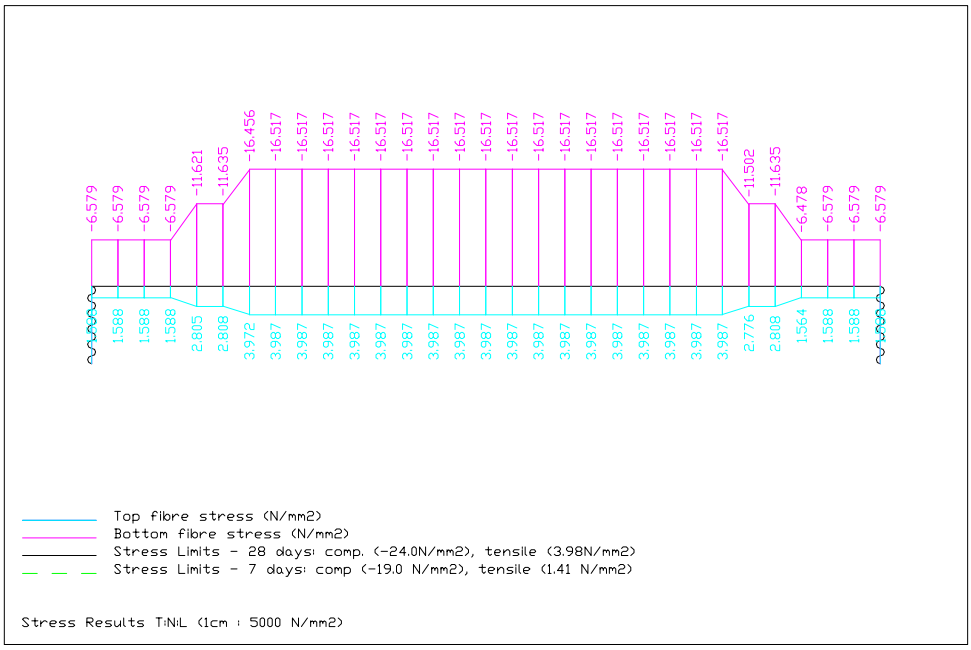
6.4 하중별 응력

Results Load Case SW
Stage 1040, elevation view



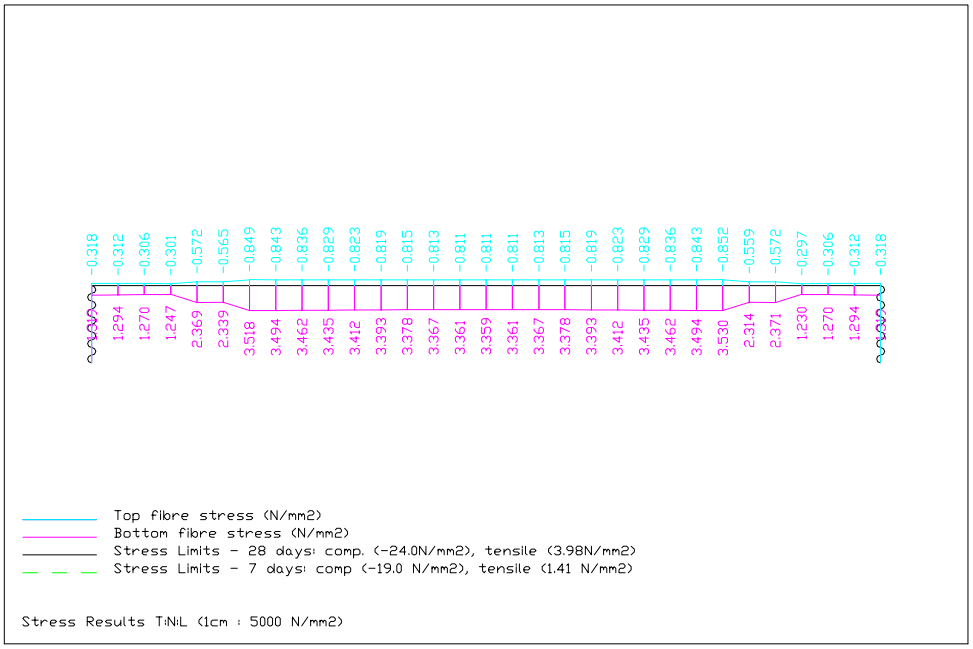
Plot 'lcTLsig-SW.pl' from 23 MAY 2017

Results Load Case PT
Stage 1040, elevation view



Plot 'lcTLsig-PT.pl' from 23 MAY 2017

Results Load Case CS
Stage 1040, elevation view



Plot 'lcTLsig-CS.pl' from 23 MAY 2017

1.27.3 풍도슬래브 TYPE-3

1. 설계개요

1.1 설계조건

1.1.1 풍도 슬래브 제원

(1) 구 분 : PSC 슬래브

(2) 제작방법 : 프리텐션 방식

(3) 하중조건 : 고정하중, 보도 활하중 및 풍압

(4) 적용지간

① 슬래브전장 : 7.170 m

② 계산지간 : 6.770 m

③ 폭 원 : 1.800 m

④ 콘크리트높이 : 0.160 m

1.1.2 단위중량

(1) 철근 콘크리트 : 25.00 kN/m^3

1.1.3 사용재료 및 허용응력

(1) PS 강재 (15.2mm)

① 인장강도 : f_{pu} = 1,900 MPa

② 항복점 응력 : f_{py} = 1,600 MPa

③ 허용 인장응력

- 초기 인장응력 : $f_{pi} = 0.9f_{py}$ = 1,440 MPa
- 도입 인장응력 : $f_{pt} = 0.7f_{pu}$ = 1,330 MPa
- 사용하중 작용시 : $f_{ps} = 0.9f_{py}$ = 1,440 MPa

④ 탄성계수 : E_p = 200,000 MPa

(2) 프리스트레스트 콘크리트

① 설계기준강도 : f_{ck} = 40 MPa

② PS도입시 압축강도 : f_{ci} = 0.80 X f_{ck} = 32 MPa

③ 허용 휨압축응력

- PS도입 직후 : f_{cat} = 0.6 X f_{ci} = 19.2 MPa
- 사용하중 도입시 : f_{ca} = 0.6 X f_{ck} = 24.0 MPa

④ 허용 휨인장응력

- PS도입 직후 : $f_{cat'}$ = 0.25 X $\sqrt{f_{ci}}$ = 1.41 MPa
- 사용하중 도입시 : f_{ca} = 0.63 X $\sqrt{f_{ck}}$ = 3.98 MPa

⑤ 탄성계수

- PS도입 직후 : E_{ci} = 1.18 X E_c = 35,409 MPa
- 사용하중 도입시 : E_c = 8,500 X $\sqrt[3]{f_{ck} + 4}$ = 30,008 MPa

1.1.4 사용성 한계

(1) 활하중에 의한 허용처짐 : $\delta_L \leq \delta_{La}$ = L / 360

1.2 참고문헌

(1) 콘크리트 구조기준 (한국콘크리트학회, 2012년)

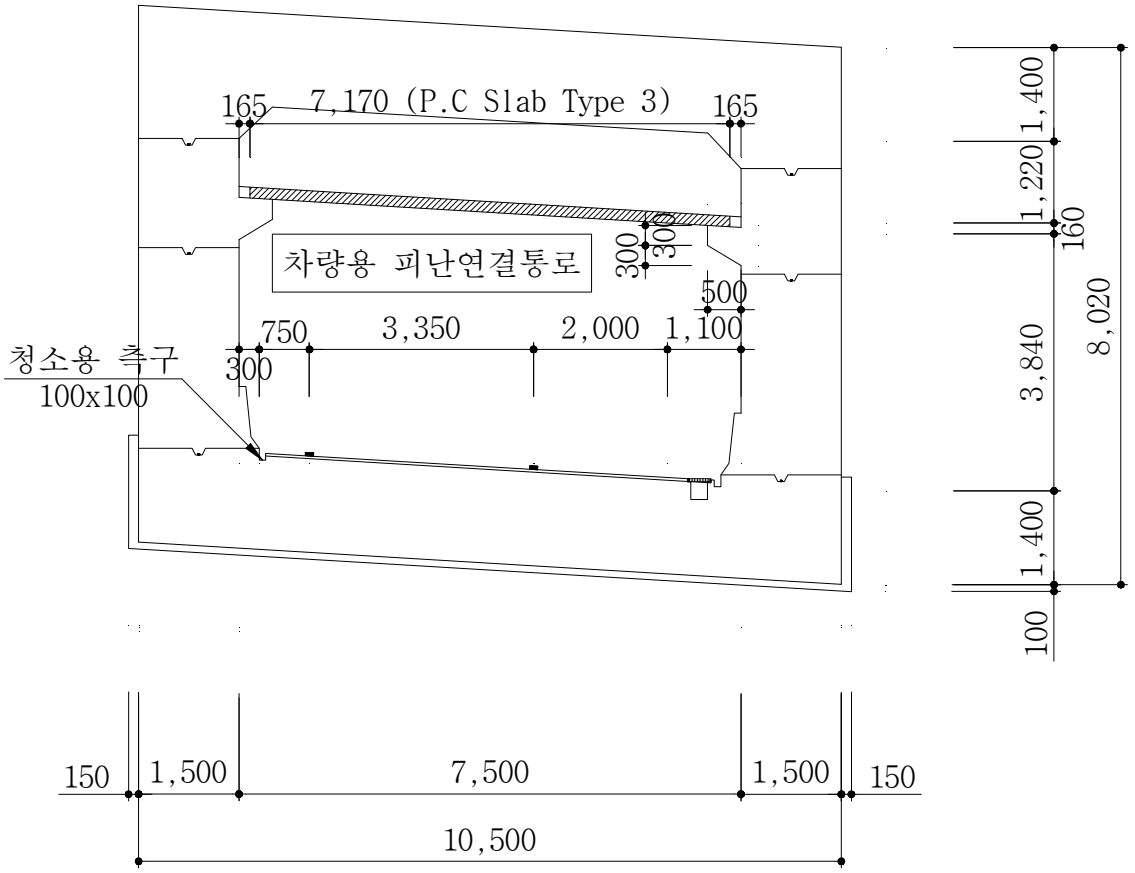
1.3 사용 프로그램

: RM Bridge V10

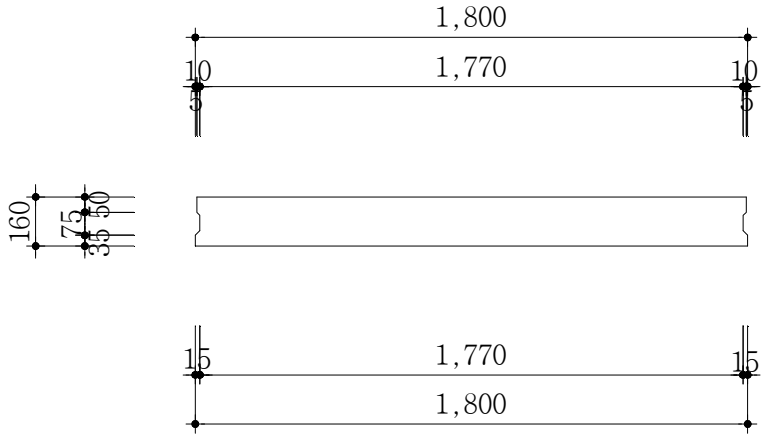
2. 풍도슬래브 단면도

2.1 터널 횡단면도

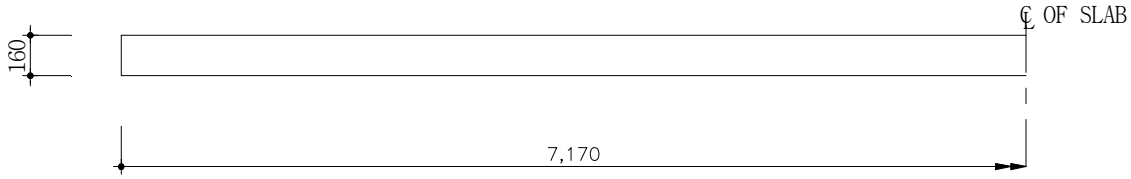
단 면 도



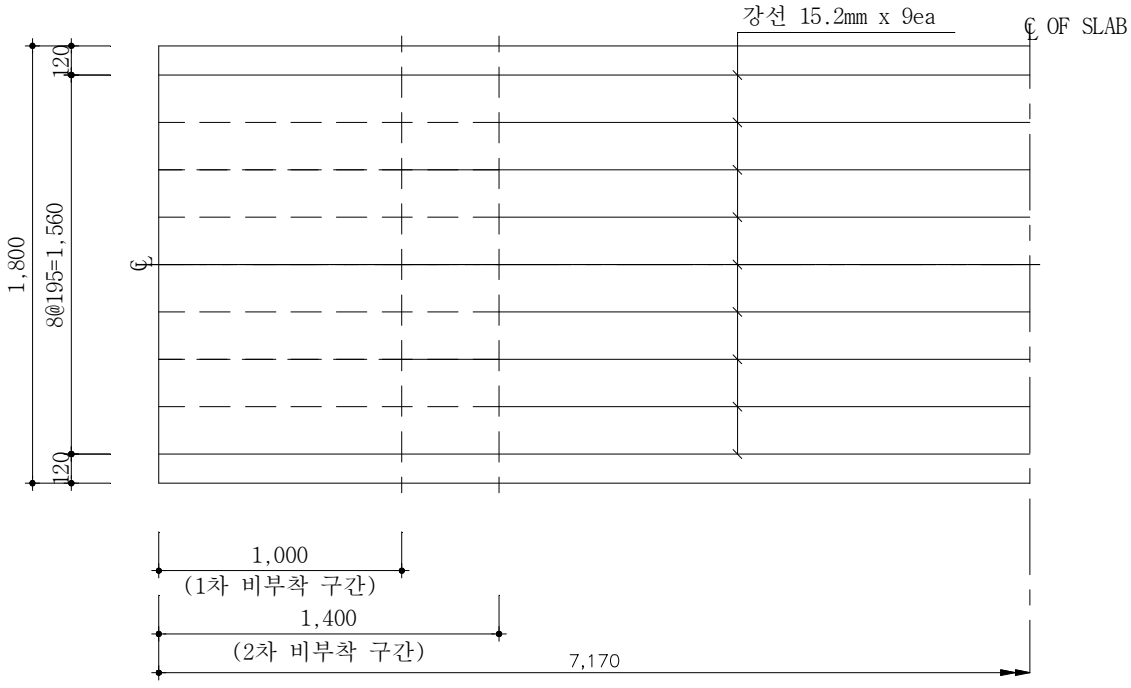
2.2 풍도슬래브 횡단면도



2.3 풍도슬래브 종단면도



2.4 풍도슬래브 강연선 배치도



3. 하중산정

3.1 고정하중

- 단위중량 25kN/m^3으로 고려함
- 풍도슬래브 단면 자중과 현장타설몰탈의 단면을 고려함
- 프로그램에서 자동으로 고려함

3.2 활하중

- 향후 작업하중 및 풍압 등을 고려하여 5.0 kN/m^2 을 재하함

3.3 크리프 및 건조수축

1) 조건

- 시멘트 : 보통(1종) 시멘트
- 지속하중 재하시의 콘크리트 재령 : t_0 = 2 (일)
- 콘크리트가 외기중에 노출되었을 때의 재령 : t_s = 0 (일)
- 상대습도 : 75 % (가정)
- 외기 또는 양생온도 : T = 20 ℃

2) 콘크리트의 크리프

$$\epsilon_{c\sigma}(t, t_o) = f_c(t_o)\left[\frac{1}{E_{ci}(t_o)} + \frac{\phi(t,t_o)}{E_{ci}}\right]$$

- $\varepsilon_{c\sigma}(t,t_0)$: 시간 t_0일에서 작용응력 $f_c(t_0)$에 의한 시간 t일에서의 탄성(순간) 변형율과 크리프 변형율을 포함한 전체 크리프 변형율
- E_{ci} : 28일 재령 콘크리트의 초기 접선탄성계수 (MPa)

$$E_{ci} = 2.15\times10^4\times\sqrt[3]{\frac{f_{cu}}{10}}$$

- $\Phi(t,t_0)$: 크리프 계수

$$\phi(t,t_o) = \phi_0\,\beta_c(t-t_o)$$

- t : 콘크리트의 재령 (일)
- t_0 : 지속하중이 작용할 때의 콘크리트의 재령 (일)

- Φ_0 : 콘크리트의 개념 크리프 계수

$$\phi_o = \phi_{RH}\beta(f_{cu})\beta(t_o)$$

- Φ_{RH} : 외기의 상대습도와 부재 두께에 의해 크리프에 미치는 영향 계수
  아래에서 RH 는 상대습도 (%)

$$\phi_{RH} = 1 + \frac{1 - 0.01RH}{0.10\sqrt[3]{h}}$$

- $\beta(f_{cu})$: 콘크리트 강도에 피해 크리프에 미치는 영향 함수
  아래에서 f_{cu} 는 콘크리트의 28일 평균 압축강도 (MPa) = f_{ck} + 8

$$\beta(f_{cu}) = \frac{16.8}{\sqrt{f_{cu}}}$$

- $\beta(t_0)$: 지속하중이 가해지는 시간 t'에 의해 크리프에 미치는 영향 함수

$$\beta(t_0) = \frac{1}{0.1 + (t_0)^{0.2}}$$

- $\beta_c(t-t_0)$: 재하기간에 따라 크리프에 미치는 영향함수

$$\beta_c(t-t_0) = \left[\frac{(t-t_0)}{\beta_H + (t-t_0)}\right]^{0.3}$$

- β_H : 외기의 상대습도와 부재의 두께에 따른 계수

$$\beta_H = 15\left[1 + (0.012RH)^{18}\right]h + 250 \leq 1500(\text{일})$$

- h : 개념적인 부재치수 (mm), $h = 2A_c/u$
  여기서 A_c는 단면적(mm^2), u는 외기와 접촉하는 단면둘레(mm)

3) 콘크리트의 건조수축 변형률

$$\epsilon_{sh}(t, t_s) = \epsilon_{sho}\beta_s(t-t_s)$$

- $\varepsilon_{sh}(t,t_s)$: 재령 t_s 에서 외기에 노출된 콘크리트의 재령 t에서의 전체 건조수축 변형율
- ε_{sh0} : 개념적인 건조수축계수

$$\epsilon_{sh0} = \epsilon_s(f_{cu})\beta_{RH}$$

- $\beta_s(t-t_s)$: 건조 기간에 따른 건조수축 변형율 함수

$$\beta_s(t-t_s) = \sqrt{\frac{(t-t_s)}{0.035\,h^2+(t-t_s)}}$$

- t_s : 수축이 시작될 때의 콘크리트의 재령 (일)
  아래에서 f_{cu} 는 콘크리트의 28일 평균 압축강도 (MPa)

$$\epsilon_s(f_{cu}) = \left[160 + 10\beta_{sc}\left(9-\frac{f_{cu}}{100}\right)\right]\times 10^{-6}$$

- β_{RH} : 외기습도에 따른 크리프와 건조수축에 미치는 영향계수
  아래에서 RH 는 상대습도 (%)

$$\beta_{RH} = \begin{cases} -1.55\left[1-\left(\frac{RH}{100}\right)^3\right] & 40\% \le RH < 99(\% \\ 0.25 & RH \ge 99\% \end{cases}$$

- h : 개념적인 부재치수 (cm), $h = 2A_c/u$
  여기서 A_c는 단면적(mm^2), u는 외기와 접촉하는 단면둘레(mm)

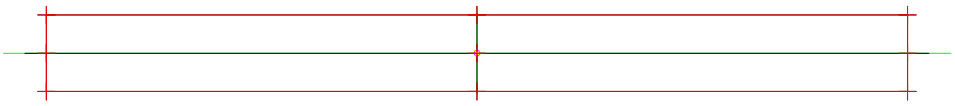
4. 모델링

4.1 단면계수

Cross-section : Standard:rec

Part : 1 Variant : 1

Description : rec



CROSS-SECTION DATA

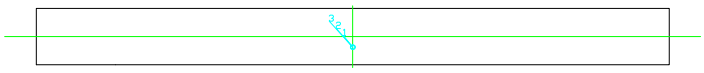
Cross-section area	0.28800E+00 m2
Shear area - Bending about Z-axis	0.28800E+00 m2
Shear area - Bending about Y-axis	0.28800E+00 m2
Torsional moment of inertia I	0.24383E-02 m4
Shear lag factor X (Ax-shear/Ax)	0.10000E+01
Moment of inertia about Y-axis	0.77760E-01 m4
Section moment about Y-axis - min	0.86400E-01 m3
Section moment about Y-axis - max	0.86400E-01 m3
Eccentricity Z (Shear lag)	0.00000E+00 m
Shear lag factor Y	0.10000E+01
Moment of inertia about Y-axis (Shear lag)	0.77760E-01 m4
Moment of inertia about Z-axis	0.61440E-03 m4
Section moment about Z-axis - min	0.76800E-02 m3
Section moment about Z-axis - max	0.76800E-02 m3
Eccentricity Y (Shear lag)	0.00000E+00 m
Shear lag factor Z	0.10000E+01
Moment of inertia about Z-axis (Shear lag)	0.61440E-03 m4
Warping moment of inertia	0.16073E-03 m6
Bending axis origin - Eccentricity ey	0.00000 m
Bending axis origin - Eccentricity ez	0.00000 m
Main axis angle	0.00000 Deg
Shear axis origin - Eccentricity ey	0.00000 m
Shear axis origin - Eccentricity ez	0.00000 m
Main axis angle - Shear	0.00000 Deg
Y-below : Gravity centre - minY	0.08000 m
Y-above : Gravity centre - maxY	0.08000 m
Z-left : Gravity centre - minZ	0.90000 m
Z-right : Gravity centre - maxZ	0.90000 m
Perimeter exposed to drying (outside)	3.92000 m
Perimeter (inside)	0.00000 m

4.2 텐던

Element:116 - Cross-section : Standard:rec - begin

Description : rec

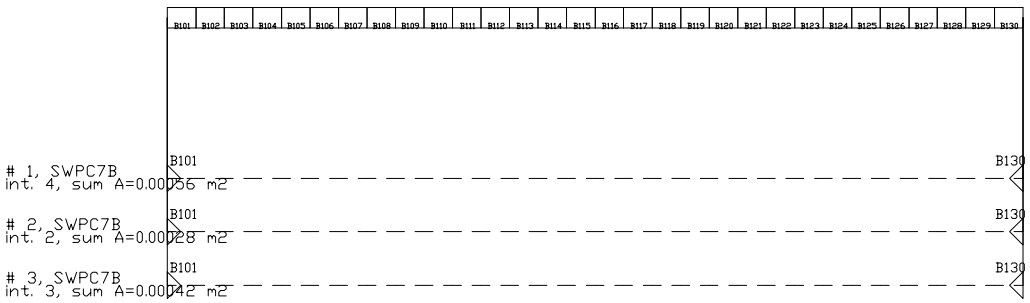
Units : m



C R O S S - S E C T I O N D A T A

Y-below	: Gravity centre - minY	0.08000 m
Y-above	: Gravity centre - maxY	0.08000 m
Z-left	: Gravity centre - minZ	0.90000 m
Z-right	: Gravity centre - maxZ	0.90000 m

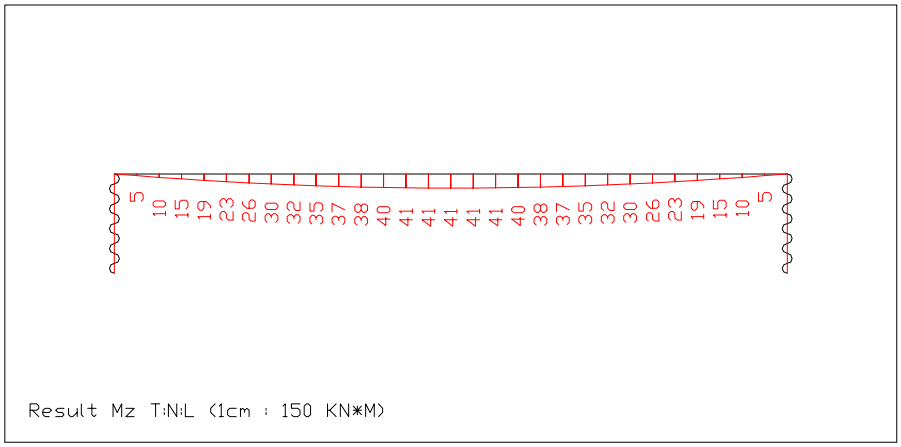
Tendon	Ey	Ez	Tendon	Ey	Ez	Tendon	Ey	Ez	Tendon	Ey	Ez
1	-0.030	-0.000									
2	-0.030	-0.000									
3	-0.030	-0.000									

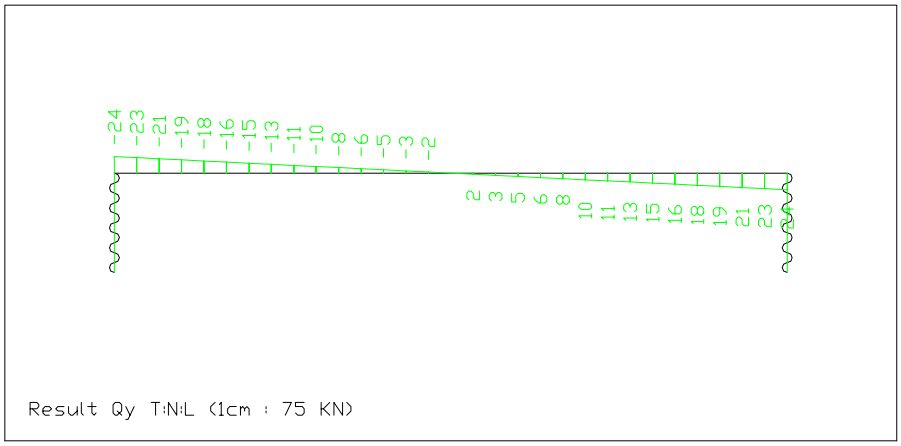


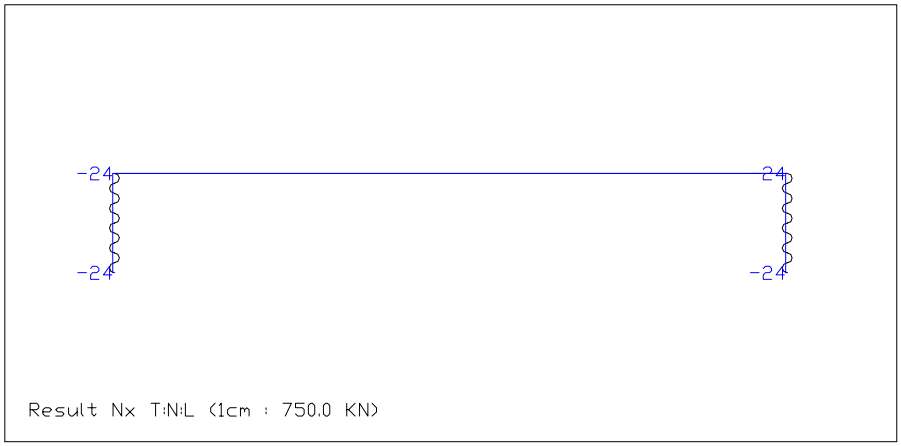
5. 단면력도

5.1 자중(SW)

Results Load Case SW
Stage 1040, elevation view



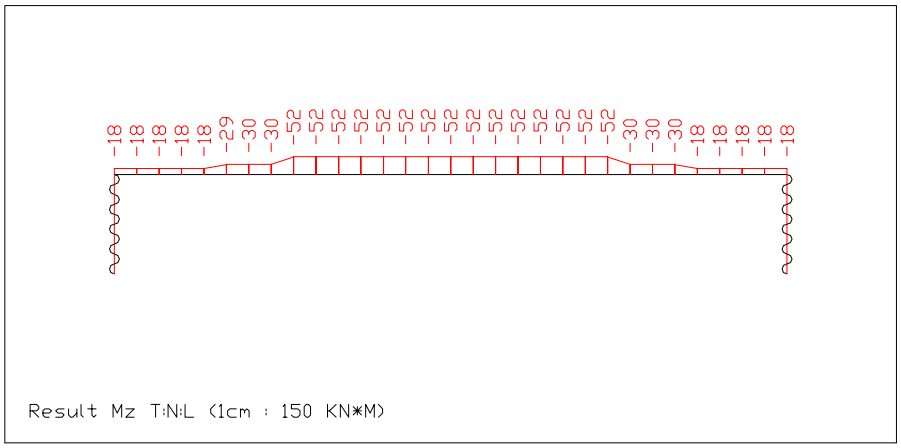


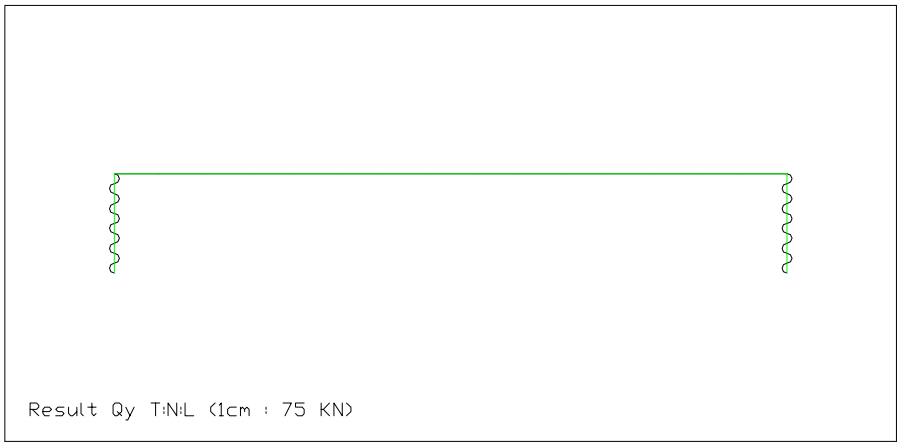


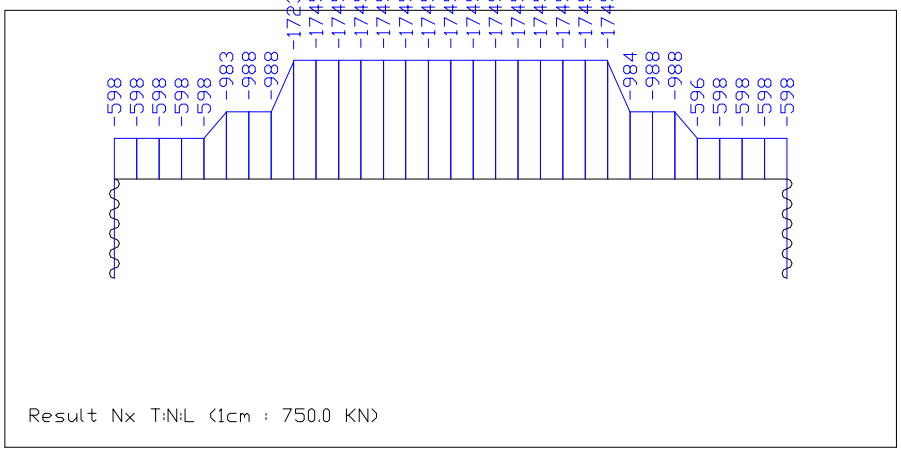
Plot 'pl-lcres-stg1040.pl' from 23 MAY 2017

5.2 프리스트레싱 하중(PT)

Results Load Case PT
Stage 1040, elevation view



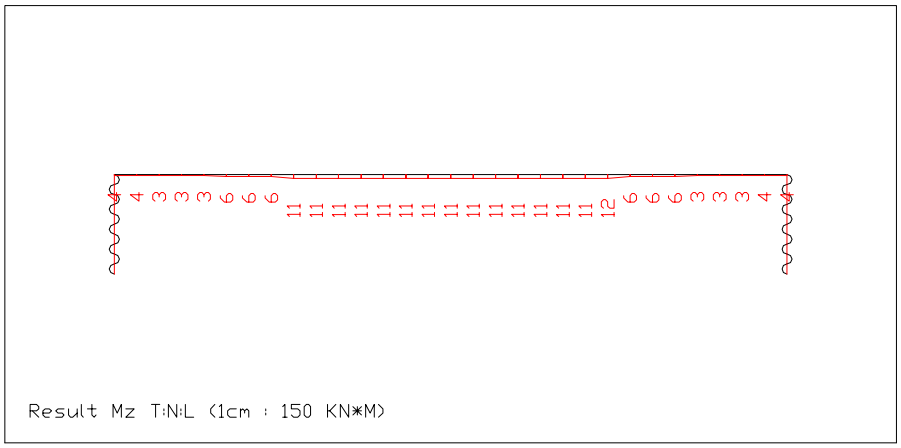


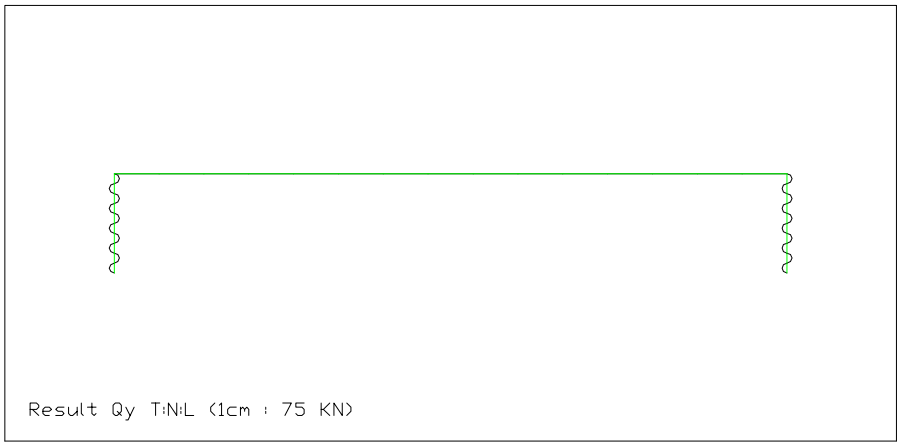


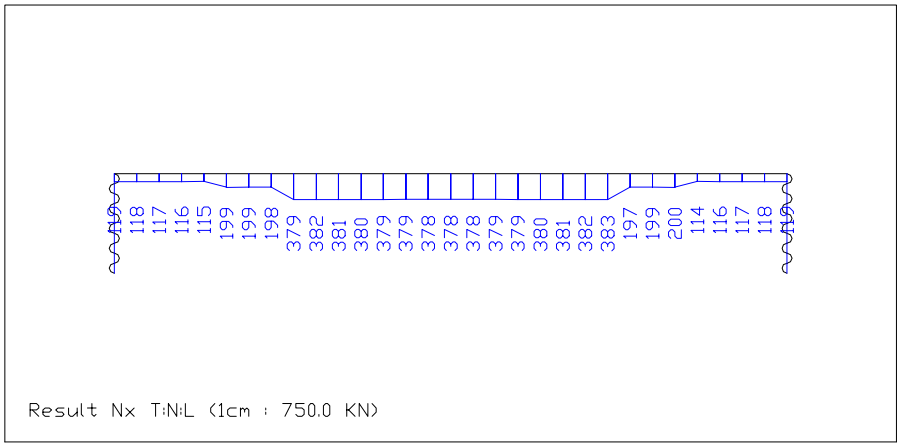
Plot 'pl-lcres-stg1040.pl' from 23 MAY 2017

5.3 크리프 및 건조수축(CS)

Results Load Case CS
Stage 1040, elevation view



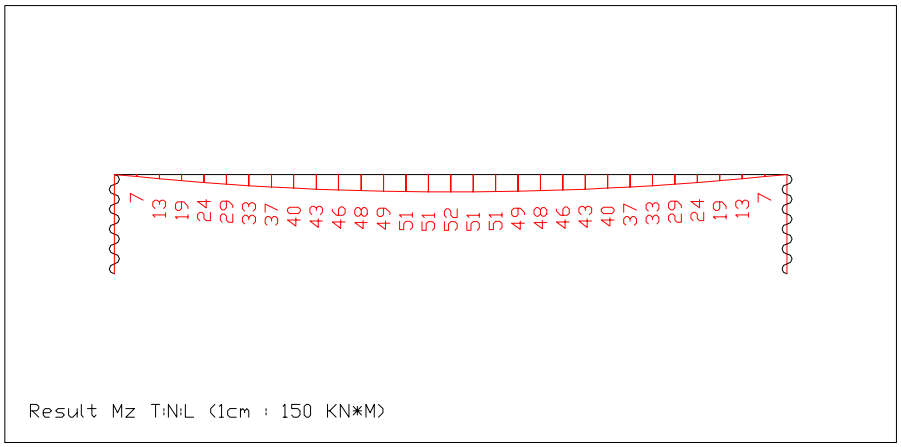


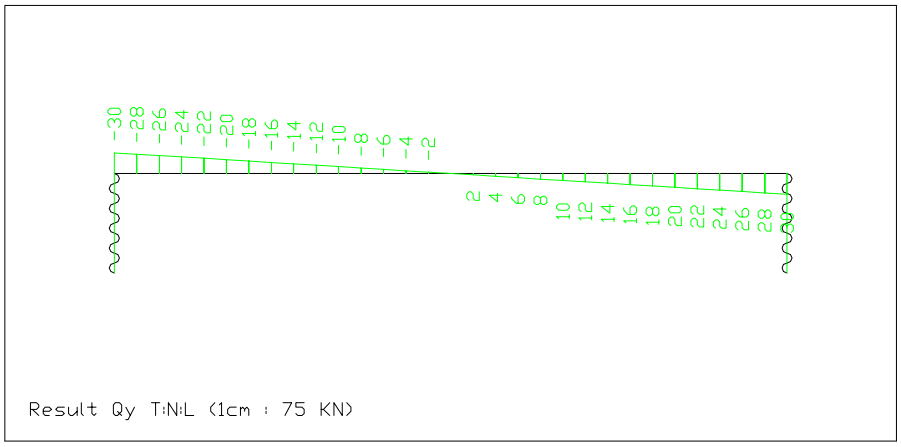


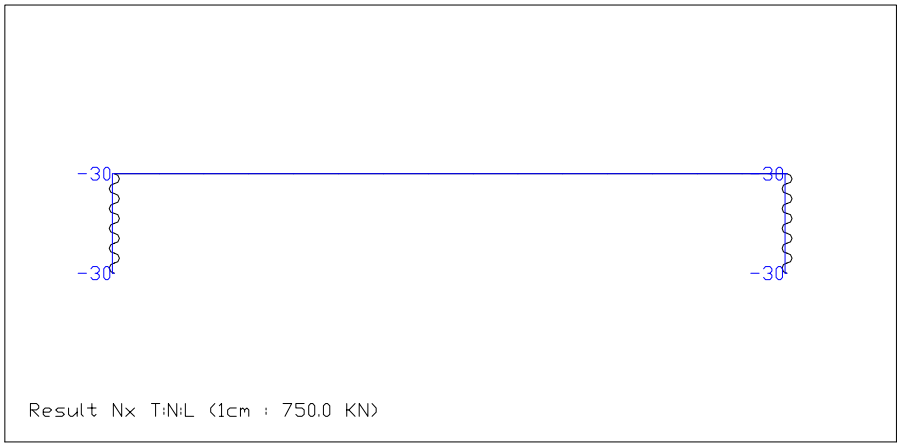
Plot 'pl-lcres-stg1040.pl' from 23 MAY 2017

5.4 활하중(LL)

Results Load Case LL
Stage 1040, elevation view







Plot 'pl-lcres-stg1040.pl' from 23 MAY 2017

6. 하중 조합 검토

6.1 하중 조합

(1) 사용하중 조합

① 1.0 SW + 1.0 PT : 프리스트레스 도입시

② 1.0 SW + 1.0 PT + 1.0 CS : 장기손실 발생시

③ 1.0 SW + 1.0 PT + 1.0 CS + 1.0 LL : 사용하중 재하시

※ SW : 슬래브 자중

PT : 프리스트레스

CS : 크리프 및 건조수축

LL : 활하중

(2) 계수하중 조합

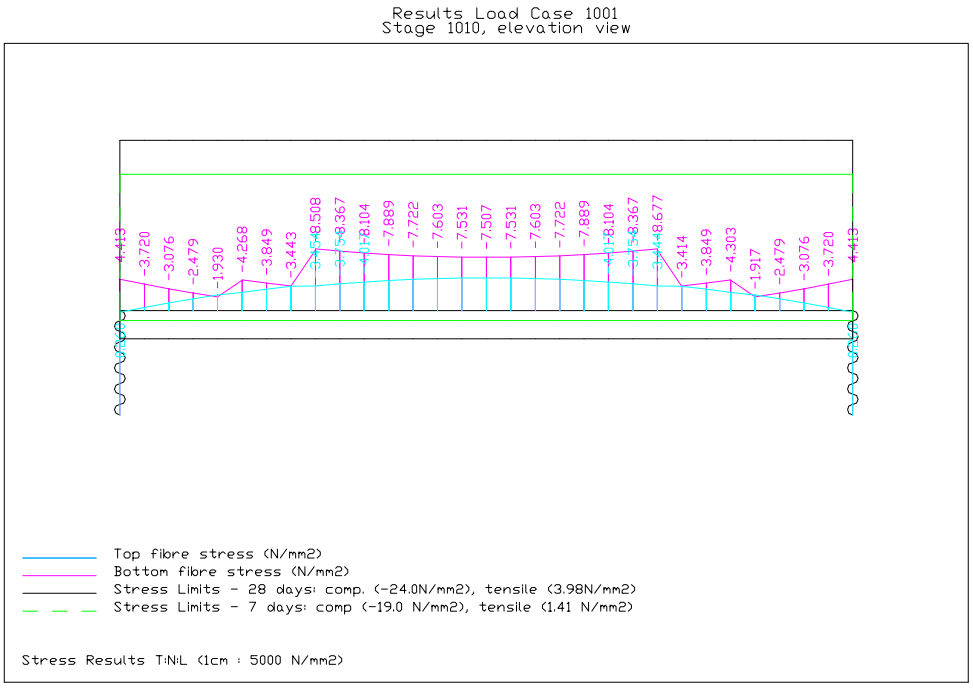
: 1.2 SW + 1.2 CS + 1.6 LL

	SW	CS	LL	계수하중
모멘트(kNm)	41	11	52	104
전단력(kN)	24	0	30	54
위험단면 모멘트(kNm)	0	4	0	4

※ 콘크리트 구조기준 2012 참조

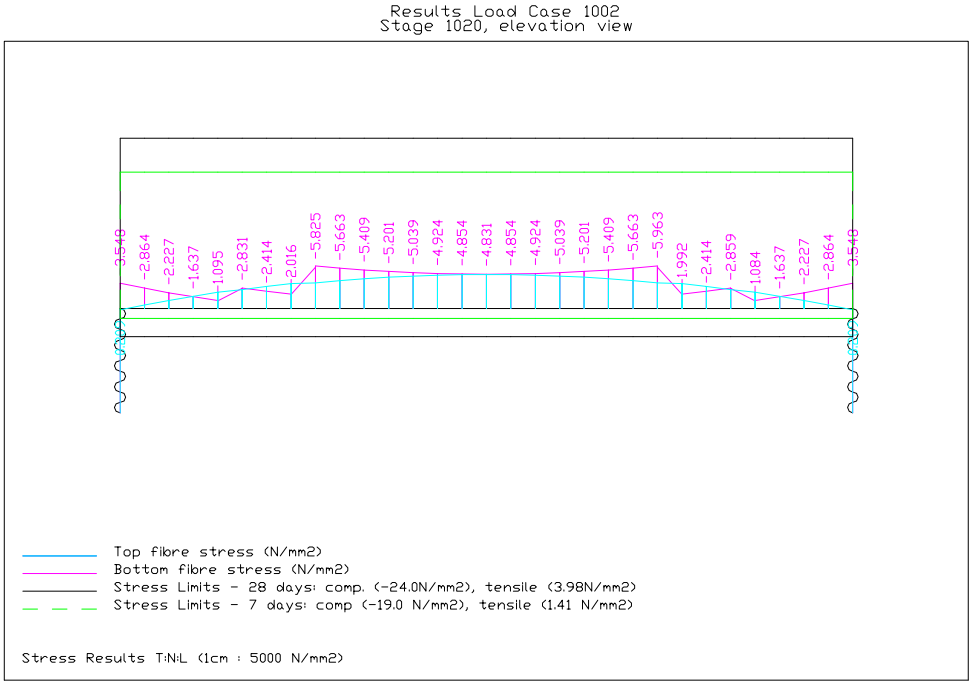
6.2 사용하중 조합에 의한 응력검토

6.2.1 프리스트레싱 도입시: SW+PT



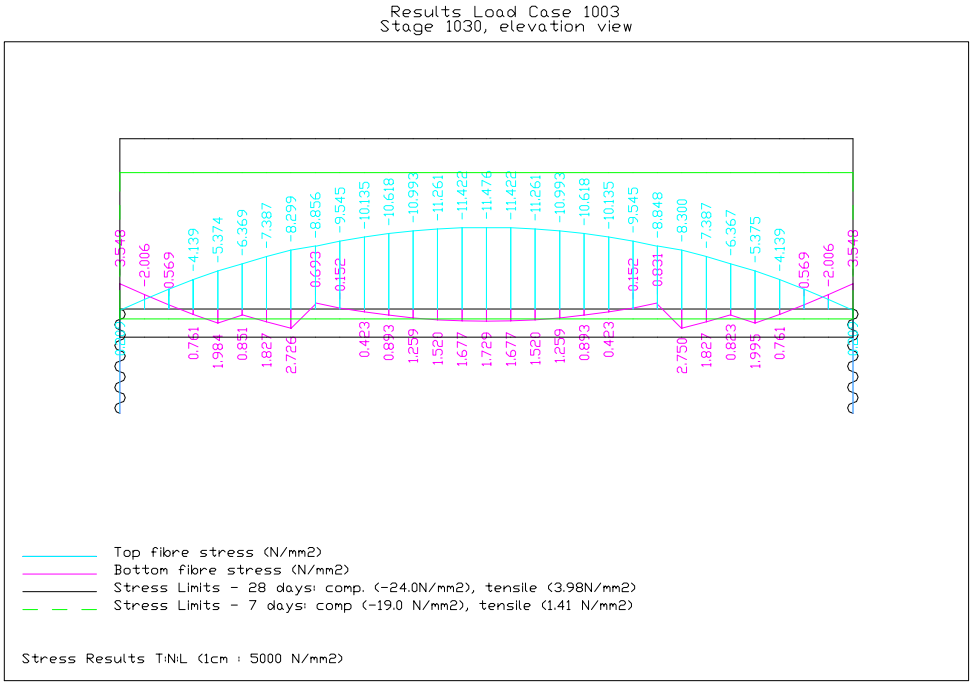
Plot 'lcTLsig-1001.pl' from 23 MAY 2017

6.2.2 장기손실 발생시: SW+PT+CS



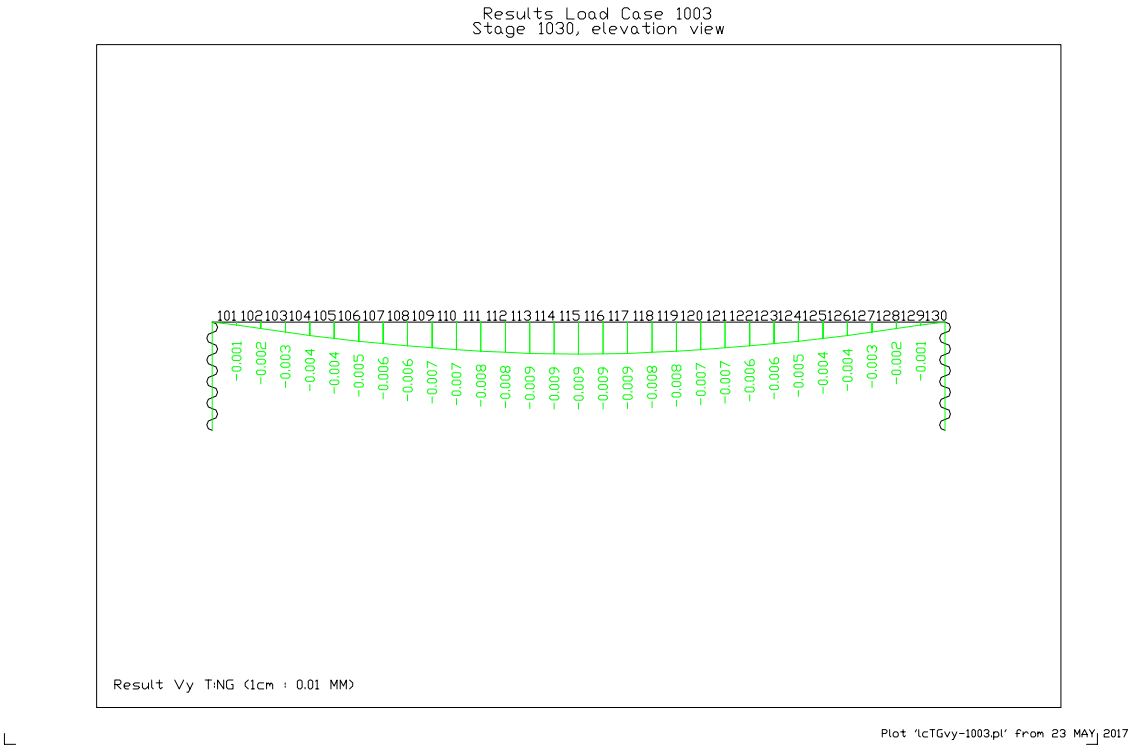
Plot 'lcTLsig-1002.pl' from 23 MAY 2017

6.2.3 사용하중 재하시: SW+PT+CS+LL



Plot 'lcTLsig-1003.pl' from 23 MAY 2017

6.2.4 처짐



최대 처짐 : 9mm < (L = 6,770mm) / 360 = 18.8mm ∴ O.K.

6.3 계수하중 조합에 의한 강도검토

A. 휨강도 검토 (지간 중앙부, 모멘트 최대부)

콘크리트 설계기준강도 $f_{ck} := 40MPa$ 검토단면 폭 $b := 1800mm$ 플랜지 두께 $t_f := 160mm$

철근항복강도 $f_y := 400MPa$ 검토단면 유효깊이 $d := 120mm$

인장철근 단면적 $A_s := 71mm^2 \times 9$

PS강재 극한강도 $f_{pu} := 1900MPa$ PS강재 유효깊이 $d_p := 110mm$

PS강재 종류에 따른 계수 $\gamma_p := 0.28$ PS강재 단면적 $A_p := 138.7mm^2 \times 9$

계수하중 모멘트 $M_u := 104kN \cdot m$

강도감소계수

휨 : $\phi_f := 0.85$

전단 : $\phi_s := 0.75$

유효깊이계수 $\beta_1 := \begin{cases} 0.85 & \text{if } f_{ck} < 28MPa \\ 0.85 - 0.05 \cdot \frac{f_{ck} - 28MPa}{7MPa} & \text{otherwise} \\ 0.65 & \text{if } f_{ck} > 56MPa \end{cases}$ $\beta_1 = 0.7643$

$\rho_p := \frac{A_p}{b \cdot d_p}$ $\rho_p = 0.00630$ $\rho := \frac{A_s}{b \cdot d}$ $\rho = 0.00296$

$f_{ps} := f_{pu} \cdot \left[1 - \frac{\gamma_p}{\beta_1} \cdot \left[\rho_p \cdot \frac{f_{pu}}{f_{ck}} + \frac{d}{d_p} \cdot \left(\rho \cdot \frac{f_y}{f_{ck}}\right)\right]\right]$ $f_{ps} = 1669MPa$

$a := \frac{A_p \cdot f_{ps} + A_s \cdot f_y}{0.85 \cdot f_{ck} \cdot b}$ $a = 38mm$

$\text{if}\left(a < t_f, \text{"직사각형 단면"}, \text{"T형보 단면"}\right) = \text{"직사각형 단면"}$

휨강도

$M_n := A_p \cdot f_{ps} \cdot d_p \cdot \left[1 - 0.59\left(\frac{\rho_p \cdot f_{ps}}{f_{ck}} + \frac{d}{d_p} \cdot \frac{\rho \cdot f_y}{f_{ck}}\right)\right] + A_s \cdot f_y \cdot d \cdot \left[1 - 0.59 \cdot \left(\frac{d_p}{d} \cdot \frac{\rho_p \cdot f_{ps}}{f_{ck}} + \frac{\rho \cdot f_y}{f_{ck}}\right)\right]$

$M_n = 215kN \cdot m$ $\phi_f \cdot M_n = 183kN \cdot m$

$c := \frac{a}{\beta_1}$ $c = 50mm$ $\varepsilon_t := 0.003 \cdot \frac{d - c}{c}$ $\varepsilon_t = 0.0042$

$\phi'_f := \begin{cases} 0.65 & \text{if } \varepsilon_t < 0.002 \\ 0.65 + \left(\varepsilon_t - 0.002\right) \cdot \frac{200}{3} & \text{otherwise} \\ 0.85 & \text{if } \varepsilon_t > 0.005 \end{cases}$ $\phi'_f = 0.7966$

$\phi'_f \cdot M_n = 171.2841kN \cdot m$ $M_u = 104kN \cdot m$

$\text{if}\left(M_u < \phi'_f \cdot M_n, \text{"O.K"}, \text{"N.G"}\right) = \text{"O.K"}$ $\frac{M_u}{\phi'_f \cdot M_n} = 0.6072$

최소 강재량 검토

$I_{zz} := 6144000000mm^4$ $y_{below} := 80mm$ $y_{above} := 80mm$ $A := 288000mm^2$

$Z_{zz} := \frac{I_{zz}}{y_{below}}$ $Z_{zz} = 76800000mm^3$

$f_{ru} := 0.5\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa$ $f_{ru} = 3.162\,MPa$

$f_{pcc} := 4.831MPa$ (손실완료후 유효프리스트레스에 의한 콘크리트 압축응력)

$M'_{cr} := (f_{ru} + f_{pcc})\cdot Z_{zz}$ (콘크리트의 휨인장강도에 기초한 단면의 최소 강재 균열모멘트)

$M'_{cr} = 614\,kN\cdot m$ $1.2\cdot M'_{cr} = 737\,kN\cdot m$ $\phi_f\cdot M_n = 183\,kN\cdot m$

$if(1.2\cdot M'_{cr} \le \phi_f\cdot M_n, "O.K", "N.G") = "N.G"$

B. 전단력 검토 (시점부, 전단력 최대부)

1) 휨전단 강도 계산: V_{ci}

복부 폭 $b_w := 1800mm$ $M_{us} := 11kN\cdot m$

단면의 계수전단력 $V_u := 54kN$

사용 고정하중에 의해 발생하는 단면의 전단력 $V_d := 24kN$

하중계수를 고려하지 않은 고정하중 모멘트 $M_d := 0kN\cdot m$

M_{max}를 발생시키는 외부 작용하중에 의한 단면의 계수전단력 $V_i := V_u - V_d$ $V_i = 30\,kN$

외부 작용하중에 의해 발생하는 단면의 최대계수모멘트 $M_{max} := M_{us} - M_d$ $M_{max} = 11\,kN\cdot m$

손실이 일어난 후 강재의 유효프리스트레스에 의한 응력 $f_{pe} := (4.413 - 0.864)MPa$

단면의 최외연에서 사용고정하중에 의한 응력 $f_d := 0MPa$

$M_{cr} := Z_{zz}\cdot\left[0.5\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right) + f_{pe} - f_d\right]$ $M_{cr} = 515\,kN\cdot m$

외부하중에 의해 발생하는 단면의 휨균열모멘트

$V_{ci.1} := 0.05\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right)\cdot b_w\cdot d + V_d + \frac{V_i\cdot M_{cr}}{M_{max}}$ $V_{ci.1} = 1498\,kN$

$V_{ci.2} := 0.14\cdot\left[\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right)\cdot b_w\cdot d\right]$ $V_{ci.2} = 191\,kN$

$V_{ci} := max(V_{ci.1}, V_{ci.2})$ $V_{ci} = 1498\,kN$

2) 복부전단 강도 계산: V_{cw}

유효프리스트레스에 의한 도심에서의 응력 $f_{pc} := -\left(\frac{-4.413 + 0.260}{2} + \frac{-0.051 + 0.864}{2}\right)\cdot MPa$

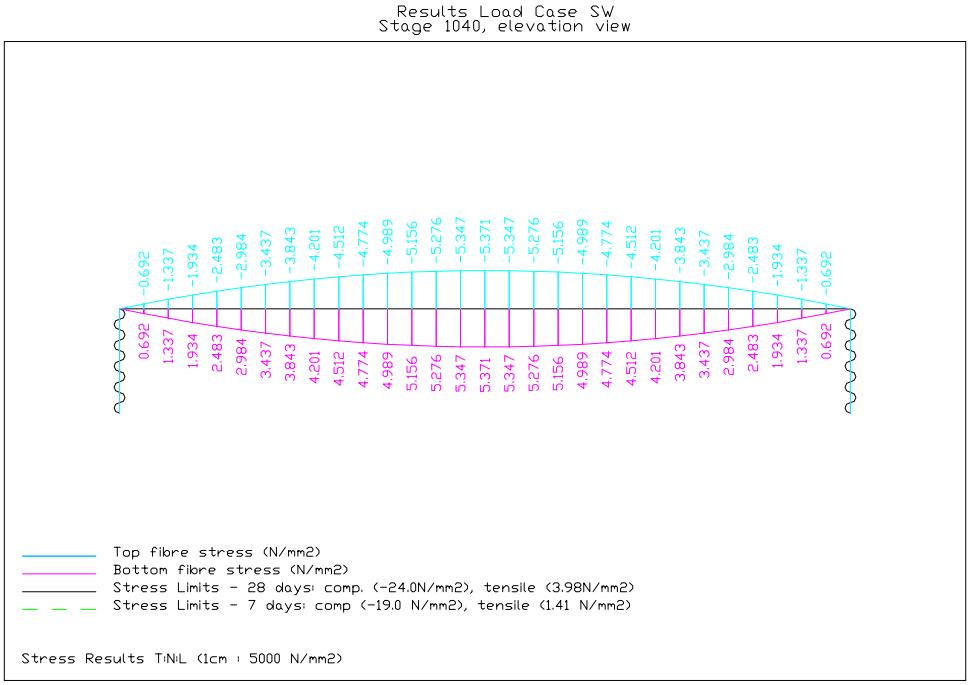
유효프리스트레스힘의 수직분력 $V_p := 0kN$

$V_{cw} := \left[0.29\cdot\left(\sqrt{\frac{f_{ck}}{MPa}}\cdot MPa\right) + 0.3\cdot f_{pc}\right]\cdot b_w\cdot d + V_p$ $V_{cw} = 504\,kN$

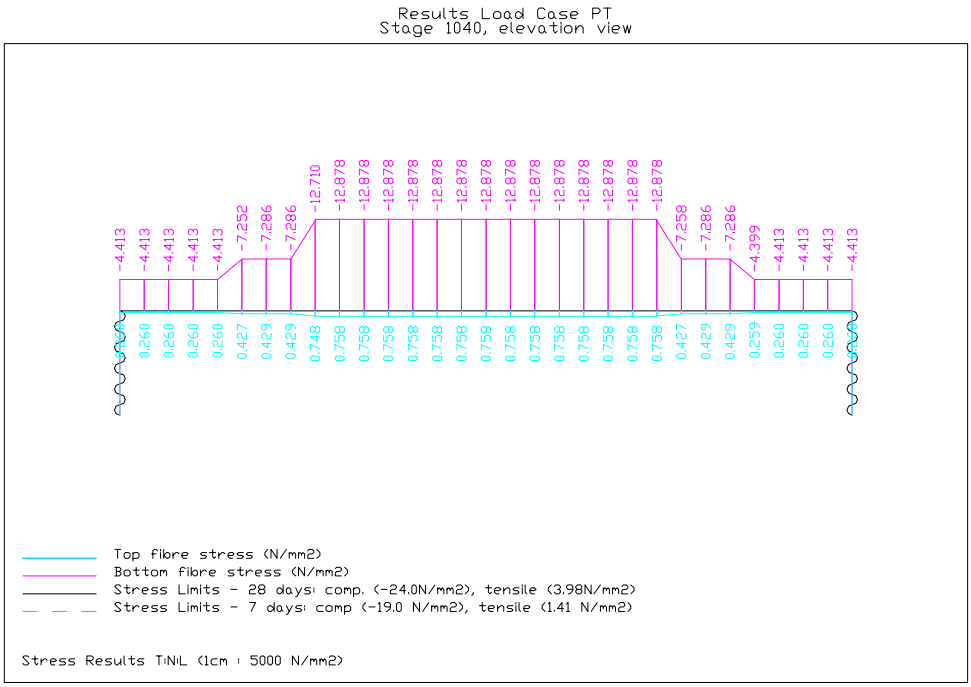
$V_c := min(V_{ci}, V_{cw})$ $V_c = 504\,kN$ $\phi_s\cdot V_c = 378\,kN$ $\frac{V_u}{\phi_s\cdot V_c} =$ ∎

$if(\phi_s\cdot V_c > V_u, "전단보강\ 필요없음", "전단보강\ 필요") = "전단보강\ 필요없음"$

6.4 하중별 응력

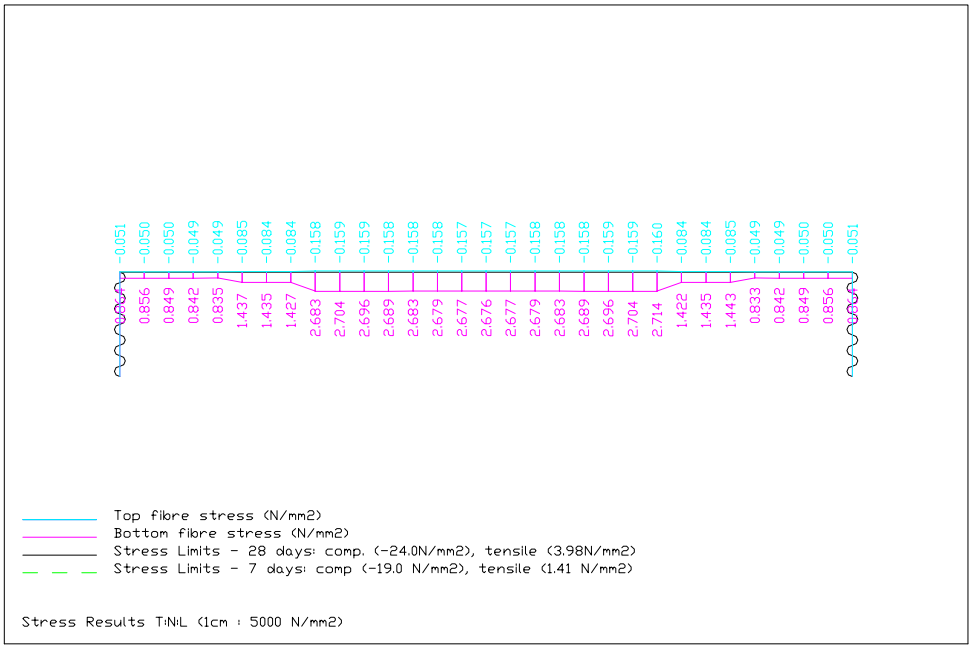


Plot 'lcTLsig-SW.pl' from 23 MAY 2017



Plot 'lcTLsig-PT.pl' from 23 MAY 2017

Results Load Case CS
Stage 1040, elevation view



Plot 'lcTLsig-CS.pl' from 23 MAY 2017

1.27.4 브라켓

【 브래킷 : 풍도슬래브 브라켓(Type-1), 본선 】

* 단면제원 및 설계가정

fck=27MPa, fy=400MPa, Φ=0.80, Φf=0.85, Φv=0.75

B(mm)	H(mm)	d(mm)	피복(mm)	외단깊이(mm)	Vu(kN)
1000.0	600.0	520.0	80.0	300.0	100.0

a = 350.000 mm, d = 520.000 mm

a / d (= 0.673) ≤ 1 → Bracket으로 설계. [콘크리트 구조설계기준] 7.9.2

지압면의 외단깊이 ≥ 0.5d , 300.000 mm ≥ 0.5 x 520.000 mm ∴ O.K

① 설계 단면력 산정

Vu = 105.600 kN

Nuc = 0.20 x 105.600 = 21.120 kN

Mu = Vu x a + Nuc x (h - d)

= 105.600 x 0.350 + 21.200 x (0.600 - 0.520)

= 38.650 kN.m

② 전단마찰철근(Avf)의 설계

: 전단마찰철근이 전단면에 수직인 경우 , [도로교 설계기준] 4.4.6.4

Vn_max ≤ 0.2 x fck x bo x d , 5.6 x bo x d

≤ 0.2 x 27 x 1000.000 x 520.000 = 2808.000 kN

≤ 5.6 x 1000.000 x 520.000 = 2912.000 kN

ΦVn_max = 0.80 x 2808.000 = 2246.400 kN ≥ Vu (=105.600 kN) ∴ O.K

$$Avf = \frac{Vu}{\Phi v \times fy \times \mu}$$ (Φv=0.80, μ=1.4λ, λ=1.0 ; 일체로 친 보통 콘크리트)

= 105600.000 / (0.80 x 400 x 1.4)

= 235.714 mm²

③ 휨모멘트 철근(Af)의 설계

Mu = 105.600 x 0.350 + 21.120 x (0.600 - 0.520) = 38.650 kN.m

$$a = \frac{Af \times fy}{0.85 \times fck \times B}$$

Mn = Mu / Φ = Af x fy x (d - a/2) → 위의 a를 대입하여 Af를 이차방정식으로 푼다.

$$Af = \frac{d - \sqrt{[d^2 - 4 \times Mu / (1.7 \times fck \times B \times \Phi)]}}{2 \times fy / (1.7 \times fck \times B)}$$

= 21.869 mm²

④ 수평인장 철근(An)의 설계

Nuc = 0.20 x 105.600 = 21.120 kN

An = Nuc / (Φ x fy) = 66.00 mm²

⑤ 주인장철근(As)의 산정

주인장철근의 단면적은 (Af + An)과 (2/3 Avf + An) 중 큰값을 취한다.

→ As = 223.142 ㎟

As(min) = 0.04 x (fck / fy) x B x d

= 0.04 x (27 / 400) x 1000.000 x 520.000

= 1404.000 ㎟

Use As = 2292.000 ㎟ (철근도심 80.00 mm)

1단 : H19- 8.0EA , d1 = 80.00 mm

Use As ≥ 223.142 ㎟ , 1404.000 ㎟ ∴ O.K

⑥ 폐쇄 스터럽,띠철근(Ah)의 산정

Ah = 0.5 x (As - An) = 0.5 x (223.142 - 66.000)

= 78.571 ㎟

사용철근량 (1단) : H13 - 2.0 EA = 253.400 ㎟

철근의 배치 범위 : 2/3 d = 2/3 x 520.00 = 346.67 mm구간에 1.0 단 설치

▶ 사용철근량(1.0단) : H13 - 2.00 EA = 253.400 ㎟ ≥ 78.571 ㎟ ∴ O.K

【 브래킷 : 풍도슬래브 브라켓(Type-2), 램프 】

* 단면제원 및 설계가정

fck=27MPa, fy=400MPa, Φ=0.80, Φf=0.85, Φv=0.75

B(mm)	H(mm)	d(mm)	피복(mm)	외단깊이(mm)	Vu(kN)
1000.0	600.0	520.0	80.0	300.0	108.0

a = 350.000 mm, d = 520.000 mm

a / d (= 0.673) ≤ 1 → Bracket으로 설계. [콘크리트 구조설계기준] 7.9.2

지압면의 외단깊이 ≥ 0.5d , 300.000 mm ≥ 0.5 x 520.000 mm ∴ O.K

① 설계 단면력 산정

Vu = 129.200 kN

Nuc = 0.20 x 129.200 = 25.840 kN

Mu = Vu x a + Nuc x (h - d)

= 129.200 x 0.350 + 25.840 x (0.600 - 0.520)

= 47.287 kN.m

② 전단마찰철근(Avf)의 설계

: 전단마찰철근이 전단면에 수직인 경우 , [도로교 설계기준] 4.4.6.4

Vn_max ≤ 0.2 x fck x bo x d , 5.6 x bo x d

≤ 0.2 x 27 x 1000.000 x 520.000 = 2808.000 kN

≤ 5.6 x 1000.000 x 520.000 = 2912.000 kN

ΦVn_max = 0.80 x 2808.000 = 2246.400 kN ≥ Vu (=129.200 kN) ∴ O.K

$$Avf = \frac{Vu}{\Phi v \times fy \times \mu}$$ (Φv=0.80, μ=1.4λ, λ=1.0 ; 일체로 친 보통 콘크리트)

= 129200.000 / (0.80 x 400 x 1.4)

= 288.393 mm²

③ 휨모멘트 철근(Af)의 설계

Mu = 129.200 x 0.350 + 25.840 x (0.600 - 0.520) = 47.287 kN.m

$$a = \frac{Af \times fy}{0.85 \times fck \times B}$$

Mn = Mu / Φ = Af x fy x (d - a/2) → 위의 a를 대입하여 Af를 이차방정식으로 푼다.

$$Af = \frac{d - \sqrt{[d^2 - 4 \times Mu / (1.7 \times fck \times B \times \Phi)]}}{2 \times fy / (1.7 \times fck \times B)}$$

= 26.758 mm²

④ 수평인장 철근(An)의 설계

Nuc = 0.20 x 129.200 = 25.840 kN

An = Nuc / (Φ x fy) = 80.750 mm²

⑤ 주인장철근(As)의 산정

주인장철근의 단면적은 (Af + An)과 (2/3 Avf + An) 중 큰값을 취한다.

→ As = 273.012 ㎟

As(min) = 0.04 x (fck / fy) x B x d

= 0.04 x (27 / 400) x 1000.000 x 520.000

= 1404.000 ㎟

Use As = 2292.800 ㎟ (철근도심 80.00 mm)

1단 : H19- 8.0EA , d1 = 80.00 mm

Use As ≥ 273.012 ㎟ , 1404.000 ㎟ ∴ O.K

⑥ 폐쇄 스터럽,띠철근(Ah)의 산정

Ah = 0.5 x (As - An) = 0.5 x (273.012 - 80.750)

= 96.131 ㎟

사용철근량 (1단) : H13 - 2.0 EA = 253.400 ㎟

철근의 배치 범위 : 2/3 d = 2/3 x 520.00 = 346.67 mm구간에 1.0 단 설치

▶ 사용철근량(1.0단) : H13 - 2.00 EA = 253.400 ㎟ ≥ 96.131 ㎟ ∴ O.K

【 브래킷 : 풍도슬래브 브라켓(Type-3), 차량용피난연결통로 】

* 단면제원 및 설계가정

fck=27MPa, fy=400MPa, Φ=0.80, Φf=0.85, Φv=0.75

B(mm)	H(mm)	d(mm)	피복(mm)	외단깊이(mm)	Vu(kN)
1000.0	600.0	520.0	80.0	300.0	108.0

a = 350.000 mm, d = 520.000 mm

a / d (= 0.673) ≤ 1 → Bracket으로 설계. [콘크리트 구조설계기준] 7.9.2

지압면의 외단깊이 ≥ 0.5d , 300.000 mm ≥ 0.5 x 520.000 mm ∴ O.K

① 설계 단면력 산정

Vu = 76.80 kN

Nuc = 0.20 x 76.800 = 15.360 kN

Mu = Vu x a + Nuc x (h - d)

= 76.800 x 0.350 + 15.360 x (0.600 - 0.520)

= 28.109 kN.m

② 전단마찰철근(Avf)의 설계

: 전단마찰철근이 전단면에 수직인 경우 , [도로교 설계기준] 4.4.6.4

Vn_max ≤ 0.2 x fck x bo x d , 5.6 x bo x d

≤ 0.2 x 27 x 1000.000 x 520.000 = 2808.000 kN

≤ 5.6 x 1000.000 x 520.000 = 2912.000 kN

ΦVn_max = 0.80 x 2808.000 = 2246.400 kN ≥ Vu (=76.800 kN) ∴ O.K

$$Avf = \frac{Vu}{\Phi v \times fy \times \mu}$$ (Φv=0.80, μ=1.4λ, λ=1.0 ; 일체로 친 보통 콘크리트)

= 76800.000 / (0.80 x 400 x 1.4)

= 171.429 mm²

③ 휨모멘트 철근(Af)의 설계

Mu = 76.800 x 0.350 + 15.360 x (0.600 - 0.520) = 28.109 kN.m

$$a = \frac{Af \times fy}{0.85 \times fck \times B}$$

Mn = Mu / Φ = Af x fy x (d - a/2) → 위의 a를 대입하여 Af를 이차방정식으로 푼다.

$$Af = \frac{d - \sqrt{[d^2 - 4 \times Mu / (1.7 \times fck \times B \times \Phi)]}}{2 \times fy / (1.7 \times fck \times B)}$$

= 15.903 mm²

④ 수평인장 철근(An)의 설계

Nuc = 0.20 x 76.800 = 15.360 kN

An = Nuc / (Φ x fy) = 48.000 mm²

⑤ 주인장철근(As)의 산정

주인장철근의 단면적은 (Af + An)과 (2/3 Avf + An) 중 큰값을 취한다.

→ As = 162.286 ㎟

As(min) = 0.04 x (fck / fy) x B x d

= 0.04 x (27 / 400) x 1000.000 x 520.000

= 1404.000 ㎟

Use As = 2292.800 ㎟ (철근도심 80.00 mm)

1단 : H19- 8.0EA , d1 = 80.00 mm

Use As ≥ 162.286 ㎟ , 1404.000 ㎟ ∴ O.K

⑥ 폐쇄 스터럽,띠철근(Ah)의 산정

Ah = 0.5 x (As - An) = 0.5 x (162.286 - 48.000)

= 57.143 ㎟

사용철근량 (1단) : H13 - 2.0 EA = 253.400 ㎟

철근의 배치 범위 : 2/3 d = 2/3 x 520.00 = 346.67 mm구간에 1.0 단 설치

▶ 사용철근량(1.0단) : H13 - 2.00 EA = 253.400 ㎟ ≥ 57.143 ㎟ ∴ O.K

1.27.5 강재 지지대

1. 설 계 조 건

1) 사 용 재 료 강 도

(1) 콘크리트
- 강 도 : fck = 27 MPa
- 탄성계수 : Ec = 27.8 x 10^5 MPa --- 도.설 2.3.3

(2) 철 근 (SD- 40)
- 항복강도 : fy = 400 MPa
- 탄성계수 : Es = 2.00 x 10^7 MPa --- 도.설 2.3.3

(3) 강 재 (SS- 400) 베이스 플레이트 : SS 400
- 탄성계수 : Ets = 2.05 x 10^7 MPa

2) 허 용 응 력

(1) 콘크리트 --- 도.설 4.5.2
- 허용휨압축응력 : fca = 0.4·fck = 10.8 MPa
- 허용전단응력 : τca = 0.08·Γfck = 0.473 MPa

(2) 철 근 --- 도.설 4.5.2.2
- 허용인장응력 : fsa = 160 MPa (충돌,지진영향무시)

(3) 강 재
- 허용휨인장응력 : fta = 161 MPa --- 도.설 3.3.2 (15%할증, 도.설2.2.2)
- 허용전단응력 : τta = 92 MPa --- 도.설 3.3.2 (15%할증, 도.설2.2.2)

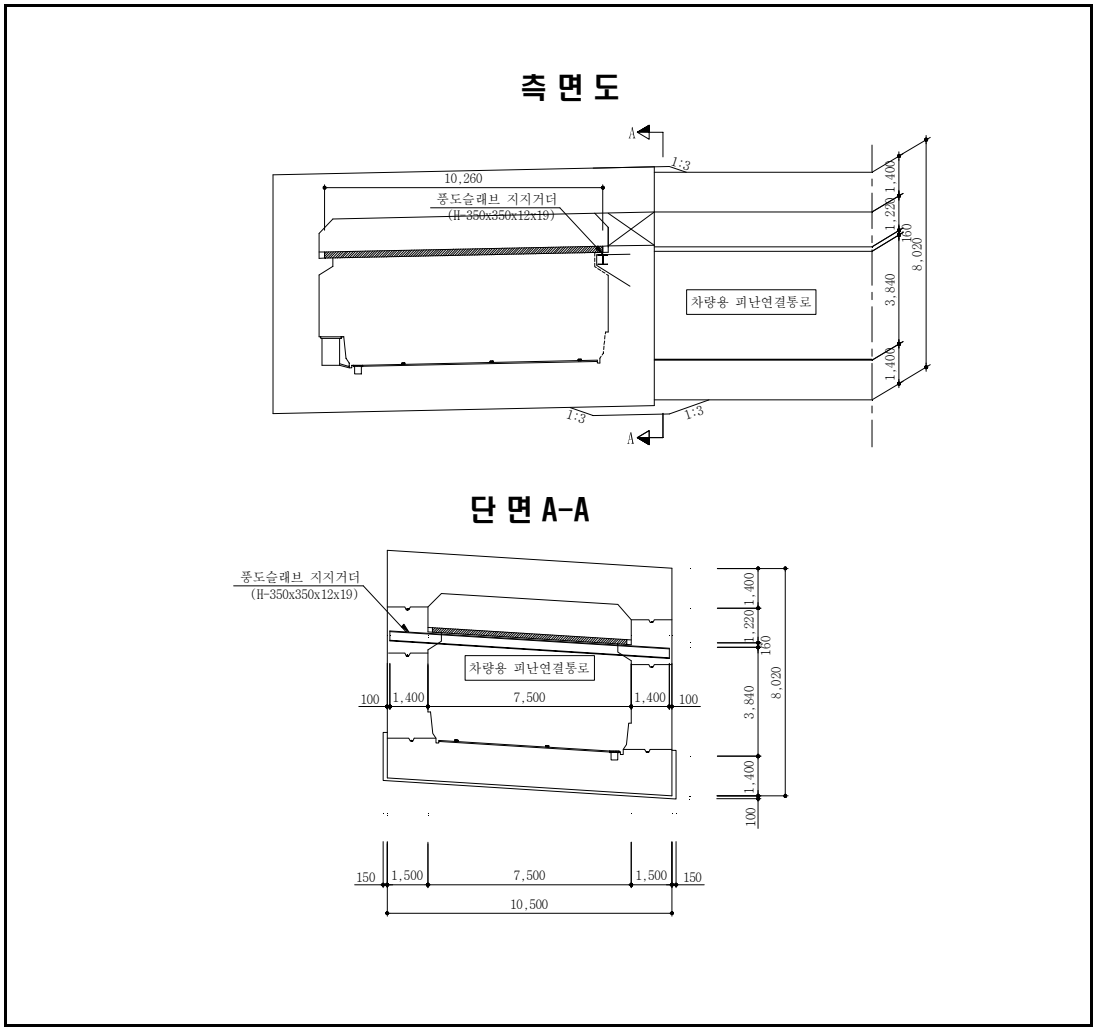
- 거더 (H-BEAM) 제원 : H- 350 x 350 x 12 x 19

단면적	전단면적	단면 2차모멘트		회 전 반 경		단 면 계 수		단위중량
(A)	(Aw)	Ix	Iy	rx	ry	Zx	Zy	(W)
mm²	mm²	mm⁴	mm⁴	mm	mm	mm³	mm³	KN/m
17,390	3,744	403,000,000	136,000,000	152	88	2,300,000	776,000	1.37

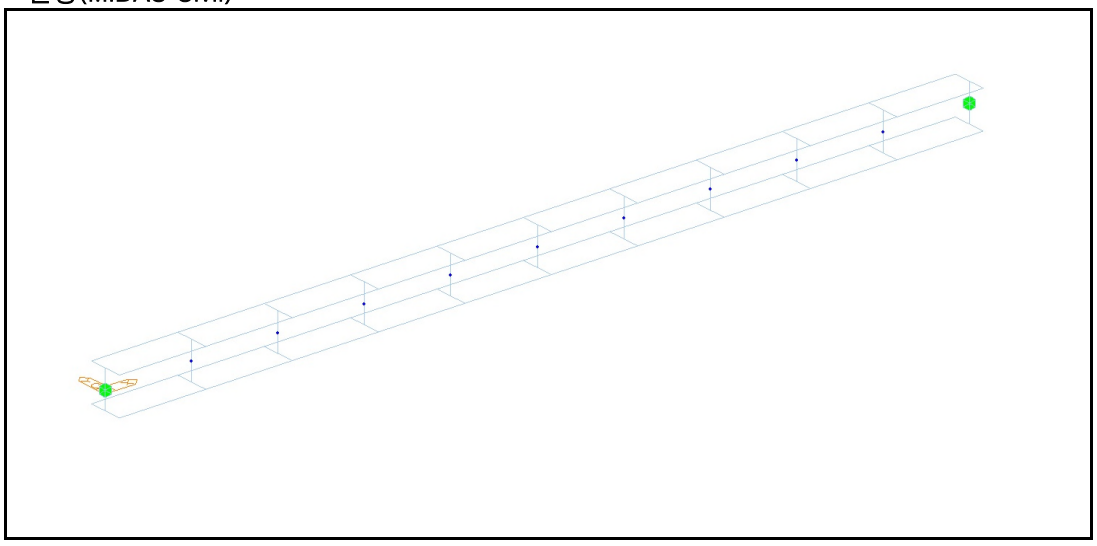
3) 참 고 문 헌

(1) 도로교 설계기준 : 한국도로교통협회
(2) 콘크리트 표준 시방서 : 한국콘크리트학회
(3) 철근 콘크리트 설계편람 : 건 교 부
(4) 도 로 설 계 요 령 : 한국도로공사

2. 가정단면

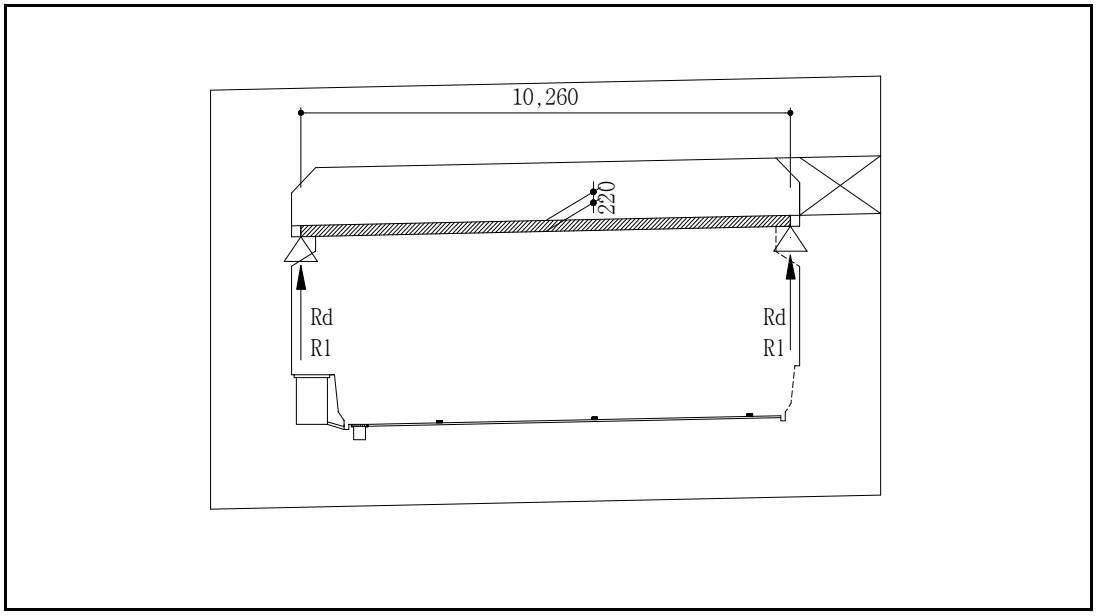


3. 모델링(MIDAS Civil)



4. 하중산정

4.1 하중산정



① 거더 자중 : 프로그램 상에서 Self Weight 기능을 이용하여 자동 고려

② 고정하중 반력

Wd	=	1.000	×	0.220	×	25.000	=	5.500	kN/m
Rd	=	5.500	×	10.260	/	2.000	=	28.215	kN/m

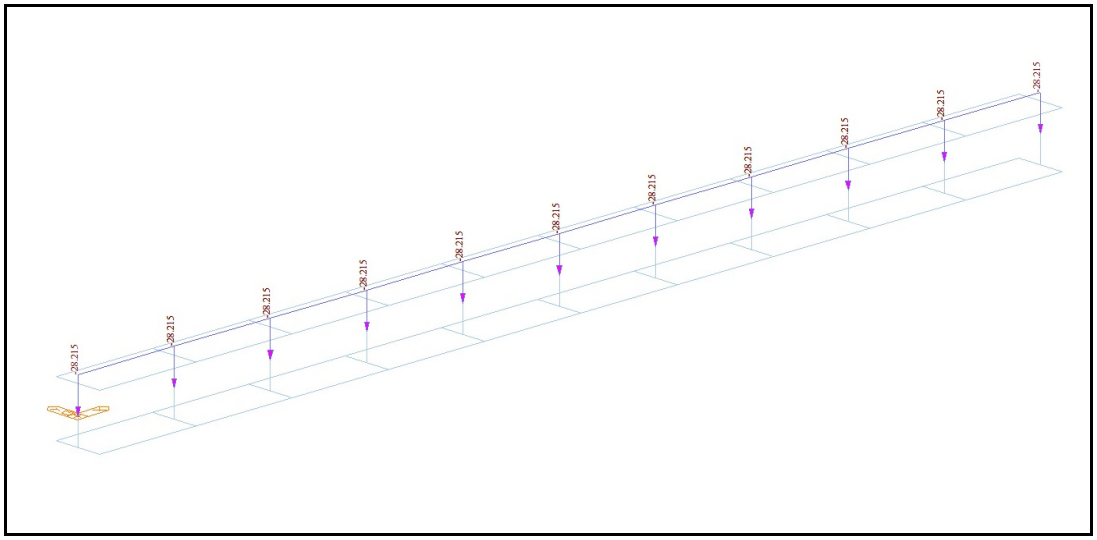
③ 활하중 반력

: 작업하중 및 풍압등을 고려하여 5.0KN/㎡을 재하

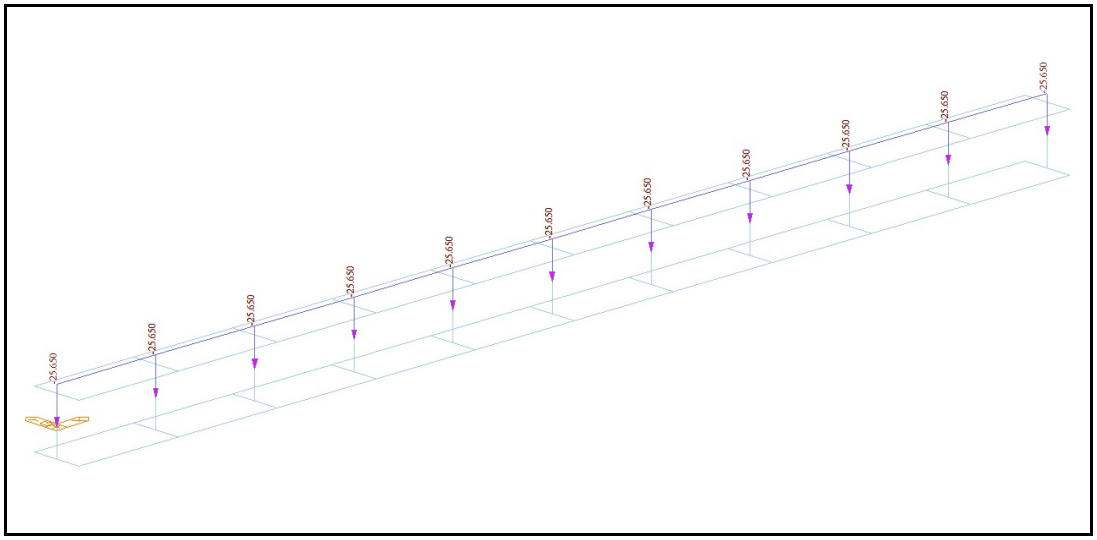
Wl	=	1.000	×	1.000	×	5.000	=	5.000	kN/m
Rl	=	5.000	×	10.260	/	2.000	=	25.650	kN/m

4.2 하중재하도

① 고정하중

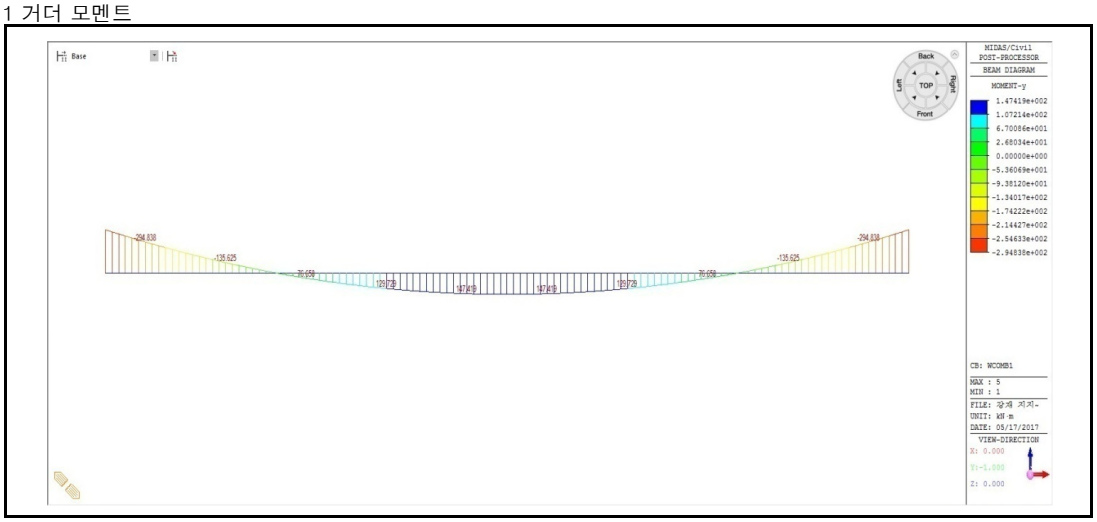


② 활하중

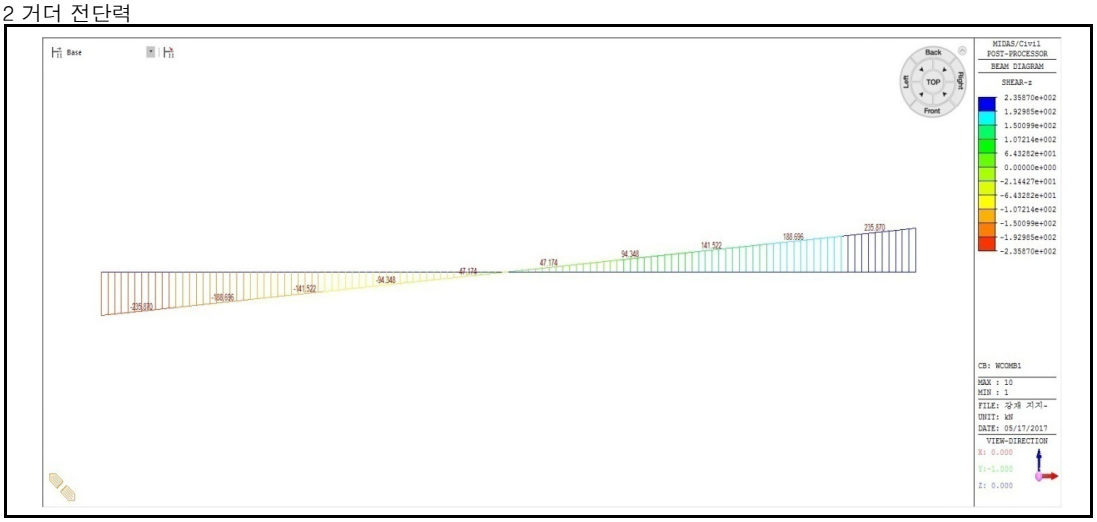


5. 해석결과

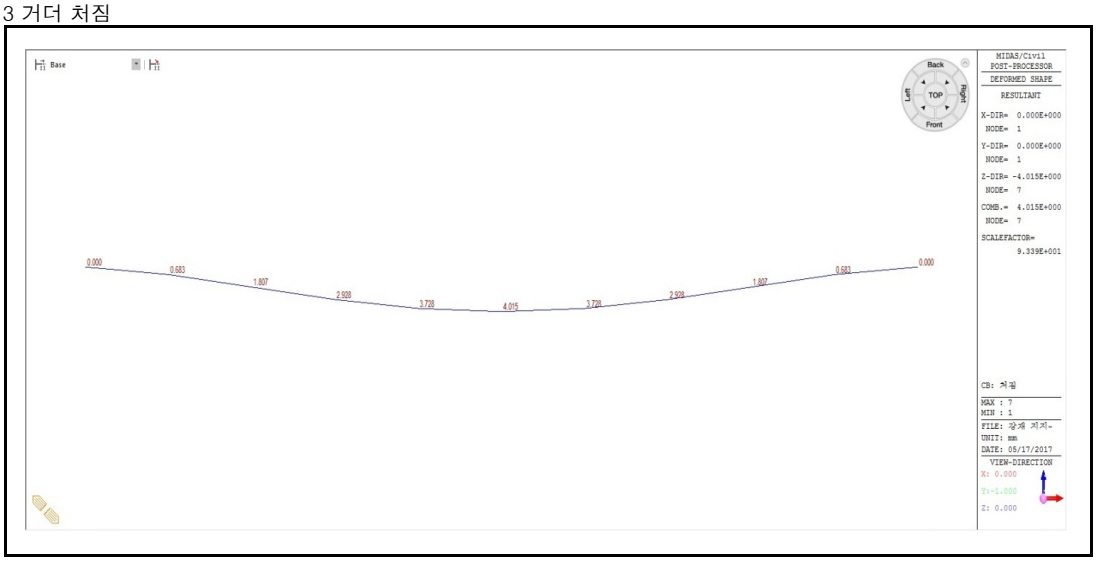
5.1 거더 모멘트



5.2 거더 전단력



5.3 거더 처짐



6. 응력검토

1) 설 계 제 원

▣ 사용 강재 :		H - 350 x 350 x 12.0 x 19				
▣ 단면 제원 :						
A =	17390.0	mm^2		rx =	152.00	mm
w =	1.370	kN/m		ry =	88.40	mm
Ix =	403000000.0	mm^4		Zx =	2300000.0	mm^3
Iy =	136000000.0	mm^4		Zy =	776000.0	mm^3

2) 단면력 산정(전산해석 output참조)

Mmax = 294.838 kN·m

Smax = 235.870 kN

3) 작용 응력 산정

(1) 휨 응 력

fb = Mmax / Zx = 294,838,000.0 / 2,300,000.0 = 128.2 MPa

(2) 전 단 응 력

v = Smax / Aw = 235,870.0 / [(350.0 - 19.0 x 2) x 12)] = 63.0 MPa

4) 허용응력 산정

(1) 허용 휨응력

fba = 161.0 MPa

(2) 허용 전단응력

va = 92.0 MPa

5) 응력 검토

휨 응 력	fba =	161.0 MPa	>	fb =	128.2 MPa	O.K !
전단응력	va =	92.0 MPa	>	v =	63.0 MPa	O.K !

7. 처짐 검토

충격하중을 포함한 활하중에 의한 각 위치별 최대 처짐량 (전산 OUTPUT 참조) (☞ 도.설 3.2.3)

< Girder > (단위 : mm)

절점NO.	1	2	3	4	5	6
처 짐 량	0.000	0.683	1.807	2.928	3.728	4.015

◈ 허용 처짐량

지간 길이 L = 7.5 m

δ1 = 4.015 < δa = L / 600 = 7.50 m / 600 = 12.50 O.K

8. 전산 OUTPUT

```
*****************************************************************************************************
**         MIDAS/Civil V.8.5.5    Modeling, Integrated Design & Analysis Software              **
**                        CIVIL STRUCTURE DESIGN SYSTEM                                      **
*****************************************************************************************************

              XXX   XXX     XX    XXXXXXXX      XXXXXXX    XXXXXXXX
              XXXX XXXX     XX    XX     XX     XX   XX    XX    XX
              XX XXX XX     XX    XX     XX     XX   XX    XX
              XX  X  XX     XX    XX     XX     XXXXXXX    XXXXXXXX
              XXX    XX    XXX    XXX    XX     XX   XX        XXX
              XXX    XX    XXX    XXX    XX    XXX   XX    XX   XXX
              XXX    XX    XXX    XXX    XX    XXX   XX    XX   XXX
              XXX    XX    XXX    XXXXXXXX     XXX   XX    XXXXXXXX  /Civil

                          VERSION 8.5.5

             COPYRIGHT (C) SINCE 1989. MIDAS Information Technology Co.,Ltd.
                          ALL RIGHTS RESERVED.              MIDAS TEAM

*****************************************************************************************************


                          ANALYSIS RESULT OUTPUTS

                          ________________________


LOAD SET FOR DISPLACMENT OUTPUT - Load Set 1
_____________________________________________________________________________________________


<< LOAD COMBI/CASE/ENVEL ABBREVIATION TABLE >>

  ABBREVIATION    FULL NAME                      TYPE           DESCRIPTION

  ------------  ------------------------------ ----------- ----------------------------------------
   No Abbreviation was made in this Load Set. All names are less than 8 char.'s

  ------------  ------------------------------ ----------- ----------------------------------------


<< SELECTED LOAD CASE/COMBINATION DETAIL LIST >>


[Selected Load Combinations]

   L. COMB    TYPE                          COMBINATION DETAIL
   --------- ---------- ------------------------------------------------------------------------------
   WCOMB1     Gen.Comb      1.000 x 자중     +  1.300 x 활하중
   처짐       Gen.Comb      1.300 x 활하중


_____________________________________________________________________________________________


LOAD SET FOR REACTION OUTPUT - Load Set 1
_____________________________________________________________________________________________


<< LOAD COMBI/CASE/ENVEL ABBREVIATION TABLE >>
```

ABBREVIATION	FULL NAME	TYPE	DESCRIPTION
No Abbreviation was made in this Load Set. All names are less than 8 char.'s			

<< SELECTED LOAD CASE/COMBINATION DETAIL LIST >>

[Selected Load Combinations]

L. COMB	TYPE	COMBINATION DETAIL
WCOMB1	Gen.Comb	1.000 x 자중 + 1.300 x 활하중
처짐	Gen.Comb	1.300 x 활하중

LOAD SET FOR ELEMENT OUTPUTS - Load Set 1

<< LOAD COMBI/CASE/ENVEL ABBREVIATION TABLE >>

ABBREVIATION	FULL NAME	TYPE	DESCRIPTION
No Abbreviation was made in this Load Set. All names are less than 8 char.'s			

<< SELECTED LOAD CASE/COMBINATION DETAIL LIST >>

[Selected Load Combinations]

L. COMB	TYPE	COMBINATION DETAIL
WCOMB1	Gen.Comb	1.000 x 자중 + 1.300 x 활하중
처짐	Gen.Comb	1.300 x 활하중

NODE DISPLACEMENT AND ROTATIONS DEFAULT PRINTOUT Unit System : kN , m

---

NODE	LC	UX	UY	UZ	RX	RY	RZ
1	WCOMB1	0.000	0.000	0.000	0.0	0.0	0.0
	처짐	0.000	0.000	0.000	0.0	0.0	0.0
2	WCOMB1	0.000	0.000	0.000	0.0	0.0	0.0

	처짐	0.000	0.000	0.000	0.0	0.0	0.0
3	WCOMB1	0.000	0.000	−0.001	0.0	0.0	0.0
	처짐	0.000	0.000	−0.001	0.0	0.0	0.0
4	WCOMB1	0.000	0.000	−0.003	0.0	0.0	0.0
	처짐	0.000	0.000	−0.002	0.0	0.0	0.0
5	WCOMB1	0.000	0.000	−0.006	0.0	0.0	0.0
	처짐	0.000	0.000	−0.003	0.0	0.0	0.0
6	WCOMB1	0.000	0.000	−0.007	0.0	0.0	0.0
	처짐	0.000	0.000	−0.004	0.0	0.0	0.0
7	WCOMB1	0.000	0.000	−0.008	0.0	0.0	0.0
	처짐	0.000	0.000	−0.004	0.0	0.0	0.0
8	WCOMB1	0.000	0.000	−0.007	0.0	−0.0	0.0
	처짐	0.000	0.000	−0.004	0.0	−0.0	0.0
9	WCOMB1	0.000	0.000	−0.006	0.0	−0.0	0.0
	처짐	0.000	0.000	−0.003	0.0	−0.0	0.0
10	WCOMB1	0.000	0.000	−0.003	0.0	−0.0	0.0
	처짐	0.000	0.000	−0.002	0.0	−0.0	0.0
11	WCOMB1	0.000	0.000	−0.001	0.0	−0.0	0.0
	처짐	0.000	0.000	−0.001	0.0	−0.0	0.0

BEAM ELEMENT FORCES & MOMENTS DEFAULT PRINTOUT Unit System : kN , m

---

ELEM	MAT	SEC	LC	PT	AXIAL	SHEAR-y	SHEAR-z	TORSION	MOMENT-y	MOMENT-z
1	1	1	WCOMB1	I	0.0	0.0	−235.9	0.0	−294.8	0.0
				J	0.0	0.0	−188.7	0.0	−135.6	0.0
			처짐	I	0.0	0.0	−125.0	0.0	−156.3	0.0
				J	0.0	0.0	−100.0	0.0	−71.9	0.0
2	1	1	WCOMB1	I	0.0	0.0	−188.7	0.0	−135.6	0.0
				J	0.0	0.0	−141.5	0.0	−11.8	0.0
			처짐	I	0.0	0.0	−100.0	0.0	−71.9	0.0
				J	0.0	0.0	−75.0	0.0	−6.3	0.0
3	1	1	WCOMB1	I	0.0	0.0	−141.5	0.0	−11.8	0.0
				J	0.0	0.0	−94.3	0.0	76.7	0.0
			처짐	I	0.0	0.0	−75.0	0.0	−6.3	0.0
				J	0.0	0.0	−50.0	0.0	40.6	0.0
4	1	1	WCOMB1	I	0.0	0.0	−94.3	0.0	76.7	0.0
				J	0.0	0.0	−47.2	0.0	129.7	0.0
			처짐	I	0.0	0.0	−50.0	0.0	40.6	0.0
				J	0.0	0.0	−25.0	0.0	68.8	0.0
5	1	1	WCOMB1	I	0.0	0.0	−47.2	0.0	129.7	0.0
				J	0.0	0.0	0.0	0.0	147.4	0.0

			처짐	I	0.0	0.0	-25.0	0.0	68.8	0.0
				J	0.0	0.0	0.0	0.0	78.2	0.0
6	1	1	WCOMB1	I	0.0	0.0	0.0	0.0	147.4	0.0
				J	0.0	0.0	47.2	0.0	129.7	0.0
			처짐	I	0.0	0.0	0.0	0.0	78.2	0.0
				J	0.0	0.0	25.0	0.0	68.8	0.0
7	1	1	WCOMB1	I	0.0	0.0	47.2	0.0	129.7	0.0
				J	0.0	0.0	94.3	0.0	76.7	0.0
			처짐	I	0.0	0.0	25.0	0.0	68.8	0.0
				J	0.0	0.0	50.0	0.0	40.6	0.0
8	1	1	WCOMB1	I	0.0	0.0	94.3	0.0	76.7	0.0
				J	0.0	0.0	141.5	0.0	-11.8	0.0
			처짐	I	0.0	0.0	50.0	0.0	40.6	0.0
				J	0.0	0.0	75.0	0.0	-6.3	0.0
9	1	1	WCOMB1	I	0.0	0.0	141.5	0.0	-11.8	0.0
				J	0.0	0.0	188.7	0.0	-135.6	0.0
			처짐	I	0.0	0.0	75.0	0.0	-6.3	0.0
				J	0.0	0.0	100.0	0.0	-71.9	0.0
10	1	1	WCOMB1	I	0.0	0.0	188.7	0.0	-135.6	0.0
				J	0.0	0.0	235.9	0.0	-294.8	0.0
			처짐	I	0.0	0.0	100.0	0.0	-71.9	0.0
				J	0.0	0.0	125.0	0.0	-156.3	0.0

BEAM ELEMENT FORCES & MOMENTS MIN/MAX SUMMARY BY PROPERTY PRINTOUT Unit System : kN , m

---

* LENGTH : the length of between two nodes

[SECTION NAME : H 350x350x12/19 , SECTION ID : 1 , SECTION SHAPE : H]
[SECTION SIZE] H:0.35 B1:0.35 tw:0.012 tf1:0.019 B2:0 tf2:0
** MAX

ELEM	COM	LC	PT	AXIAL	SHEAR-y	SHEAR-z	TORSION	MOMENT-y	MOMENT-z	LENGTH
1	AXL	WCOMB1	1 I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75
1	SHY	WCOMB1	1 I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75
10	SHZ	WCOMB1	1 J	0.0	0.0	235.9	0.0	-294.8	0.0	0.75
1	TOR	WCOMB1	1 I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75
5	MTY	WCOMB1	1 J	0.0	0.0	0.0	0.0	147.4	0.0	0.75
1	MTZ	WCOMB1	1 I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75

** MIN

ELEM	COM	LC	PT	AXIAL	SHEAR-y	SHEAR-z	TORSION	MOMENT-y	MOMENT-z	LENGTH
1	AXL	WCOMB1	1 I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75

1 SHY	WCOMB1	1	I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75	
1 SHZ	WCOMB1	1	I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75	
1 TOR	WCOMB1	1	I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75	
1 MTY	WCOMB1	1	I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75	
1 MTZ	WCOMB1	1	I	0.0	0.0	-235.9	0.0	-294.8	0.0	0.75	

BEAM ELEMENT STRESSES DEFAULT PRINTOUT Unit System : kN , m

ELEM	MAT	SEC	LC	PT	AXIAL	SHEAR-y	SHEAR-z	(+y)-BENDING-(-y)	(+z)-BENDING-(-z)
1	1	1	WCOMB1	I	0.0	0.0	-60801.0	0.0	0.0 128031.3 -128031.3
				J	0.0	0.0	-48640.8	0.0	0.0 58894.4 -58894.4
			처짐	I	0.0	0.0	-32232.9	0.0	0.0 67874.2 -67874.2
				J	0.0	0.0	-25786.3	0.0	0.0 31222.2 -31222.2
2	1	1	WCOMB1	I	0.0	0.0	-48640.8	0.0	0.0 58894.4 -58894.4
				J	0.0	0.0	-36480.6	0.0	0.0 5121.3 -5121.3
			처짐	I	0.0	0.0	-25786.3	0.0	0.0 31222.2 -31222.2
				J	0.0	0.0	-19339.7	0.0	0.0 2715.0 -2715.0
3	1	1	WCOMB1	I	0.0	0.0	-36480.6	0.0	0.0 5121.3 -5121.3
				J	0.0	0.0	-24320.4	0.0	0.0 -33288.1 33288.1
			처짐	I	0.0	0.0	-19339.7	0.0	0.0 2715.0 -2715.0
				J	0.0	0.0	-12893.2	0.0	0.0 -17647.3 17647.3
4	1	1	WCOMB1	I	0.0	0.0	-24320.4	0.0	0.0 -33288.1 33288.1
				J	0.0	0.0	-12160.2	0.0	0.0 -56333.8 56333.8
			처짐	I	0.0	0.0	-12893.2	0.0	0.0 -17647.3 17647.3
				J	0.0	0.0	-6446.6	0.0	0.0 -29864.7 29864.7
5	1	1	WCOMB1	I	0.0	0.0	-12160.2	0.0	0.0 -56333.8 56333.8
				J	0.0	0.0	0.0	0.0	0.0 -64015.6 64015.6
			처짐	I	0.0	0.0	-6446.6	0.0	0.0 -29864.7 29864.7
				J	0.0	0.0	0.0	0.0	0.0 -33937.1 33937.1
6	1	1	WCOMB1	I	0.0	0.0	0.0	0.0	0.0 -64015.6 64015.6
				J	0.0	0.0	12160.2	0.0	0.0 -56333.8 56333.8
			처짐	I	0.0	0.0	0.0	0.0	0.0 -33937.1 33937.1
				J	0.0	0.0	6446.6	0.0	0.0 -29864.7 29864.7
7	1	1	WCOMB1	I	0.0	0.0	12160.2	0.0	0.0 -56333.8 56333.8
				J	0.0	0.0	24320.4	0.0	0.0 -33288.1 33288.1
			처짐	I	0.0	0.0	6446.6	0.0	0.0 -29864.7 29864.7
				J	0.0	0.0	12893.2	0.0	0.0 -17647.3 17647.3
8	1	1	WCOMB1	I	0.0	0.0	24320.4	0.0	0.0 -33288.1 33288.1
				J	0.0	0.0	36480.6	0.0	0.0 5121.3 -5121.3
			처짐	I	0.0	0.0	12893.2	0.0	0.0 -17647.3 17647.3
				J	0.0	0.0	19339.7	0.0	0.0 2715.0 -2715.0
9	1	1	WCOMB1	I	0.0	0.0	36480.6	0.0	0.0 5121.3 -5121.3
				J	0.0	0.0	48640.8	0.0	0.0 58894.4 -58894.4
			처짐	I	0.0	0.0	19339.7	0.0	0.0 2715.0 -2715.0

				J	0.0	0.0	25786.3	0.0	0.0	31222.2 -31222.2
10	1	1	WCOMB1	I	0.0	0.0	48640.8	0.0	0.0	58894.4 -58894.4
				J	0.0	0.0	60801.0	0.0	0.0	128031.3 -128031.3
			처짐	I	0.0	0.0	25786.3	0.0	0.0	31222.2 -31222.2
				J	0.0	0.0	32232.9	0.0	0.0	67874.2 -67874.2

BEAM ELEMENT STRESSES MIN/MAX SUMMARY BY PROPERTY PRINTOUT Unit System : kN , m

---

[SECTION NAME : H 350x350x12/19 , SECTION ID : 1 , SECTION SHAPE : H]
[SECTION SIZE] H:0.35 B1:0.35 tw:0.012 tf1:0.019 B2:0 tf2:0

** MAX

ELEM	COM	LC	PT	AXIAL	SHEAR-y	SHEAR-Z	(+y)-BENDING-(-y)	(+z)-BENDING-(-z)		
1	AXL	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
1	SHY	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
10	SHZ	WCOMB1	1 J	0.0	0.0	60801.0	0.0	0.0	128031.3	-128031.3
1	BY+	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
1	BY-	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
1	BZ+	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
5	BZ-	WCOMB1	1 J	0.0	0.0	0.0	0.0	0.0	-64015.6	64015.6

** MIN

ELEM	COM	LC	PT	AXIAL	SHEAR-y	SHEAR-Z	(+y)-BENDING-(-y)	(+z)-BENDING-(-z)		
1	AXL	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
1	SHY	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
1	SHZ	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
1	BY+	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
1	BY-	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3
5	BZ+	WCOMB1	1 J	0.0	0.0	0.0	0.0	0.0	-64015.6	64015.6
1	BZ-	WCOMB1	1 I	0.0	0.0	-60801.0	0.0	0.0	128031.3	-128031.3

REACTION FORCES & MOMENTS DEFAULT PRINTOUT Unit System : kN , m

---

Node	LC	FX	FY	FZ	MX	MY	MZ
1	WCOMB1	0.0	0.0	235.9	0.0	-294.8	0.0
	처짐	0.0	0.0	125.0	0.0	-156.3	0.0
2	WCOMB1	0.0	0.0	235.9	0.0	294.8	0.0
	처짐	0.0	0.0	125.0	0.0	156.3	0.0

SUMMATION OF REACTION FORCES

LC	SUM-FX	SUM-FY	SUM-FZ

WCOMB1	0.0	0.0	471.7
처짐	0.0	0.0	250.1

REACTION FORCES & MOMENTS LOCAL PRINTOUT Unit System : kN , m

Node	LC	FX	FY	FZ	MX	MY	MZ

1.28 지하차도 입구 마감벽

목 차

1. 설계개요 및 조건

2. 단면가정

3. 구조해석모델링

4. 하중산정

5. 하중조합

6. 구조해석결과

7. 단면설계

8. 단면설계 요약

9. 우각부보강설계

10. 사용성검토

11. 주철근조립도

1. 설계개요 및 조건

1.1 개요

• Plane Strain의 평면 판요소로 해석

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 단위중량

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	24.5	아스팔트 포장	23.0
흙(지하수위 이상)	19.0	흙(지하수위 이하)	10.0
물	10.0	모르타르	21.5
기계실하중	25.0	무근콘크리트	23.0

(3) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,700 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(4) 토사 내부마찰각 : Φ = 30°

(5) 토압 : K_o = 0.500

1.4 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

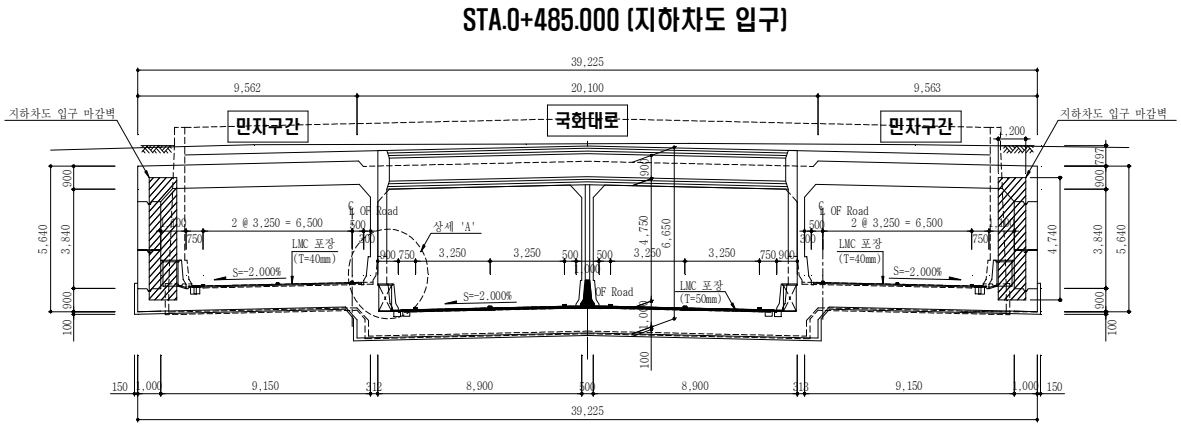
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

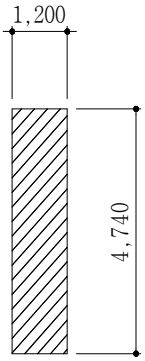
(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면가정

설계적용 토피 = 1.000 m



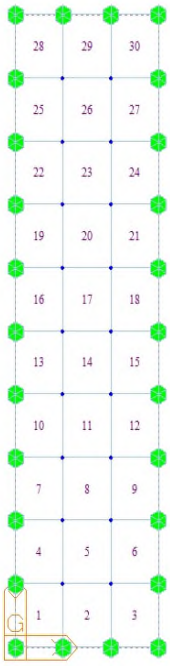


3. 구조해석 모델링

3.1 해석모형

절점

부재 및 경계조건



3.2 단면제원

번 호	폭(m)	높이(m)	단면적(m²)	단면2차모멘트(m⁴)	비 고
1	1.00	0.70	0.700	0.028583	마감벽

4. 하중산정

4.1 고정하중

- 구조물자중 (프로그램에서 자동재하)

4.2 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 1.000 / 1.200 = 0.833

- 노면 활하중 (DB-24) Lv = 39.000 kN/m²

  Lh1 = 0.500 × 39.000 = 19.500 kN/m²

4.3 수평토압(지하수 無) ---------- LC 2

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + (0.500 + 0.900 / 2) × 19.000)

= 14.775 kN/m²

$q_{N2'}$ = 14.775 + 4.740 × 19.000 × 0.500 = 59.805 kN/m²

4.4 수평 토압(지하수 有) ---------- LC 3

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 19.000 +

(0.000 + 0.900 / 2) × 10.000) = 12.750 kN/m²

q_{N2} = 12.750 + 4.740 × 10.000 × 0.500 = 36.450 kN/m²

4.5 수평 수압(지하수 有) ---------- LC 4

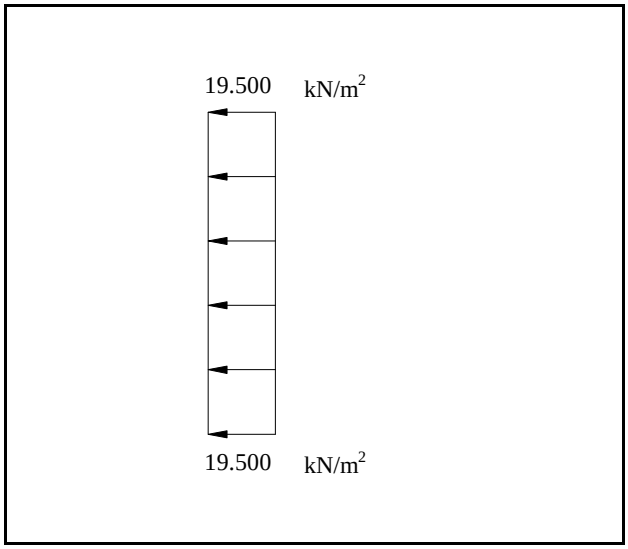
1) 벽체

q_{W1} = 10.000 × (0.000 + 0.900 / 2) = 4.500 kN/m²

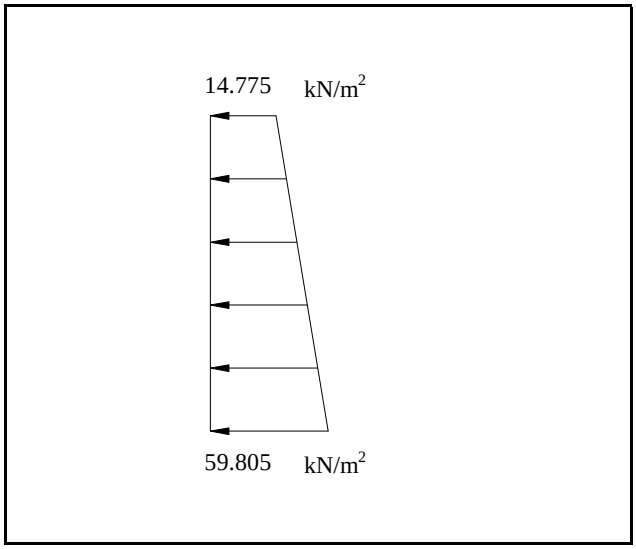
q_{W2} = 4.500 + 4.740 × 10.000 = 51.900 kN/m²

4.6 하중재하도

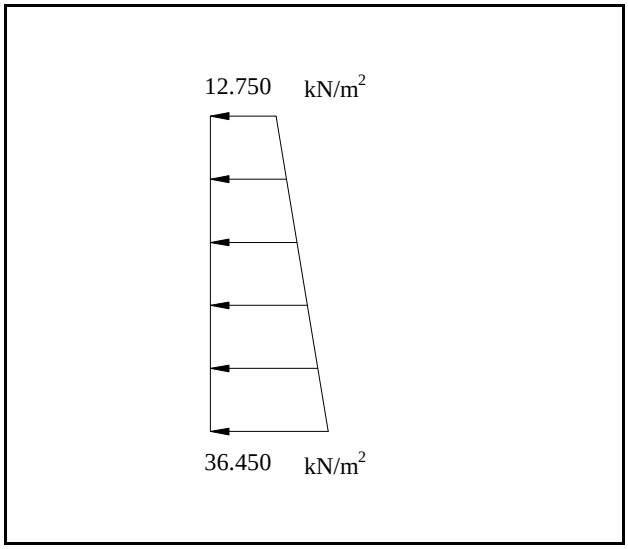
1) 활하중에 의한 측압 ------- LC 1



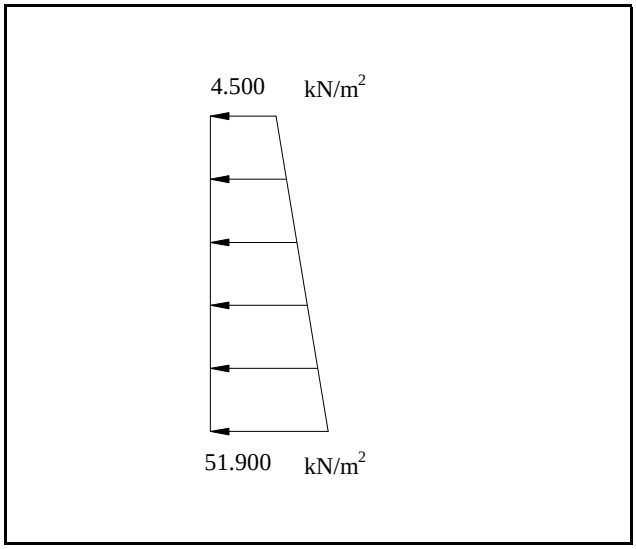
2) 수평 토압(지하수 무) ------- LC 2



3) 수평 토압(지하수 유) ------- LC 3



4) 수평 수압(지하수 유) ------- LC 4



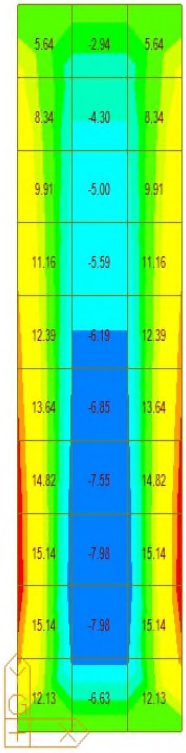
5. 하중조합

하중 조합	활하중	지하수 없을때	지하수 있을때		비고
	수평	수평 토압	수평 토압	수평 수압	
	LC01	LC02	LC03	LC04	
CB01	1.60	1.60			극한하중 조합
CB02		1.60			
CB03	1.60		1.60	1.60	
CB4			1.60	1.60	
CB5	1.00	1.00			사용하중 조합
CB6		1.00			
CB7	1.00		1.00	1.00	
CB8			1.00	1.00	

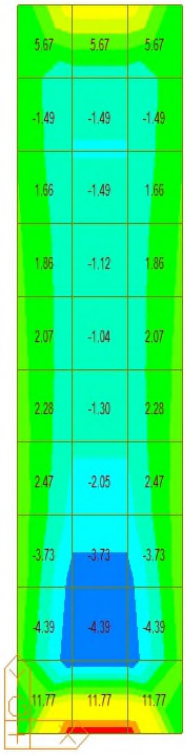
6. 구조해석 결과

6.1 부재력도

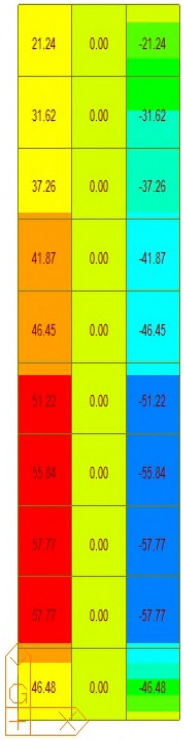
B.M.D (계수하중) [kN·m] : Mxx



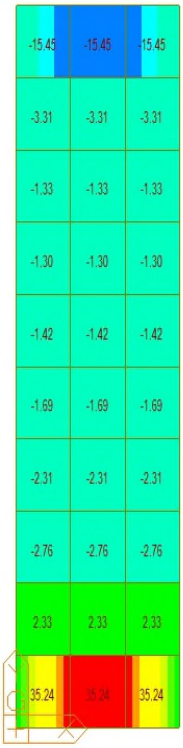
B.M.D (계수하중) [kN·m] : Myy



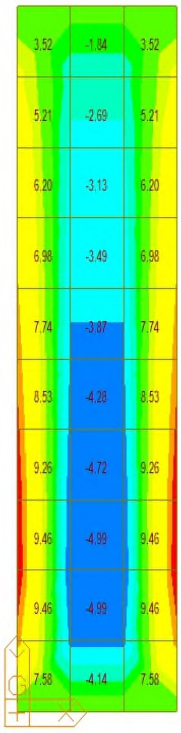
S.F.D (계수하중) [kN] : Vxx



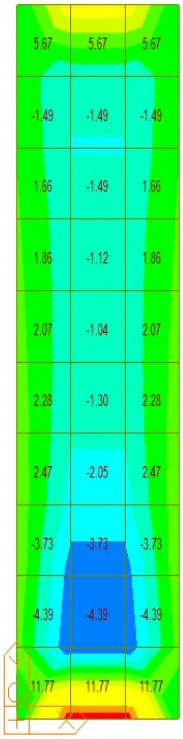
S.F.D (계수하중) [kN] : Vyy



B.M.D (사용하중) [kN·m] : Mxx



B.M.D (사용하중) [kN·m] : Myy



6.2 부재력 집계

구분		계수하중			사용하중	
		Mu(kN·m)	Pu(kN)	Vu(kN)	Mo(kN·m)	Po(kN)
벽체 Mxx	단 부	15.140		57.770	9.460	
	중앙부	7.980			4.990	
벽체 Myy	상 부	5.670		15.450	3.540	
	중앙부	4.390			2.750	
	하 부	11.770		35.240	7.360	

7. 단면검토

1) 벽체 단부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 99.061 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	9.5
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	700.0	600.0	100.0	15.140	57.770

전단설계시 단면의 유효높이 ds = 600.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 3.33ea = 662.000 ㎟

∴ P = As / (B × D) = 0.00110

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 11.538 mm

최외단 인장철근 변형률 εt = 0.12961 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 133749513 N·mm

= 133.750 kN·m > 15.140 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 74.296 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 389.711 kN

∴ 전단철근이 필요없음.

2) 벽체 중앙부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 50.501 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	5.0
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	700.0	620.0	80.0	7.980	0.000

전단설계시 단면의 유효높이 ds = 620.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 3.33ea = 662.000 ㎟

∴ P = As / (B × D) = 0.00107

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 11.538 mm

최외단 인장철근 변형률 εt = 0.13403 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 138251113 N·mm

= 138.251 kN·m > 7.980 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ／ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 37.876 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 402.702 kN

∴ 전단철근이 필요없음.

3) 벽체 상부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 37.074 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	3.5
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	700.0	600.0	100.0	5.670	15.450

전단설계시 단면의 유효높이 ds = 600.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 3.33ea = 662.000 ㎟

∴ P = As / (B × D) = 0.00110

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 11.538 mm

최외단 인장철근 변형률 εt = 0.12961 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 133749513 N·mm

= 133.750 kN·m > 5.670 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 27.805 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 389.711 kN

∴ 전단철근이 필요없음.

4) 벽체 중앙부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 27.775 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	2.8
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	700.0	620.0	80.0	4.390	0.000

전단설계시 단면의 유효높이 ds = 620.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 3.33ea = 662.000 ㎟

∴ P = As / (B × D) = 0.00107

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 11.538 mm

최외단 인장철근 변형률 εt = 0.13403 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 138251113 N·mm

= 138.251 kN·m > 4.390 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 20.832 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 402.702 kN

∴ 전단철근이 필요없음.

5) 벽체 하부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 76.993 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	7.4
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	700.0	600.0	100.0	11.770	35.240

전단설계시 단면의 유효높이 ds = 600.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 3.33ea = 662.000 ㎟

∴ P = As / (B × D) = 0.00110

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 11.538 mm

최외단 인장철근 변형률 εt = 0.12961 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 133749513 N·mm

= 133.750 kN·m > 11.770 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 57.745 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 389.711 kN

∴ 전단철근이 필요없음.

8. 단면설계요약

1) 휨설계 요약

구분		Mu (kN·m)	Pu (kN)	사용철근				ΦMn (kN·m)	ΦPn (kN)	안전율	비고
				1단		2단					
벽체 Mxx	단 부	15.140		H16	300	H0	0	133.750		8.83	O.K
	중앙부	7.980		H16	300	H0	0	138.251		17.32	O.K
벽체 Myy	상 부	5.670		H16	300	H0	0	133.750		23.59	O.K
	중앙부	4.390		H16	300	H0	0	138.251		31.49	O.K
	하 부	11.770		H16	300	H0	0	133.750		11.36	O.K

2) 전단설계 요약

구분		Vu (kN·m)	사용철근			ΦVn (kN·m)	안전율	비고
			직경	개수	간격			
벽체 Mxx	단 부	57.770	H13	1.7EA	300	전단철근 필요없음		
	중앙부	0.000	H13	1.7EA	300	전단철근 필요없음		
벽체 Myy	상 부	15.450	H13	1.7EA	300	전단철근 필요없음		
	중앙부	0.000	H13	1.7EA	300	전단철근 필요없음		
	하 부	35.240	H13	1.7EA	300	전단철근 필요없음		

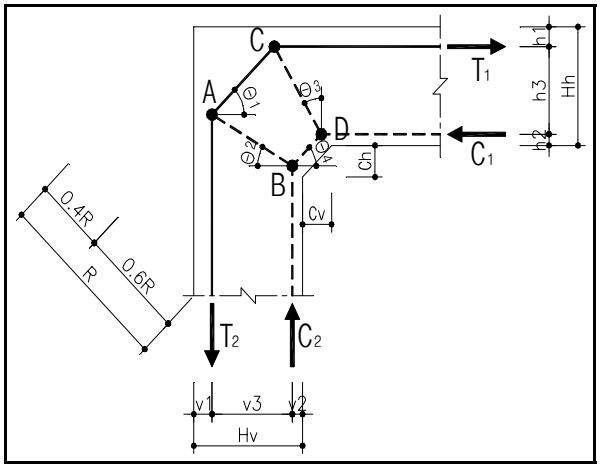
9. 우각부 보강 설계 (스트럿-타이 모델 해석에 의한 라멘접합부 보강)

9.1 벽체 Mxx (단부)

(1) 계산조건

슬래브두께	H_h	=	700.00 mm	벽체 높이	H_v	=	700.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	520.00 mm	벽체측 우력 거리	v_3	=	520.00 mm
수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	15.140 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 989.95 mm

② 사잇각

Θ_1 = 45.00°

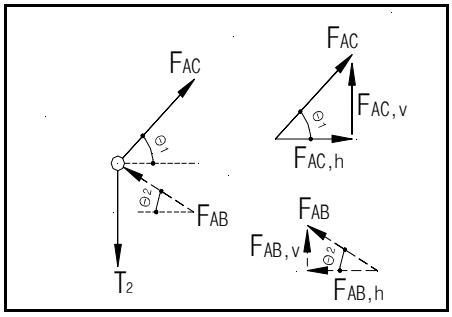
Θ_2 = 17.70°

Θ_3 = 17.70°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

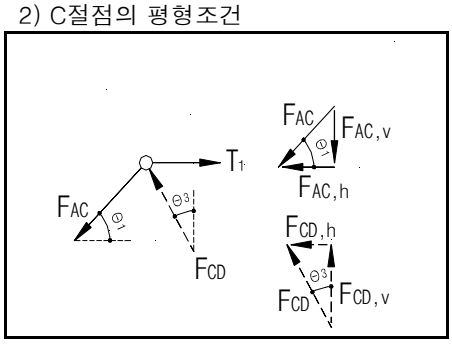
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\Theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\Theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\epsilon = F_{CD} \cdot \cos\Theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \dfrac{\sin\Theta_1}{\cos\Theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \dfrac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \dfrac{M_u}{h_3} = \dfrac{15.140}{0.520} =$ 29.115 kN

$T_2 = \dfrac{M_u}{v_3} = \dfrac{15.140}{0.520} =$ 29.115 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \dfrac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 31.212 kN

식 ⑥ 으로부터

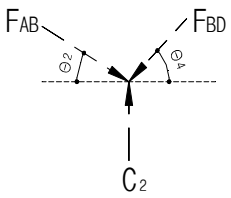
$F_{AC} = \dfrac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 31.212 kN

따라서 $F_{AC} =$ **31.212** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 23.167 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 31.212 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 23.167 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	31.212	타이
AB	-23.167	스트럿
BD	-31.212	스트럿
CD	-23.167	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 31.212 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{31,211.652}{0.85 \times 400} = 91.80 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	16	@	600	=	331.00	mm^2	(2 cycle)
우각부철근 As	= H	0	@	0	=	0.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**331.00**	mm^2	

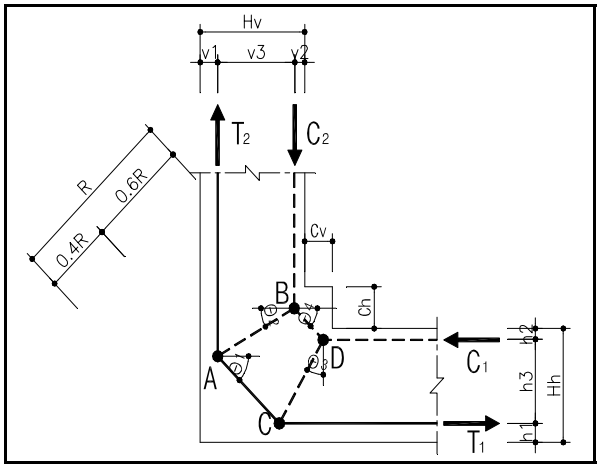
$A_{s,used}$ = 331.00 mm^2 > 91.80 mm^2 ……O.K

9.2 벽체 Myy (상부)

(1) 계산조건

슬래브두께	H_h	=	700.00 mm	벽체 높이	H_v	=	900.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	520.00 mm	벽체측 우력 거리	v_3	=	720.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	5.670 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1140.18 mm

② 사잇각

θ_1 = 45.00°

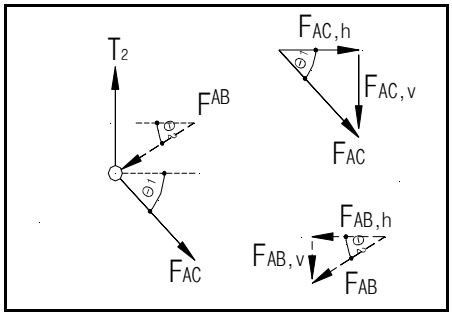
θ_2 = 6.83°

θ_3 = 28.83°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

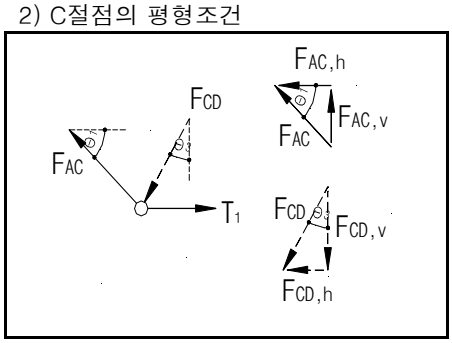
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$

$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{5.670}{0.520} =$ 10.904 kN

$T_2 = \frac{M_u}{v_3} = \frac{5.670}{0.720} =$ 7.875 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 9.946 kN

식 ⑥ 으로부터

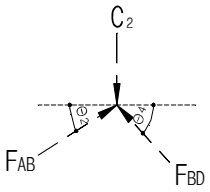
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 9.946 kN

따라서 $F_{AC} =$ **9.946** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 7.083 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 9.946 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 8.028 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	9.946	타이
AB	-7.083	스트럿
BD	-9.946	스트럿
CD	-8.028	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 9.946 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{9,945.838}{0.85 \times 400} = 29.25 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	16	@	600	=	331.00	mm^2	(2 cycle)
우각부철근 As	= H	0	@	0	=	0.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**331.00**	mm^2	

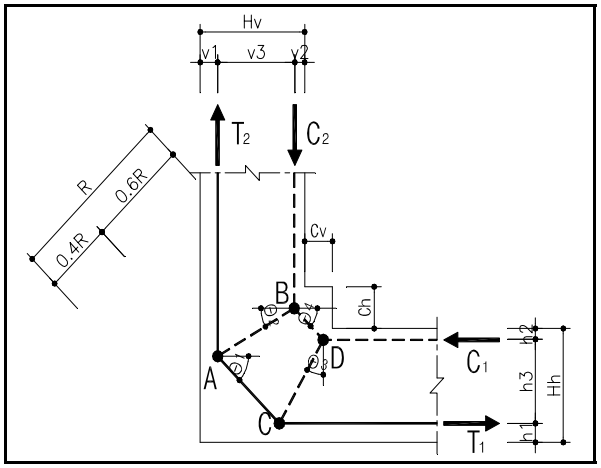
$A_{s,used}$ = 331.00 mm^2 > 29.25 mm^2 ……O.K

9.3 벽체 Myy (하부)

(1) 계산조건

슬래브두께	H_h	=	700.00 mm	벽체 높이	H_v	=	900.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	520.00 mm	벽체측 우력 거리	v_3	=	720.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	11.770 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1140.18 mm

② 사잇각

Θ_1 = 45.00°

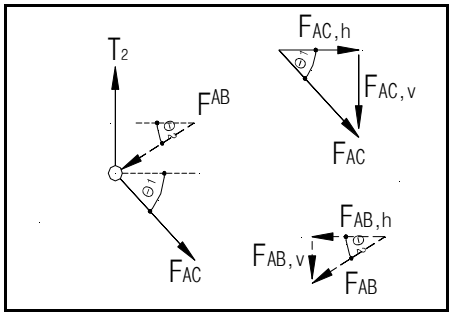
Θ_2 = 6.83°

Θ_3 = 28.83°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

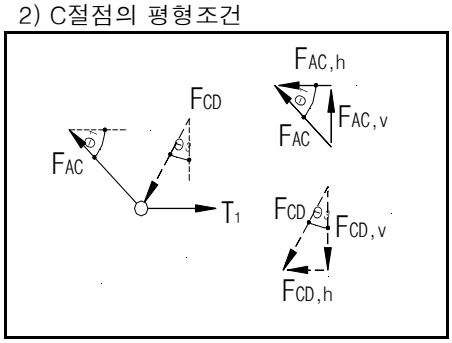
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\Theta$ => $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{11.770}{0.520} =$ 22.635 kN

$T_2 = \frac{M_u}{v_3} = \frac{11.770}{0.720} =$ 16.347 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 20.646 kN

식 ⑥ 으로부터

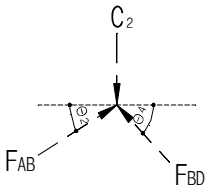
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 20.646 kN

따라서 $F_{AC} =$ **20.646** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 14.703 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 20.646 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 16.664 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	20.646	타이
AB	-14.703	스트럿
BD	-20.646	스트럿
CD	-16.664	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 20.646 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{20,645.946}{0.85 \times 400} = 60.72 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	16	@	600	=	331.00	mm^2	(2 cycle)
우각부철근 As	= H	0	@	0	=	0.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**331.00**	mm^2	

$A_{s,used}$ = 331.00 mm^2 > 60.72 mm^2 ……O.K

10. 사용성 검토

10.1 처짐 검토

1) Mxx 벽체 : 최소부재두께 적용

철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	1.200	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.050	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.050m	<	H	=	0.700m	(처짐검토 생략)

2) Myy 벽체 : 최소부재두께 적용

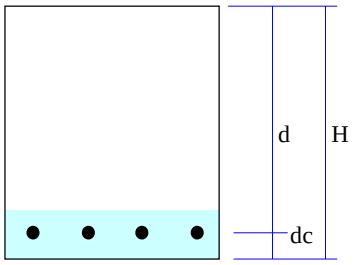
철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	4.740	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.198	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.198m	<	H	=	0.700m	(처짐검토 생략)

10.2 균열 검토

1) 벽체 단부(Mxx) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	700.00	mm,	B =	1000.00	mm ,
d =	600.00	mm,	dc =	100.00	mm ,
Mo =	9.460	kN· m,	As =	662.000	mm^2
N =	3.33		n =	7	

- 응력산정

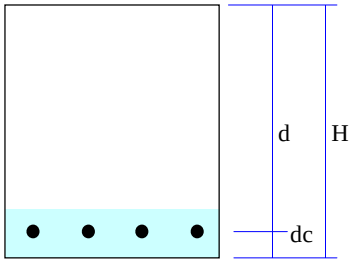
x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	70.081	mm
f s = M / (As (d - x / 3))	=	24.782	mm
f st = fs (H -Dc_min - x) / (D - x)	=	24.782	mm

- 철근의 최대 중심간격

Cc = 100 - 16 / 2	=	92.000	mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]	=	2542.213	mm

최외단철근 평균배근간격; 1000 / 3.3 = 300 mm < 2542.213 mm **O.K!!**

2) 벽체 중앙부(Mxx) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	700.00	mm,	B =	1000.00	mm ,
d =	620.00	mm,	dc =	80.00	mm ,
Mo =	4.990	kN· m,	As =	662.000	mm^2
N =	3.33		n =	7	

- 응력산정

$x = -(n \cdot As / b) + (n \cdot As / b \cdot \sqrt{(1 + (2 \cdot b \cdot d / n \cdot As))}$ = 71.311 mm

$f_s = M / (As (d - x / 3))$ = 12.642 mm

$f_{st} = fs (H - Dc_min - x) / (D - x)$ = 12.642 mm

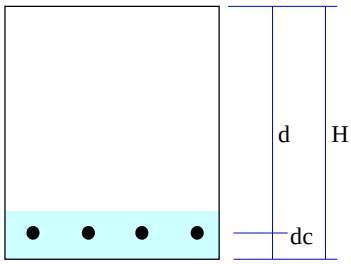
- 철근의 최대 중심간격

Cc = 80 - 16 / 2 = 72.000 mm

S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)] = 6644.317 mm

최외단철근 평균배근간격; 1000 / 3.3 = 300 mm < 6644.317 mm **O.K!!**

3) 벽체 상부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	700.00	mm,	B =	1000.00	mm ,
d =	600.00	mm,	dc =	100.00	mm ,
Mo =	3.540	kN· m,	As =	662.000	mm^2
N =	3.33		n =	7	

- 응력산정

$x = -(n \cdot As / b) + (n \cdot As / b \cdot \sqrt{(1 + (2 \cdot b \cdot d / n \cdot As))}$ = 70.081 mm

$f_s = M / (As (d - x / 3))$ = 9.273 mm

$f_{st} = fs (H - Dc_min - x) / (D - x)$ = 9.273 mm

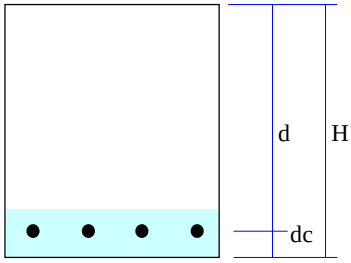
- 철근의 최대 중심간격

Cc = 100 - 16 / 2 = 92.000 mm

S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)] = 6793.599 mm

최외단철근 평균배근간격; 1000 / 3.3 = 300 mm < 6793.599 mm **O.K!!**

4) 벽체 중앙부(Myy) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	700.00	mm,	B =	1000.00	mm ,
d =	620.00	mm,	dc =	80.00	mm ,
Mo =	2.750	kN· m,	As =	662.000	mm^2
N =	3.33		n =	7	

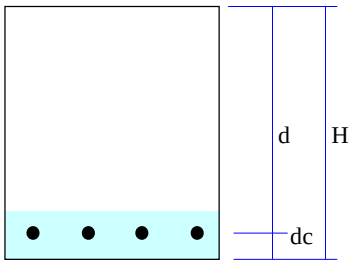
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	71.311	mm	
f s = M / (As (d - x / 3))	=	6.967	mm	
f st = fs (H -Dc_min - x) / (D - x)	=	6.967	mm	

- 철근의 최대 중심간격

Cc = 80 - 16 / 2	=	72.000	mm			
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]	=	12056.415	mm			
최외단철근 평균배근간격; 1000 / 3.3 =	300	mm	<	12056.415	mm	O.K!!

5) 벽체 하부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	700.00	mm,	B =	1000.00	mm ,
d =	600.00	mm,	dc =	100.00	mm ,
Mo =	7.360	kN· m,	As =	662.000	mm^2
N =	3.33		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	70.081	mm	
f s = M / (As (d - x / 3))	=	19.280	mm	
f st = fs (H -Dc_min - x) / (D - x)	=	19.280	mm	

- 철근의 최대 중심간격

Cc = 100 - 16 / 2	=	92.000	mm			
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]	=	3267.573	mm			
최외단철근 평균배근간격; 1000 / 3.3 =	300	mm	<	3267.573	mm	O.K!!

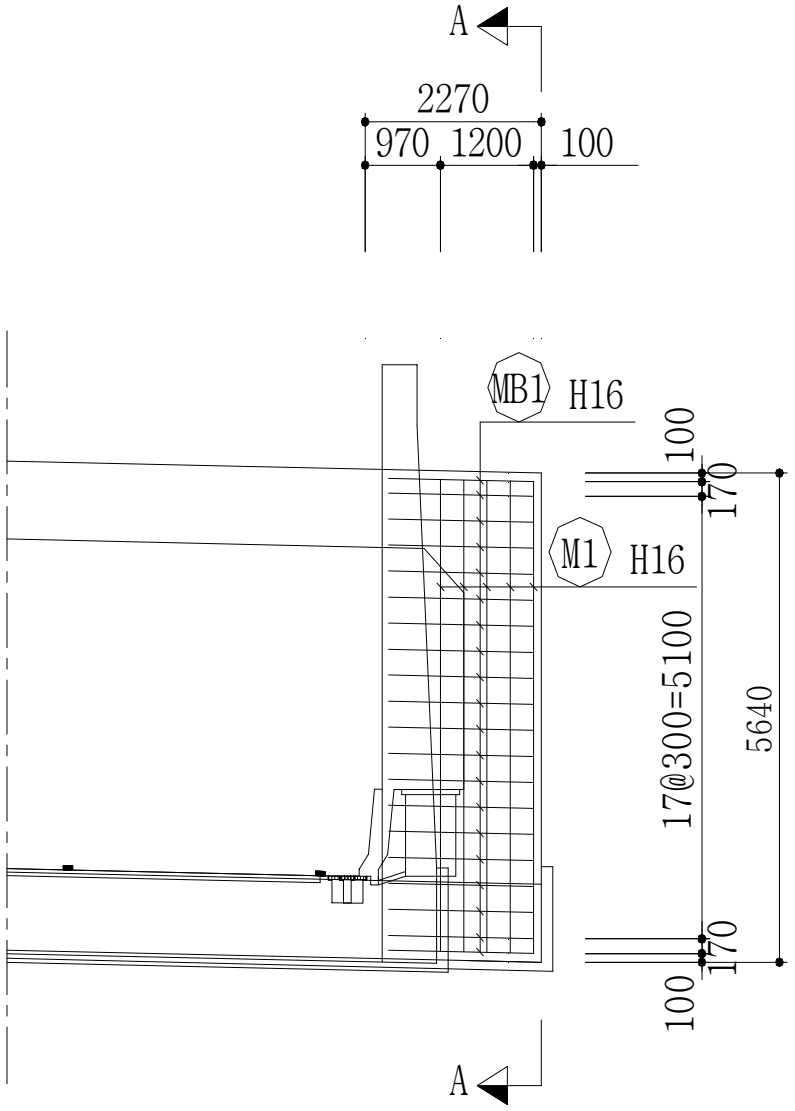
10.3 사용성검토 요약

1) 균열검토 요약

구분		Mo (kN·m)	주철근 (mm)	fs (Mpa)	Cc (mm)	S (mm)	Smin (mm)	비고
벽체 Mxx	단 부	9.460	H16	25	92.0	300	2542	**O.K**
	중앙부	4.990	H16	13	72.0	300	6644	**O.K**
벽체 Myy	상 부	3.540	H16	9	92.0	300	6794	**O.K**
	중앙부	2.750	H16	7	72.0	300	12056	**O.K**
	하 부	7.360	H16	19	92.0	300	3268	**O.K**

11. 주철근 조립도

주철근 조립도



제2장 집수정

2.1 집수정 단면
2.2 점검통로 단면 A-A
2.3 점검통로 단면 C-C
2.4 점검통로 단면 D-D
2.5 점검통로 단면 E-E
2.6 점검통로 단면 F-F
2.7 보강거더 #1,#2
2.8 강거더 #3,#4
2.9 보강거더 #5,#6
2.10 집수정 마감벽
2.11 집수정 점검통로 마감벽 #1
2.12 집수정 점검통로 마감벽 #2
2.13 집수정 점검통로 마감벽 #3
2.14 내부계단 및 월류벽

2.1 집수정 단면

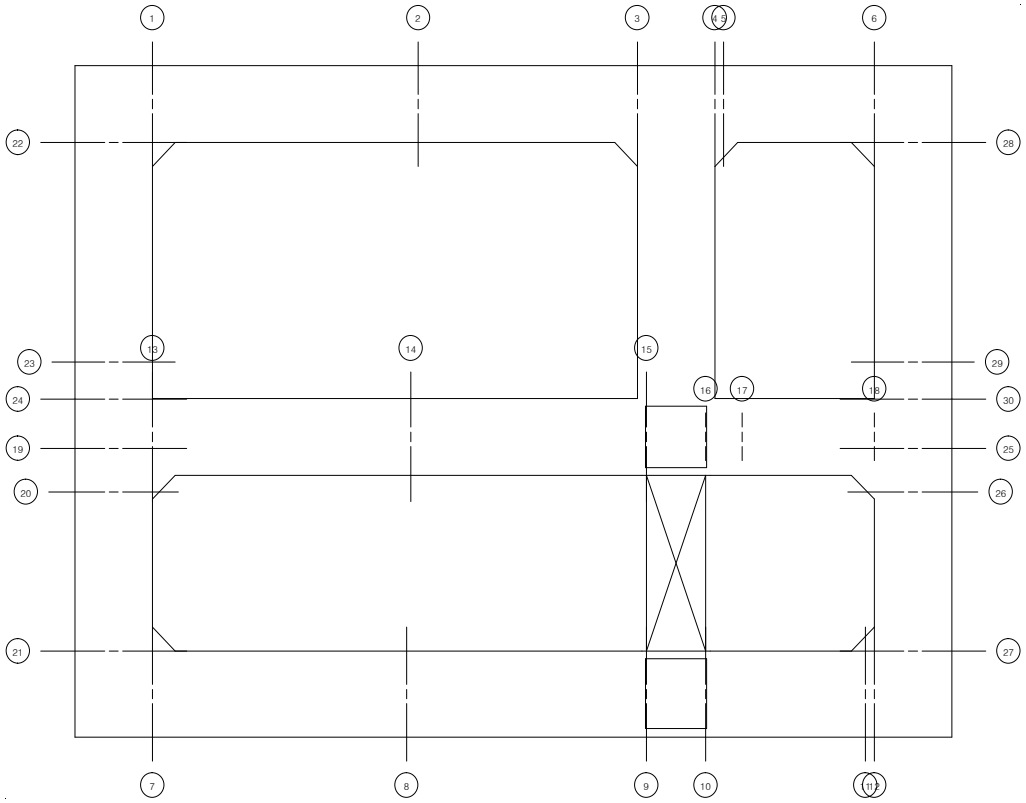
BOX 구조계산서

▣ STA. 1K+231.400 (BLOCK1 : 단면 A-A)
▣ 토 피(FH) = 10.60 m ▣ 선 형 = ∞
▣ 지반 조건 : 토사
▣ 구조형식 : 지중 2 련
(내공 : 2@(10.65M × 10.605M), 사각 : 90°)

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. 단면력정리
16. 단면검토 및 철근량 산정
17. 수평철근 검토
18. 거더,기둥,내측벽체 검토
19. 절점부 검토
20. 사용성 검토
21. STM-우각부
22. 기초 지지력 검토
23. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qu(kN)	Qa(kN)	비 고
직접기초	389.968	1200	700.0	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	4543.962	7605.084	1.674	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1622	4140.59	5946.49	7838.49	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.44
		중앙부	2	1000	1520	2563.64	3163.93	5110.32	H32 - 8.0EA	6353.60	1.23
		우측	3	1000	1667	2387.58	3480.76	4310.53	H32 - 8.0EA	6353.60	1.46
	2경간	좌측	4	1000	1667	901.22	3480.76	1603.84	H32 - 8.0EA	6353.60	3.86
		중앙부	5	1000	1520	612.07	2046.21	1192.49	H25 - 8.0EA	4053.60	3.34
		우측	6	1000	1667	2153.12	3480.76	3878.27	H32 - 8.0EA	6353.60	1.62
하부슬래브	1경간	좌측	7	1000	1822	5017.40	6728.00	8440.34	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.34
		중앙부	8	1000	1670	3492.33	5523.05	6361.84	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.58
		우측	9	1000	1700	2013.26	2892.20	3547.67	H29 - 8.0EA	5139.20	1.44
	2경간	좌측	10	1000	1700	1959.05	2892.20	3450.39	H29 - 8.0EA	5139.20	1.48
		중앙부	11	1000	1720	685.83	2927.15	1179.82	H29 - 8.0EA	5139.20	4.27
		우측	12	1000	1817	4132.19	6035.60	6919.70	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.46
중간슬래브	1경간	좌측	13	1000	1687	1529.26	2868.90	2704.49	H29 - 8.0EA	5139.20	1.88
		중앙부	14	1000	1520	876.54	2577.68	1712.92	H29 - 8.0EA	5139.20	2.94
		우측	15	1000	1520	903.53	2577.68	1766.21	H29 - 8.0EA	5139.20	2.85
	2경간	좌측	16	1000	1520	439.62	2577.68	854.86	H29 - 8.0EA	5139.20	5.86
		중앙부	17	1000	1520	772.55	2577.68	1507.92	H29 - 8.0EA	5139.20	3.34
		우측	18	1000	1687	1449.67	2868.90	2561.82	H29 - 8.0EA	5139.20	1.98

좌측벽체	1층	상부 (외측)	19	1000	1767	860.41	6643.75	-	H25 - 8.0EA	10407.20	7.72
		상부 (내측)	19	1000	1620	1724.40	8549.85	-	H32 - 8.0EA	10407.20	4.96
		중앙부	20	1000	1620	811.51	5775.18	-	H32 - 8.0EA	10407.20	7.12
		하부	21	1000	1722	5152.86	12060.21	-	H32 - 8.0EA + H29 - 8.0EA	17846.40	2.34
	2층	상부	22	1000	1717	4316.31	10328.62	-	H32 - 4.0EA + H25 - 4.0EA + H29 - 8.0EA	16696.40	2.39
		중앙부	23	1000	1620	2204.55	8879.03	-	H32 - 8.0EA	10407.20	4.03
		하부 (외측)	24	1000	1767	372.37	3453.82	-	H25 - 8.0EA	10407.20	9.28
		하부 (내측)	24	1000	1620	2899.57	8493.72	-	H32 - 8.0EA	10407.20	2.93
우측벽체	1층	상부 (외측)	25	1000	1728	1081.15	10019.93	-	H25 - 8.0EA + H29 - 4.0EA	11762.40	9.27
		상부 (내측)	25	1000	1620	1957.96	8130.57	-	H29 - 8.0EA	11762.40	4.15
		중앙부	26	1000	1620	1274.10	9005.28	-	H29 - 8.0EA	11762.40	7.07
		하부	27	1000	1717	3464.13	10712.47	-	H29 - 8.0EA + H29 - 8.0EA	15417.60	3.09
	2층	상부	28	1000	1767	1969.85	7837.22	-	H25 - 4.0EA + H32 - 4.0EA	10342.80	3.98
		중앙부	29	1000	1620	1684.12	8040.84	-	H29 - 8.0EA	9192.80	4.78
		하부 (외측)	30	1000	1767	558.57	7592.42	-	H25 - 8.0EA	9192.80	13.59
		하부 (내측)	30	1000	1620	2012.37	7086.99	-	H29 - 8.0EA	9192.80	3.52

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부 슬래브	1 경간	좌측	1	1800.0	2647.3	O.K	1567.7	1986.0	O.K
		중앙부	2	1800.0	1986.0	O.K	1022.1	1324.7	O.K
		우측	3	1800.0	1986.0	O.K	862.1	1324.7	O.K
	2 경간	좌측	4	1800.0	1986.0	O.K	320.8	1324.7	O.K
		중앙부	5	1800.0	1986.0	O.K	238.5	661.3	O.K
		우측	6	1800.0	1986.0	O.K	775.7	1324.7	O.K
하부 슬래브	1 경간	좌측	7	1800.0	2647.3	O.K	1688.1	1986.0	O.K
		중앙부	8	1800.0	2647.3	O.K	1272.4	1986.0	O.K
		우측	9	1800.0	1986.0	O.K	709.5	1324.7	O.K
	2 경간	좌측	10	1800.0	2647.3	O.K	690.1	1986.0	O.K
		중앙부	11	1800.0	2647.3	O.K	236.0	661.3	O.K
		우측	12	1800.0	2647.3	O.K	1383.9	1986.0	O.K
중간 슬래브	1 경간	좌측	13	1800.0	1986.0	O.K	540.9	1324.7	O.K
		중앙부	14	1800.0	1986.0	O.K	342.6	1324.7	O.K
		우측	15	1800.0	1986.0	O.K	353.2	1324.7	O.K
	2 경간	좌측	16	1800.0	1986.0	O.K	171.0	661.3	O.K
		중앙부	17	1800.0	1986.0	O.K	301.6	661.3	O.K
		우측	18	1800.0	1986.0	O.K	512.4	661.3	O.K
좌측 벽체	1 층	1층(상부)	19	1800.0	1986.0	O.K	0.0	1324.7	O.K
		1층(상부)	19	1800.0	1986.0	O.K	0.0	661.3	O.K
		1층(중앙부)	20	1800.0	1986.0	O.K	0.0	661.3	O.K
		1층(하부)	21	1800.0	3310.7	O.K	0.0	1986.0	O.K
	2 층	2층(상부)	22	1800.0	3310.7	O.K	0.0	1986.0	O.K
		2층(중앙부)	23	1800.0	1986.0	O.K	0.0	661.3	O.K
		2층(하부)	24	1800.0	1986.0	O.K	0.0	1324.7	O.K
		2층(하부)	24	1800.0	1986.0	O.K	0.0	661.3	O.K
우측 벽체	1 층	1층(상부)	25	1800.0	3310.7	O.K	0.0	1986.0	O.K
		1층(상부)	25	1800.0	3310.7	O.K	0.0	1324.7	O.K
		1층(중앙부)	26	1800.0	3310.7	O.K	0.0	1324.7	O.K
		1층(하부)	27	1800.0	3310.7	O.K	0.0	1986.0	O.K
	2 층	2층(상부)	28	1800.0	1986.0	O.K	0.0	1324.7	O.K
		2층(중앙부)	29	1800.0	1986.0	O.K	0.0	661.3	O.K
		2층(하부)	30	1800.0	1986.0	O.K	0.0	1324.7	O.K
		2층(하부)	30	1800.0	1986.0	O.K	0.0	661.3	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	945.2	1666.3	2101.31	2.00	247.74	H16	150	397.20	O.K
		우측	3	974.3	1351.6	2165.88	2.00	125.79	H16	150	397.20	O.K
	2경간	좌측	4	974.3	1075.1	2165.88	2.00	33.61	H16	150	397.20	O.K
		중앙부	5	987.3	947.1	2194.76	2.00	-	H16	150	397.20	O.K
		우측	6	974.3	1226.2	2165.88	2.00	83.96	H16	150	397.20	O.K
하부슬래브	1경간	좌측	7	1075.1	1934.7	2390.10	2.00	259.66	H16	150	397.20	O.K
		우측	9	1104.2	1279.2	2454.66	2.00	51.47	H16	150	397.20	O.K
	2경간	좌측	10	1104.2	635.9	2454.66	2.00	-	H16	150	397.20	O.K
		중앙부	11	1117.2	1727.1	2483.54	2.00	177.29	H16	150	397.20	O.K
		우측	12	1071.7	663.6	2382.47	2.00	-	H16	150	397.20	O.K
중간슬래브	1경간	좌측	13	987.3	608.7	2194.76	2.00	-	H16	150	397.20	O.K
		우측	15	987.3	503.9	2194.76	2.00	-	H16	150	397.20	O.K
	2경간	좌측	16	987.3	1229.9	1591.01	2.00	159.61	H16	300	397.20	O.K
		중앙부	17	987.3	1185.7	2194.76	2.00	65.28	H16	150	397.20	O.K
		우측	18	987.3	1252.0	1591.01	2.00	174.14	H16	300	397.20	O.K
좌측벽체	1층	상부	19	1191.4	1664.3	2462.44	2.00	147.80	H16	150	397.20	O.K
		중앙부	20	1208.2	1390.8	2495.17	2.00	56.34	H16	150	397.20	O.K
		하부	21	1167.3	1792.8	2402.85	2.00	201.09	H16	150	397.20	O.K
	2층	상부	22	1118.0	1677.7	1733.77	2.00	361.06	H16	300	397.20	O.K
		중앙부	23	1178.7	1100.1	2465.66	2.00	131.25	H16	150	397.20	O.K
		하부	24	1165.9	1206.8	1801.43	2.00	25.55	H16	300	397.20	O.K
우측벽체	1층	상부	25	1104.2	1317.2	1724.29	2.00	136.46	H16	300	397.20	O.K
		중앙부	26	1147.7	1228.8	2434.65	2.00	25.04	H16	150	397.20	O.K
		하부	27	1105.5	1445.4	1721.12	2.00	219.34	H16	300	397.20	O.K
	2층	상부	28	1108.8	1275.6	1744.31	2.00	104.24	H16	300	397.20	O.K
		중앙부	29	1133.1	522.4	2420.08	2.00	-	H16	150	397.20	O.K
		하부	30	1120.9	590.6	1756.40	2.00	262.50	H16	300	397.20	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	1622	H32 - 8.0EA + H29 - 8.0EA	125	236.294	O.K	1.890
		중앙부	2	1520	H32 - 8.0EA	125	218.307	O.K	1.746
		우측	3	1667	H32 - 8.0EA	125	240.157	O.K	1.921
	2경간	좌측	4	1667	H32 - 8.0EA	125	831.857	O.K	6.655
		중앙부	5	1520	H25 - 8.0EA	-	-	-	-
		우측	6	1667	H32 - 8.0EA	125	293.596	O.K	2.349
하부슬래브	1경간	좌측	7	1822	H32 - 8.0EA + H29 - 8.0EA	125	186.651	O.K	1.493
		중앙부	8	1670	H29 - 8.0EA + H29 - 8.0EA	125	309.784	O.K	2.478
		우측	9	1700	H29 - 8.0EA	125	214.694	O.K	1.718
	2경간	좌측	10	1700	H29 - 8.0EA	125	224.589	O.K	1.797
		중앙부	11	1720	H29 - 8.0EA	-	-	-	-
		우측	12	1817	H29 - 8.0EA + H29 - 8.0EA	125	218.804	O.K	1.750
중간슬래브	1경간	좌측	13	1687	H29 - 8.0EA	125	456.643	O.K	3.653
		중앙부	14	1520	H29 - 8.0EA	125	685.031	O.K	5.480
		우측	15	1520	H29 - 8.0EA	125	1067.694	O.K	8.542
	2경간	좌측	16	1520	H29 - 8.0EA	125	2374.410	O.K	18.995
		중앙부	17	1520	H29 - 8.0EA	125	789.914	O.K	6.319
		우측	18	1687	H29 - 8.0EA	125	2260.708	O.K	18.086

좌측벽체	1층	1층(상부)	19	1767	H25 - 8.0EA	125	783.900	O.K	6.271
		1층(상부)	19	1620	H32 - 8.0EA	125	342.095	O.K	2.737
		1층(중앙부)	20	1620	H32 - 8.0EA	125	815.023	O.K	6.520
		1층(하부)	21	1722	H32 - 8.0EA + H29 - 8.0EA	125	149.582	O.K	1.197
	2층	2층(상부)	22	1717	H32 - 4.0EA + H25 - 4.0EA + H29 - 8.0EA	125	195.183	O.K	1.561
		2층(중앙부)	23	1620	H32 - 8.0EA	125	272.648	O.K	2.181
		2층(하부)	24	1767	H25 - 8.0EA	-	-	-	-
		2층(하부)	24	1620	H32 - 8.0EA	125	165.569	O.K	1.325
우측벽체	1층	1층(상부)	25	1728	H25 - 8.0EA + H29 - 4.0EA	125	2673.717	O.K	21.390
		1층(상부)	25	1620	H29 - 8.0EA	125	203.147	O.K	1.625
		1층(중앙부)	26	1620	H29 - 8.0EA	125	401.620	O.K	3.213
		1층(하부)	27	1717	H29 - 8.0EA + H29 - 8.0EA	125	259.717	O.K	2.078
	2층	2층(상부)	28	1767	H25 - 4.0EA + H32 - 4.0EA	125	254.705	O.K	2.038
		2층(중앙부)	29	1620	H29 - 8.0EA	125	297.701	O.K	2.382
		2층(하부)	30	1767	H25 - 8.0EA	-	-	-	-
		2층(하부)	30	1620	H29 - 8.0EA	125	215.143	O.K	1.721

2. 설 계 조 건

1) 구조형식

- 지중 2 련 BOX (내공 : 2@(10.65M × 10.605M), 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (ω_c) = 25.00 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sc
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 10.000 kN/m² (∵ 토피 : 10.600 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

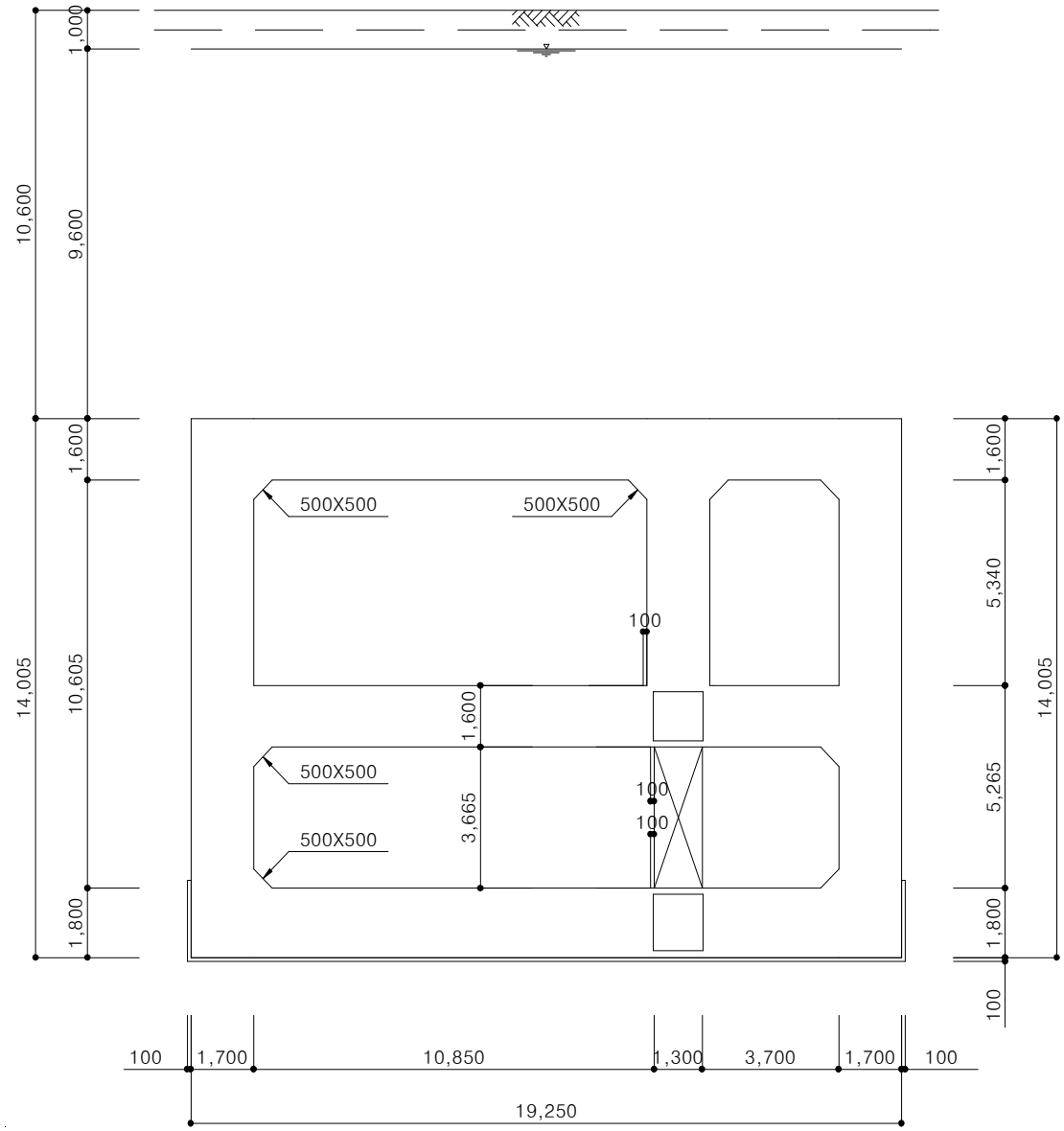
10) 사용프로그램 : SAP2000

11) 참고문헌

- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정

1) 단 면 가 정


1,000
10,600
9,600
1,600
14,005
10,605
1,800
500X500
500X500
100
1,600
500X500
3,665
100
100
500X500
1,600
5,340
5,265
1,800
14,005
100
100
1,700
10,850
1,300
3,700
1,700
100
19,250

4. 부 력 검 토

: 부력에 대한 안전률 Fs = 1.2 (R/B)
부력에 대한 안정계산시 구체자중과 측면마찰력, 상재하중만을 고려
(최소토피 H = 10.600 m 에 대하여 검토)

1) 구체자중

- 상부슬래브	:	19.250 × 1.600 × 25.0	=	770.000	kN/m
- 하부슬래브	:	19.250 × 1.800 × 25.0	=	866.250	kN/m
- 1층 좌측외벽	:	1.700 × 3.665 × 25.0	=	155.763	kN/m
- 2층 좌측외벽	:	1.700 × 5.340 × 25.0	=	226.950	kN/m
- 1층 우측외벽	:	1.700 × 3.665 × 25.0	=	155.763	kN/m
- 2층 우측외벽	:	1.700 × 5.340 × 25.0	=	226.950	kN/m
- 1층 중간벽체 1	:	(1.300 × 1.300) × 3.665 / 3.250 × 25.0	=	47.645	kN/m
- 2층 중간벽체 1	:	1.700 × 5.340 × 25.0	=	226.950	kN/m
- 중간슬래브 1	:	1.600 × 10.650 × 25.0	=	426.000	kN/m
- 중간슬래브 2	:	1.600 × 3.500 × 25.0	=	140.000	kN/m
- 헌치 1	:	0.500 × 0.500 × 1/2 × 8EA × 25.0	=	25.000	kN/m
		∴ Σ	=	3267.270	kN/m

2) 상재 하중

- ASPHALT 포장하중	:	0.500 × 19.250 × 23.0	=	221.375	kN/m
- 흙의 자중(지하수위 이상	:	0.500 × 19.250 × 19.0	=	182.875	kN/m
- 흙의 자중(지하수위 이하	:	9.600 × 19.250 × 10.0	=	1848.000	kN/m
- 지하수 자중	:	9.600 × 19.250 × 10.0	=	1848.000	kN/m
		∴ Σ	=	4100.250	kN/m

4) 측면마찰력

$F = 2 \times C \times D + Ku \times \gamma \times D^2 \times \tan\delta$

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 $\delta = 2/3 \times \Phi$로 적용

① 지하수위 이상

$F1 = Ku \times \gamma t \times D1^2 \times \tan\delta$

$= 0.500 \times 19.000 \times 1.000^2 \times \tan(30.0 \times 2/3)$

$= 3.458$ kN/m

② 지하수위 이하

$F2 = Ku \times (2 \times D1 \times D2 \times \gamma t + D2^2 \times \gamma sub) \times \tan\delta$

$= 0.500 \times (2 \times 1.000 \times 9.600 \times 19.000 + 9.600^2 \times 10.000) \times \tan(30.0 \times 2/3)$

$= 234.106$ kN/m

∴ ∑ = 3.458 + 234.106 = 237.564 kN/m

※ 구조물 벽체와 주변 뒷채움 흙과의 측면 마찰력은 재질간의 접촉 불확실성을 고려하여 무시한다. [철도설계기준2004(노반변,p.170)]

5) 부력

U = B × hs × γw (여기서,hs=구조물높이+토피고-지하수위)

= 19.250 × 23.605 × 10.000

= 4543.962 kN/m

6) 안정검토

R = 3267.270 + 4100.250 + 237.564 = 7605.084 kN/m

Fs = R / U

= 7605.084 / 4543.962

= 1.674 > 1.200 ∴O.K

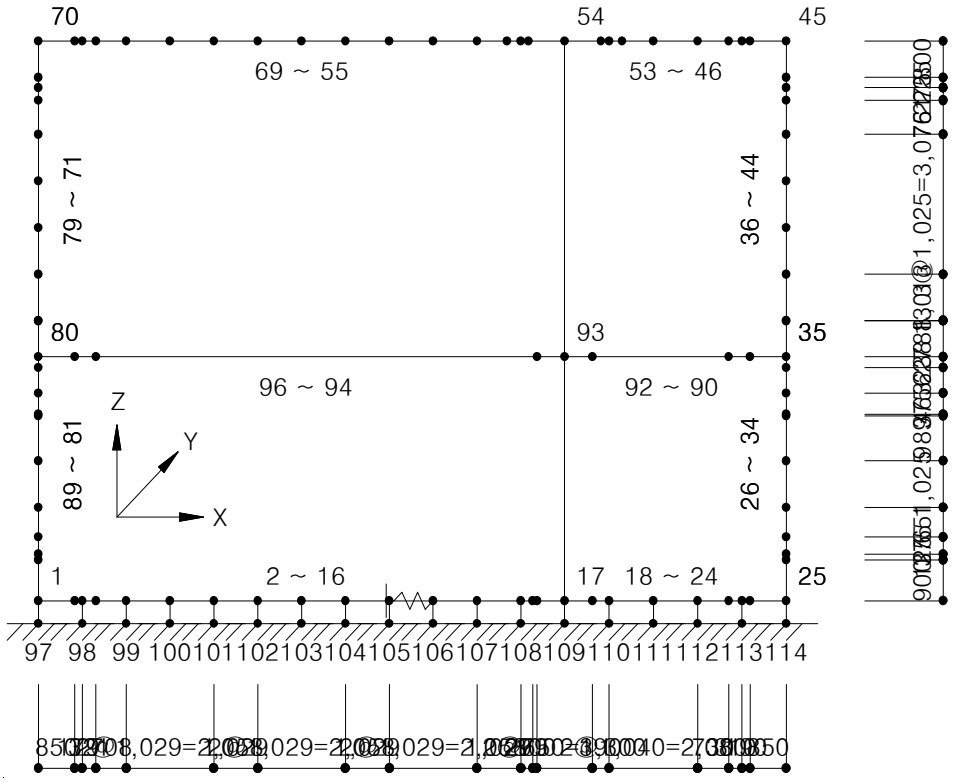
5. 해석모델 및 단면제원 (상시)

1) Modeling

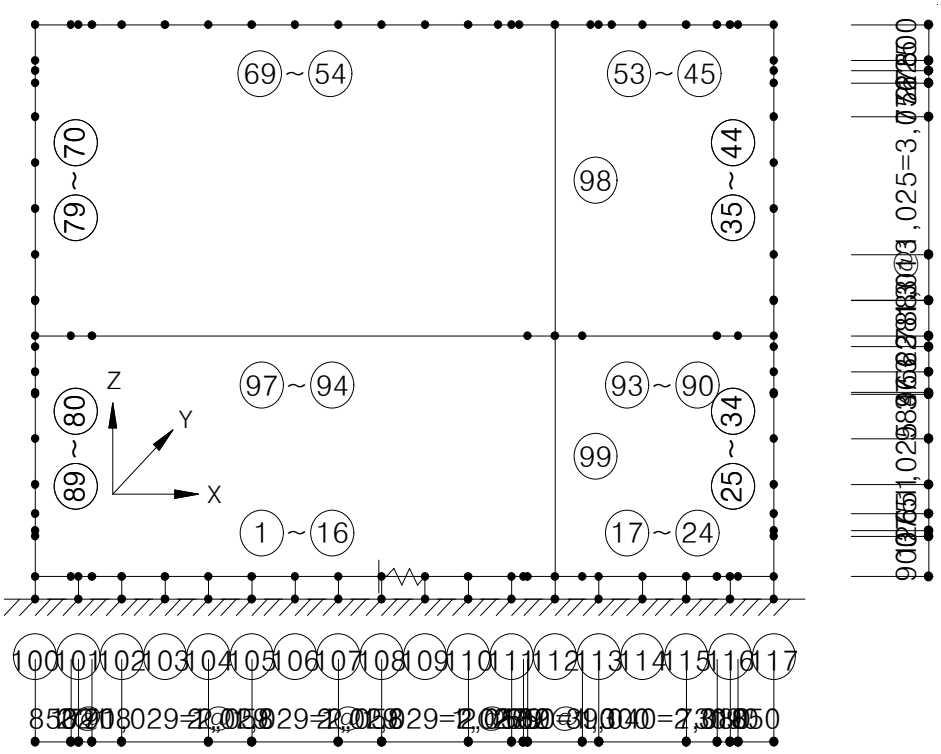
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	2.300 × 1.000	= 2.300	1.01392	1,24
3	1.800 × 1.000	= 1.800	0.48600	4~21
5	2.200 × 1.000	= 2.200	0.88733	25,33~36,44,70,78~81,89
7	1.700 × 1.000	= 1.700	0.40942	28~30,37~41,73~77,84~86,98
10	2.100 × 1.000	= 2.100	0.77175	45,53~54,69,90,97
12	1.600 × 1.000	= 1.600	0.34133	48~50,57~66,92~95
14	1.300 × 1.300 / 6.500	= 0.260	0.03662	99

NO	A (m²)		I (m⁴)	절 점
2	2.121 × 1.000	= 2.121	0.79494	3
4	2.110 × 1.000	= 2.110	0.78283	23
6	2.075 × 1.000	= 2.075	0.74407	27,88
8	1.737 × 1.000	= 1.737	0.43648	32,83
9	1.975 × 1.000	= 1.975	0.64157	43,72
11	1.910 × 1.000	= 1.910	0.58066	47,52
13	1.921 × 1.000	= 1.921	0.59059	56,68

NO	Section(Tapper)	부 재
15	SEC 1 ~ 2	2
16	SEC 2 ~ 3	3
17	SEC 3 ~ 4	22
18	SEC 4 ~ 1	23
19	SEC 5 ~ 6	26
20	SEC 6 ~ 7	27
21	SEC 7 ~ 8	31
22	SEC 8 ~ 5	32
23	SEC 7 ~ 9	42
24	SEC 9 ~ 5	43
25	SEC 10 ~ 11	46
26	SEC 11 ~ 12	47
27	SEC 12 ~ 11	51
28	SEC 11 ~ 10	52
29	SEC 10 ~ 13	55
30	SEC 13 ~ 12	56
31	SEC 12 ~ 13	67
32	SEC 13 ~ 10	68
33	SEC 5 ~ 9	71
34	SEC 9 ~ 7	72
35	SEC 5 ~ 8	82
36	SEC 8 ~ 7	83
37	SEC 7 ~ 6	87
38	SEC 6 ~ 5	88
39	SEC 10 ~ 12	91
40	SEC 12 ~ 10	96

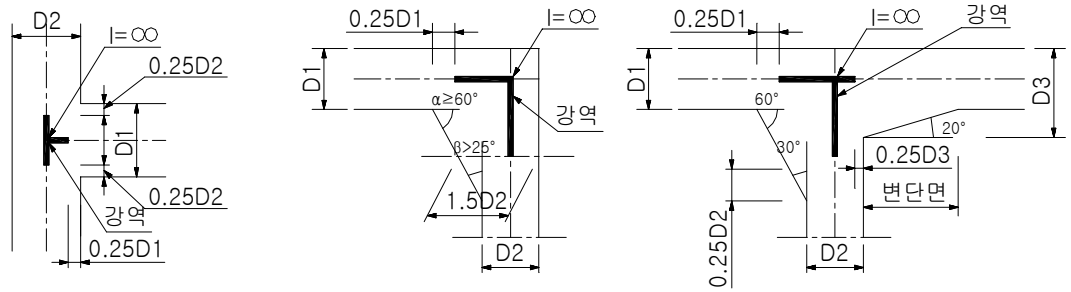
3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	58	10.292	12.805
2	0.850	0.500	59	9.262	12.805
3	1.029	0.500	60	8.233	12.805
4	1.350	0.500	61	7.204	12.805
5	2.058	0.500	62	6.175	12.805
6	3.087	0.500	63	5.146	12.805
7	4.117	0.500	64	4.117	12.805
8	5.146	0.500	65	3.087	12.805
9	6.175	0.500	66	2.058	12.805
10	7.204	0.500	67	1.350	12.805
11	8.233	0.500	68	1.029	12.805
12	9.262	0.500	69	0.850	12.805
13	10.292	0.500	70	0.000	12.805
14	11.321	0.500	71	0.000	12.005
15	11.600	0.500	72	0.000	11.780
16	11.700	0.500	73	0.000	11.505
17	12.350	0.500	74	0.000	10.754
18	13.000	0.500	75	0.000	9.729
19	13.390	0.500	76	0.000	8.703
20	14.430	0.500	77	0.000	7.678
21	15.470	0.500	78	0.000	6.665
22	16.200	0.500	79	0.000	6.653
23	16.510	0.500	80	0.000	5.865
24	16.700	0.500	81	0.000	5.627
25	17.550	0.500	82	0.000	5.065
26	17.550	1.400	83	0.000	4.602
27	17.550	1.525	84	0.000	4.565
28	17.550	1.900	85	0.000	3.576
29	17.550	2.551	86	0.000	2.551
30	17.550	3.576	87	0.000	1.900
31	17.550	4.565	88	0.000	1.525
32	17.550	4.602	89	0.000	1.400
33	17.550	5.065	90	16.700	5.865
34	17.550	5.627	91	16.200	5.865
35	17.550	5.865	92	13.000	5.865
36	17.550	6.653	93	12.350	5.865
37	17.550	6.665	94	11.700	5.865
38	17.550	7.678	95	1.350	5.865
39	17.550	8.703	96	0.850	5.865
40	17.550	9.729	97	0.000	0.000
41	17.550	10.754	98	1.029	0.000

42	17.550	11.505	99	2.058	0.000
43	17.550	11.780	100	3.087	0.000
44	17.550	12.005	101	4.117	0.000
45	17.550	12.805	102	5.146	0.000
46	16.700	12.805	103	6.175	0.000
47	16.510	12.805	104	7.204	0.000
48	16.200	12.805	105	8.233	0.000
49	15.470	12.805	106	9.262	0.000
50	14.430	12.805	107	10.292	0.000
51	13.700	12.805	108	11.321	0.000
52	13.390	12.805	109	12.350	0.000
53	13.200	12.805	110	13.390	0.000
54	12.350	12.805	111	14.430	0.000
55	11.500	12.805	112	15.470	0.000
56	11.321	12.805	113	16.510	0.000
57	11.000	12.805	114	17.550	0.000

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 70 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(2) 70 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(3) 54 지점 - 슬래브 상면 좌측

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(4) 54 지점 - 슬래브 상면 우측

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(5) 54 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(6) 45 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(7) 45 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 mm

(8) 80 지점 - 슬래브 중간

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 mm

(9) 80 지점 - 슬래브 상부벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 ㎜

(10) 80 지점 - 슬래브 하부벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 ㎜

(11) 93 지점 - 슬래브 중간 좌측

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 ㎜

(12) 93 지점 - 슬래브 중간 우측

D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 ㎜

(13) 93 지점 - 슬래브 상부벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 ㎜

(14) 93 지점 - 슬래브 하부벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1300 = 475 ㎜

(15) 35 지점 - 슬래브 중간

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 ㎜

(16) 35 지점 - 슬래브 상부벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 ㎜

(17) 35 지점 - 슬래브 하부벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 ㎜

(18) 1 지점 - 슬래브 하면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1800 × 500) / (2 × 500) = 450 ㎜

(19) 1 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1800 / 2 + 500 - (1700 × 500) / (2 × 500) = 550 ㎜

(20) 17 지점 - 슬래브 하면 좌측

D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 1800 = 200 ㎜

(21) 17 지점 - 슬래브 하면 우측

D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 1800 = 200 ㎜

(22) 17 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1800 / 2 - 0.25 × 1700 = 475 ㎜

(23) 25 지점 - 슬래브 하면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1800 × 500) / (2 × 500) = 450 ㎜

(24) 25 지점 - 슬래브 벽체 연결부

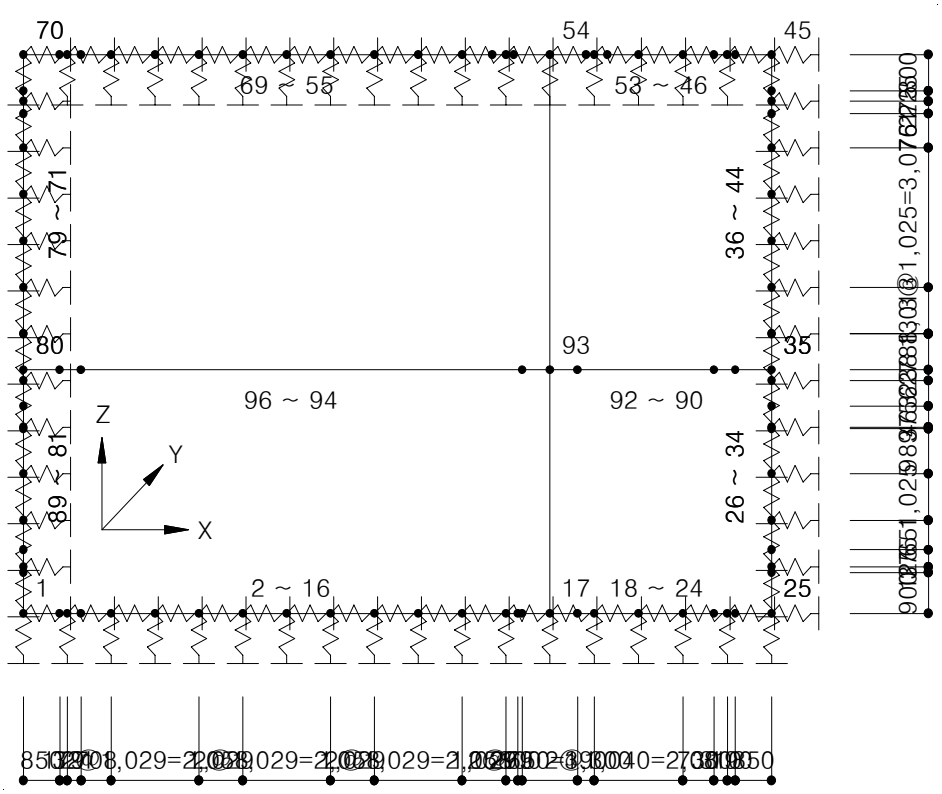
D1 / 2 + H - (D2 × H) / (2 × B) = 1800 / 2 + 500 - (1700 × 500) / (2 × 500) = 550 ㎜

6. 해석모델 및 단면제원 (지진시)

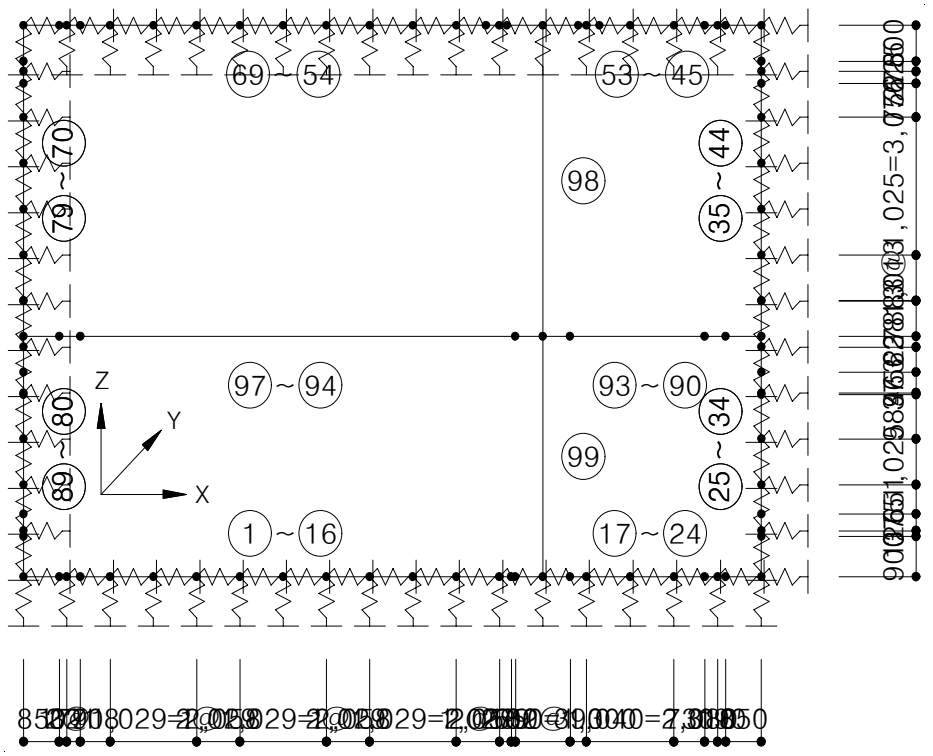
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)		I (m⁴)	부 재
1	2.300 × 1.000	= 2.300	1.01392	1,24
3	1.800 × 1.000	= 1.800	0.48600	4~21
5	2.200 × 1.000	= 2.200	0.88733	25,33~36,44,70,78~81,89
7	1.700 × 1.000	= 1.700	0.40942	28~30,37~41,73~77,84~86,98
10	2.100 × 1.000	= 2.100	0.77175	45,53~54,69,90,97
12	1.600 × 1.000	= 1.600	0.34133	48~50,57~66,92~95
14	1.300 × 1.300 / 6.500	= 0.260	0.03662	99

NO	A (m²)		I (m⁴)	절 점
2	2.121 × 1.000	= 2.121	0.79494	3
4	2.110 × 1.000	= 2.110	0.78283	23
6	2.075 × 1.000	= 2.075	0.74407	27,88
8	1.737 × 1.000	= 1.737	0.43648	32,83
9	1.975 × 1.000	= 1.975	0.64157	43,72
11	1.910 × 1.000	= 1.910	0.58066	47,52
13	1.921 × 1.000	= 1.921	0.59059	56,68

NO	Section(Tapper)	부 재
15	SEC 1 ~ 2	2
16	SEC 2 ~ 3	3
17	SEC 3 ~ 4	22
18	SEC 4 ~ 1	23
19	SEC 5 ~ 6	26
20	SEC 6 ~ 7	27
21	SEC 7 ~ 8	31
22	SEC 8 ~ 5	32
23	SEC 7 ~ 9	42
24	SEC 9 ~ 5	43
25	SEC 10 ~ 11	46
26	SEC 11 ~ 12	47
27	SEC 12 ~ 11	51
28	SEC 11 ~ 10	52
29	SEC 10 ~ 13	55
30	SEC 13 ~ 12	56
31	SEC 12 ~ 13	67
32	SEC 13 ~ 10	68
33	SEC 5 ~ 9	71
34	SEC 9 ~ 7	72
35	SEC 5 ~ 8	82
36	SEC 8 ~ 7	83
37	SEC 7 ~ 6	87
38	SEC 6 ~ 5	88
39	SEC 10 ~ 12	91
40	SEC 12 ~ 10	96

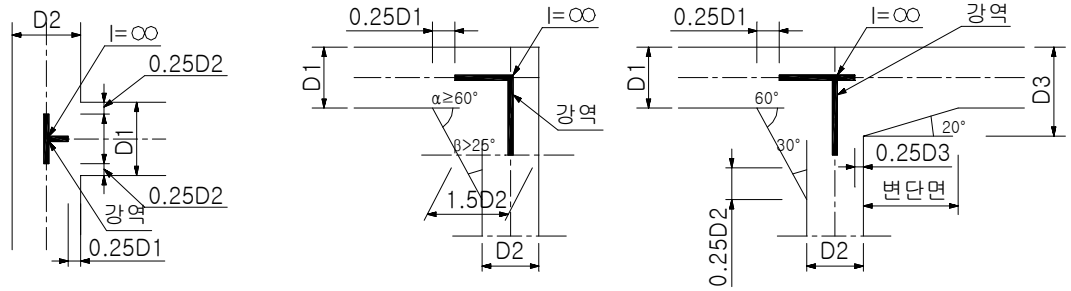
3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.000	49	15.470	12.305
2	0.850	0.000	50	14.430	12.305
3	1.029	0.000	51	13.700	12.305
4	1.350	0.000	52	13.390	12.305
5	2.058	0.000	53	13.200	12.305
6	3.087	0.000	54	12.350	12.305
7	4.117	0.000	55	11.500	12.305
8	5.146	0.000	56	11.321	12.305
9	6.175	0.000	57	11.000	12.305
10	7.204	0.000	58	10.292	12.305
11	8.233	0.000	59	9.262	12.305
12	9.262	0.000	60	8.233	12.305
13	10.292	0.000	61	7.204	12.305
14	11.321	0.000	62	6.175	12.305
15	11.600	0.000	63	5.146	12.305
16	11.700	0.000	64	4.117	12.305
17	12.350	0.000	65	3.087	12.305
18	13.000	0.000	66	2.058	12.305
19	13.390	0.000	67	1.350	12.305
20	14.430	0.000	68	1.029	12.305
21	15.470	0.000	69	0.850	12.305
22	16.200	0.000	70	0.000	12.305
23	16.510	0.000	71	0.000	11.505
24	16.700	0.000	72	0.000	11.280
25	17.550	0.000	73	0.000	11.005
26	17.550	0.900	74	0.000	10.254
27	17.550	1.025	75	0.000	9.229
28	17.550	1.400	76	0.000	8.203
29	17.550	2.051	77	0.000	7.178
30	17.550	3.076	78	0.000	6.165
31	17.550	4.065	79	0.000	6.153
32	17.550	4.102	80	0.000	5.365
33	17.550	4.565	81	0.000	5.127
34	17.550	5.127	82	0.000	4.565
35	17.550	5.365	83	0.000	4.102
36	17.550	6.153	84	0.000	4.065
37	17.550	6.165	85	0.000	3.076
38	17.550	7.178	86	0.000	2.051
39	17.550	8.203	87	0.000	1.400
40	17.550	9.229	88	0.000	1.025
41	17.550	10.254	89	0.000	0.900

42	17.550	11.005	90	16.700	5.365
43	17.550	11.280	91	16.200	5.365
44	17.550	11.505	92	13.000	5.365
45	17.550	12.305	93	12.350	5.365
46	16.700	12.305	94	11.700	5.365
47	16.510	12.305	95	1.350	5.365
48	16.200	12.305	96	0.850	5.365

8) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (㎜), H = 헌치높이 (㎜)

(1) 70 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 ㎜
(2) 70 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 ㎜
(3) 54 지점 - 슬래브 상면 좌측
D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 ㎜
(4) 54 지점 - 슬래브 상면 우측
D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 ㎜
(5) 54 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 ㎜
(6) 45 지점 - 슬래브 상면
D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 ㎜
(7) 45 지점 - 슬래브 벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 ㎜
(8) 80 지점 - 슬래브 중간
D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 ㎜
(9) 80 지점 - 슬래브 상부벽체 연결부
D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 ㎜
(10) 80 지점 - 슬래브 하부벽체 연결부
D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 ㎜
(11) 93 지점 - 슬래브 중간 좌측
D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 ㎜
(12) 93 지점 - 슬래브 중간 우측
D2 / 2 - 0.25 × D1 = 1700 / 2 - 0.25 × 1600 = 450 ㎜

(13) 93 지점 - 슬래브 상부벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 ㎜

(14) 93 지점 - 슬래브 하부벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1300 = 475 ㎜

(15) 35 지점 - 슬래브 중간

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1600 × 500) / (2 × 500) = 550 ㎜

(16) 35 지점 - 슬래브 상부벽체 연결부

D2 / 2 - 0.25 × D1 = 1600 / 2 - 0.25 × 1700 = 375 ㎜

(17) 35 지점 - 슬래브 하부벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1600 / 2 + 500 - (1700 × 500) / (2 × 500) = 450 ㎜

(18) 1 지점 - 슬래브 하면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1800 × 500) / (2 × 500) = 450 ㎜

(19) 1 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1800 / 2 + 500 - (1700 × 500) / (2 × 500) = 550 ㎜

(20) 17 지점 - 슬래브 하면 좌측

D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 1800 = 200 ㎜

(21) 17 지점 - 슬래브 하면 우측

D2 / 2 - 0.25 × D1 = 1300 / 2 - 0.25 × 1800 = 200 ㎜

(22) 17 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 1800 / 2 - 0.25 × 1700 = 475 ㎜

(23) 25 지점 - 슬래브 하면

D2 / 2 + B - (D1 × B) / (2 × H) = 1700 / 2 + 500 - (1800 × 500) / (2 × 500) = 450 ㎜

(24) 25 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 1800 / 2 + 500 - (1700 × 500) / (2 × 500) = 550 ㎜

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 300000.00 kN/m²

Bv = √(B × L) = √(19.250 × 6.500) = 11.19 m (L < B)

Kvo = 1 / 0.3 × 1 × 300000 = 1000000.00 kN/m³

Kv = 1000000.000 × (11.186 / 0.3) $^{-3 / 4}$ = 66273.04 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 90435 kN/m	1
Kv2	Kv x (1.029/2 + 1.029/2) = 68206 kN/m	3,5~14
Kv3	Kv x (1.029/2 + 1.040/2) = 68565 kN/m	17
Kv4	Kv x (1.040/2 + 1.040/2) = 68924 kN/m	19~21,23
Kv5	Kv x (1.040/2 + 1.700/2) = 90794 kN/m	25
Kh	1E10 kN/m (무한강성)	12

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 모래(SP) (EL. : 10.501 ~ -0.399, N=5)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 1.0 × Vo = 1.0 × 289.0 = 289.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 289.0² = 170277.0 kN/m²
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 170277.0 = 449531.3 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.8 × Vo = 0.8 × 289.0 = 231.2 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 231.2² = 108977.0 kN/m²
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 108977.0 = 287699.3 kN/m²

(2) 풍화 잔류토(RS) (EL. : -0.399 ~ -3.499, N=14)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 424.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 1.0 × Vo = 1.0 × 424.0 = 424.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 424.0² = 366516.0 kN/m²
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 366516.0 = 967602.2 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 424.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 1.0 × Vo = 1.0 × 424.0 = 424.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 424.0² = 366516.0 kN/m²
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 366516.0 = 967602.2 kN/m²

(3) 풍화암(WR) (EL. : -3.499 ~ -19.499, N=50)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 1.0 × Vo = 1.0 × 631.0 = 631.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 631.0^2 = 811745.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.3) × 811745.0 = 2110537.0 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 1.0 × Vo = 1.0 × 631.0 = 631.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 631.0^2 = 811745.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + ν) × Gd (ν : 흙의 포아슨 비)
  = 2 × (1 + 0.3) × 811745.0 = 2110537.0 kN/m^2

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제3토층 ,풍화 잔류토(RS)

① 연직방향 지반반력계수

Bv = √(B × L) = √(19.250 × 6.500) = 11.186 m (L < B)

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 967602.2 = 3225340.67 kN/m^3

Kv = 3225340.670 × (11.186 / 0.3)$^{-3/4}$ = 213753.14 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 213753.140 = 71251.05 kN/m^3

(2) 하부슬래브 : 제4토층 , 풍화암(WR)

① 연직방향 지반반력계수

Bv = √(B × L) = √(19.250 × 6.500) = 11.186 m (L < B)

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m^3

Kv = 7035123.330 × (11.186 / 0.3)$^{-3/4}$ = 466239.03 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 466239.030 = 155413.01 kN/m^3

(3) 측벽 : 제3토층 , 풍화 잔류토(RS)

① 수평방향 지반반력계수

Bh = √(H × L) = √(14.005 × 6.500) = 9.541 m (L < H)

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 967602.2 = 3225340.67 kN/m^3

Kh = 3225340.670 × (9.541 / 0.3)$^{-3/4}$ = 240834.03 kN/m^3

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 240834.030 = 80278.01 kN/m^3

(4) 측벽 : 제4토층 , 풍화암(WR)

① 수평방향 지반반력계수

Bh = √(H × L) = √(14.005 × 6.500) = 9.541 m (L < H)

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kh = 7035123.330 × (9.541 / 0.3)$^{-3 / 4}$ = 525307.96 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 525307.960 = 175102.65 kN/m³

(5) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.040/2 + 1.040/2) = 222303 kN/m	47,49~50,52
Ksb1	Ksb x (1.040/2 + 1.040/2) = 74101 kN/m	
Kv2	Kv x (1.040/2 + 1.029/2) = 221146 kN/m	54
Ksb2	Ksb x (1.040/2 + 1.029/2) = 73715 kN/m	
Kv3	Kv x (1.029/2 + 1.029/2) = 219988 kN/m	56,58~66,68
Ksb3	Ksb x (1.029/2 + 1.029/2) = 73329 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.025/2 + 1.025/2) = 538661 kN/m	27,29~30,32,34,36,38~40,75~77,79,81,83,85~86,88
Kss1	Kss x (1.025/2 + 1.025/2) = 179554 kN/m	
Kh2	Kh x (1.025/2 + 1.025/2) = 246956 kN/m	41,43,72,74
Kss2	Kss x (1.025/2 + 1.025/2) = 82319 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 479839 kN/m	3,5~14
Ksb1	Ksb x (1.029/2 + 1.029/2) = 159946 kN/m	
Kv2	Kv x (1.029/2 + 1.040/2) = 482364 kN/m	17
Ksb2	Ksb x (1.029/2 + 1.040/2) = 160788 kN/m	
Kv3	Kv x (1.040/2 + 1.040/2) = 484889 kN/m	19~21,23
Ksb3	Ksb x (1.040/2 + 1.040/2) = 161630 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 636223 kN/m	1
Ksb1	Kh x (1.025/2 + 1.800/2) = 742108 kN/m	
Kv2	Kv x (1.040/2 + 1.700/2) = 638747 kN/m	25
Ksb2	Kh x (1.025/2 + 1.800/2) = 742108 kN/m	
Kv3	Kv x (1.040/2 + 1.700/2) = 292842 kN/m	45
Ksb3	Kh x (1.025/2 + 1.600/2) = 316145 kN/m	
Kv4	Kv x (1.029/2 + 1.700/2) = 291684 kN/m	70
Ksb4	Kh x (1.600/2 + 1.025/2) = 316145 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제3토층 ,풍화 잔류토(RS)

① 연직방향 지반반력계수

Bv = √(B × L) = √(19.250 × 6.500) = 11.186 m (L < B)

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 967602.2 = 3225340.67 kN/m³

Kv = 3225340.670 × (11.186 / 0.3)$^{-3 / 4}$ = 213753.14 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 213753.140 = 71251.05 kN/m³

(2) 하부슬래브 : 제4토층 , 풍화암(WR)

① 연직방향 지반반력계수

Bv = √(B × L) = √(19.250 × 6.500) = 11.186 m (L < B)

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kv = 7035123.330 × (11.186 / 0.3)$^{-3 / 4}$ = 466239.03 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 466239.030 = 155413.01 kN/m³

(3) 측벽 : 제3토층 , 풍화 잔류토(RS)

① 수평방향 지반반력계수

Bh = √(H × L) = √(14.005 × 6.500) = 9.541 m (L < H)

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 967602.2 = 3225340.67 kN/m³

Kh = 3225340.670 × (9.541 / 0.3)$^{-3 / 4}$ = 240834.03 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 240834.030 = 80278.01 kN/m³

(4) 측벽 : 제4토층 , 풍화암(WR)

① 수평방향 지반반력계수

Bh = √(H × L) = √(14.005 × 6.500) = 9.541 m (L < H)

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kh = 7035123.330 × (9.541 / 0.3)$^{-3 / 4}$ = 525307.96 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 525307.960 = 175102.65 kN/m³

(5) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.040/2 + 1.040/2) = 222303 kN/m	47,49~50,52
Ksb1	Ksb x (1.040/2 + 1.040/2) = 74101 kN/m	
Kv2	Kv x (1.040/2 + 1.029/2) = 221146 kN/m	54
Ksb2	Ksb x (1.040/2 + 1.029/2) = 73715 kN/m	
Kv3	Kv x (1.029/2 + 1.029/2) = 219988 kN/m	56,58~66,68
Ksb3	Ksb x (1.029/2 + 1.029/2) = 73329 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.025/2 + 1.025/2) = 538661 kN/m	27,29~30,32,34,36,38~40,75~77,79,81,83,85~86,88
Kss1	Kss x (1.025/2 + 1.025/2) = 179554 kN/m	
Kh2	Kh x (1.025/2 + 1.025/2) = 246956 kN/m	41,43,72,74
Kss2	Kss x (1.025/2 + 1.025/2) = 82319 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.029/2 + 1.029/2) = 479839 kN/m	3,5~14
Ksb1	Ksb x (1.029/2 + 1.029/2) = 159946 kN/m	
Kv2	Kv x (1.029/2 + 1.040/2) = 482364 kN/m	17
Ksb2	Ksb x (1.029/2 + 1.040/2) = 160788 kN/m	
Kv3	Kv x (1.040/2 + 1.040/2) = 484889 kN/m	19~21,23
Ksb3	Ksb x (1.040/2 + 1.040/2) = 161630 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.700/2 + 1.029/2) = 636223 kN/m	1
Ksb1	Kh x (1.025/2 + 1.800/2) = 742108 kN/m	
Kv2	Kv x (1.040/2 + 1.700/2) = 638747 kN/m	25
Ksb2	Kh x (1.025/2 + 1.800/2) = 742108 kN/m	
Kv3	Kv x (1.040/2 + 1.700/2) = 292842 kN/m	45
Ksb3	Kh x (1.025/2 + 1.600/2) = 316145 kN/m	
Kv4	Kv x (1.029/2 + 1.700/2) = 291684 kN/m	70
Ksb4	Kh x (1.600/2 + 1.025/2) = 316145 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

설계지진	성능기 / 준 재현주기	기 능 수 행	붕 괴 방 지
	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.13 = 0.074
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.13 = 0.182

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 토 사	: 10.100 × 19.00	=	191.900	kN/m²
	∴ Total Wd1	=	203.400	kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00	=	9.500	kN/m²
- 흙(지하수위 이하)	: 9.600 × 10.00	=	96.000	kN/m²
	∴ Total Wd2	=	117.000	kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

토피고(D,m)	도로면의 활하중 (kN/m²)	토피고(D,m)	도로면의 활하중 (kN/m²)
1.0	39.0	1.5	25.0
2.0	18.0	2.5	14.0
3.0	11.0	3.5	10.0
4.0	10.0	5.0	10.0
6.0	10.0	7.0	10.0
8.0	10.0	9.0	10.0
10.0	10.0		

주) 중간토피에 대한 것은 그 상위의 것을 취한다.

① 상부 슬래브에 작용하는 하중 (WI1) - 토피 4m 이상

- WI1 = 10.000 kN/m²

② 측벽에 작용하는 하중 (WI2)

- WI2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 10.900 × 19.000) × 0.500 = 109.300 kN/m²
Wh2 = 109.300 + 0.800 × 19.000 × 0.500 = 116.900 kN/m²
Wh3 = 116.900 + 0.225 × 19.000 × 0.500 = 119.041 kN/m²
Wh4 = 119.041 + 0.275 × 19.000 × 0.500 = 121.650 kN/m²
Wh5 = 121.650 + 0.751 × 19.000 × 0.500 = 128.783 kN/m²
Wh6 = 128.783 + 1.025 × 19.000 × 0.500 = 138.524 kN/m²
Wh7 = 138.524 + 1.025 × 19.000 × 0.500 = 148.266 kN/m²
Wh8 = 148.266 + 1.025 × 19.000 × 0.500 = 158.007 kN/m²
Wh9 = 158.007 + 1.013 × 19.000 × 0.500 = 167.630 kN/m²
Wh10 = 167.630 + 0.013 × 19.000 × 0.500 = 167.749 kN/m²
Wh11 = 167.749 + 0.788 × 19.000 × 0.500 = 175.230 kN/m²
Wh12 = 175.230 + 0.238 × 19.000 × 0.500 = 177.490 kN/m²
Wh13 = 177.490 + 0.562 × 19.000 × 0.500 = 182.830 kN/m²
Wh14 = 182.830 + 0.463 × 19.000 × 0.500 = 187.231 kN/m²
Wh15 = 187.231 + 0.037 × 19.000 × 0.500 = 187.580 kN/m²
Wh16 = 187.580 + 0.989 × 19.000 × 0.500 = 196.974 kN/m²
Wh17 = 196.974 + 1.025 × 19.000 × 0.500 = 206.715 kN/m²
Wh18 = 206.715 + 0.651 × 19.000 × 0.500 = 212.897 kN/m²
Wh19 = 212.897 + 0.375 × 19.000 × 0.500 = 216.456 kN/m²
Wh20 = 216.456 + 0.125 × 19.000 × 0.500 = 217.648 kN/m²
Wh21 = 217.648 + 0.900 × 19.000 × 0.500 = 226.197 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 10.400 × 10.00 = 62.500 kN/m²
Wh2 = 62.500 + 0.800 × 10.000 × 0.500 = 66.500 kN/m²
Wh3 = 66.500 + 0.225 × 10.000 × 0.500 = 67.627 kN/m²
Wh4 = 67.627 + 0.275 × 10.000 × 0.500 = 69.000 kN/m²
Wh5 = 69.000 + 0.751 × 10.000 × 0.500 = 72.754 kN/m²
Wh6 = 72.754 + 1.025 × 10.000 × 0.500 = 77.881 kN/m²
Wh7 = 77.881 + 1.025 × 10.000 × 0.500 = 83.008 kN/m²
Wh8 = 83.008 + 1.025 × 10.000 × 0.500 = 88.135 kN/m²
Wh9 = 88.135 + 1.013 × 10.000 × 0.500 = 93.200 kN/m²
Wh10 = 93.200 + 0.013 × 10.000 × 0.500 = 93.262 kN/m²
Wh11 = 93.262 + 0.788 × 10.000 × 0.500 = 97.200 kN/m²
Wh12 = 97.200 + 0.238 × 10.000 × 0.500 = 98.390 kN/m²
Wh13 = 98.390 + 0.562 × 10.000 × 0.500 = 101.200 kN/m²
Wh14 = 101.200 + 0.463 × 10.000 × 0.500 = 103.517 kN/m²
Wh15 = 103.517 + 0.037 × 10.000 × 0.500 = 103.700 kN/m²
Wh16 = 103.700 + 0.989 × 10.000 × 0.500 = 108.644 kN/m²
Wh17 = 108.644 + 1.025 × 10.000 × 0.500 = 113.771 kN/m²
Wh18 = 113.771 + 0.651 × 10.000 × 0.500 = 117.025 kN/m²
Wh19 = 117.025 + 0.375 × 10.000 × 0.500 = 118.898 kN/m²
Wh20 = 118.898 + 0.125 × 10.000 × 0.500 = 119.525 kN/m²
Wh21 = 119.525 + 0.900 × 10.000 × 0.500 = 124.025 kN/m²

6) 지하수압 (지하수위 : GL = -1.000 m)

① 상부슬래브에 작용하는 하중

- Ww1 = 9.600 × 10.000 = 96.000 kN/m²

② 측벽에 작용하는 하중

- Ww2 = 10.400 × 10.000 = 104.000 kN/m²
  Ww3 = 104.000 + 0.800 × 10.000 = 112.000 kN/m²
  Ww4 = 112.000 + 0.225 × 10.000 = 114.254 kN/m²
  Ww5 = 114.254 + 0.275 × 10.000 = 117.000 kN/m²
  Ww6 = 117.000 + 0.751 × 10.000 = 124.508 kN/m²
  Ww7 = 124.508 + 1.025 × 10.000 = 134.763 kN/m²
  Ww8 = 134.763 + 1.025 × 10.000 = 145.017 kN/m²
  Ww9 = 145.017 + 1.025 × 10.000 = 155.271 kN/m²
  Ww10 = 155.271 + 1.013 × 10.000 = 165.400 kN/m²
  Ww11 = 165.400 + 0.013 × 10.000 = 165.525 kN/m²
  Ww12 = 165.525 + 0.787 × 10.000 = 173.400 kN/m²
  Ww13 = 173.400 + 0.238 × 10.000 = 175.779 kN/m²
  Ww14 = 175.779 + 0.562 × 10.000 = 181.400 kN/m²
  Ww15 = 181.400 + 0.463 × 10.000 = 186.033 kN/m²
  Ww16 = 186.033 + 0.037 × 10.000 = 186.400 kN/m²
  Ww17 = 186.400 + 0.989 × 10.000 = 196.288 kN/m²
  Ww18 = 196.288 + 1.025 × 10.000 = 206.542 kN/m²
  Ww19 = 206.542 + 0.651 × 10.000 = 213.050 kN/m²
  Ww20 = 213.050 + 0.375 × 10.000 = 216.796 kN/m²
  Ww21 = 216.796 + 0.125 × 10.000 = 218.050 kN/m²
  Ww22 = 218.050 + 0.900 × 10.000 = 227.050 kN/m²

③ 하부슬래브에 작용하는 하중

- Ww23 = (10.600 + 14.005 - 1.000) × 10.000 = 236.050 kN/m²

7) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

8) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 15 \times 10^{-5}$
- 온도선팽창 계수 $\alpha = 1.0 \times 10^{-5}$
- $\Delta T = -\frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
실트 섞인 모래(SM	2.200	156.000	124.800	20.000	0.056	0.071
모래(SP)	8.700	289.000	231.200	20.000	0.120	0.151
풍화 잔류토(RS)	3.100	424.000	424.000	20.000	0.029	0.029
풍화암(WR)	16.000	631.000	631.000	20.000	0.101	0.101
계					0.306	0.352

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.306 = 0.383	1.25 Tg' = 1.25 × 0.352 = 0.440

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.180/(2.5×0.130) = 0.554	Ts = Cv / (2.5 × Ca) = 0.180/(2.5×0.130) = 0.554
To(sec)	To = 0.2 × Ts = 0.2 × 0.554 = 0.111	To = 0.2 × Ts = 0.2 × 0.554 = 0.111

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $C_d = \frac{1.5}{40h+1} + 0.5$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa)

- 붕괴방지수준시(재현주기 1000년적용)

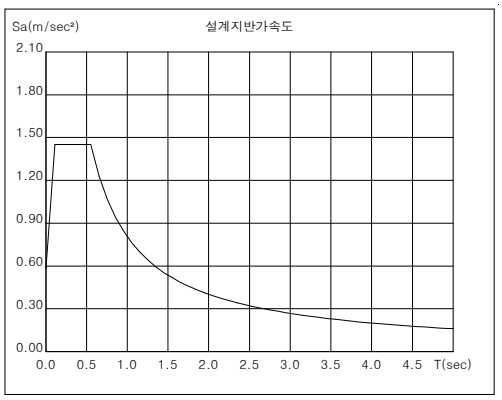
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 1.454 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 2.977 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg

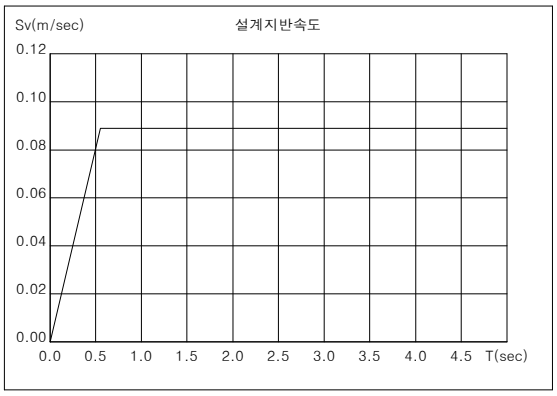
5) 속도 응답스펙트럼(Sv) - 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.383 / 2π × 1.454 = 0.089 m/s	Sv = Tg/2π × Sa = 0.440 / 2π × 2.977 = 0.208 m/s

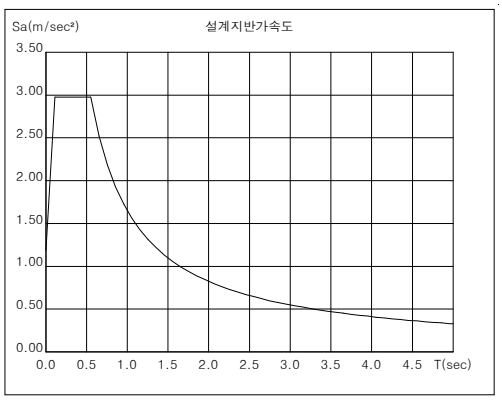
6) 설계응답 응답스펙트럼

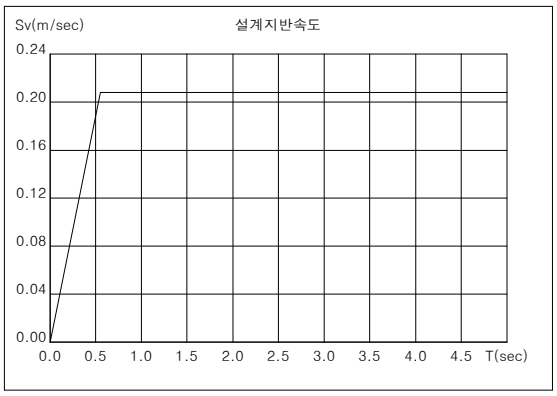
(1) 기능수행수준





(2) 붕괴방지수준





7) 층별 변위값 정리

- 제 1층의 두께(H1) = 14.000 m
- 제 2층의 두께(H2) = 16.000 m
- 제 1층의 습윤단위 체적중량(γ1) = 20.000 kN/m³
- 제 2층의 습윤단위 체적중량(γ2) = 20.000 kN/m³
- 제 1층의 평균전단파속도(Vsod1) = 257.171 m/sec
- 제 2층의 평균전단파속도(Vsod2) = 631.000 m/sec
- 제 1층과 제2층의 임피던스비(α)

  (γ1×Vsod1) / (γ2×Vsod2) = (20.000 × 257.171) / (20.000 × 631.000)

  = 0.408

- 지반의 설계 고유 진동수(Wo)

$(1+\alpha)\times\cos[Wo\times(H1/Vsod1 + H2/Vsod2)] + (1-\alpha)\times\cos[Wo\times(H1/Vsod1 - H2/Vsod2)] = 0$

$(1 + 0.408) \times \cos[Wo \times (14.000 / 257.171 + 16.000 / 631.000)] +$

$(1 - 0.408) \times \cos[Wo \times (14.000 / 257.171 - 16.000 / 631.000)] = 0$

에서 시행착오법으로 산정, Wo = 23.815

- 각 층별 변위 계산식

  - 제1층 변위 계산식

$Uh1 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times x1/Vsod1)$

  - 제2층 변위 계산식

$Uh2 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times H1/Vsod1) \times$

$[\cos(Wo \times x2/Vsod2) - \sin(Wo \times x2/Vsod2) / \tan(Wo \times H2/Vsod2)]$

8) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 11.400 m
- 하부슬래브 EL. = 23.705 m
- 기반암 심도(H) = 30.000 m

$Po = Ksb,top \times (U(Zu) - U(Zb))$

기능수행수준	붕괴방지수준
$Po = 71251.050 \times (0.003403 - 0.000776)$ $= 187.177\ kN/m^2$	$Po = 71251.050 \times (0.009136 - 0.002083)$ $= 502.534\ kN/m^2$

9) 측벽 지반변위 하중

$P(z) = Kh \times (Uh(z) - Uh(b))$

(1) 기능수행수준

z(m)	Kh (kN/m^3)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m^2)
11.400	240834.030	0.003403	0.002627	632.671
12.200	240834.030	0.002949	0.002173	523.332
12.425	240834.030	0.002818	0.002042	491.783
12.700	240834.030	0.002656	0.001880	452.768
13.451	240834.030	0.002207	0.001431	344.633
14.476	525307.960	0.001822	0.001046	549.472
15.502	525307.960	0.001715	0.000939	493.264
16.527	525307.960	0.001605	0.000829	435.480
17.540	525307.960	0.001493	0.000717	376.646
17.552	525307.960	0.001492	0.000716	376.120
18.340	525307.960	0.001404	0.000628	329.893
18.578	525307.960	0.001377	0.000601	315.710
19.140	525307.960	0.001313	0.000537	282.090
19.603	525307.960	0.001260	0.000484	254.249
19.640	525307.960	0.001256	0.000480	252.148
20.629	525307.960	0.001141	0.000365	191.737
21.654	525307.960	0.001021	0.000245	128.700
22.305	525307.960	0.000944	0.000168	88.252
22.680	525307.960	0.000899	0.000123	64.613
22.805	525307.960	0.000884	0.000108	56.733
23.705	525307.960	0.000776	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
11.400	240834.030	0.009136	0.007053	1698.602
12.200	240834.030	0.007917	0.005834	1405.026
12.425	240834.030	0.007566	0.005483	1320.493
12.700	240834.030	0.007132	0.005049	1215.971
13.451	240834.030	0.005925	0.003842	925.284
14.476	525307.960	0.004893	0.002810	1476.115
15.502	525307.960	0.004604	0.002521	1324.301
16.527	525307.960	0.004308	0.002225	1168.810
17.540	525307.960	0.004009	0.001926	1011.743
17.552	525307.960	0.004006	0.001923	1010.167
18.340	525307.960	0.003769	0.001686	885.669
18.578	525307.960	0.003697	0.001614	847.847
19.140	525307.960	0.003526	0.001443	758.019
19.603	525307.960	0.003384	0.001301	683.426
19.640	525307.960	0.003372	0.001289	677.122
20.629	525307.960	0.003065	0.000982	515.852
21.654	525307.960	0.002741	0.000658	345.653
22.305	525307.960	0.002534	0.000451	236.914
22.680	525307.960	0.002414	0.000331	173.877
22.805	525307.960	0.002373	0.000290	152.339
23.705	525307.960	0.002083	0.000000	0.000

10) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

구분	기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
Vu	170277.000 × 0.000528 = 89.910	108977.000 × 0.001419 = 154.640
Vb	811745.000 × 0.000120 = 97.410	811745.000 × 0.000322 = 261.380
Vs	(89.910 + 97.410) / 2 = 93.660	(154.640 + 261.380) / 2 = 208.010

11) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fu = 1.600×25.000×0.074×(1 - 0.015×11.400) = 2.454	fu = 1.600×25.000×0.182×(1 - 0.015×11.400) = 6.035

② 하부슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fb = 1.800×25.000×0.074×(1 - 0.015×23.705) = 2.146	fb = 1.800×25.000×0.182×(1 - 0.015×23.705) = 5.278

③ 중간슬래브

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fb = 1.600×25.000×0.074×(1 - 0.015×14.005) = 2.529	fb = 1.600×25.000×0.182×(1 - 0.015×14.005) = 6.221

④ 중간벽체

기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
fu1 = (1.700×1.300×25.000×0.074× (1-0.015×10.500))/6.500 = 0.521	fu1 = (1.700×1.300×25.000×0.182× (1-0.015×10.500))/6.500 = 1.282
fb1 = (1.700×1.300×25.000×0.074 × (1-0.015×23.705))/6.500 = 0.405	fb1 = (1.700×1.300×25.000×0.182 × (1-0.015×23.705))/6.500 = 0.997
fu1 = 1.700×25.000×0.074×(1-0.015×10.500) = 0.521	fu1 = 1.700×25.000×0.182×(1-0.015×10.500) = 1.282
fb1 = 1.700×25.000×0.074×(1-0.015×23.705) = 0.405	fb1 = 1.700×25.000×0.182×(1-0.015×23.705) = 0.997

⑤ 측벽

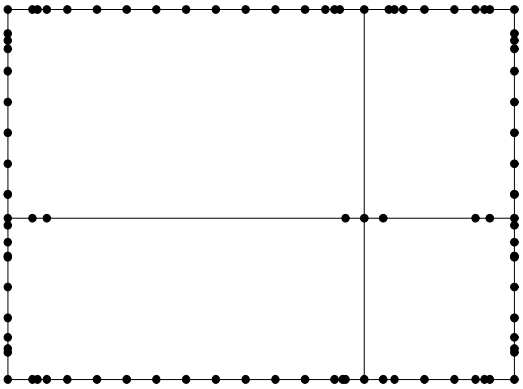
기능수행수준(kN/m²)	붕괴방지수준(kN/m²)
f1 = 1.700×25.000×0.074×(1-0.015×11.400) = 2.607	f1 = 1.700×25.000×0.182×(1-0.015×11.400) = 6.412
f2 = 1.700×25.000×0.074×(1-0.015×12.200) = 2.569	f2 = 1.700×25.000×0.182×(1-0.015×12.200) = 6.319
f3 = 1.700×25.000×0.074×(1-0.015×12.425) = 2.559	f3 = 1.700×25.000×0.182×(1-0.015×12.425) = 6.293
f4 = 1.700×25.000×0.074×(1-0.015×12.700) = 2.546	f4 = 1.700×25.000×0.182×(1-0.015×12.700) = 6.261
f5 = 1.700×25.000×0.074×(1-0.015×13.451) = 2.510	f5 = 1.700×25.000×0.182×(1-0.015×13.451) = 6.174
f6 = 1.700×25.000×0.074×(1-0.015×14.476) = 2.462	f6 = 1.700×25.000×0.182×(1-0.015×14.476) = 6.055
f7 = 1.700×25.000×0.074×(1-0.015×15.502) = 2.414	f7 = 1.700×25.000×0.182×(1-0.015×15.502) = 5.936
f8 = 1.700×25.000×0.074×(1-0.015×16.527) = 2.365	f8 = 1.700×25.000×0.182×(1-0.015×16.527) = 5.817
f9 = 1.700×25.000×0.074×(1-0.015×17.540) = 2.318	f9 = 1.700×25.000×0.182×(1-0.015×17.540) = 5.700
f10 = 1.700×25.000×0.074×(1-0.015×17.552)	f10 = 1.700×25.000×0.182×(1-0.015×17.552)

= 2.317	= 5.699

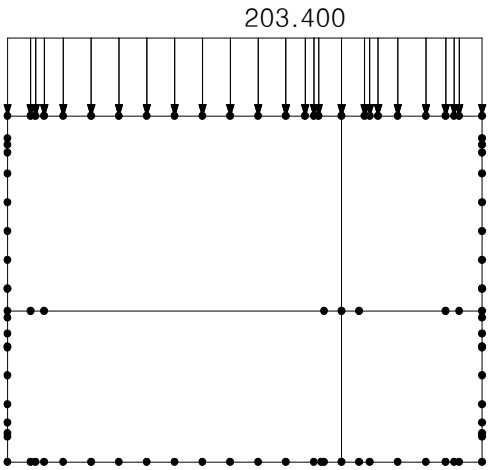
f11 = 1.700×25.000×0.074×(1-0.015×18.340) = 2.280	f11 = 1.700×25.000×0.182×(1-0.015×18.340) = 5.607
f12 = 1.700×25.000×0.074×(1-0.015×18.578) = 2.269	f12 = 1.700×25.000×0.182×(1-0.015×18.578) = 5.579
f13 = 1.700×25.000×0.074×(1-0.015×19.140) = 2.242	f13 = 1.700×25.000×0.182×(1-0.015×19.140) = 5.514
f14 = 1.700×25.000×0.074×(1-0.015×19.603) = 2.220	f14 = 1.700×25.000×0.182×(1-0.015×19.603) = 5.461
f15 = 1.700×25.000×0.074×(1-0.015×19.640) = 2.218	f15 = 1.700×25.000×0.182×(1-0.015×19.640) = 5.456
f16 = 1.700×25.000×0.074×(1-0.015×20.629) = 2.172	f16 = 1.700×25.000×0.182×(1-0.015×20.629) = 5.342
f17 = 1.700×25.000×0.074×(1-0.015×21.654) = 2.123	f17 = 1.700×25.000×0.182×(1-0.015×21.654) = 5.223
f18 = 1.700×25.000×0.074×(1-0.015×22.305) = 2.093	f18 = 1.700×25.000×0.182×(1-0.015×22.305) = 5.147
f19 = 1.700×25.000×0.074×(1-0.015×22.680) = 2.075	f19 = 1.700×25.000×0.182×(1-0.015×22.680) = 5.104
f20 = 1.700×25.000×0.074×(1-0.015×22.805) = 2.069	f20 = 1.700×25.000×0.182×(1-0.015×22.805) = 5.089
f21 = 1.700×25.000×0.074×(1-0.015×23.705) = 2.027	f21 = 1.700×25.000×0.182×(1-0.015×23.705) = 4.985

11. 하 중 재 하 (상시)

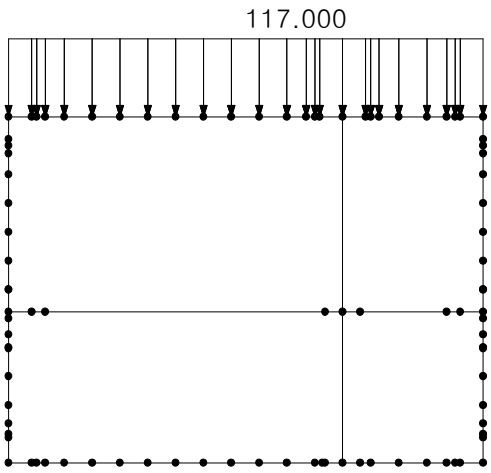
1) CASE1 - 구체자중(SW)



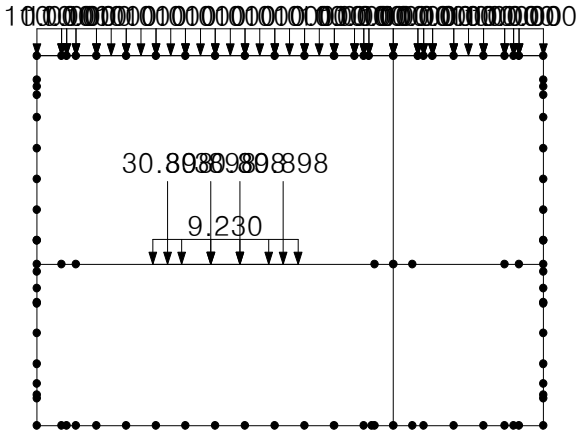
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



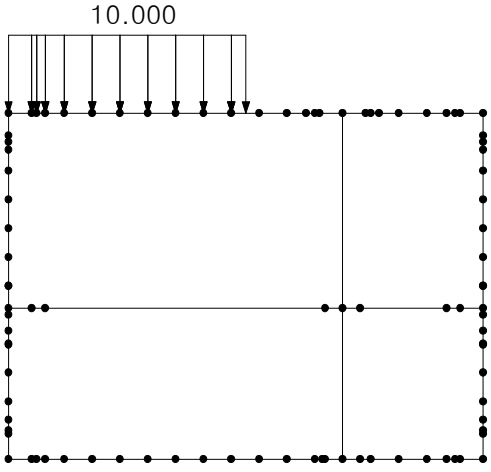
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



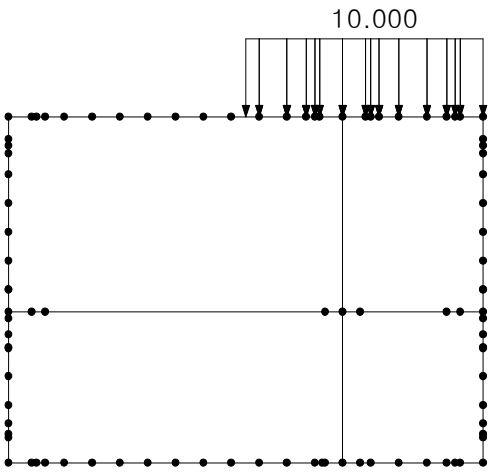
4) CASE4 - 만재활하중(LIVEFU)



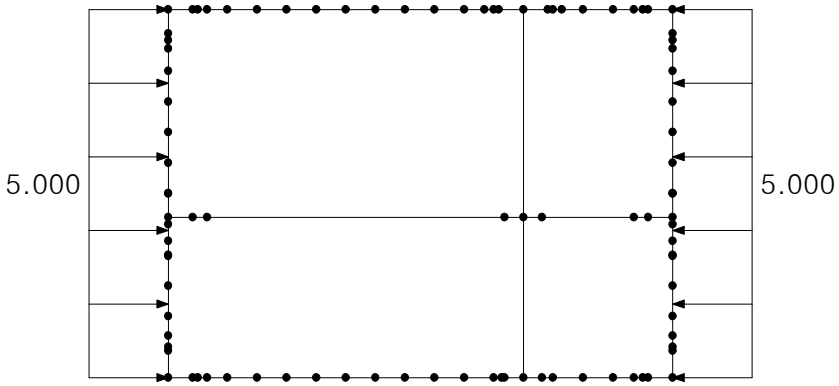
5) CASE5 - 편재활하중(좌측)(LIVELE)



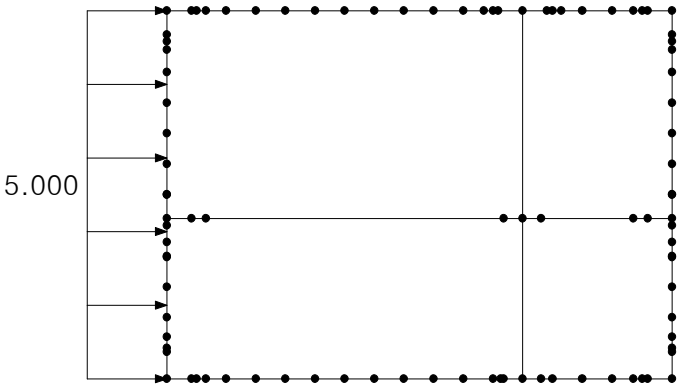
6) CASE6 - 편재활하중(우측)(LIVERI)



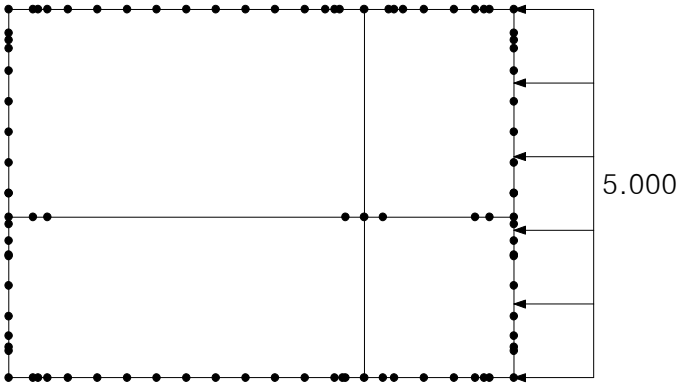
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



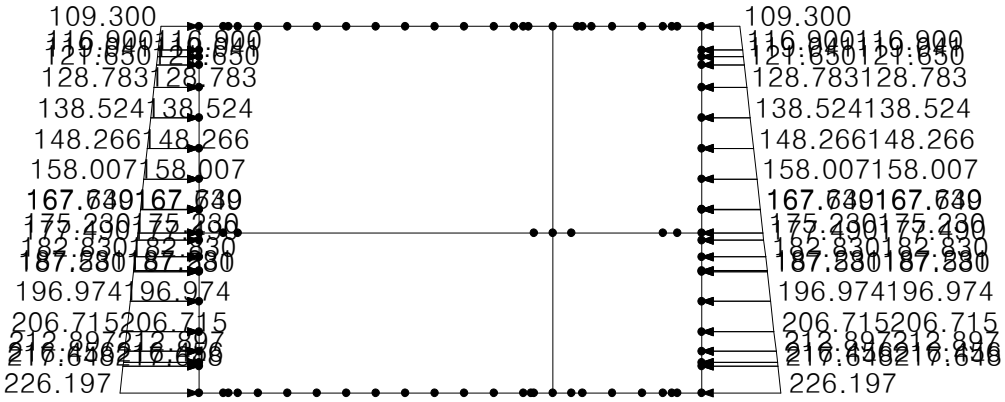
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



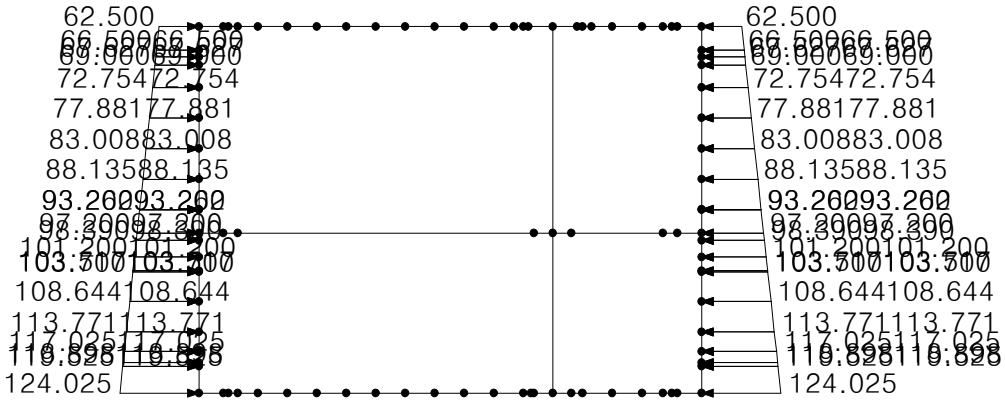
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



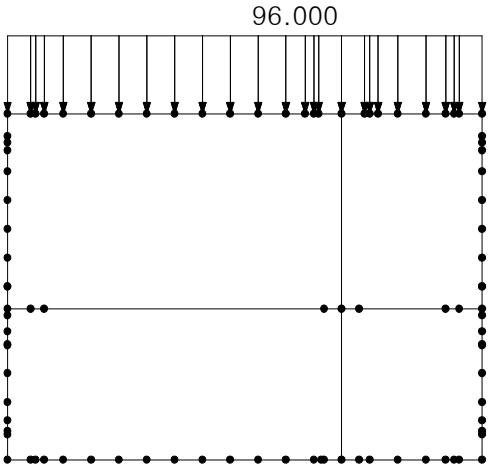
10) CASE10 - 양토압 : 지하수無(SOILB)



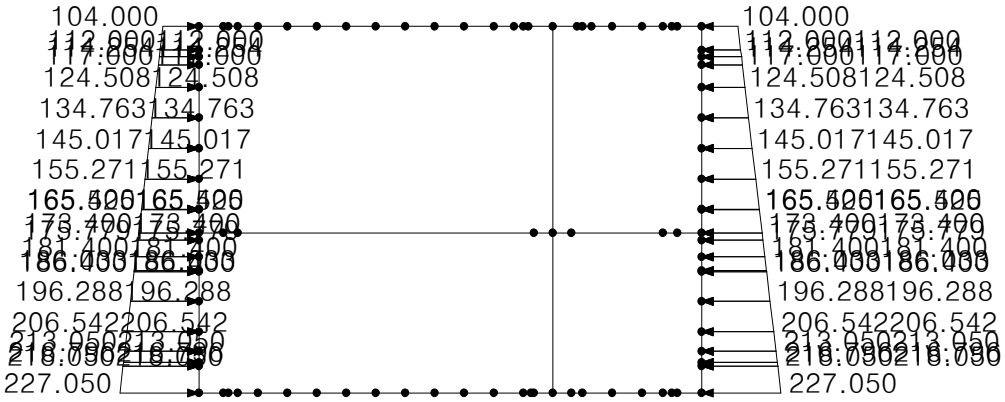
11) CASE11 - 양토압 : 지하수有(SOILBW)



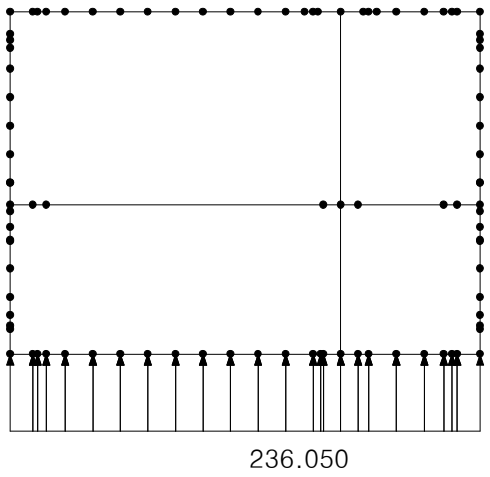
12) CASE12 - 연직수압(WATERV)



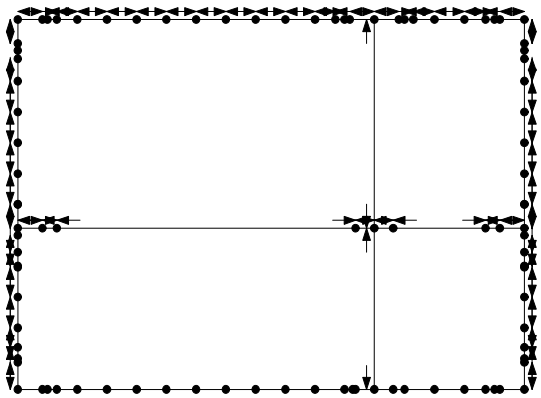
13) CASE13 - 수평수압(WATERH)



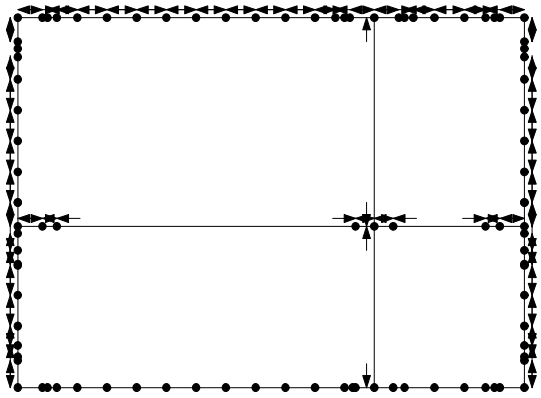
14) CASE14 - 부력(BUOYANCY)



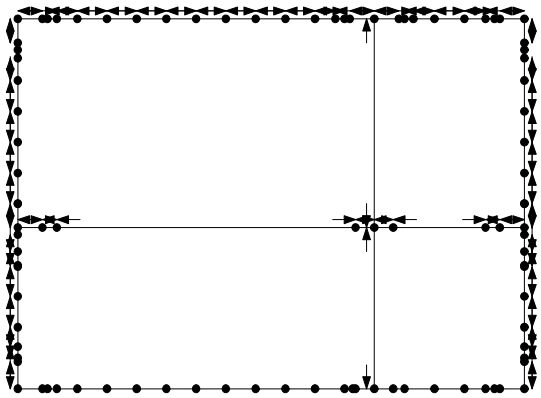
15) CASE15 - 온도변화(+) +10° C(TEMPPLUS)



16) CASE16 - 온도변화(-) -10° C(TEMPMINU)

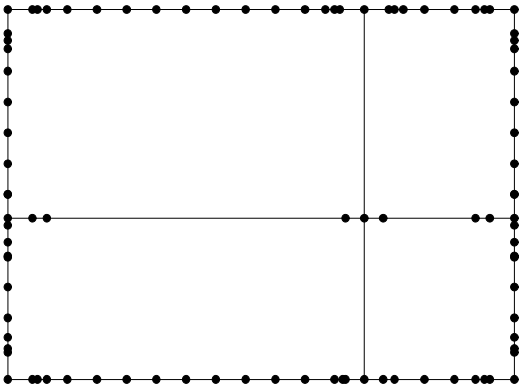


17) CASE17 - 건조수축 -15° C(SHRINK)

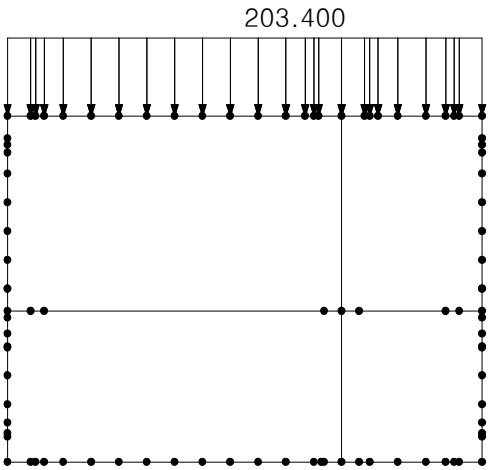


12. 하중 재하 (기능수행)

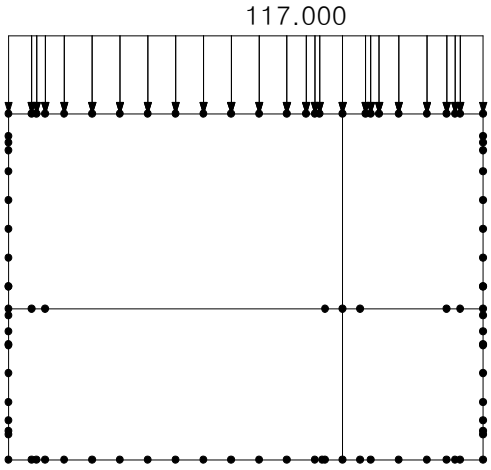
1) CASE1 - 구체자중(SW)



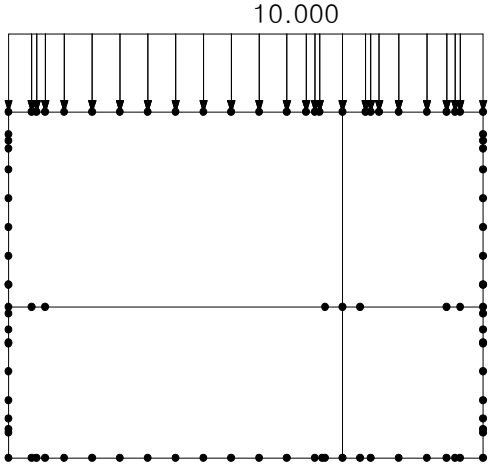
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



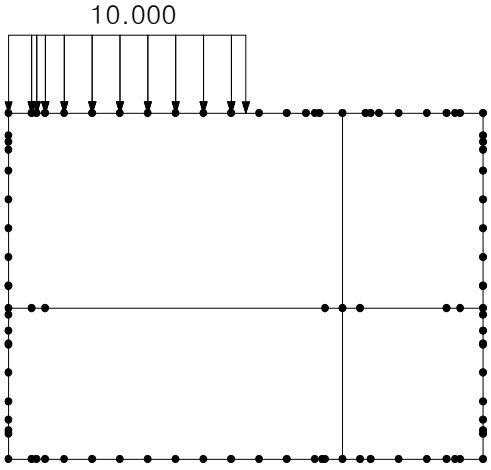
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



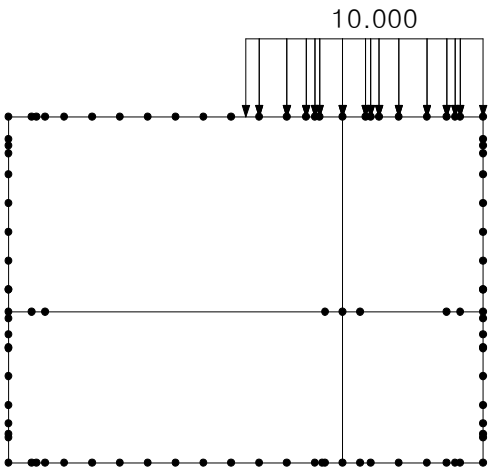
4) CASE4 - 지진시 만재활하중(LIVEFUE)



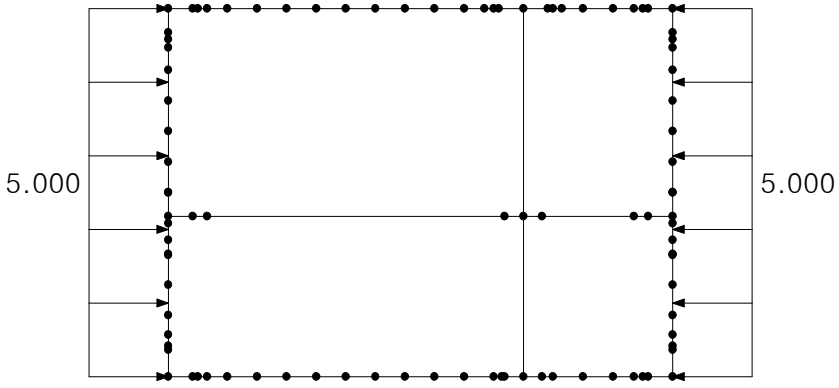
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



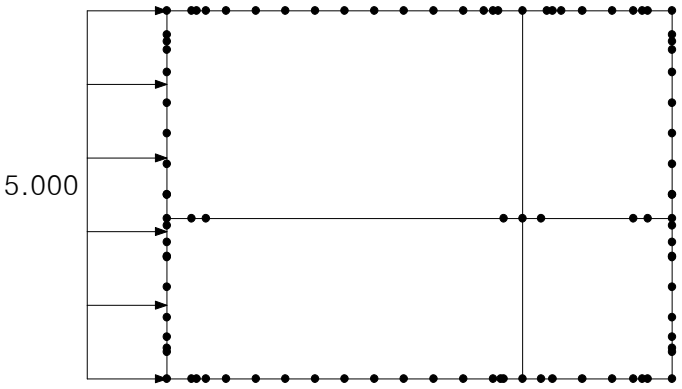
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



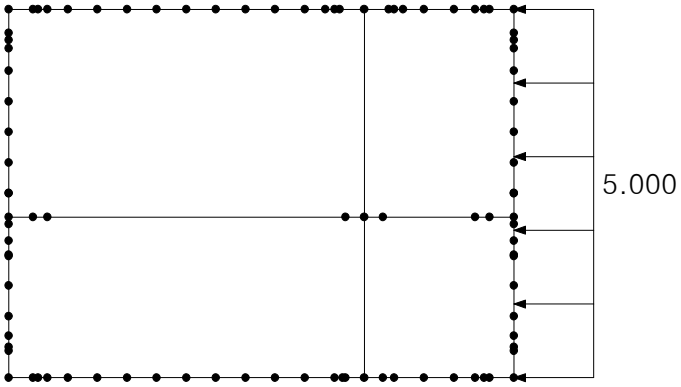
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



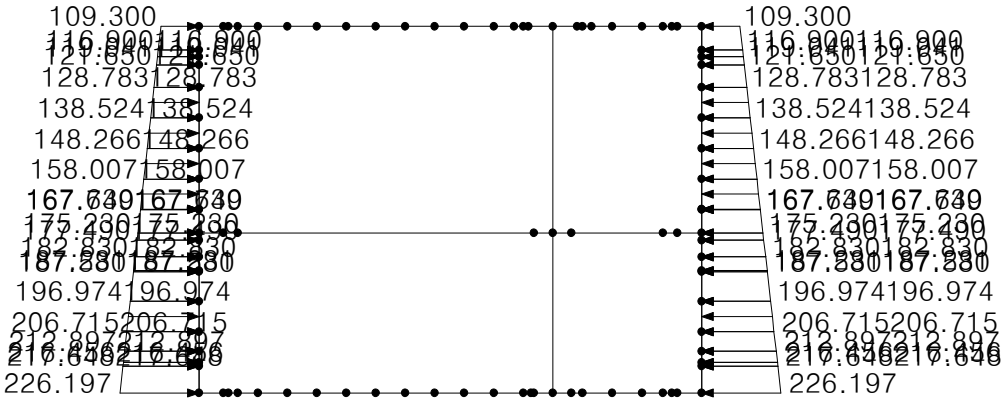
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



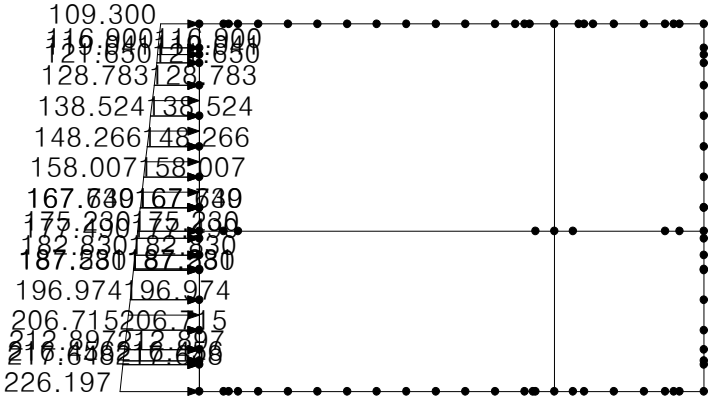
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



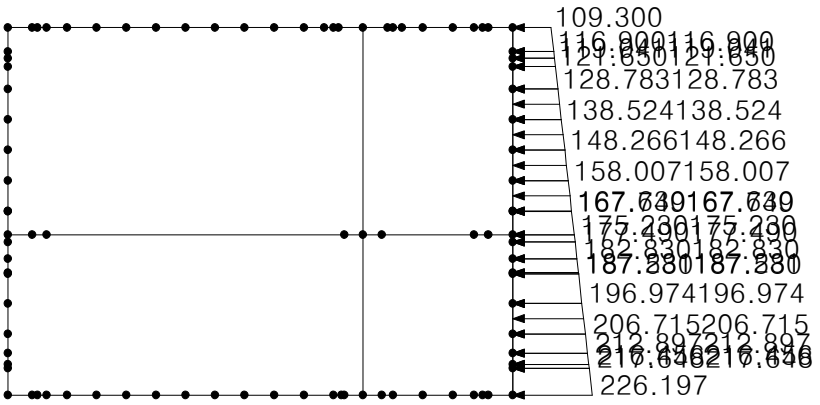
10) CASE10 - 지진시 양토압 2(SOILBE2)



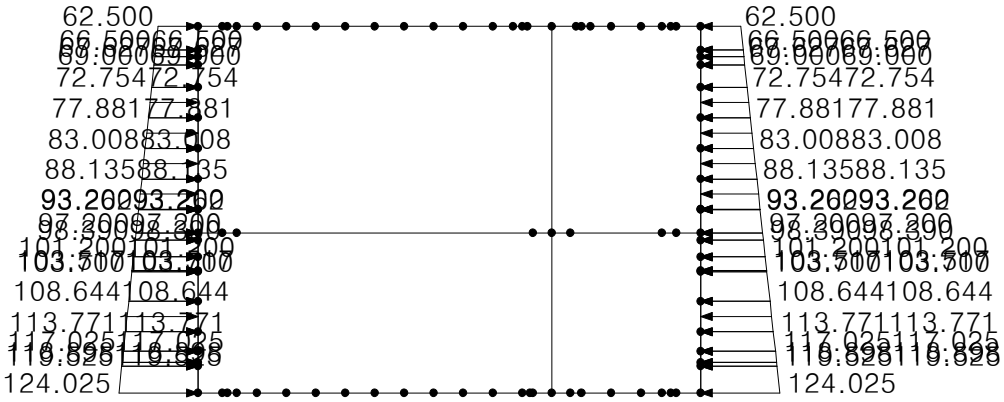
11) CASE11 - 지진시 편토압(좌측) 2(SOILLE2)



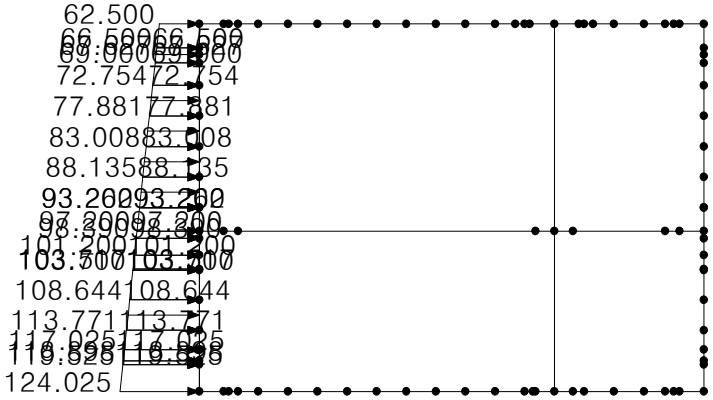
12) CASE12 - 지진시 편토압(우측) 2(SOILRE2)



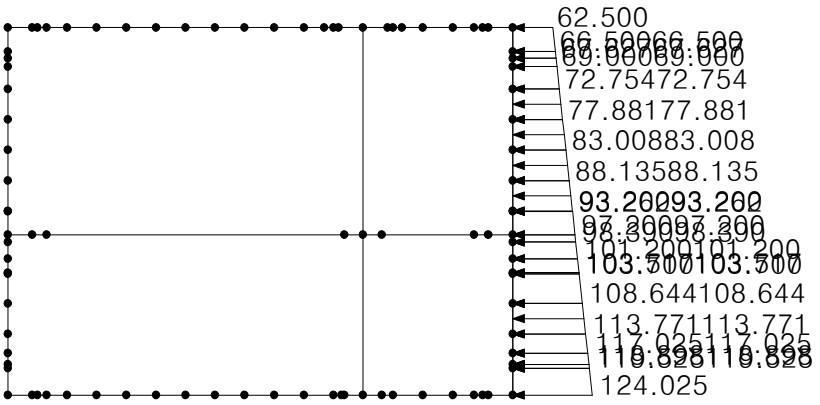
13) CASE13 - 지진시 양토압 2 : 지하수有(SOILBWE2)



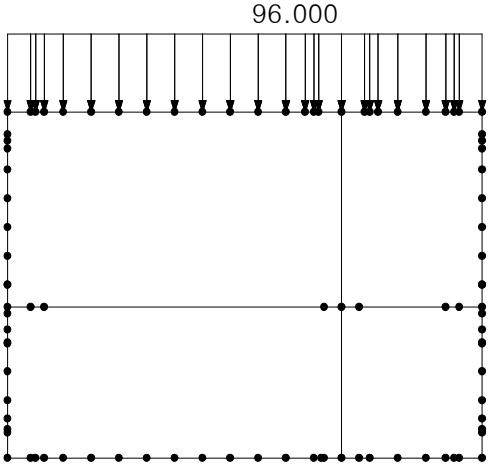
14) CASE14 - 지진시 편토압(좌측) 2 : 지하수有(SOILLWE2)



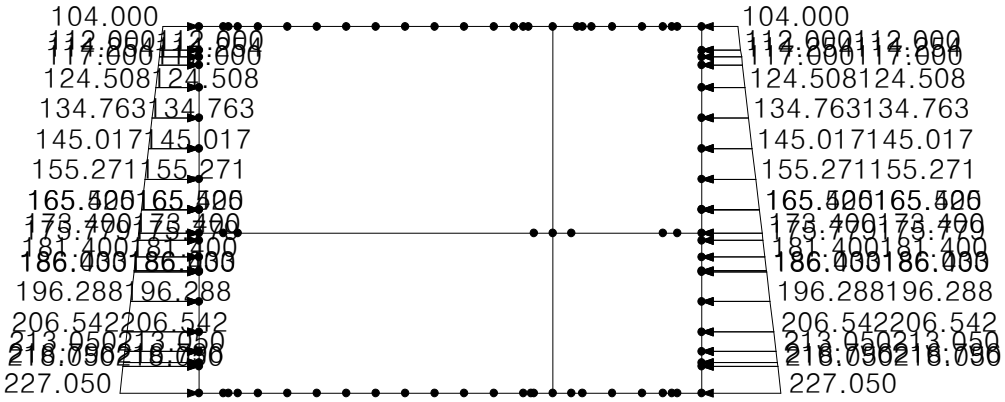
15) CASE15 - 지진시 편토압(우측) 2 : 지하수有(SOILRWE2)



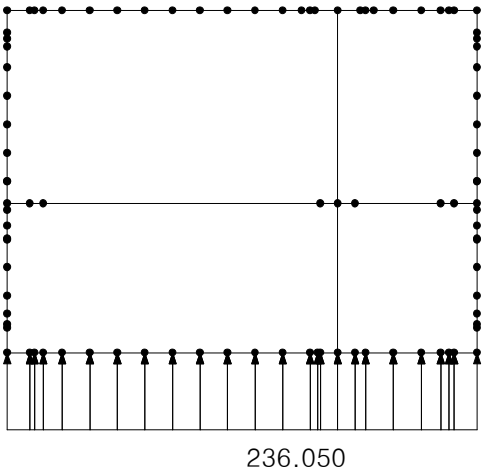
16) CASE16 - 연직수압(WATERV)



17) CASE17 - 수평수압(WATERH)

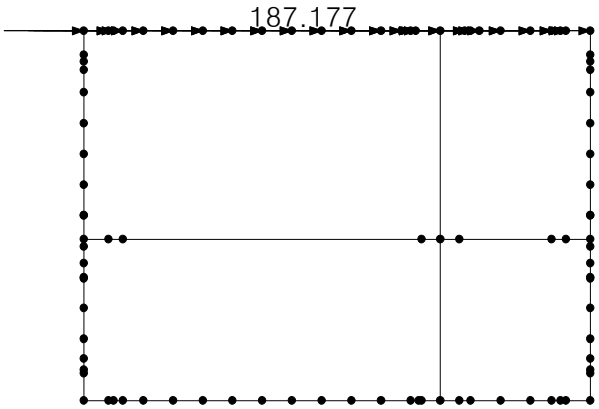


18) CASE18 - 부력(BUOYANCY)

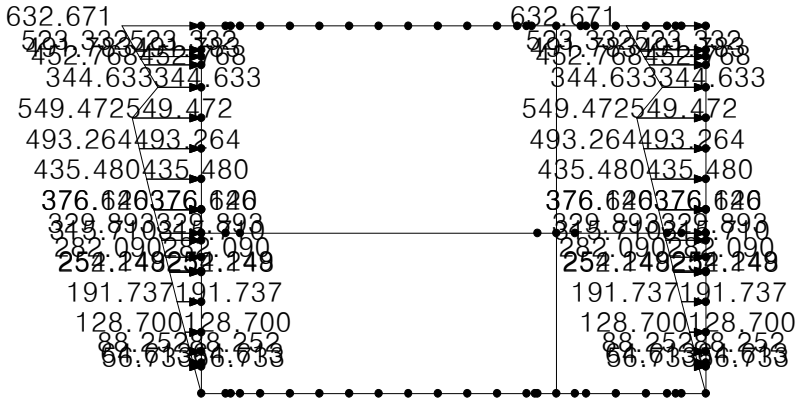


- 지진재하방향(좌측에서 우측으로)

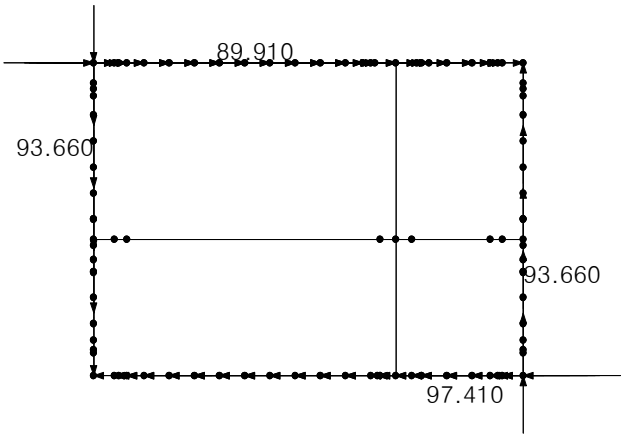
19) CASE19 - 슬래브 지반변위(기능수행)(FUNSLAB)



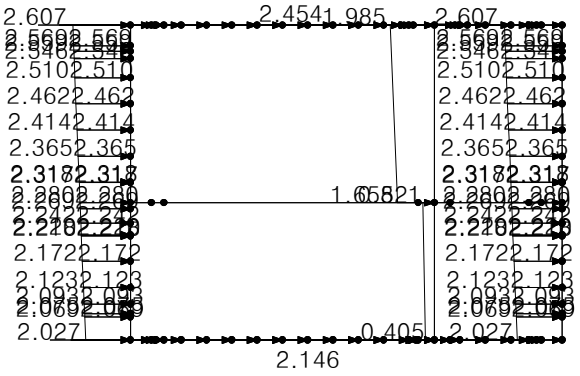
20) CASE20 - 벽체 지반변위(기능수행)(FUNWALL)



21) CASE21 - 주면전단력(기능수행)(FUNMS)

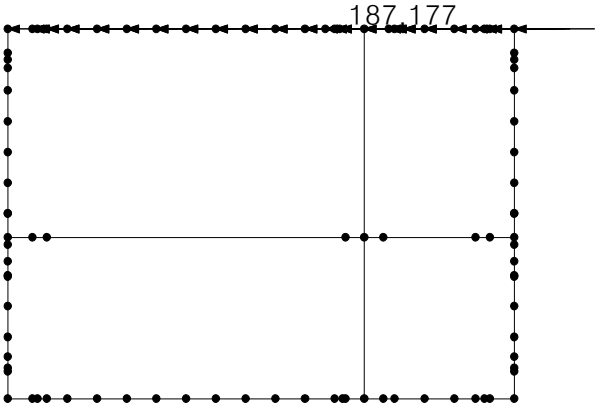


22) CASE22 - 구체 관성력(기능수행)(FUNINER)

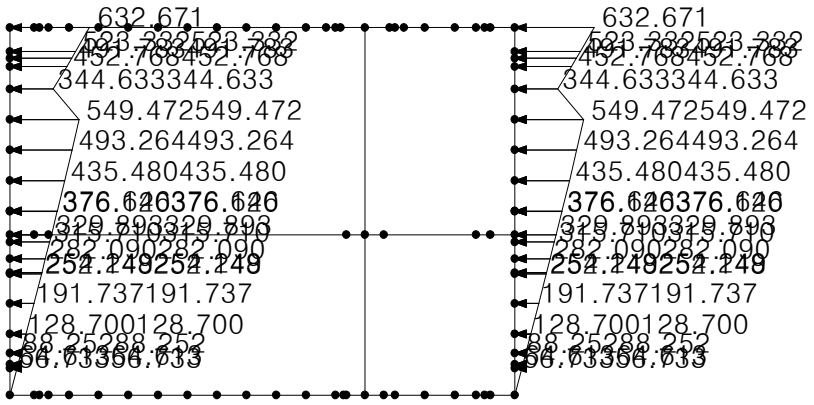


- 지진재하방향(우측에서 좌측으로)

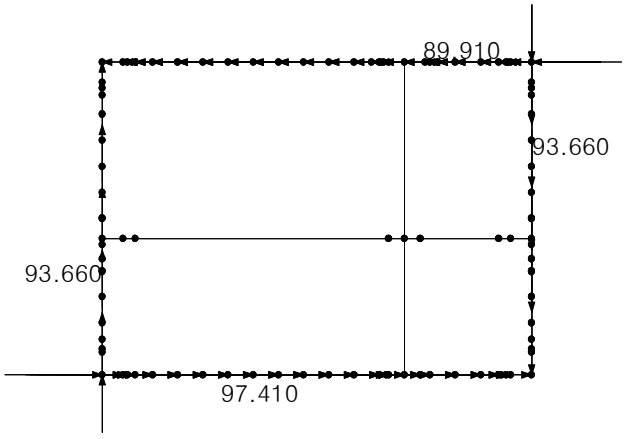
23) CASE23 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



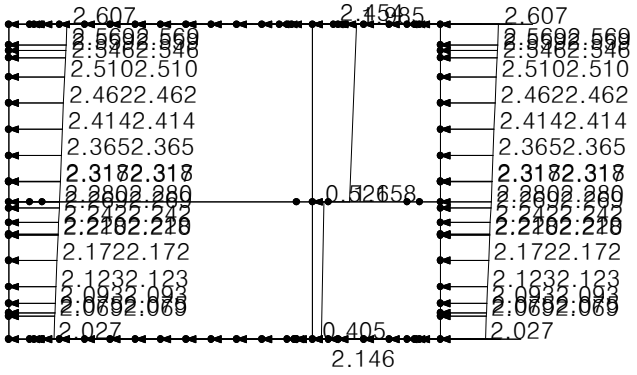
24) CASE24 - 벽체 지반변위(기능수행)2(FUNWALL2)



25) CASE25 - 주면전단력(기능수행)2(FUNMS2)

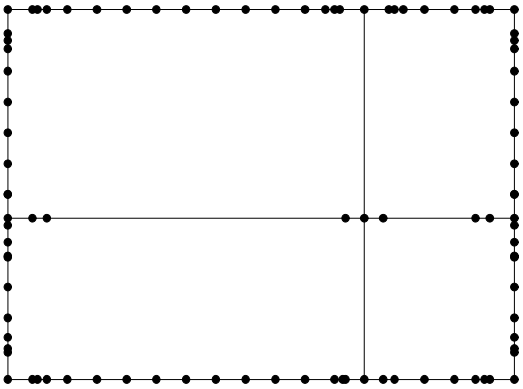


26) CASE26 - 구체 관성력(기능수행)2(FUNINER2)

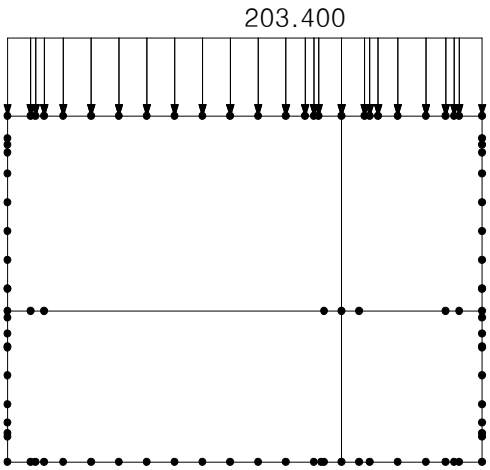


13. 하중 재하 (붕괴방지)

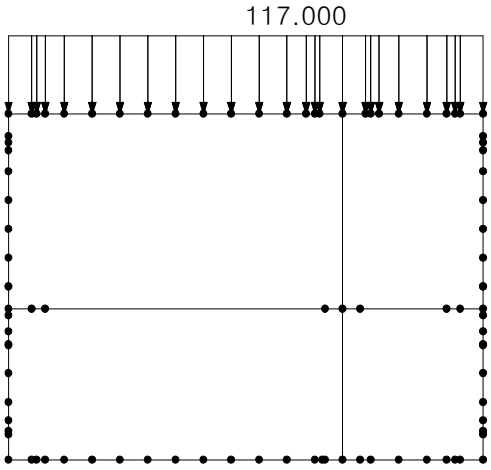
1) CASE1 - 구체자중(SW)



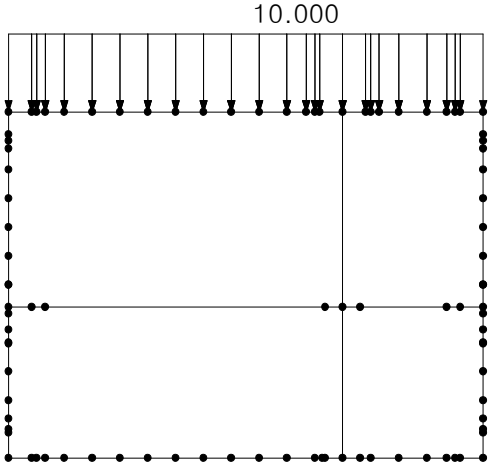
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



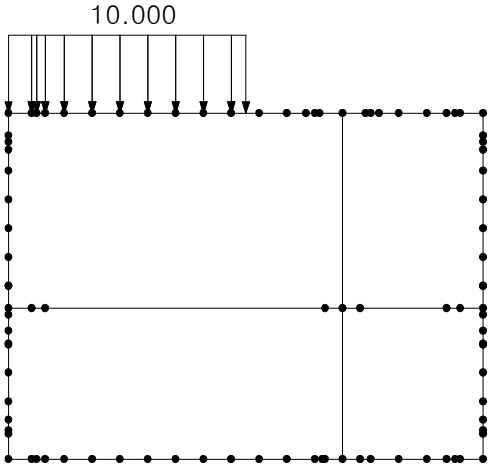
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



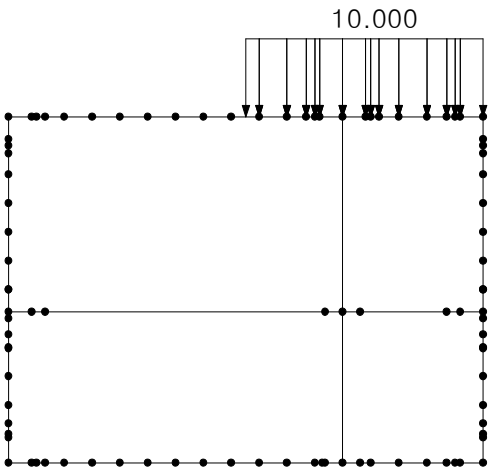
4) CASE4 - 지진시 만재활하중(LIVEFUE)



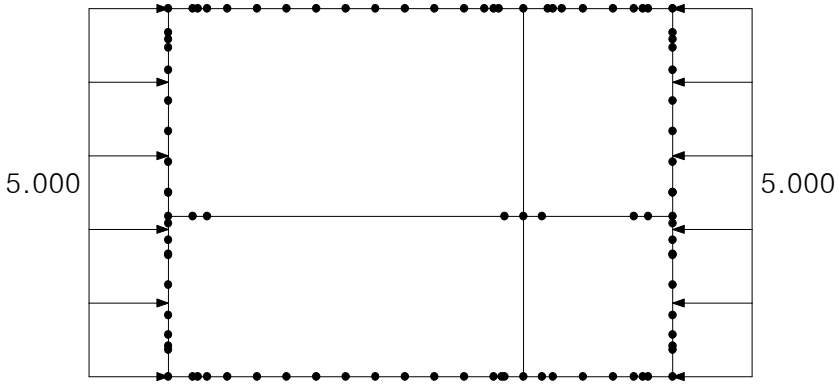
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



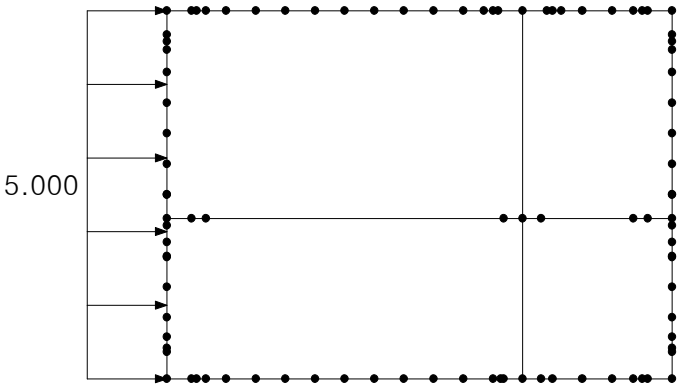
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



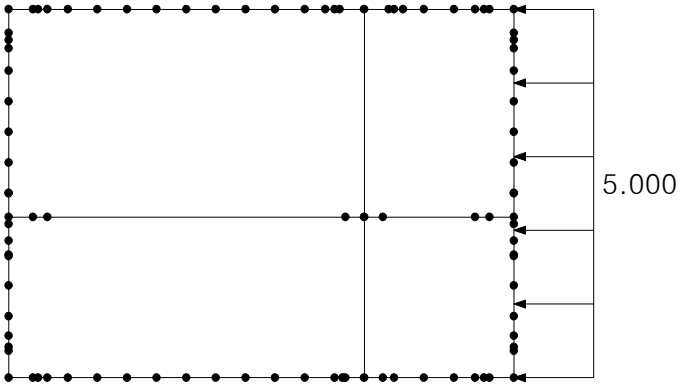
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



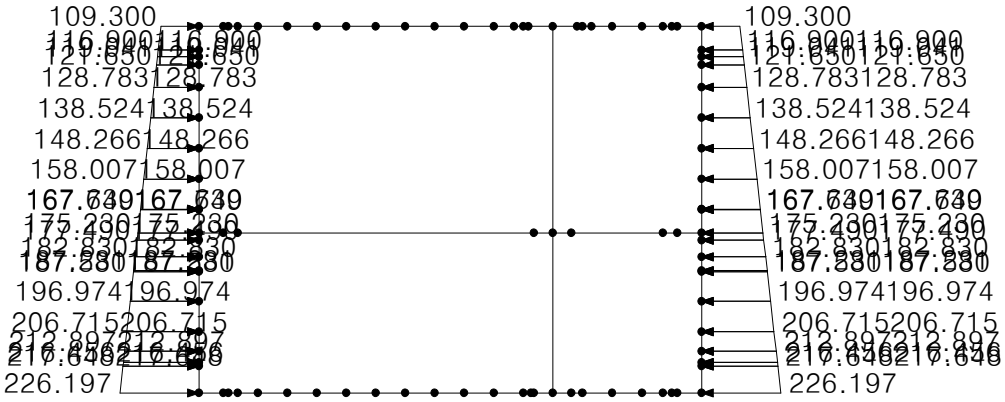
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



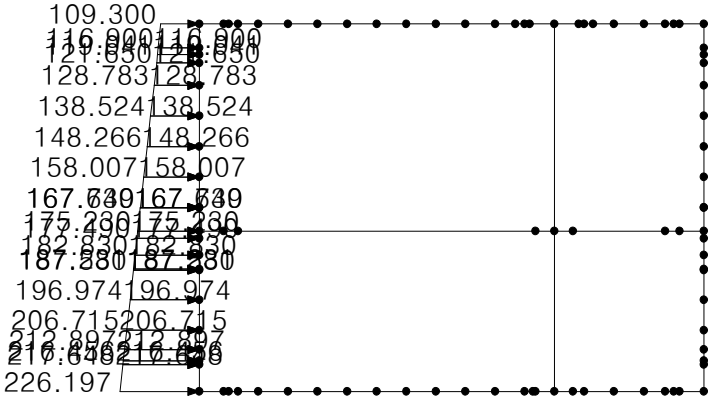
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



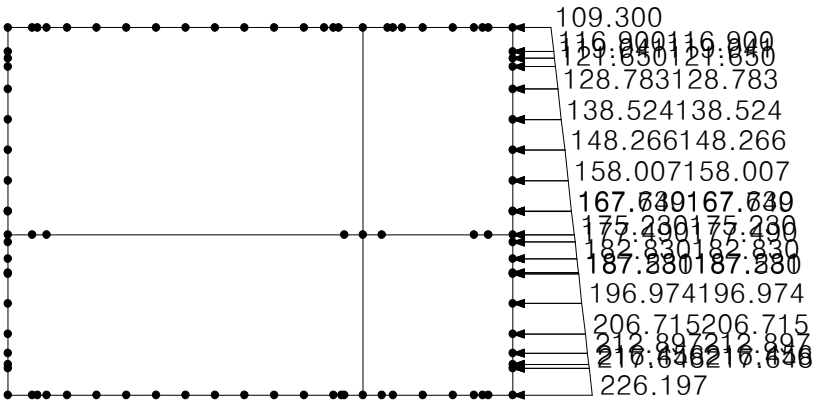
10) CASE10 - 지진시 양토압(SOILBE)



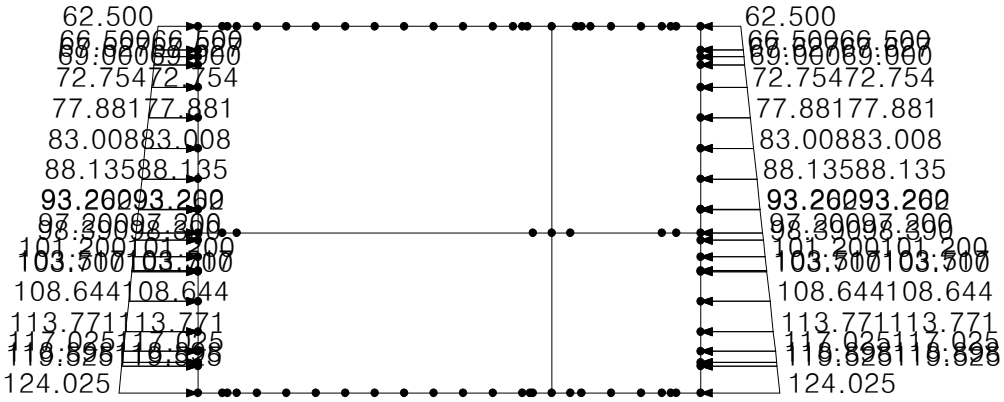
11) CASE11 - 지진시 편토압(좌측)(SOILLE)



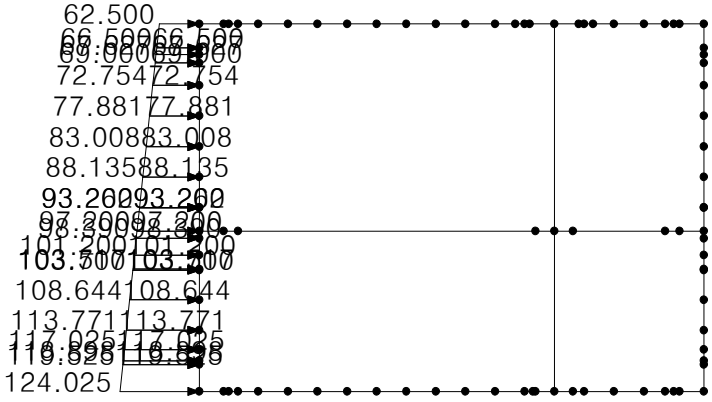
12) CASE12 - 지진시 편토압(우측)(SOILRE)



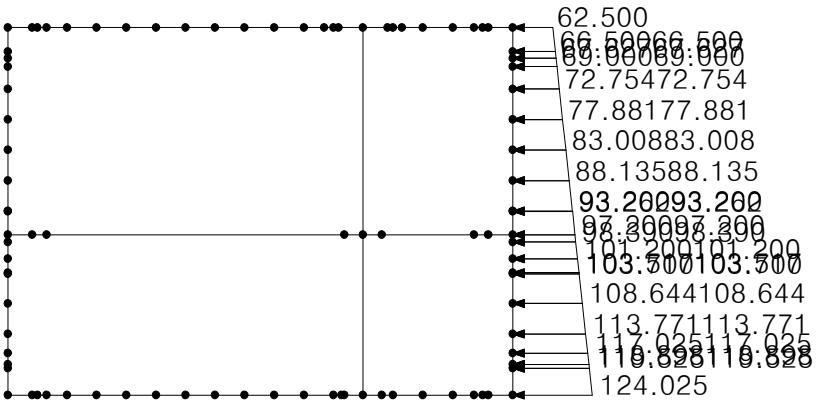
13) CASE13 - 지진시 양토압 : 지하수有(SOILBWE)



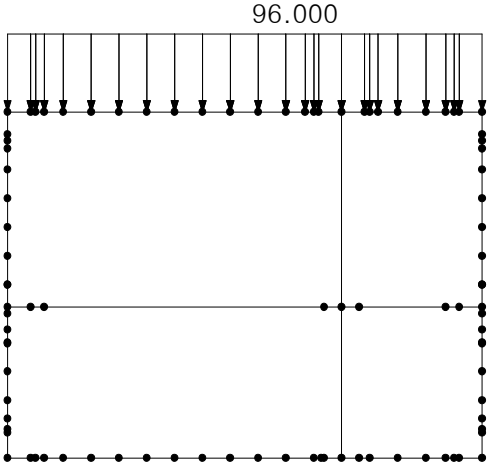
14) CASE14 - 지진시 편토압(좌측) : 지하수有(SOILLWE)



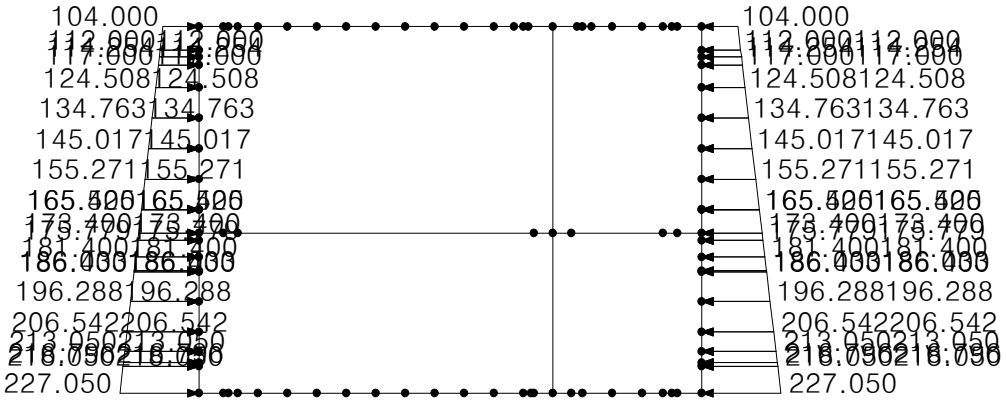
15) CASE15 - 지진시 편토압(우측) : 지하수有(SOILRWE)



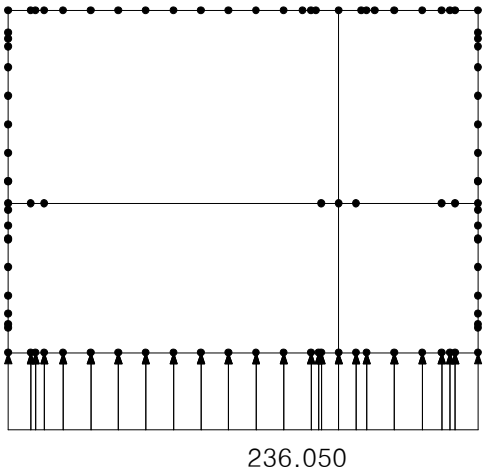
16) CASE16 - 연직수압(WATERV)



17) CASE17 - 수평수압(WATERH)

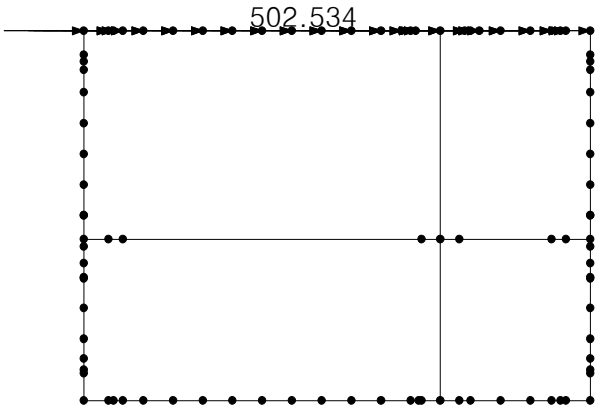


18) CASE18 - 부력(BUOYANCY)

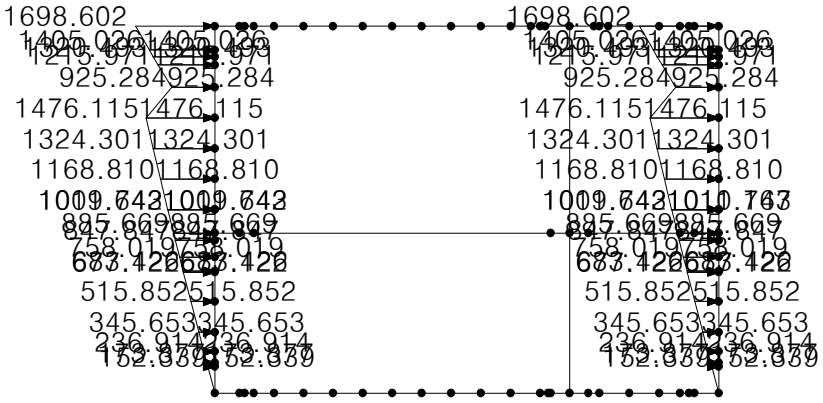


- 지진재하방향(좌측에서 우측으로)

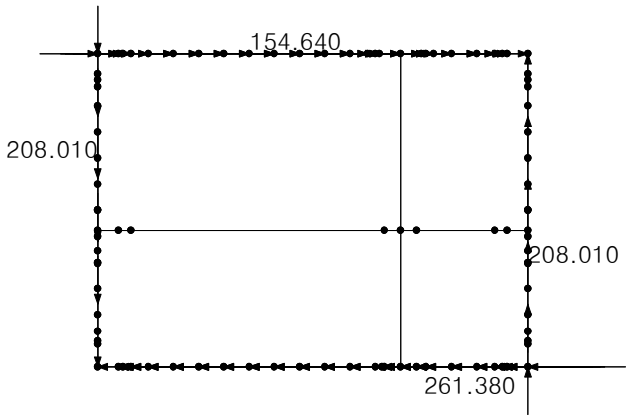
19) CASE19 - 슬래브 지반변위(붕괴방지)(COLSLAB)



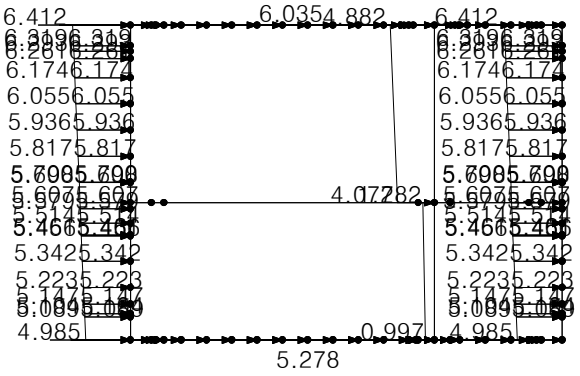
20) CASE20 - 벽체 지반변위(붕괴방지)(COLWALL)



21) CASE21 - 주면전단력(붕괴방지)(COLMS)

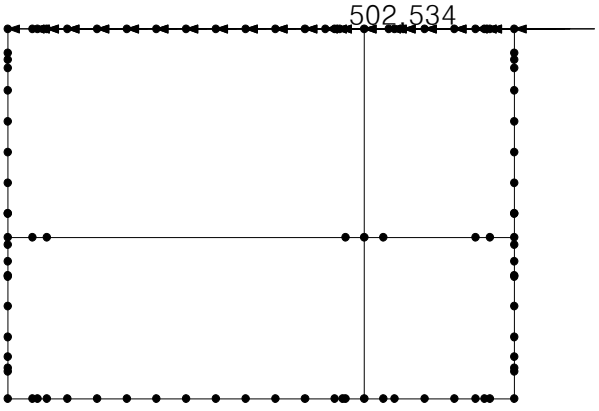


22) CASE22 - 구체 관성력(붕괴방지)(COLINER)

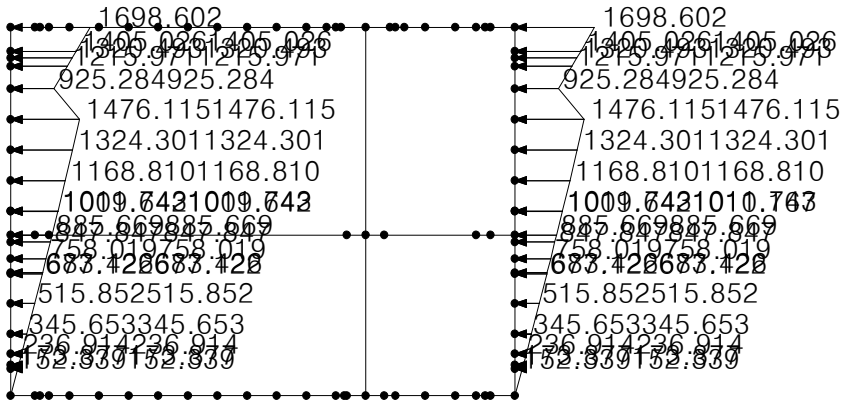


- 지진재하방향(우측에서 좌측으로)

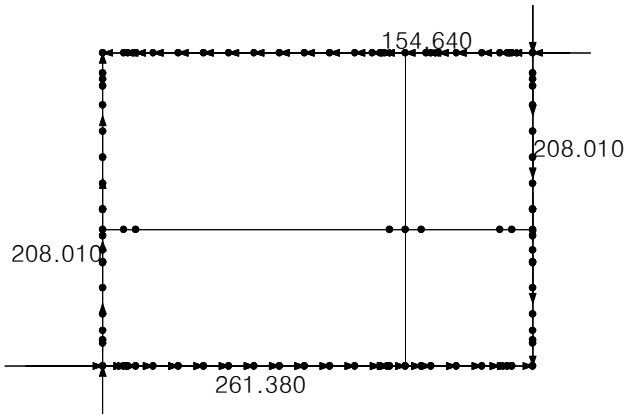
23) CASE23 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



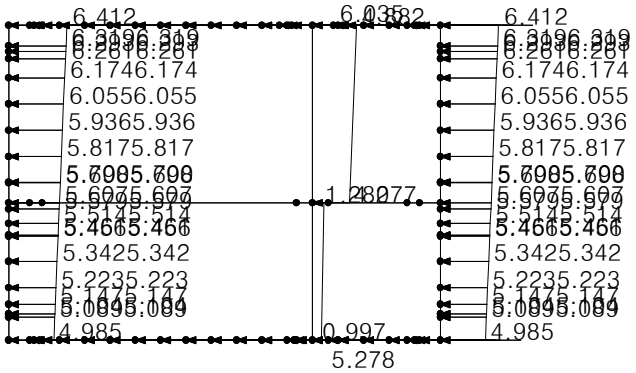
24) CASE24 - 벽체 지반변위(붕괴방지)2(COLWALL2)



25) CASE25 - 주면전단력(붕괴방지)2(COLMS2)



26) CASE26 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 0.875, h = 10.600 m

1) 계수하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.400						
LC2	1.200	1.400	1.600	1.600	1.200		
LC3	1.200		1.000				
LC4	1.200	1.400	1.600	0.800	1.200		
LC5	0.900	0.900		1.600			
LC6	0.900	0.900		0.800			
LC7	1.200	1.400	1.600	1.600	1.200	1.200	●
LC8	1.200	1.400	1.600	0.800	1.200	1.200	●
LC9	0.900	0.900		1.600			●
LC10	0.900	0.900		0.800			●

2) 사용하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.000						
LC2	1.000	1.000	1.000	1.000	1.000		
LC3	1.000		1.000				
LC4	1.000	1.000	1.000	0.500	1.000		
LC5	1.000	1.000		1.000			
LC6	1.000	1.000		0.500			
LC7	1.000	1.000	1.000	1.000	1.000	1.000	●
LC8	1.000	1.000	1.000	0.500	1.000	1.000	●
LC9	1.000	1.000		1.000			●
LC10	1.000	1.000		0.500			●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

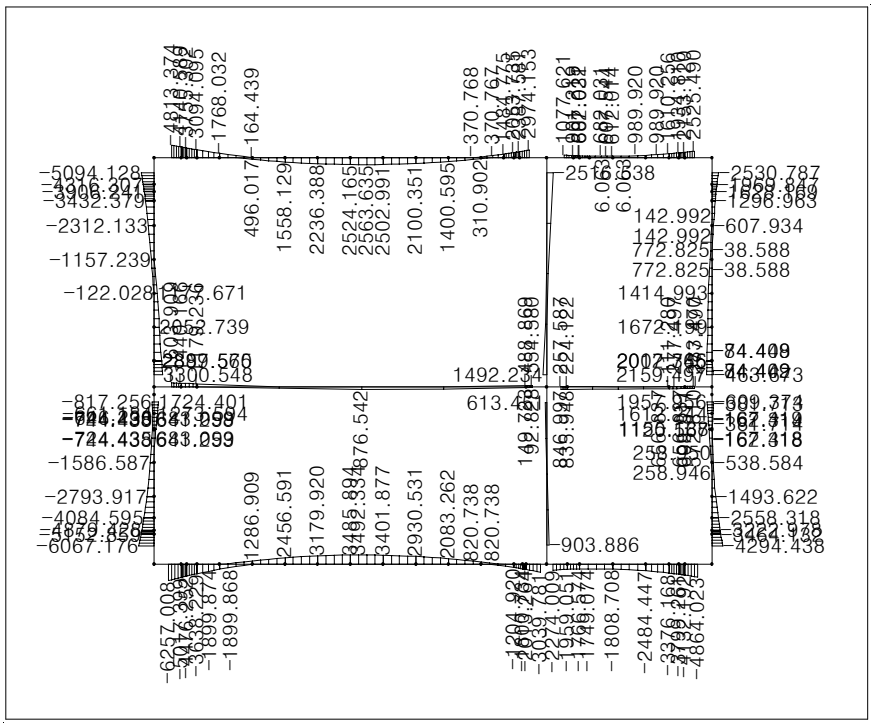
4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

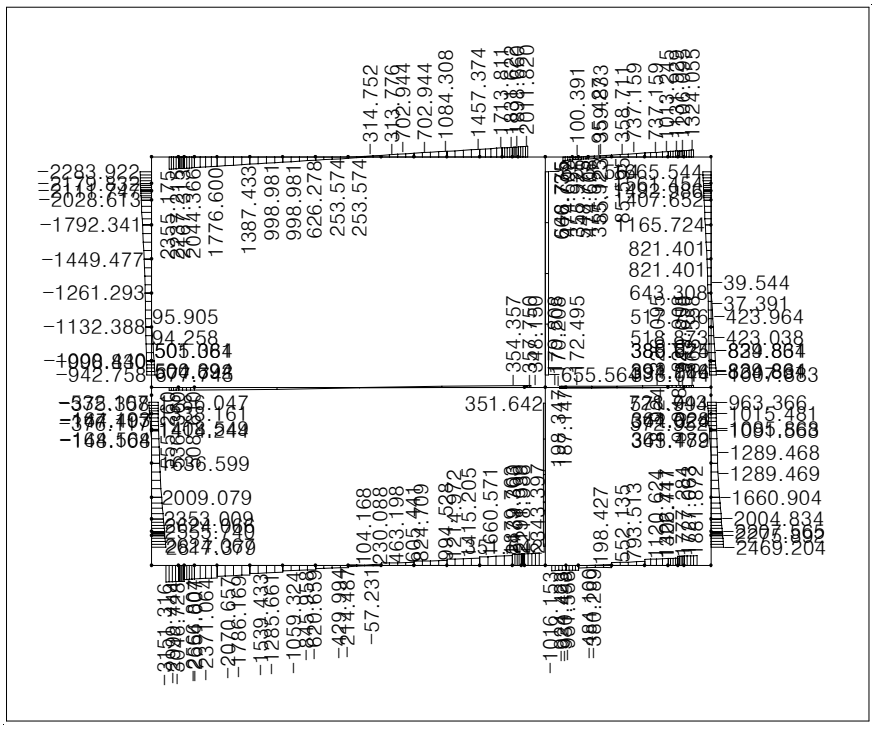
15. 단면력정리

15.1 상시

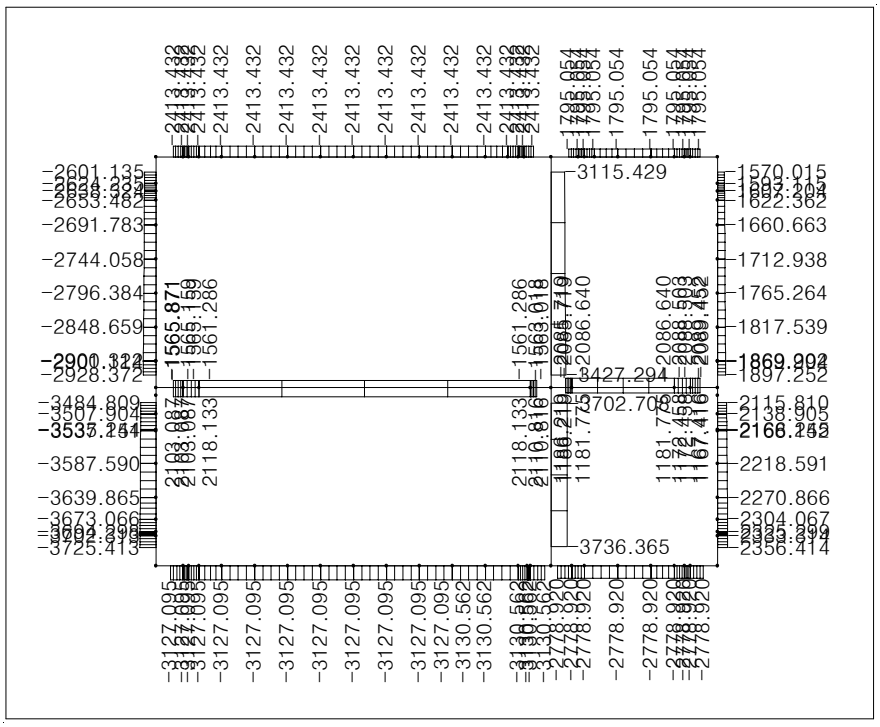
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



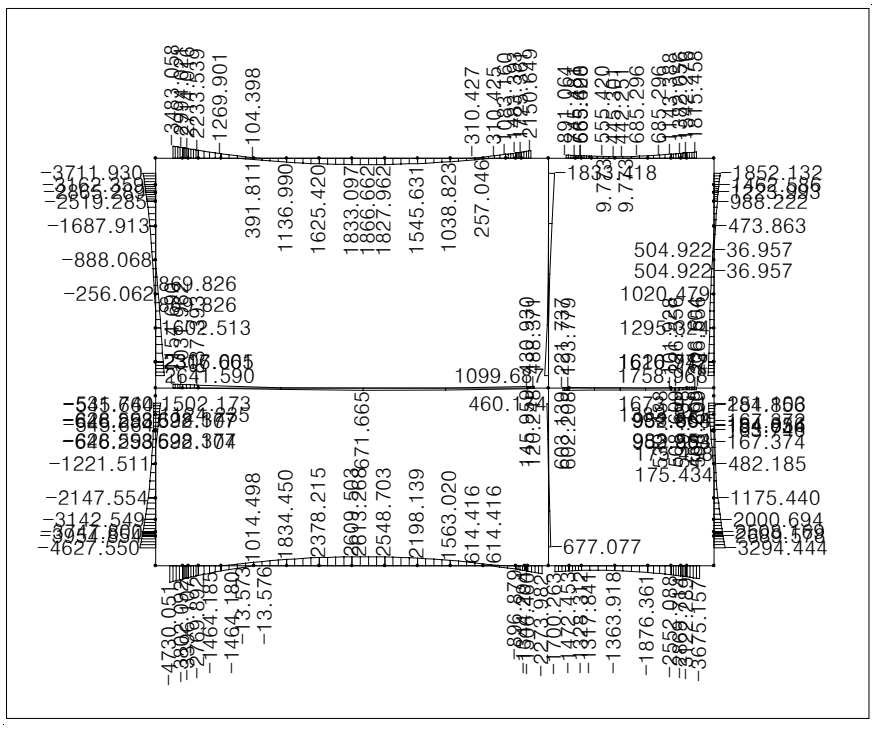
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

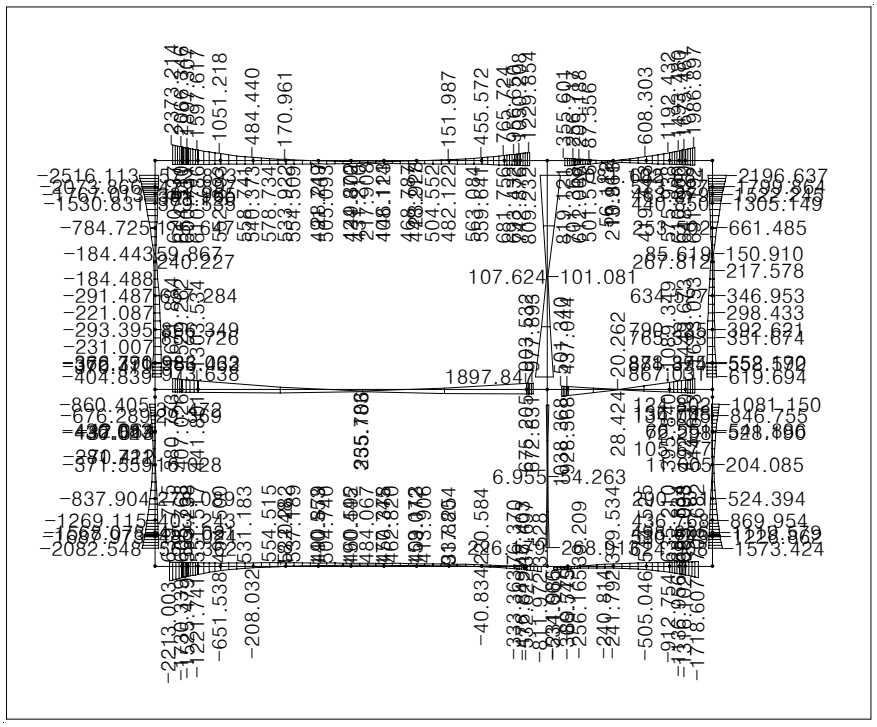


5) 단면력 정리

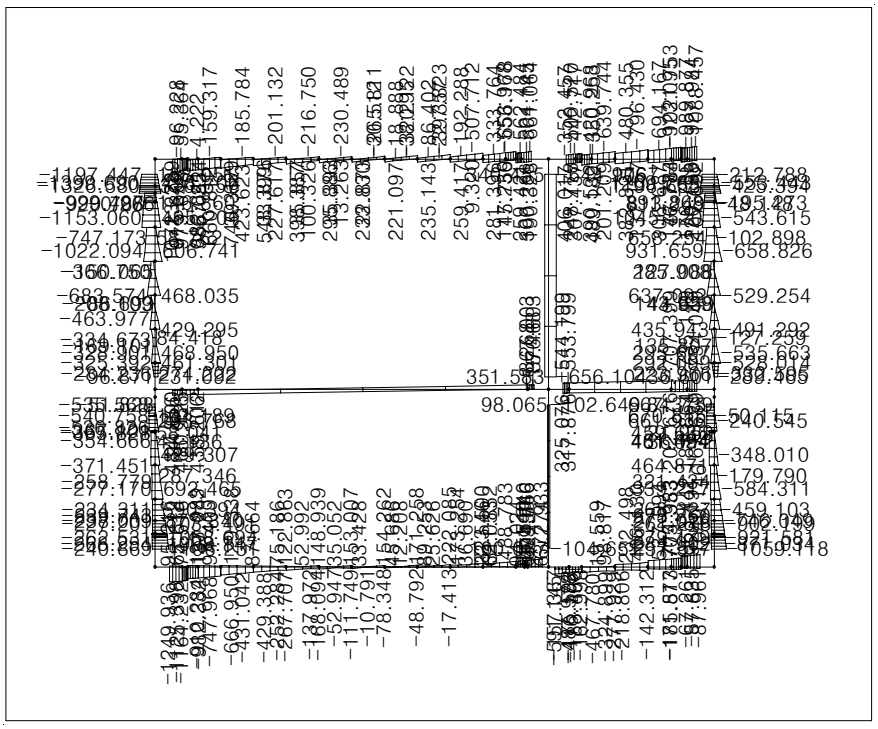
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	4140.59	1666.31	2413.43	2994.02	1000.00	1766.67	
		중앙부	2	2563.64	120.17	2413.43	1866.66	1000.00	1600.00	
		우측	3	2387.58	1351.65	2413.43	1725.36	1000.00	1766.67	
	2 경간	좌측	4	901.22	456.51	1795.05	745.48	1000.00	1766.67	
		중앙부	5	0.00	474.61	1795.05	0.00	1000.00	1600.00	
		우측	6	2153.12	637.61	1795.05	1542.28	1000.00	1766.67	
하부 슬래브	1 경간	좌측	7	5017.40	1934.75	3127.10	3802.09	1000.00	1966.67	
		중앙부	8	3492.33	143.37	3127.10	2613.27	1000.00	1800.00	
		우측	9	2013.26	1279.16	3130.56	1506.46	1000.00	1800.00	
	2 경간	좌측	10	1959.05	635.93	2778.92	1472.45	1000.00	1800.00	
		중앙부	11	0.00	1727.06	2778.92	0.00	1000.00	1800.00	
		우측	12	4132.19	663.57	2778.92	3122.29	1000.00	1966.67	
중간 슬래브	1 경간	좌측	13	1440.17	459.65	2103.09	1031.96	1000.00	1766.67	
		중앙부	14	876.54	124.19	2118.13	671.67	1000.00	1600.00	
		우측	15	488.88	271.80	2118.13	430.94	1000.00	1600.00	
	2 경간	좌측	16	224.12	255.06	2086.64	193.78	1000.00	1600.00	
		중앙부	17	772.55	210.90	2086.64	582.48	1000.00	1600.00	
		우측	18	277.50	277.14	2088.50	226.56	1000.00	1766.67	
좌측 벽체	1 층	상부 (외측)	19	817.26	1664.34	3484.81	531.74	1000.00	1866.67	
		상부 (내측)	20	1724.40	1664.34	3484.81	1502.17	1000.00	1700.00	
		중앙부	21	811.51	1390.80	3529.01	740.33	1000.00	1700.00	
		하부	22	5152.86	1792.82	3702.31	3954.85	1000.00	1866.67	
	2 층	상부	23	4316.31	1677.75	2624.24	3162.36	1000.00	1866.67	
		중앙부	24	2204.56	1100.13	2861.57	1743.30	1000.00	1700.00	
		하부 (외측)	25	0.00	1206.79	2901.11	0.00	1000.00	1866.67	
		하부 (내측)	26	2899.57	1206.79	2901.11	2316.66	1000.00	1700.00	
우측 벽체	1 층	상부 (외측)	27	609.37	1317.21	2115.81	251.10	1000.00	1866.67	
		상부 (내측)	28	1957.96	1317.21	2115.81	1673.97	1000.00	1700.00	
		중앙부	29	1274.10	1068.12	2160.01	1086.32	1000.00	1700.00	
		하부	30	3464.13	1445.43	2333.31	2689.58	1000.00	1866.67	
	2 층	상부	31	1969.85	1051.13	1593.12	1462.59	1000.00	1866.67	
		중앙부	32	1684.12	522.44	1830.46	1330.96	1000.00	1700.00	
		하부 (외측)	33	84.41	590.56	1869.99	0.00	1000.00	1866.67	
		하부 (내측)	34	2012.37	590.56	1869.99	1620.97	1000.00	1700.00	

15.2 지진시(기능수행)

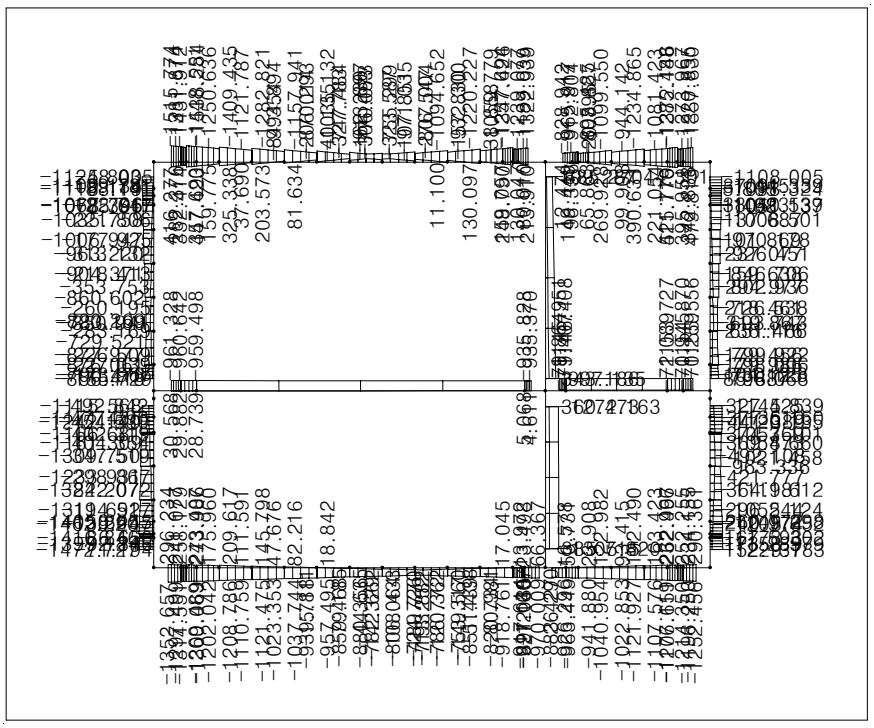
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

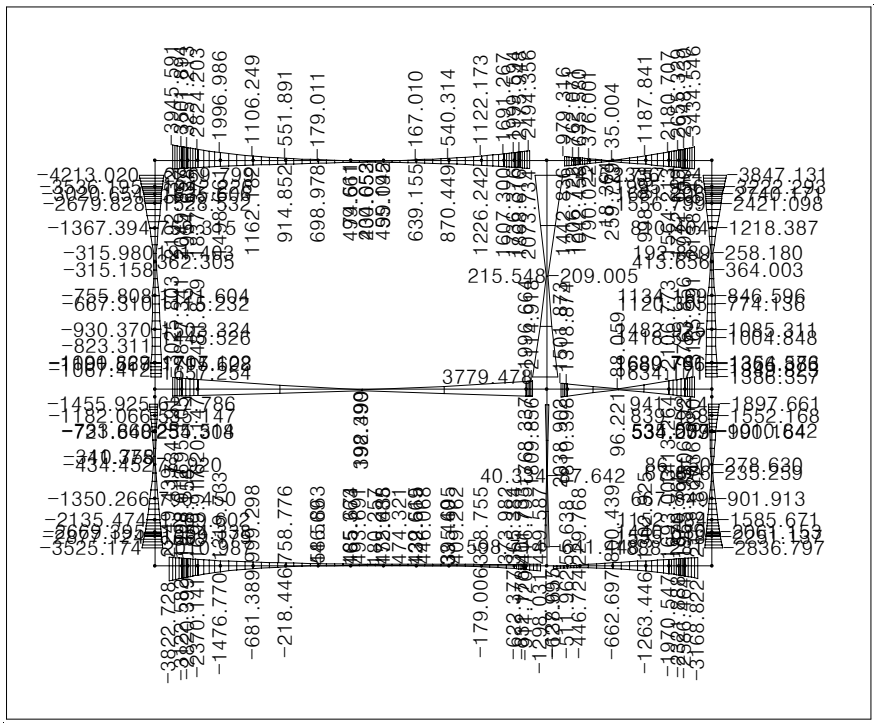


4) 단면력 정리

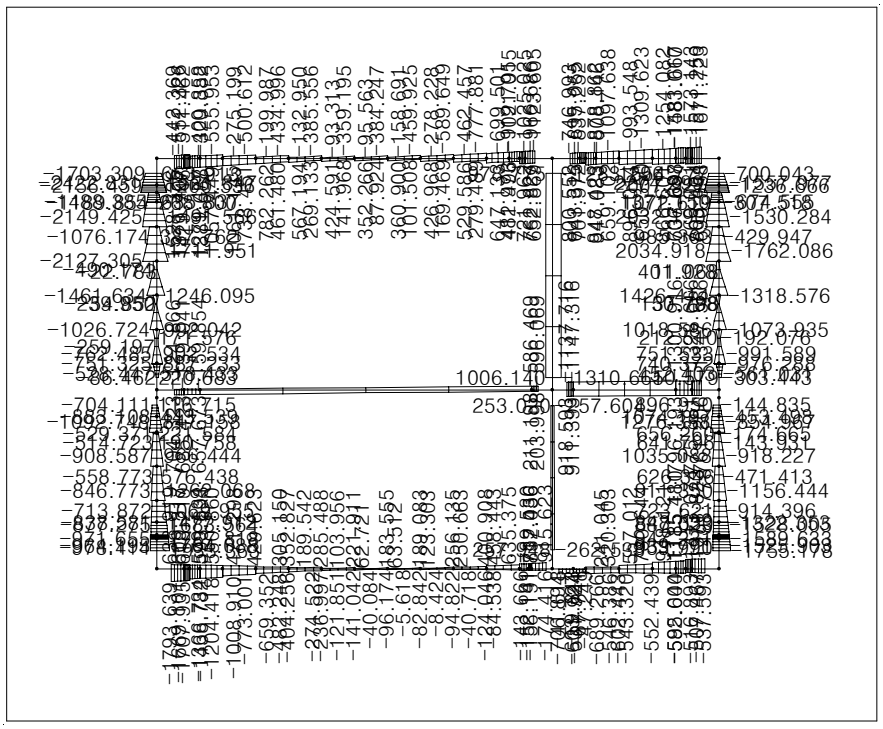
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	2066.35	654.86	1431.91	1000.00	1766.67	
		중앙부	2	416.80	104.46	770.07	1000.00	1600.00	
		우측	3	1050.21	416.50	1239.08	1000.00	1766.67	
	2 경간	좌측	4	256.72	561.92	912.80	1000.00	1766.67	
		중앙부	5	612.07	500.52	808.83	1000.00	1600.00	
		우측	6	1675.46	712.96	1273.97	1000.00	1766.67	
하부 슬래브	1 경간	좌측	7	1730.34	554.25	1314.55	1000.00	1966.67	
		중앙부	8	478.15	52.77	855.85	1000.00	1800.00	
		우측	9	532.62	210.69	927.14	1000.00	1800.00	
	2 경간	좌측	10	366.55	280.46	926.30	1000.00	1800.00	
		중앙부	11	685.83	922.19	1206.65	1000.00	1800.00	
		우측	12	1316.10	300.11	1214.35	1000.00	1966.67	
중간 슬래브	1 경간	좌측	13	1529.26	389.25	960.64	1000.00	1766.67	
		중앙부	14	355.78	189.81	947.66	1000.00	1600.00	
		우측	15	903.53	284.44	935.83	1000.00	1600.00	
	2 경간	좌측	16	437.04	636.36	1146.41	1000.00	1600.00	
		중앙부	17	471.77	592.20	1148.24	1000.00	1600.00	
		우측	18	1449.67	658.44	1154.87	1000.00	1766.67	
좌측 벽체	1 층	상부 (외측)	19	860.41	325.37	1115.57	1000.00	1866.67	
		상부 (내측)	20	32.27	325.37	1115.57	1000.00	1700.00	
		중앙부	21	0.00	536.83	1225.07	1000.00	1700.00	
		하부	22	1687.97	487.55	1416.85	1000.00	1866.67	
	2 층	상부	23	2073.87	810.40	1116.12	1000.00	1866.67	
		중앙부	24	853.73	204.86	766.16	1000.00	1700.00	
		하부 (외측)	25	372.37	258.44	877.98	1000.00	1866.67	
		하부 (내측)	26	986.43	258.44	877.98	1000.00	1700.00	
우측 벽체	1 층	상부 (외측)	27	1081.15	332.81	1145.84	1000.00	1866.67	
		상부 (내측)	28	124.80	332.81	1145.84	1000.00	1700.00	
		중앙부	29	91.69	665.15	1124.75	1000.00	1700.00	
		하부	30	1226.86	379.55	1173.30	1000.00	1866.67	
	2 층	상부	31	1799.86	721.48	1098.32	1000.00	1866.67	
		중앙부	32	765.39	147.69	688.10	1000.00	1700.00	
		하부 (외측)	33	558.57	215.88	799.92	1000.00	1866.67	
		하부 (내측)	34	881.89	215.88	799.92	1000.00	1700.00	

15.3 지진시(붕괴방지)

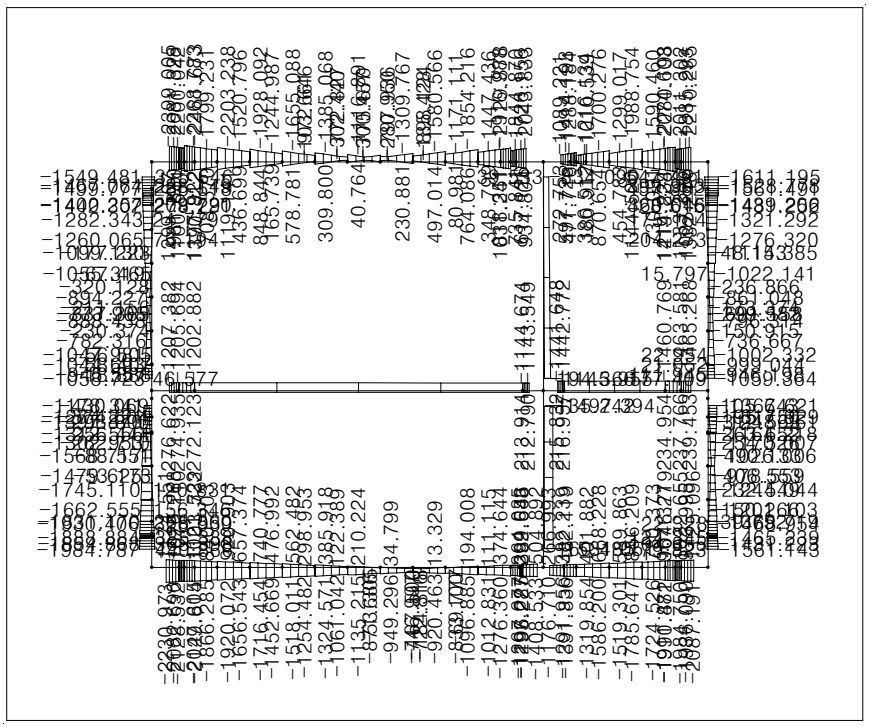
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중				B	H	비고
				모멘트	응답계수	전단력	축력			
				kN.m	kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	3501.89	1167.30	969.69	2200.04	1000.00	1766.67	
		중앙부	2	430.65	143.55	222.90	775.67	1000.00	1600.00	
		우측	3	2175.95	725.32	686.67	1844.87	1000.00	1766.67	
	2 경간	좌측	4	762.07	254.02	1075.11	1288.18	1000.00	1766.67	
		중앙부	5	1042.46	347.49	947.08	1010.54	1000.00	1600.00	
		우측	6	2948.13	982.71	1226.15	2011.30	1000.00	1766.67	
하부 슬래브	1 경간	좌측	7	3122.58	1040.86	896.21	2128.53	1000.00	1966.67	
		중앙부	8	493.69	164.56	82.07	1069.33	1000.00	1800.00	
		우측	9	911.72	303.91	288.10	1293.29	1000.00	1800.00	
	2 경간	좌측	10	511.96	170.65	604.97	1291.96	1000.00	1800.00	
		중앙부	11	1870.77	623.59	1371.82	1990.87	1000.00	1800.00	
		우측	12	2586.46	862.16	624.62	1984.75	1000.00	1966.67	
중간 슬래브	1 경간	좌측	13	2817.34	939.11	608.71	1205.69	1000.00	1766.67	
		중앙부	14	398.39	132.80	409.27	1173.78	1000.00	1600.00	
		우측	15	1996.66	665.56	503.91	1144.67	1000.00	1600.00	
	2 경간	좌측	16	1318.87	439.63	1229.88	1442.77	1000.00	1600.00	
		중앙부	17	878.79	292.93	1185.72	1447.27	1000.00	1600.00	
		우측	18	2763.86	921.29	1251.96	1463.58	1000.00	1766.67	
좌측 벽체	1 층	상부 (외측)	19	1455.93	485.31	649.37	1178.34	1000.00	1866.67	
		상부 (내측)	20	627.79	209.26	649.37	1178.34	1000.00	1700.00	
		중앙부	21	339.82	113.28	1039.49	1367.56	1000.00	1700.00	
		하부	22	2877.12	959.04	947.17	1888.88	1000.00	1866.67	
	2 층	상부	23	3536.20	1178.73	1366.45	1499.78	1000.00	1866.67	
		중앙부	24	1445.53	481.84	292.02	847.91	1000.00	1700.00	
		하부 (외측)	25	1101.57	367.19	390.22	1047.98	1000.00	1866.67	
		하부 (내측)	26	1715.63	571.88	390.22	1047.98	1000.00	1700.00	
우측 벽체	1 층	상부 (외측)	27	1897.66	632.55	659.34	1367.62	1000.00	1866.67	
		상부 (내측)	28	941.31	313.77	659.34	1367.62	1000.00	1700.00	
		중앙부	29	628.85	209.62	1228.84	1266.81	1000.00	1700.00	
		하부	30	2251.14	750.38	841.70	1465.24	1000.00	1866.67	
	2 층	상부	31	3222.29	1074.10	1275.58	1561.49	1000.00	1866.67	
		중앙부	32	1418.57	472.86	212.51	802.26	1000.00	1700.00	
		하부 (외측)	33	1366.38	455.46	354.53	1002.33	1000.00	1866.67	
		하부 (내측)	34	1689.71	563.24	354.53	1002.33	1000.00	1700.00	

15.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-4140.59	-	-1167.30	-2066.35	-4140.59	
		중앙부	2	2563.64	-	143.55	416.80	2563.64	
		우측	3	-2387.58	-	-725.32	-1050.21	-2387.58	
	2 경간	좌측	4	-901.22	-	-254.02	-256.72	-901.22	
		중앙부	5	-	-	347.49	612.07	612.07	
		우측	6	-2153.12	-	-982.71	-1675.46	-2153.12	
하부 슬래브	1 경간	좌측	7	-5017.40	-	-1040.86	-1730.34	-5017.40	
		중앙부	8	3492.33	-	164.56	478.15	3492.33	
		우측	9	-2013.26	-	-303.91	-532.62	-2013.26	
	2 경간	좌측	10	-1959.05	-	-170.65	-366.55	-1959.05	
		중앙부	11	-	-	623.59	685.83	685.83	
		우측	12	-4132.19	-	-862.16	-1316.10	-4132.19	
중간 슬래브	1 경간	좌측	13	-1440.17	-	-939.11	-1529.26	-1529.26	
		중앙부	14	876.54	-	132.80	355.78	876.54	
		우측	15	-488.88	-	-665.56	-903.53	-903.53	
	2 경간	좌측	16	-224.12	-	-439.63	-437.04	-439.63	
		중앙부	17	772.55	-	292.93	471.77	772.55	
		우측	18	-277.50	-	-921.29	-1449.67	-1449.67	
좌측 벽체	1 층	상부 (외측)	19	-817.26	-	-485.31	-860.41	-860.41	
		상부 (내측)	20	1724.40	-	209.26	32.27	1724.40	
		중앙부	21	811.51	-	113.28	-	811.51	
		하부	22	-5152.86	-	-959.04	-1687.97	-5152.86	
	2 층	상부	23	-4316.31	-	-1178.73	-2073.87	-4316.31	
		중앙부	24	2204.56	-	481.84	853.73	2204.56	
		하부 (외측)	25	-	-	-367.19	-372.37	-372.37	
		하부 (내측)	26	2899.57	-	571.88	986.43	2899.57	
우측 벽체	1 층	상부 (외측)	27	-609.37	-	-632.55	-1081.15	-1081.15	
		상부 (내측)	28	1957.96	-	313.77	124.80	1957.96	
		중앙부	29	1274.10	-	209.62	91.69	1274.10	
		하부	30	-3464.13	-	-750.38	-1226.86	-3464.13	
	2 층	상부	31	-1969.85	-	-1074.10	-1799.86	-1969.85	
		중앙부	32	1684.12	-	472.86	765.39	1684.12	
		하부 (외측)	33	-84.41	-	-455.46	-558.57	-558.57	
		하부 (내측)	34	2012.37	-	563.24	881.89	2012.37	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	1666.31	-	969.69	654.86	1666.31	
		중앙부	2	-120.17	-	-222.90	-104.46	-222.90	
		우측	3	-1351.65	-	-686.67	-416.50	-1351.65	
	2 경간	좌측	4	-456.51	-	-1075.11	-561.92	-1075.11	
		중앙부	5	474.61	-	947.08	-500.52	947.08	
		우측	6	-637.61	-	-1226.15	-712.96	-1226.15	
하부 슬래브	1 경간	좌측	7	-1934.75	-	-896.21	-554.25	-1934.75	
		중앙부	8	-143.37	-	-82.07	-52.77	-143.37	
		우측	9	1279.16	-	288.10	210.69	1279.16	
	2 경간	좌측	10	635.93	-	604.97	280.46	635.93	
		중앙부	11	1727.06	-	1371.82	922.19	1727.06	
		우측	12	663.57	-	624.62	300.11	663.57	
중간 슬래브	1 경간	좌측	13	459.65	-	608.71	389.25	608.71	
		중앙부	14	124.19	-	409.27	189.81	409.27	
		우측	15	-271.80	-	-503.91	-284.44	-503.91	
	2 경간	좌측	16	-255.06	-	-1229.88	-636.36	-1229.88	
		중앙부	17	-210.90	-	-1185.72	-592.20	-1185.72	
		우측	18	-277.14	-	-1251.96	-658.44	-1251.96	
좌측 벽체	1 층	상부 (외측)	19	1664.34	-	649.37	325.37	1664.34	
		상부 (내측)	20	1664.34	-	649.37	325.37	1664.34	
		중앙부	21	1390.80	-	-1039.49	-536.83	1390.80	
		하부	22	1792.82	-	947.17	487.55	1792.82	
	2 층	상부	23	-1677.75	-	-1366.45	-810.40	-1677.75	
		중앙부	24	-1100.13	-	-292.02	-204.86	-1100.13	
		하부 (외측)	25	-1206.79	-	-390.22	-258.44	-1206.79	
		하부 (내측)	26	-1206.79	-	-390.22	-258.44	-1206.79	
우측 벽체	1 층	상부 (외측)	27	-1317.21	-	659.34	332.81	-1317.21	
		상부 (내측)	28	-1317.21	-	659.34	332.81	-1317.21	
		중앙부	29	-1068.12	-	1228.84	665.15	1228.84	
		하부	30	-1445.43	-	-841.70	-379.55	-1445.43	
	2 층	상부	31	1051.13	-	1275.58	721.48	1275.58	
		중앙부	32	-522.44	-	212.51	147.69	-522.44	
		하부 (외측)	33	590.56	-	354.53	215.88	590.56	
		하부 (내측)	34	590.56	-	354.53	215.88	590.56	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-2413.43	-	-2200.04	-1431.91	-2413.43	
		중앙부	2	-2413.43	-	-775.67	-770.07	-2413.43	
		우측	3	-2413.43	-	-1844.87	-1239.08	-2413.43	
	2 경간	좌측	4	-1795.05	-	-1288.18	-912.80	-1795.05	
		중앙부	5	-1795.05	-	-1010.54	-808.83	-1795.05	
		우측	6	-1795.05	-	-2011.30	-1273.97	-2011.30	
하부 슬래브	1 경간	좌측	7	-3127.10	-	-2128.53	-1314.55	-3127.10	
		중앙부	8	-3127.10	-	-1069.33	-855.85	-3127.10	
		우측	9	-3130.56	-	-1293.29	-927.14	-3130.56	
	2 경간	좌측	10	-2778.92	-	-1291.96	-926.30	-2778.92	
		중앙부	11	-2778.92	-	-1990.87	-1206.65	-2778.92	
		우측	12	-2778.92	-	-1984.75	-1214.35	-2778.92	
중간 슬래브	1 경간	좌측	13	2103.09	-	-1205.69	-960.64	2103.09	
		중앙부	14	2118.13	-	-1173.78	-947.66	2118.13	
		우측	15	2118.13	-	-1144.67	-935.83	2118.13	
	2 경간	좌측	16	-2086.64	-	-1442.77	-1146.41	-2086.64	
		중앙부	17	-2086.64	-	-1447.27	-1148.24	-2086.64	
		우측	18	-2088.50	-	-1463.58	-1154.87	-2088.50	
좌측 벽체	1 층	상부 (외측)	19	-3484.81	-	-1178.34	-1115.57	-3484.81	
		상부 (내측)	20	-3484.81	-	-1178.34	-1115.57	-3484.81	
		중앙부	21	-3529.01	-	-1367.56	-1225.07	-3529.01	
		하부	22	-3702.31	-	-1888.88	-1416.85	-3702.31	
	2 층	상부	23	-2624.24	-	-1499.78	-1116.12	-2624.24	
		중앙부	24	-2861.57	-	-847.91	-766.16	-2861.57	
		하부 (외측)	25	-2901.11	-	-1047.98	-877.98	-2901.11	
		하부 (내측)	26	-2901.11	-	-1047.98	-877.98	-2901.11	
우측 벽체	1 층	상부 (외측)	27	-2115.81	-	-1367.62	-1145.84	-2115.81	
		상부 (내측)	28	-2115.81	-	-1367.62	-1145.84	-2115.81	
		중앙부	29	-2160.01	-	-1266.81	-1124.75	-2160.01	
		하부	30	-2333.31	-	-1465.24	-1173.30	-2333.31	
	2 층	상부	31	-1593.12	-	-1561.49	-1098.32	-1593.12	
		중앙부	32	-1830.46	-	-802.26	-688.10	-1830.46	
		하부 (외측)	33	-1869.99	-	-1002.33	-799.92	-1869.99	
		하부 (내측)	34	-1869.99	-	-1002.33	-799.92	-1869.99	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-2994.02	-	-	-	-2994.02	
		중앙부	2	1866.66	-	-	-	1866.66	
		우측	3	-1725.36	-	-	-	-1725.36	
	2 경간	좌측	4	-745.48	-	-	-	-745.48	
		중앙부	5	-	-	-	-	-	
		우측	6	-1542.28	-	-	-	-1542.28	
하부 슬래브	1 경간	좌측	7	-3802.09	-	-	-	-3802.09	
		중앙부	8	2613.27	-	-	-	2613.27	
		우측	9	-1506.46	-	-	-	-1506.46	
	2 경간	좌측	10	-1472.45	-	-	-	-1472.45	
		중앙부	11	-	-	-	-	-	
		우측	12	-3122.29	-	-	-	-3122.29	
중간 슬래브	1 경간	좌측	13	-1031.96	-	-	-	-1031.96	
		중앙부	14	671.67	-	-	-	671.67	
		우측	15	-430.94	-	-	-	-430.94	
	2 경간	좌측	16	-193.78	-	-	-	-193.78	
		중앙부	17	582.48	-	-	-	582.48	
		우측	18	-226.56	-	-	-	-226.56	
좌측 벽체	1 층	상부 (외측)	19	-531.74	-	-	-	-531.74	
		상부 (내측)	20	1502.17	-	-	-	1502.17	
		중앙부	21	740.33	-	-	-	740.33	
		하부	22	-3954.85	-	-	-	-3954.85	
	2 층	상부	23	-3162.36	-	-	-	-3162.36	
		중앙부	24	1743.30	-	-	-	1743.30	
		하부 (외측)	25	-	-	-	-	-	
		하부 (내측)	26	2316.66	-	-	-	2316.66	
우측 벽체	1 층	상부 (외측)	27	-251.10	-	-	-	-251.10	
		상부 (내측)	28	1673.97	-	-	-	1673.97	
		중앙부	29	1086.32	-	-	-	1086.32	
		하부	30	-2689.58	-	-	-	-2689.58	
	2 층	상부	31	-1462.59	-	-	-	-1462.59	
		중앙부	32	1330.96	-	-	-	1330.96	
		하부 (외측)	33	-	-	-	-	-	
		하부 (내측)	34	1620.97	-	-	-	1620.97	

16. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	1622	4140.59	5946.49	7838.49	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.44
		중앙부	2	1000	1520	2563.64	3163.93	5110.32	H32 - 8.0EA	6353.60	1.23
		우측	3	1000	1667	2387.58	3480.76	4310.53	H32 - 8.0EA	6353.60	1.46
	2경간	좌측	4	1000	1667	901.22	3480.76	1603.84	H32 - 8.0EA	6353.60	3.86
		중앙부	5	1000	1520	612.07	2046.21	1192.49	H25 - 8.0EA	4053.60	3.34
		우측	6	1000	1667	2153.12	3480.76	3878.27	H32 - 8.0EA	6353.60	1.62
하부슬래브	1경간	좌측	7	1000	1822	5017.40	6728.00	8440.34	H32 - 8.0EA + H29 - 8.0EA	11492.80	1.34
		중앙부	8	1000	1670	3492.33	5523.05	6361.84	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.58
		우측	9	1000	1700	2013.26	2892.20	3547.67	H29 - 8.0EA	5139.20	1.44
	2경간	좌측	10	1000	1700	1959.05	2892.20	3450.39	H29 - 8.0EA	5139.20	1.48
		중앙부	11	1000	1720	685.83	2927.15	1179.82	H29 - 8.0EA	5139.20	4.27
		우측	12	1000	1817	4132.19	6035.60	6919.70	H29 - 8.0EA + H29 - 8.0EA	10278.40	1.46
중간슬래브	1경간	좌측	13	1000	1687	1529.26	2868.90	2704.49	H29 - 8.0EA	5139.20	1.88
		중앙부	14	1000	1520	876.54	2577.68	1712.92	H29 - 8.0EA	5139.20	2.94
		우측	15	1000	1520	903.53	2577.68	1766.21	H29 - 8.0EA	5139.20	2.85
	2경간	좌측	16	1000	1520	439.62	2577.68	854.86	H29 - 8.0EA	5139.20	5.86
		중앙부	17	1000	1520	772.55	2577.68	1507.92	H29 - 8.0EA	5139.20	3.34
		우측	18	1000	1687	1449.67	2868.90	2561.82	H29 - 8.0EA	5139.20	1.98

좌측벽체	1층	상부(외측)	19	1000	1767	860.41	6643.75	-	H25 - 8.0EA	10407.20	7.72
		상부(내측)	19	1000	1620	1724.40	8549.85	-	H32 - 8.0EA	10407.20	4.96
		중앙부	20	1000	1620	811.51	5775.18	-	H32 - 8.0EA	10407.20	7.12
		하부	21	1000	1722	5152.86	12060.21	-	H32 - 8.0EA + H29 - 8.0EA	17846.40	2.34
	2층	상부	22	1000	1717	4316.31	10328.62	-	H32 - 4.0EA + H25 - 4.0EA + H29 - 8.0EA	16696.40	2.39
		중앙부	23	1000	1620	2204.55	8879.03	-	H32 - 8.0EA	10407.20	4.03
		하부(외측)	24	1000	1767	372.37	3453.82	-	H25 - 8.0EA	10407.20	9.28
		하부(내측)	24	1000	1620	2899.57	8493.72	-	H32 - 8.0EA	10407.20	2.93
우측벽체	1층	상부(외측)	25	1000	1728	1081.15	10019.93	-	H25 - 8.0EA + H29 - 4.0EA	11762.40	9.27
		상부(내측)	25	1000	1620	1957.96	8130.57	-	H29 - 8.0EA	11762.40	4.15
		중앙부	26	1000	1620	1274.10	9005.28	-	H29 - 8.0EA	11762.40	7.07
		하부	27	1000	1717	3464.13	10712.47	-	H29 - 8.0EA + H29 - 8.0EA	15417.60	3.09
	2층	상부	28	1000	1767	1969.85	7837.22	-	H25 - 4.0EA + H32 - 4.0EA	10342.80	3.98
		중앙부	29	1000	1620	1684.12	8040.84	-	H29 - 8.0EA	9192.80	4.78
		하부(외측)	30	1000	1767	558.57	7592.42	-	H25 - 8.0EA	9192.80	13.59
		하부(내측)	30	1000	1620	2012.37	7086.99	-	H29 - 8.0EA	9192.80	3.52

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	945.2	1666.3	2101.31	2.00	247.74	H16	150	397.20	O.K
		우측	3	974.3	1351.6	2165.88	2.00	125.79	H16	150	397.20	O.K
	2경간	좌측	4	974.3	1075.1	2165.88	2.00	33.61	H16	150	397.20	O.K
		중앙부	5	987.3	947.1	2194.76	2.00	-	H16	150	397.20	O.K
		우측	6	974.3	1226.2	2165.88	2.00	83.96	H16	150	397.20	O.K
하부슬래브	1경간	좌측	7	1075.1	1934.7	2390.10	2.00	259.66	H16	150	397.20	O.K
		우측	9	1104.2	1279.2	2454.66	2.00	51.47	H16	150	397.20	O.K
	2경간	좌측	10	1104.2	635.9	2454.66	2.00	-	H16	150	397.20	O.K
		중앙부	11	1117.2	1727.1	2483.54	2.00	177.29	H16	150	397.20	O.K
		우측	12	1071.7	663.6	2382.47	2.00	-	H16	150	397.20	O.K
중간슬래브	1경간	좌측	13	987.3	608.7	2194.76	2.00	-	H16	150	397.20	O.K
		우측	15	987.3	503.9	2194.76	2.00	-	H16	150	397.20	O.K
	2경간	좌측	16	987.3	1229.9	1591.01	2.00	159.61	H16	300	397.20	O.K
		중앙부	17	987.3	1185.7	2194.76	2.00	65.28	H16	150	397.20	O.K
		우측	18	987.3	1252.0	1591.01	2.00	174.14	H16	300	397.20	O.K
좌측벽체	1층	상부	19	1191.4	1664.3	2462.44	2.00	147.80	H16	150	397.20	O.K
		중앙부	20	1208.2	1390.8	2495.17	2.00	56.34	H16	150	397.20	O.K
		하부	21	1167.3	1792.8	2402.85	2.00	201.09	H16	150	397.20	O.K
	2층	상부	22	1118.0	1677.7	1733.77	2.00	361.06	H16	300	397.20	O.K
		중앙부	23	1178.7	1100.1	2465.66	2.00	131.25	H16	150	397.20	O.K
		하부	24	1165.9	1206.8	1801.43	2.00	25.55	H16	300	397.20	O.K
우측벽체	1층	상부	25	1104.2	1317.2	1724.29	2.00	136.46	H16	300	397.20	O.K
		중앙부	26	1147.7	1228.8	2434.65	2.00	25.04	H16	150	397.20	O.K
		하부	27	1105.5	1445.4	1721.12	2.00	219.34	H16	300	397.20	O.K
	2층	상부	28	1108.8	1275.6	1744.31	2.00	104.24	H16	300	397.20	O.K
		중앙부	29	1133.1	522.4	2420.08	2.00	-	H16	150	397.20	O.K
		하부	30	1120.9	590.6	1756.40	2.00	262.50	H16	300	397.20	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1621.95	100.00	4140.59	1666.31

* 강도감소계수(Φ) 산정

T = As x fy = 11492.800 x 400.00 = 4597120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 200.310 mm, c = 200.310 / β1 = 200.310 / 0.85 = 235.659 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 235.659) / 235.659 = 0.01822

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 7838.494 \text{ mm}^2$$

* 사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm), [사용률 = 1.466]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00709

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 200.310 mm

ΦMn = 0.85 x 11492.800 x 400 x (1621.95 - a/2) = 5946.493 kN.m

≥ Mu (= 4140.589 kN.m) ∴ O.K [안전률 1.436]

* 전단에 대한 검토 (d = 1455.28 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1455.28 = 945.234 kN

< Vu (= 1666.310 kN) , 전단보강 필요.

Av_req = (1666.310-945.234) x 150.00 / (400x1455.28xΦ) x 1000 = 247.744 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1455.28 / 150.00 x 1000 = 1541.436 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1455.28 / 1000 = 5041.249 kN ≥ 1541.436 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1260.312 + 1541.436) = 2101.311 kN ≥ 1666.310 kN ∴ O.K

▣ TITLE : 상부슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1520.00	80.00	2563.64	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 6353.600 x 400.00 = 2541440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 110.738 mm, c = 110.738 / β1 = 110.738 / 0.85 = 130.280 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 130.280) / 130.280 = 0.03200

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 5110.321 \text{ mm}^2$$

* 사용철근량 = 6353.6 mm² (철근도심 : 80.0 mm) , [사용률 = 1.243]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00418

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 110.738 mm

ΦMn = 0.85 x 6353.600 x 400 x (1520.00 - a/2) = 3163.931 kN.m

≥ Mu (= 2563.635 kN.m) ∴ O.K [안전률 1.234]

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1666.67	100.00	2387.58	1351.65

* 강도감소계수(Φ) 산정

T = As x fy = 6353.600 x 400.00 = 2541440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 110.738 mm, c = 110.738 / β1 = 110.738 / 0.85 = 130.280 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 130.280) / 130.280 = 0.03538

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4310.532 \text{ mm}^2$$

* 사용철근량 = 6353.6 mm² (철근도심 : 100.0 mm), [사용률 = 1.474]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00381

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 110.738 mm

ΦMn = 0.85 x 6353.600 x 400 x (1666.67 - a/2) = 3480.764 kN.m

≥ Mu (= 2387.581 kN.m) ∴ O.K [안전률 1.458]

* 전단에 대한 검토 (d = 1500.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1500.00 = 974.279 kN

< Vu (= 1351.645 kN) , 전단보강 필요.

Av_req = (1351.645-974.279) x 150.00 / (400x1500.00xΦ) x 1000 = 125.789 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1500.00 / 150.00 x 1000 = 1588.800 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1500.00 / 1000 = 5196.152 kN ≥ 1588.800 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1299.038 + 1588.800) = 2165.879 kN ≥ 1351.645 kN ∴ O.K

▣ TITLE : 상부슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1666.67	100.00	901.22	1075.11

* 강도감소계수(Φ) 산정

T = As x fy = 6353.600 x 400.00 = 2541440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 110.738 mm, c = 110.738 / β1 = 110.738 / 0.85 = 130.280 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 130.280) / 130.280 = 0.03538

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1603.836 \text{ mm}^2$$

* 사용철근량 = 6353.6 mm² (철근도심 : 100.0 mm), [사용률 = 3.962]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00381

ρmax ≥ ρuse ≥ ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 110.738 mm

ΦMn = 0.85 x 6353.600 x 400 x (1666.67 - a/2) = 3480.764 kN.m

≥ Mu (= 901.219 kN.m) ∴ O.K [안전률 3.862]

* 전단에 대한 검토 (d = 1500.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1500.00 = 974.279 kN

< Vu (= 1075.110 kN) , 전단보강 필요.

Av_req = (1075.110-974.279) x 150.00 / (400x1500.00xΦ) x 1000 = 33.610 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1500.00 / 150.00 x 1000 = 1588.800 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1500.00 / 1000 = 5196.152 kN ≥ 1588.800 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1299.038 + 1588.800) = 2165.879 kN ≥ 1075.110 kN ∴ O.K

▣ TITLE : 상부슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1520.00	80.00	612.07	947.08

* 강도감소계수(Φ) 산정

T = As x fy = 4053.600 x 400.00 = 1621440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 70.651 mm, c = 70.651 / β1 = 70.651 / 0.85 = 83.119 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 83.119) / 83.119 = 0.05186

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1192.491 \text{ mm}^2$$

* 사용철근량 = 4053.6 mm² (철근도심 : 80.0 mm) , [사용률 = 3.399]

1단 : H25 - 8.0 EA (= 4053.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00267

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 70.651 mm

ΦMn = 0.85 x 4053.600 x 400 x (1520.00 - a/2) = 2046.214 kN.m

≥ Mu (= 612.066 kN.m) ∴ O.K [안전률 3.343]

* 전단에 대한 검토 (d = 1520.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1520.00 = 987.269 kN

≥ Vu (= 947.083 kN) , 전단보강 불필요.

▣ TITLE : 상부슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1666.67	100.00	2153.12	1226.15

* 강도감소계수(Φ) 산정

T = As x fy = 6353.600 x 400.00 = 2541440.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 110.738 mm, c = 110.738 / β1 = 110.738 / 0.85 = 130.280 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1666.67 - 130.280) / 130.280 = 0.03538

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \ , \ As = 3878.269 \ mm^2$$

* 사용철근량 = 6353.6 mm² (철근도심 : 100.0 mm), [사용률 = 1.638]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00381

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 110.738 mm

ΦMn = 0.85 x 6353.600 x 400 x (1666.67 - a/2) = 3480.764 kN.m

≥ Mu (= 2153.120 kN.m) ∴ O.K [안전률 1.617]

* 전단에 대한 검토 (d = 1500.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1500.00 = 974.279 kN

< Vu (= 1226.150 kN) , 전단보강 필요.

Av_req = (1226.150-974.279) x 150.00 / (400x1500.00xΦ) x 1000 = 83.957 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1500.00 / 150.00 x 1000 = 1588.800 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1500.00 / 1000 = 5196.152 kN ≥ 1588.800 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1299.038 + 1588.800) = 2165.879 kN ≥ 1226.150 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1966.67	1821.95	100.00	5017.40	1934.75

* 강도감소계수(Φ) 산정

T = As x fy = 11492.800 x 400.00 = 4597120.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 200.310 mm, c = 200.310 / β1 = 200.310 / 0.85 = 235.659 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1866.67 - 235.659) / 235.659 = 0.02076

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 8440.340 \text{ mm}^2$$

* 사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm), [사용률 = 1.362]

1단 : H32 - 8.0 EA (= 6353.6 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00631

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 200.310 mm

ΦMn = 0.85 x 11492.800 x 400 x (1821.95 - a/2) = 6728.003 kN.m

≥ Mu (= 5017.399 kN.m) ∴ O.K [안전률 1.341]

* 전단에 대한 검토 (d = 1655.28 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1655.28 = 1075.138 kN

< Vu (= 1934.747 kN) , 전단보강 필요.

Av_req = (1934.747-1075.138) x 150.00 / (400x1655.28xΦ) x 1000 = 259.656 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1655.28 / 150.00 x 1000 = 1753.276 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1655.28 / 1000 = 5734.070 kN ≥ 1753.276 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1433.517 + 1753.276) = 2390.095 kN ≥ 1934.747 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1800.00	1670.00	80.00	3492.33	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 10278.400 x 400.00 = 4111360.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 179.144 mm, c = 179.144 / β1 = 179.144 / 0.85 = 210.758 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1720.00 - 210.758) / 210.758 = 0.02148

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \ , \ As = 6361.842 \ mm^2$$

* 사용철근량 = 10278.4 mm² (철근도심 : 130.0 mm), [사용률 = 1.616]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00615

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 179.144 mm

ΦMn = 0.85 x 10278.400 x 400 x (1670.00 - a/2) = 5523.052 kN.m

≥ Mu (= 3492.334 kN.m) ∴ O.K [안전률 1.581]

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1800.00	1700.00	100.00	2013.26	1279.16

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1700.00 - 105.379) / 105.379 = 0.04540

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \;,\; As = 3547.674\ mm^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.449]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00302

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1700.00 - a/2) = 2892.202 kN.m

≥ Mu (= 2013.264 kN.m) ∴ O.K [안전률 1.437]

* 전단에 대한 검토 (d = 1700.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1700.00 = 1104.182 kN

< Vu (= 1279.163 kN) , 전단보강 필요.

Av_req = (1279.163-1104.182) x 150.00 / (400x1700.00xΦ) x 1000 = 51.465 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1700.00 / 150.00 x 1000 = 1800.640 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1700.00 / 1000 = 5888.973 kN ≥ 1800.640 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1472.243 + 1800.640) = 2454.662 kN ≥ 1279.163 kN ∴ O.K

▣ TITLE : 하부슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1800.00	1700.00	100.00	1959.05	635.93

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1700.00 - 105.379) / 105.379 = 0.04540

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 3450.390 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm), [사용률 = 1.489]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00302

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1700.00 - a/2) = 2892.202 kN.m

≥ Mu (= 1959.051 kN.m) ∴ O.K [안전률 1.476]

* 전단에 대한 검토 (d = 1700.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1700.00 = 1104.182 kN

≥ Vu (= 635.925 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1800.00	1720.00	80.00	685.83	1727.06

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1720.00 - 105.379) / 105.379 = 0.04597

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1179.820 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm) , [사용률 = 4.356]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00299

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1720.00 - a/2) = 2927.148 kN.m

≥ Mu (= 685.834 kN.m) ∴ O.K [안전률 4.268]

* 전단에 대한 검토 (d = 1720.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1720.00 = 1117.173 kN

< Vu (= 1727.063 kN) , 전단보강 필요.

Av_req = (1727.063-1117.173) x 150.00 / (400x1720.00xΦ) x 1000 = 177.294 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1720.00 / 150.00 x 1000 = 1821.824 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1720.00 / 1000 = 5958.255 kN ≥ 1821.824 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1489.564 + 1821.824) = 2483.541 kN ≥ 1727.063 kN ∴ O.K

▣ TITLE : 하부슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1966.67	1816.67	100.00	4132.19	663.57

* 강도감소계수(Φ) 산정

T = As x fy = 10278.400 x 400.00 = 4111360.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 179.144 mm, c = 179.144 / β1 = 179.144 / 0.85 = 210.758 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1866.67 - 210.758) / 210.758 = 0.02357

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 6919.695 \text{ mm}^2$$

* 사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm) , [사용률 = 1.485]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

2단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00566

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 179.144 mm

ΦMn = 0.85 x 10278.400 x 400 x (1816.67 - a/2) = 6035.601 kN.m

≥ Mu (= 4132.192 kN.m) ∴ O.K [안전률 1.461]

* 전단에 대한 검토 (d = 1650.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1650.00 = 1071.706 kN

≥ Vu (= 663.572 kN) , 전단보강 불필요.

▣ TITLE : 중간슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1686.67	80.00	1529.26	608.71

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1686.67 - 105.379) / 105.379 = 0.04502

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2704.488 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm) , [사용률 = 1.900]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00305

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1686.67 - a/2) = 2868.904 kN.m

≥ Mu (= 1529.262 kN.m) ∴ O.K [안전률 1.876]

* 전단에 대한 검토 (d = 1520.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1520.00 = 987.269 kN

≥ Vu (= 608.713 kN) , 전단보강 불필요.

▣ TITLE : 중간슬래브 1경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1520.00	80.00	876.54	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 105.379) / 105.379 = 0.04027

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1712.917 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm) , [사용률 = 3.000]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00338

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1520.00 - a/2) = 2577.683 kN.m

≥ Mu (= 876.542 kN.m) ∴ O.K [안전률 2.941]

▣ TITLE : 중간슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1520.00	80.00	903.53	503.91

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 105.379) / 105.379 = 0.04027

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1766.206 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm) , [사용률 = 2.910]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00338

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1520.00 - a/2) = 2577.683 kN.m

≥ Mu (= 903.532 kN.m) ∴ O.K [안전률 2.853]

* 전단에 대한 검토 (d = 1520.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1520.00 = 987.269 kN

≥ Vu (= 503.909 kN) , 전단보강 불필요.

▣ TITLE : 중간슬래브 2경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1520.00	80.00	439.63	1229.88

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 105.379) / 105.379 = 0.04027

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \;,\; As = 854.857 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm), [사용률 = 6.012]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00338

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1520.00 - a/2) = 2577.683 kN.m

≥ Mu (= 439.625 kN.m) ∴ O.K [안전률 5.863]

* 전단에 대한 검토 (d = 1520.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1520.00 = 987.269 kN

< Vu (= 1229.876 kN) , 전단보강 필요.

Av_req = (1229.876-987.269) x 300.00 / (400x1520.00xΦ) x 1000 = 159.610 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1520.00 / 300.00 x 1000 = 804.992 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1520.00 / 1000 = 5265.434 kN ≥ 804.992 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1316.359 + 804.992) = 1591.013 kN ≥ 1229.876 kN ∴ O.K

▣ TITLE : 중간슬래브 2경간(중앙부)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1600.00	1520.00	80.00	772.55	1185.72

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1520.00 - 105.379) / 105.379 = 0.04027

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1507.917 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm) , [사용률 = 3.408]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00338

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1520.00 - a/2) = 2577.683 kN.m

≥ Mu (= 772.554 kN.m) ∴ O.K [안전률 3.337]

* 전단에 대한 검토 (d = 1520.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1520.00 = 987.269 kN

< Vu (= 1185.716 kN) , 전단보강 필요.

Av_req = (1185.716-987.269) x 150.00 / (400x1520.00xΦ) x 1000 = 65.279 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1520.00 / 150.00 x 1000 = 1609.984 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1520.00 / 1000 = 5265.434 kN ≥ 1609.984 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1316.359 + 1609.984) = 2194.757 kN ≥ 1185.716 kN ∴ O.K

▣ TITLE : 중간슬래브 2경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	1766.67	1686.67	80.00	1449.67	1251.96

* 강도감소계수(Φ) 산정

T = As x fy = 5139.200 x 400.00 = 2055680.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 89.572 mm, c = 89.572 / β1 = 89.572 / 0.85 = 105.379 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1686.67 - 105.379) / 105.379 = 0.04502

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2561.821 \text{ mm}^2$$

* 사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm) , [사용률 = 2.006]

1단 : H29 - 8.0 EA (= 5139.2 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00305

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 89.572 mm

ΦMn = 0.85 x 5139.200 x 400 x (1686.67 - a/2) = 2868.904 kN.m

≥ Mu (= 1449.673 kN.m) ∴ O.K [안전률 1.979]

* 전단에 대한 검토 (d = 1520.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 1520.00 = 987.269 kN

< Vu (= 1251.956 kN) , 전단보강 필요.

Av_req = (1251.956-987.269) x 300.00 / (400x1520.00xΦ) x 1000 = 174.136 mm²

Av_use = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1520.00 / 300.00 x 1000 = 804.992 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 1520.00 / 1000 = 5265.434 kN ≥ 804.992 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm) 콘.설 7.4.2 ∴ O.K

ΦVn = 0.75 x (1316.359 + 804.992) = 1591.013 kN ≥ 1251.956 kN ∴ O.K

▣ TITLE : 좌측벽체 1층(상부)_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,867	100	1,767	3484.809	860.405	246.9

㉯ 철근비 검토

As = 4053.600 mm² (인장중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

Asf = 6353.600 mm² (압축중심 = 80.00 mm), 1단 : H32- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0061) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1866.7 x 1000.0 = 42840000.0 N

Cs = As x fy = 1621440.0 N, Cs' = Asf x fy = 2541440.0 N

Xp = (42840000.0 x 933.33 + 1621440.0 x 100.000 + 2541440.0 x 1786.667) / 47002880.0

= 950.726 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 1060.00 mm, ab = k1 x cb = 901.00 mm

Cc = 0.85 x 27.0 x 901000.000 = 20677.950 kN, ∑Csi = 2395.625 kN, ∑Tsi = 1621.440 kN

Pb = 20677.950 + 2395.625 - 1621.440 = 21452.135 kN

Mb = Cc x 1316.167 + ∑(Csi*di) + ∑(Tsi*di) = 13006.365 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 606.297 mm, e = Mu/Pu = 246.902 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 1684.56 mm, a = k1 x c = 1431.87 mm 를 사용.

Cc = 0.85 x 27.0 x 1431871.796 = 32861.458 kN

∑Csi = 2395.625 kN, ∑Tsi = 118.553 kN

Pn = 32861.458 + 2395.625 - 118.553 = 35138.530 kN

Mn = Cc x 1050.731 + ∑(Csi*di) + ∑(Tsi*di) = 8675.912 kN.m

- 편심오차 : |e - Mn/Pn(=246.906)| = 0.0042 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1866.67 - 100.00 = 1766.667 mm

c = 1684.555 mm, a = k1 x c = 1431.872 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1766.67-1684.56) / 1684.56 = 0.00015

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34351.228 kN < Pn = 35138.530 kN

ΦPn = 0.78 x 34351.228 = 26908.462 kN ≥ Pu = 3484.809 kN ∴ O.K

ΦMn = ΦPn x 0.247 = 6643.746 kN.m ≥ Mu = 860.405 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1600.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1600.00 = 1191.395 kN

< Vu (= 1664.343 kN) , 전단보강 필요.

Req Av = (1664.343 - 1191.395) x 150.00 / (400.0 x 1600.00 x Φ) = 147.796 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1600.00 / 150.00 = 1694.720 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1600.00 = 5542.563 kN ≥ 1694.720 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1588.527 + 1694.720) = 2462.435 kN ≥ 1664.343 kN ∴ O.K

▣ TITLE : 좌측벽체 1층(상부)_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	3484.809	1724.401	494.8

㉯ 철근비 검토

As = 6353.600 mm² (인장중심 = 80.00 mm), 1단 : H32- 8.0EA, d1 = 80.00 mm

Asf = 4053.600 mm² (압축중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0061) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1700.0 x 1000.0 = 39015000.0 N

Cs = As x fy = 2541440.0 N, Cs' = Asf x fy = 1621440.0 N

Xp = (39015000.0 x 850.00 + 2541440.0 x 80.000 + 1621440.0 x 1600.000) / 43177880.0

= 832.842 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 1528.410 kN, ∑Tsi = 2541.440 kN

Pb = 18961.290 + 1528.410 - 2541.440 = 17948.260 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 11695.353 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 651.615 mm, e = Mu/Pu = 494.834 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 1135.69 mm, a = k1 x c = 965.34 mm 를 사용.

Cc = 0.85 x 27.0 x 965340.328 = 22154.561 kN

∑Csi = 1528.410 kN, ∑Tsi = 1625.657 kN

Pn = 22154.561 + 1528.410 - 1625.657 = 22057.313 kN

Mn = Cc x 1137.330 + ∑(Csi*di) + ∑(Tsi*di) = 10914.545 kN.m

- 편심오차 : |e - Mn/Pn(=494.827)| = 0.0071 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 1135.695 mm, a = k1 x c = 965.340 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-1135.69) / 1135.69 = 0.00128

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34351.228 kN ≥ Pn = 22057.313 kN

ΦPn = 0.78 x 22057.313 = 17278.229 kN ≥ Pu = 3484.809 kN ∴ O.K

ΦMn = ΦPn x 0.495 = 8549.850 kN.m ≥ Mu = 1724.401 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1206.288 kN

< Vu (= 1664.343 kN) , 전단보강 필요.

Req Av = (1664.343 - 1206.288) x 150.00 / (400.0 x 1620.00 x Φ) = 141.375 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1620.00 / 150.00 = 1715.904 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1620.00 = 5611.845 kN ≥ 1715.904 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1608.383 + 1715.904) = 2493.216 kN ≥ 1664.343 kN ∴ O.K

▣ TITLE : 좌측벽체 1층(중앙부)

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	3529.012	811.506	230

㉯ 철근비 검토

As = 6353.600 mm² (인장중심 = 80.00 mm), 1단 : H32- 8.0EA, d1 = 80.00 mm

Asf = 4053.600 mm² (압축중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0061) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1700.0 x 1000.0 = 39015000.0 N

Cs = As x fy = 2541440.0 N, Cs' = Asf x fy = 1621440.0 N

Xp = (39015000.0 x 850.00 + 2541440.0 x 80.000 + 1621440.0 x 1600.000) / 43177880.0

= 832.842 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 1528.410 kN, ∑Tsi = 2541.440 kN

Pb = 18961.290 + 1528.410 - 2541.440 = 17948.260 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 11695.353 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 651.615 mm, e = Mu/Pu = 229.953 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 1571.25 mm, a = k1 x c = 1335.56 mm 를 사용.

Cc = 0.85 x 27.0 x 1335560.360 = 30651.110 kN

∑Csi = 1528.410 kN, ∑Tsi = 118.283 kN

Pn = 30651.110 + 1528.410 - 118.283 = 32061.237 kN

Mn = Cc x 952.220 + ∑(Csi*di) + ∑(Tsi*di) = 7372.719 kN.m

- 편심오차 : |e - Mn/Pn(=229.957)| = 0.0046 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 1571.247 mm, a = k1 x c = 1335.560 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-1571.25) / 1571.25 = 0.00009

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34351.228 kN ≥ Pn = 32061.237 kN

ΦPn = 0.78 x 32061.237 = 25114.635 kN ≥ Pu = 3529.012 kN ∴ O.K

ΦMn = ΦPn x 0.230 = 5775.180 kN.m ≥ Mu = 811.506 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1208.242 kN

< Vu (= 1390.799 kN) , 전단보강 필요.

Req Av = (1390.799 - 1208.242) x 150.00 / (400.0 x 1620.00 x Φ) = 56.345 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1620.00 / 150.00 = 1715.904 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1620.00 = 5611.845 kN ≥ 1715.904 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1610.989 + 1715.904) = 2495.170 kN ≥ 1390.799 kN ∴ O.K

▣ TITLE : 좌측벽체 1층(하부)

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,867	100	1,722	3702.313	5152.859	1391.8

㉯ 철근비 검토

As = 11492.800 mm² (인장중심 = 144.72 mm), 1단 : H32- 8.0EA, d1 = 100.00 mm

2단 : H29- 8.0EA, d1 = 200.00 mm

Asf = 6353.600 mm² (압축중심 = 80.00 mm), 1단 : H32- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0105) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1866.7 x 1000.0 = 42840000.0 N

Cs = As x fy = 4597120.0 N, Cs' = Asf x fy = 2541440.0 N

Xp = (42840000.0 x 933.33 + 4597120.0 x 144.717 + 2541440.0 x 1786.667) / 49978560.0

= 904.187 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 1033.17 mm, ab = k1 x cb = 878.19 mm

Cc = 0.85 x 27.0 x 878194.487 = 20154.563 kN, ∑Csi = 2395.625 kN, ∑Tsi = 4597.120 kN

Pb = 20154.563 + 2395.625 - 4597.120 = 17953.068 kN

Mb = Cc x 1282.853 + ∑(Csi*di) + ∑(Tsi*di) = 16154.003 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 899.791 mm, e = Mu/Pu = 1391.795 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 635.44 mm, a = k1 x c = 540.13 mm 를 사용.

Cc = 0.85 x 27.0 x 540125.142 = 12395.872 kN

∑Csi = 2395.625 kN, ∑Tsi = 4597.120 kN

Pn = 12395.872 + 2395.625 - 4597.120 = 10194.377 kN

Mn = Cc x 1451.887 + ∑(Csi*di) + ∑(Tsi*di) = 14188.576 kN.m

- 편심오차 : |e - Mn/Pn(=1391.804)| = 0.0096 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1866.67 - 100.00 = 1766.667 mm

c = 635.441 mm, a = k1 x c = 540.125 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1766.67-635.44) / 635.44 = 0.00534

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 36595.188 kN ≥ Pn = 10194.377 kN

ΦPn = 0.85 x 10194.377 = 8665.220 kN ≥ Pu = 3702.313 kN ∴ O.K

ΦMn = ΦPn x 1.392 = 12060.206 kN.m ≥ Mu = 5152.859 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1555.28 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1555.28 = 1167.330 kN

< Vu (= 1792.820 kN) , 전단보강 필요.

Req Av = (1792.820 - 1167.330) x 150.00 / (400.0 x 1555.28 x Φ) = 201.086 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1555.28 / 150.00 = 1647.356 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1555.28 = 5387.659 kN ≥ 1647.356 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1556.440 + 1647.356) = 2402.847 kN ≥ 1792.820 kN ∴ O.K

▣ TITLE : 좌측벽체 2층(상부)

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,867	100	1,717	2624.235	4316.307	1644.8

㉯ 철근비 검토

As = 10342.800 ㎟ (인장중심 = 149.69 mm), 1단 : H32- 4.0EA + H25- 4.0EA, d1 = 100.00 mm
2단 : H29- 8.0EA, d1 = 200.00 mm

Asf = 6353.600 ㎟ (압축중심 = 80.00 mm), 1단 : H32- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0098) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1866.7 x 1000.0 = 42840000.0 N

Cs = As x fy = 4137120.0 N, Cs' = Asf x fy = 2541440.0 N

Xp = (42840000.0 x 933.33 + 4137120.0 x 149.689 + 2541440.0 x 1786.667) / 49518560.0
= 911.658 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 1030.19 mm, ab = k1 x cb = 875.66 mm

Cc = 0.85 x 27.0 x 875658.777 = 20096.369 kN, ∑Csi = 2395.625 kN, ∑Tsi = 4137.120 kN

Pb = 20096.369 + 2395.625 - 4137.120 = 18354.874 kN

Mb = Cc x 1279.149 + ∑(Csi*di) + ∑(Tsi*di) = 15641.979 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 852.198 mm, e = Mu/Pu = 1644.787 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 467.99 mm, a = k1 x c = 397.79 mm 를 사용.

Cc = 0.85 x 27.0 x 397789.728 = 9129.274 kN

∑Csi = 2395.625 kN, ∑Tsi = 4137.120 kN

Pn = 9129.274 + 2395.625 - 4137.120 = 7387.779 kN

Mn = Cc x 1518.083 + ∑(Csi*di) + ∑(Tsi*di) = 12151.322 kN.m

- 편심오차 : |e - Mn/Pn(=1644.787)| = 0.0001 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1866.67 - 100.00 = 1766.667 mm

c = 467.988 mm, a = k1 x c = 397.790 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1766.67-467.99) / 467.99 = 0.00833

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 36248.302 kN ≥ Pn = 7387.779 kN

ΦPn = 0.85 x 7387.779 = 6279.612 kN ≥ Pu = 2624.235 kN ∴ O.K

ΦMn = ΦPn x 1.645 = 10328.623 kN.m ≥ Mu = 4316.307 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1550.31 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1550.31 = 1117.986 kN

< Vu (= 1677.745 kN) , 전단보강 필요.

Req Av = (1677.745 - 1117.986) x 300.00 / (400.0 x 1550.31 x Φ) = 361.063 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1550.31 / 300.00 = 821.045 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1550.31 = 5370.436 kN ≥ 821.045 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1490.648 + 821.045) = 1733.769 kN ≥ 1677.745 kN ∴ O.K

▣ TITLE : 좌측벽체 2층(중앙부)

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	2861.574	2204.555	770.4

㉯ 철근비 검토

As = 6353.600 mm² (인장중심 = 80.00 mm), 1단 : H32- 8.0EA, d1 = 80.00 mm

Asf = 4053.600 mm² (압축중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0061) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1700.0 x 1000.0 = 39015000.0 N

Cs = As x fy = 2541440.0 N, Cs' = Asf x fy = 1621440.0 N

Xp = (39015000.0 x 850.00 + 2541440.0 x 80.000 + 1621440.0 x 1600.000) / 43177880.0

= 832.842 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 1528.410 kN, ∑Tsi = 2541.440 kN

Pb = 18961.290 + 1528.410 - 2541.440 = 17948.260 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 11695.353 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 651.615 mm, e = Mu/Pu = 770.399 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 806.16 mm, a = k1 x c = 685.23 mm 를 사용.

Cc = 0.85 x 27.0 x 685232.735 = 15726.091 kN

∑Csi = 1528.410 kN, ∑Tsi = 2541.440 kN

Pn = 15726.091 + 1528.410 - 2541.440 = 14713.061 kN

Mn = Cc x 1277.384 + ∑(Csi*di) + ∑(Tsi*di) = 11334.818 kN.m

- 편심오차 : |e - Mn/Pn(=770.392)| = 0.0079 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 806.156 mm, a = k1 x c = 685.233 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-806.16) / 806.16 = 0.00303

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34351.228 kN ≥ Pn = 14713.061 kN

ΦPn = 0.78 x 14713.061 = 11525.231 kN ≥ Pu = 2861.574 kN ∴ O.K

ΦMn = ΦPn x 0.770 = 8879.032 kN.m ≥ Mu = 2204.555 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1178.734 kN

ΦVc/2 < Vu (= 1100.132 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 mm²

Av_use = H16 - 2.0 EA = 397.200 mm² ∴ O.K

▣ TITLE : 좌측벽체 2층(하부)_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,867	100	1,767	2901.114	372.371	128.4

㉯ 철근비 검토

As = 4053.600 mm² (인장중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

Asf = 6353.600 mm² (압축중심 = 80.00 mm), 1단 : H32- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0061) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1866.7 x 1000.0 = 42840000.0 N

Cs = As x fy = 1621440.0 N, Cs' = Asf x fy = 2541440.0 N

Xp = (42840000.0 x 933.33 + 1621440.0 x 100.000 + 2541440.0 x 1786.667) / 47002880.0

= 950.726 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 1060.00 mm, ab = k1 x cb = 901.00 mm

Cc = 0.85 x 27.0 x 901000.000 = 20677.950 kN, ∑Csi = 2395.625 kN, ∑Tsi = 1621.440 kN

Pb = 20677.950 + 2395.625 - 1621.440 = 21452.135 kN

Mb = Cc x 1316.167 + ∑(Csi*di) + ∑(Tsi*di) = 13006.365 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 606.297 mm, e = Mu/Pu = 128.355 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 1944.76 mm, a = k1 x c = 1653.05 mm 를 사용.

Cc = 0.85 x 27.0 x 1653045.464 = 37937.393 kN

∑Csi = 2618.352 kN, ∑Tsi = 0.000 kN

Pn = 37937.393 + 2618.352 - 0.000 = 40555.745 kN

Mn = Cc x 940.144 + ∑(Csi*di) + ∑(Tsi*di) = 5205.413 kN.m

- 편심오차 : |e - Mn/Pn(=128.352)| = 0.0025 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1866.67 - 100.00 = 1766.667 mm

c = 1944.759 mm, a = k1 x c = 1653.045 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1766.67-1944.76) / 1944.76 = -0.00027

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34351.228 kN < Pn = 40555.745 kN

ΦPn = 0.78 x 34351.228 = 26908.462 kN ≥ Pu = 2901.114 kN ∴ O.K

ΦMn = ΦPn x 0.128 = 3453.824 kN.m ≥ Mu = 372.371 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1600.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1600.00 = 1165.908 kN

< Vu (= 1206.789 kN) , 전단보강 필요.

Req Av = (1206.789 - 1165.908) x 300.00 / (400.0 x 1600.00 x Φ) = 25.550 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1600.00 / 300.00 = 847.360 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1600.00 = 5542.563 kN ≥ 847.360 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1554.544 + 847.360) = 1801.428 kN ≥ 1206.789 kN ∴ O.K

▣ TITLE : 좌측벽체 2층(하부)_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	2901.114	2899.565	999.5

㉯ 철근비 검토

As = 6353.600 mm² (인장중심 = 80.00 mm), 1단 : H32- 8.0EA, d1 = 80.00 mm

Asf = 4053.600 mm² (압축중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0061) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1700.0 x 1000.0 = 39015000.0 N

Cs = As x fy = 2541440.0 N, Cs' = Asf x fy = 1621440.0 N

Xp = (39015000.0 x 850.00 + 2541440.0 x 80.000 + 1621440.0 x 1600.000) / 43177880.0

= 832.842 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 1528.410 kN, ∑Tsi = 2541.440 kN

Pb = 18961.290 + 1528.410 - 2541.440 = 17948.260 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 11695.353 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 651.615 mm, e = Mu/Pu = 999.466 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 564.45 mm, a = k1 x c = 479.78 mm 를 사용.

Cc = 0.85 x 27.0 x 479781.103 = 11010.976 kN

∑Csi = 1528.410 kN, ∑Tsi = 2541.440 kN

Pn = 11010.976 + 1528.410 - 2541.440 = 9997.946 kN

Mn = Cc x 1380.109 + ∑(Csi*di) + ∑(Tsi*di) = 9992.658 kN.m

- 편심오차 : |e - Mn/Pn(=999.471)| = 0.0050 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 564.448 mm, a = k1 x c = 479.781 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-564.45) / 564.45 = 0.00561

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34351.228 kN ≥ Pn = 9997.946 kN

ΦPn = 0.85 x 9997.946 = 8498.254 kN ≥ Pu = 2901.114 kN ∴ O.K

ΦMn = ΦPn x 0.999 = 8493.717 kN.m ≥ Mu = 2899.565 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1180.482 kN

< Vu (= 1206.789 kN) , 전단보강 필요.

Req Av = (1206.789 - 1180.482) x 300.00 / (400.0 x 1620.00 x Φ) = 16.239 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1620.00 / 300.00 = 857.952 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1620.00 = 5611.845 kN ≥ 857.952 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1573.976 + 857.952) = 1823.946 kN ≥ 1206.789 kN ∴ O.K

▣ TITLE : 우측벽체 1층(상부)_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,867	100	1,728	2115.81	1081.15	511

㉯ 철근비 검토

As = 6623.200 mm² (인장중심 = 138.80 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm
2단 : H29- 4.0EA, d1 = 200.00 mm

Asf = 5139.200 mm² (압축중심 = 80.00 mm), 1단 : H29- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0069) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1866.7 x 1000.0 = 42840000.0 N

Cs = As x fy = 2649280.0 N, Cs' = Asf x fy = 2055680.0 N

Xp = (42840000.0 x 933.33 + 2649280.0 x 138.797 + 2055680.0 x 1786.667) / 47544960.0
= 925.956 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 1036.72 mm, ab = k1 x cb = 881.21 mm

Cc = 0.85 x 27.0 x 881213.552 = 20223.851 kN, ∑Csi = 1937.735 kN, ∑Tsi = 2649.280 kN

Pb = 20223.851 + 1937.735 - 2649.280 = 19512.306 kN

Mb = Cc x 1287.263 + ∑(Csi*di) + ∑(Tsi*di) = 13867.267 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 710.693 mm, e = Mu/Pu = 510.986 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 1259.63 mm, a = k1 x c = 1070.69 mm 를 사용.

Cc = 0.85 x 27.0 x 1070685.806 = 24572.239 kN

∑Csi = 1937.735 kN, ∑Tsi = 1477.216 kN

Pn = 24572.239 + 1937.735 - 1477.216 = 25032.759 kN

Mn = Cc x 1192.527 + ∑(Csi*di) + ∑(Tsi*di) = 12791.434 kN.m

- 편심오차 : |e - Mn/Pn(=510.988)| = 0.0015 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1866.67 - 100.00 = 1766.667 mm

c = 1259.630 mm, a = k1 x c = 1070.686 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1766.67-1259.63) / 1259.63 = 0.00121

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.
최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.
εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.
Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34760.010 kN ≥ Pn = 25032.759 kN

ΦPn = 0.78 x 25032.759 = 19608.994 kN ≥ Pu = 2115.810 kN ∴ O.K

ΦMn = ΦPn x 0.511 = 10019.928 kN.m ≥ Mu = 1081.150 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1561.20 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1561.20 = 1104.178 kN

< Vu (= 1317.213 kN) , 전단보강 필요.

Req Av = (1317.213 - 1104.178) x 300.00 / (400.0 x 1561.20 x Φ) = 136.455 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1561.20 / 300.00 = 826.813 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1561.20 = 5408.166 kN ≥ 826.813 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1472.237 + 826.813) = 1724.288 kN ≥ 1317.213 kN ∴ O.K

▣ TITLE : 우측벽체 1층(상부)_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	2115.81	1957.956	925.4

㉯ 철근비 검토

As = 5139.200 mm² (인장중심 = 80.00 mm), 1단 : H29- 8.0EA, d1 = 80.00 mm

Asf = 6623.200 mm² (압축중심 = 138.80 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

2단 : H29- 4.0EA, d1 = 200.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0069) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1700.0 x 1000.0 = 39015000.0 N

Cs = As x fy = 2055680.0 N, Cs' = Asf x fy = 2649280.0 N

Xp = (39015000.0 x 850.00 + 2055680.0 x 80.000 + 2649280.0 x 1561.203) / 43719960.0

= 856.892 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 2497.278 kN, ∑Tsi = 2055.680 kN

Pb = 18961.290 + 2497.278 - 2055.680 = 19402.888 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 11509.415 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 593.181 mm, e = Mu/Pu = 925.393 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 507.24 mm, a = k1 x c = 431.15 mm 를 사용.

Cc = 0.85 x 27.0 x 431152.954 = 9894.960 kN

∑Csi = 2497.278 kN, ∑Tsi = 2055.680 kN

Pn = 9894.960 + 2497.278 - 2055.680 = 10336.558 kN

Mn = Cc x 1404.424 + ∑(Csi*di) + ∑(Tsi*di) = 9565.305 kN.m

- 편심오차 : |e - Mn/Pn(=925.386)| = 0.0072 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 507.239 mm, a = k1 x c = 431.153 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-507.24) / 507.24 = 0.00658

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34760.010 kN ≥ Pn = 10336.558 kN

ΦPn = 0.85 x 10336.558 = 8786.074 kN ≥ Pu = 2115.810 kN ∴ O.K

ΦMn = ΦPn x 0.925 = 8130.573 kN.m ≥ Mu = 1957.956 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1145.763 kN

< Vu (= 1317.213 kN) , 전단보강 필요.

Req Av = (1317.213 - 1145.763) x 300.00 / (400.0 x 1620.00 x Φ) = 105.833 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1620.00 / 300.00 = 857.952 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1620.00 = 5611.845 kN ≥ 857.952 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1527.684 + 857.952) = 1789.227 kN ≥ 1317.213 kN ∴ O.K

▣ TITLE : 우측벽체 1층(중앙부)

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	2160.013	1274.104	589.9

㉯ 철근비 검토

As = 5139.200 mm² (인장중심 = 80.00 mm), 1단 : H29- 8.0EA, d1 = 80.00 mm

Asf = 6623.200 mm² (압축중심 = 138.80 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

2단 : H29- 4.0EA, d1 = 200.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0069) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1700.0 x 1000.0 = 39015000.0 N

Cs = As x fy = 2055680.0 N, Cs' = Asf x fy = 2649280.0 N

Xp = (39015000.0 x 850.00 + 2055680.0 x 80.000 + 2649280.0 x 1561.203) / 43719960.0

= 856.892 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 2497.278 kN, ∑Tsi = 2055.680 kN

Pb = 18961.290 + 2497.278 - 2055.680 = 19402.888 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 11509.415 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 593.181 mm, e = Mu/Pu = 589.859 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 975.50 mm, a = k1 x c = 829.17 mm 를 사용.

Cc = 0.85 x 27.0 x 829173.632 = 19029.535 kN

∑Csi = 2497.278 kN, ∑Tsi = 2037.249 kN

Pn = 19029.535 + 2497.278 - 2037.249 = 19489.563 kN

Mn = Cc x 1205.413 + ∑(Csi*di) + ∑(Tsi*di) = 11496.149 kN.m

- 편심오차 : |e - Mn/Pn(=589.862)| = 0.0024 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 975.498 mm, a = k1 x c = 829.174 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-975.50) / 975.50 = 0.00198

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34760.010 kN ≥ Pn = 19489.563 kN

ΦPn = 0.78 x 19489.563 = 15266.824 kN ≥ Pu = 2160.013 kN ∴ O.K

ΦMn = ΦPn x 0.590 = 9005.280 kN.m ≥ Mu = 1274.104 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1147.717 kN

< Vu (= 1228.840 kN) , 전단보강 필요.

Req Av = (1228.840 - 1147.717) x 150.00 / (400.0 x 1620.00 x Φ) = 25.038 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 150 mm)

Vs = 397.200 x 400.0 x 1620.00 / 150.00 = 1715.904 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1620.00 = 5611.845 kN ≥ 1715.904 kN ∴ O.K

s = 150.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1530.289 + 1715.904) = 2434.645 kN ≥ 1228.840 kN ∴ O.K

▣ TITLE : 우측벽체 1층(하부)

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,867	100	1,717	2333.314	3464.132	1484.6

㉯ 철근비 검토

As = 10278.400 mm² (인장중심 = 150.00 mm), 1단 : H29- 8.0EA, d1 = 100.00 mm

2단 : H29- 8.0EA, d1 = 200.00 mm

Asf = 5139.200 mm² (압축중심 = 80.00 mm), 1단 : H29- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0091) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1866.7 x 1000.0 = 42840000.0 N

Cs = As x fy = 4111360.0 N, Cs' = Asf x fy = 2055680.0 N

Xp = (42840000.0 x 933.33 + 4111360.0 x 150.000 + 2055680.0 x 1786.667) / 49007040.0

= 903.411 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 1030.00 mm, ab = k1 x cb = 875.50 mm

Cc = 0.85 x 27.0 x 875500.000 = 20092.725 kN, ∑Csi = 1937.735 kN, ∑Tsi = 4111.360 kN

Pb = 20092.725 + 1937.735 - 4111.360 = 17919.100 kN

Mb = Cc x 1278.917 + ∑(Csi*di) + ∑(Tsi*di) = 15367.893 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 857.626 mm, e = Mu/Pu = 1484.640 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 546.58 mm, a = k1 x c = 464.60 mm 를 사용.

Cc = 0.85 x 27.0 x 464596.442 = 10662.488 kN

∑Csi = 1937.735 kN, ∑Tsi = 4111.360 kN

Pn = 10662.488 + 1937.735 - 4111.360 = 8488.864 kN

Mn = Cc x 1484.368 + ∑(Csi*di) + ∑(Tsi*di) = 12602.881 kN.m

- 편심오차 : |e - Mn/Pn(=1484.637)| = 0.0033 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1866.67 - 100.00 = 1766.667 mm

c = 546.584 mm, a = k1 x c = 464.596 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1766.67-546.58) / 546.58 = 0.00670

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 35862.565 kN ≥ Pn = 8488.864 kN

ΦPn = 0.85 x 8488.864 = 7215.534 kN ≥ Pu = 2333.314 kN ∴ O.K

ΦMn = ΦPn x 1.485 = 10712.473 kN.m ≥ Mu = 3464.132 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1550.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1550.00 = 1105.455 kN

< Vu (= 1445.431 kN) , 전단보강 필요.

Req Av = (1445.431 - 1105.455) x 300.00 / (400.0 x 1550.00 x Φ) = 219.339 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1550.00 / 300.00 = 820.880 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1550.00 = 5369.358 kN ≥ 820.880 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1473.940 + 820.880) = 1721.115 kN ≥ 1445.431 kN ∴ O.K

▣ TITLE : 우측벽체 2층(상부)

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,867	100	1,767	1593.115	1969.847	1236.5

㉯ 철근비 검토

As = 5203.600 mm² (인장중심 = 100.00 mm), 1단 : H25- 4.0EA + H32- 4.0EA, d1 = 100.00 mm

Asf = 5139.200 mm² (압축중심 = 80.00 mm), 1단 : H29- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0061) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1866.7 x 1000.0 = 42840000.0 N

Cs = As x fy = 2081440.0 N, Cs' = Asf x fy = 2055680.0 N

Xp = (42840000.0 x 933.33 + 2081440.0 x 100.000 + 2055680.0 x 1786.667) / 46977120.0

= 933.752 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 1060.00 mm, ab = k1 x cb = 901.00 mm

Cc = 0.85 x 27.0 x 901000.000 = 20677.950 kN, ∑Csi = 1937.735 kN, ∑Tsi = 2081.440 kN

Pb = 20677.950 + 1937.735 - 2081.440 = 20534.245 kN

Mb = Cc x 1316.167 + ∑(Csi*di) + ∑(Tsi*di) = 13363.483 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 650.790 mm, e = Mu/Pu = 1236.475 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 389.62 mm, a = k1 x c = 331.18 mm 를 사용.

Cc = 0.85 x 27.0 x 331180.501 = 7600.592 kN

∑Csi = 1937.735 kN, ∑Tsi = 2081.440 kN

Pn = 7600.592 + 1937.735 - 2081.440 = 7456.888 kN

Mn = Cc x 1601.076 + ∑(Csi*di) + ∑(Tsi*di) = 9220.251 kN.m

- 편심오차 : |e - Mn/Pn(=1236.474)| = 0.0006 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1866.67 - 100.00 = 1766.667 mm

c = 389.624 mm, a = k1 x c = 331.181 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1766.67-389.62) / 389.62 = 0.01060

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 34331.802 kN ≥ Pn = 7456.888 kN

ΦPn = 0.85 x 7456.888 = 6338.355 kN ≥ Pu = 1593.115 kN ∴ O.K

ΦMn = ΦPn x 1.236 = 7837.218 kN.m ≥ Mu = 1969.847 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1600.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1600.00 = 1108.794 kN

< Vu (= 1275.583 kN) , 전단보강 필요.

Req Av = (1275.583 - 1108.794) x 300.00 / (400.0 x 1600.00 x Φ) = 104.243 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1600.00 / 300.00 = 847.360 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1600.00 = 5542.563 kN ≥ 847.360 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1478.392 + 847.360) = 1744.314 kN ≥ 1275.583 kN ∴ O.K

▣ TITLE : 우측벽체 2층(중앙부)

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	1830.455	1684.12	920.1

㉯ 철근비 검토

As = 5139.200 mm² (인장중심 = 80.00 mm), 1단 : H29- 8.0EA, d1 = 80.00 mm

Asf = 4053.600 mm² (압축중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0054) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1700.0 x 1000.0 = 39015000.0 N

Cs = As x fy = 2055680.0 N, Cs' = Asf x fy = 1621440.0 N

Xp = (39015000.0 x 850.00 + 2055680.0 x 80.000 + 1621440.0 x 1600.000) / 42692120.0

= 841.408 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 1528.410 kN, ∑Tsi = 2055.680 kN

Pb = 18961.290 + 1528.410 - 2055.680 = 18434.020 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 11171.746 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 606.040 mm, e = Mu/Pu = 920.055 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 554.10 mm, a = k1 x c = 470.98 mm 를 사용.

Cc = 0.85 x 27.0 x 470982.599 = 10809.051 kN

∑Csi = 1528.410 kN, ∑Tsi = 2055.680 kN

Pn = 10809.051 + 1528.410 - 2055.680 = 10281.781 kN

Mn = Cc x 1384.509 + ∑(Csi*di) + ∑(Tsi*di) = 9459.774 kN.m

- 편심오차 : |e - Mn/Pn(=920.052)| = 0.0033 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 554.097 mm, a = k1 x c = 470.983 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-554.10) / 554.10 = 0.00577

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 33984.916 kN ≥ Pn = 10281.781 kN

ΦPn = 0.85 x 10281.781 = 8739.513 kN ≥ Pu = 1830.455 kN ∴ O.K

ΦMn = ΦPn x 0.920 = 8040.837 kN.m ≥ Mu = 1684.120 kN.m ∴ O.K

㉴ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1133.147 kN

ΦVc/2 ≥ Vu (= 522.436 kN) , 전단보강 불필요.

▣ TITLE : 우측벽체 2층(하부)_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,867	100	1,767	1869.994	558.572	298.7

㉯ 철근비 검토

As = 4053.600 mm² (인장중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

Asf = 5139.200 mm² (압축중심 = 80.00 mm), 1단 : H29- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0054) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1866.7 x 1000.0 = 42840000.0 N

Cs = As x fy = 1621440.0 N, Cs' = Asf x fy = 2055680.0 N

Xp = (42840000.0 x 933.33 + 1621440.0 x 100.000 + 2055680.0 x 1786.667) / 46517120.0

= 941.996 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 1060.00 mm, ab = k1 x cb = 901.00 mm

Cc = 0.85 x 27.0 x 901000.000 = 20677.950 kN, ∑Csi = 1937.735 kN, ∑Tsi = 1621.440 kN

Pb = 20677.950 + 1937.735 - 1621.440 = 20994.245 kN

Mb = Cc x 1316.167 + ∑(Csi*di) + ∑(Tsi*di) = 12806.864 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 610.018 mm, e = Mu/Pu = 298.702 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 1578.88 mm, a = k1 x c = 1342.05 mm 를 사용.

Cc = 0.85 x 27.0 x 1342050.425 = 30800.057 kN

∑Csi = 1937.735 kN, ∑Tsi = 289.268 kN

Pn = 30800.057 + 1937.735 - 289.268 = 32448.525 kN

Mn = Cc x 1095.641 + ∑(Csi*di) + ∑(Tsi*di) = 9692.593 kN.m

- 편심오차 : |e - Mn/Pn(=298.707)| = 0.0043 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1866.67 - 100.00 = 1766.667 mm

c = 1578.883 mm, a = k1 x c = 1342.050 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1766.67-1578.88) / 1578.88 = 0.00036

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 33984.916 kN ≥ Pn = 32448.525 kN

ΦPn = 0.78 x 32448.525 = 25418.011 kN ≥ Pu = 1869.994 kN ∴ O.K

ΦMn = ΦPn x 0.299 = 7592.422 kN.m ≥ Mu = 558.572 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 1600.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1600.00 = 1120.884 kN

ΦVc/2 < Vu (= 590.556 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 300.00 / 400 = 262.500 mm²

Av_use = H16 - 2.0 EA = 397.200 mm² ∴ O.K

▣ TITLE : 우측벽체 2층(하부)_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	1869.994	2012.365	1076.1

㉯ 철근비 검토

As = 5139.200 ㎟ (인장중심 = 80.00 mm), 1단 : H29- 8.0EA, d1 = 80.00 mm

Asf = 4053.600 ㎟ (압축중심 = 100.00 mm), 1단 : H25- 8.0EA, d1 = 100.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0054) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 1700.0 x 1000.0 = 39015000.0 N

Cs = As x fy = 2055680.0 N, Cs' = Asf x fy = 1621440.0 N

Xp = (39015000.0 x 850.00 + 2055680.0 x 80.000 + 1621440.0 x 1600.000) / 42692120.0

= 841.408 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 1528.410 kN, ∑Tsi = 2055.680 kN

Pb = 18961.290 + 1528.410 - 2055.680 = 18434.020 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 11171.746 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 606.040 mm, e = Mu/Pu = 1076.134 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 424.20 mm, a = k1 x c = 360.57 mm 를 사용.

Cc = 0.85 x 27.0 x 360567.942 = 8275.034 kN

∑Csi = 1528.410 kN, ∑Tsi = 2055.680 kN

Pn = 8275.034 + 1528.410 - 2055.680 = 7747.764 kN

Mn = Cc x 1439.716 + ∑(Csi*di) + ∑(Tsi*di) = 8337.670 kN.m

- 편심오차 : |e - Mn/Pn(=1076.139)| = 0.0044 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 424.198 mm, a = k1 x c = 360.568 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-424.20) / 424.20 = 0.00846

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 33984.916 kN ≥ Pn = 7747.764 kN

ΦPn = 0.85 x 7747.764 = 6585.600 kN ≥ Pu = 1869.994 kN ∴ O.K

ΦMn = ΦPn x 1.076 = 7086.991 kN.m ≥ Mu = 2012.365 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1134.895 kN

ΦVc/2 < Vu (= 590.556 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 300.00 / 400 = 262.500 mm²

Av_use = H16 - 2.0 EA = 397.200 mm² ∴ O.K

17. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 7838.494 × 0.20 = 1567.70 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1567.699 ∴ O.K

2) 상부슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 5110.321 × 0.20 = 1022.06 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 1022.064 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 4310.532 × 0.20 = 862.11 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 862.106 ∴ O.K

4) 상부슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1603.836 × 0.20 = 320.77 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 320.767 ∴ O.K

5) 상부슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1192.491 × 0.20 = 238.50 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 238.498 ∴ O.K

6) 상부슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 3878.269 × 0.20 = 775.65 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 775.654 ∴ O.K

7) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1800 × 0.0020 = 3600.00 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 8440.340 × 0.20 = 1688.07 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1688.068 ∴ O.K

8) 하부슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1800 × 0.0020 = 3600.00 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 6361.842 × 0.20 = 1272.37 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1272.368 ∴ O.K

9) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1800 × 0.0020 = 3600.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 3547.674 × 0.20 = 709.54 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 709.535 ∴ O.K

10) 하부슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1800 × 0.0020 = 3600.00 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 3450.390 × 0.20 = 690.08 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 690.078 ∴ O.K

11) 하부슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1800 × 0.0020 = 3600.00 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1179.820 × 0.20 = 235.96 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 235.964 ∴ O.K

12) 하부슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1800 × 0.0020 = 3600.00 ㎟

∴ Used As = H16 - 13.3EA = 2647.338 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 6919.695 × 0.20 = 1383.94 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1383.939 ∴ O.K

13) 중간슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 2704.488 × 0.20 = 540.90 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 540.898 ∴ O.K

14) 중간슬래브 : 1경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1712.917 × 0.20 = 342.58 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 342.583 ∴ O.K

15) 중간슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1766.206 × 0.20 = 353.24 ㎟

∴ Used As = H16 - 6.7EA = 1324.662 ㎟ ≥ 353.241 ∴ O.K

16) 중간슬래브 : 2경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 854.857 × 0.20 = 170.97 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 170.971 ∴ O.K

17) 중간슬래브 : 2경간(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1507.917 × 0.20 = 301.58 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 301.583 ∴ O.K

18) 중간슬래브 : 2경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 1600 × 0.0020 = 3200.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 2561.821 × 0.20 = 512.36 ㎟

∴ Used As = H16 - 3.3EA = 661.338 ㎟ ≥ 512.364 ∴ O.K

19) 좌측벽체 : 1층(상부)_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

20) 좌측벽체 : 1층(상부)_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

21) 좌측벽체 : 1층(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

22) 좌측벽체 : 1층(하부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

23) 좌측벽체 : 2층(상부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

24) 좌측벽체 : 2층(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

25) 좌측벽체 : 2층(하부)_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

26) 좌측벽체 : 2층(하부)_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

27) 우측벽체 : 1층(상부)_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

28) 우측벽체 : 1층(상부)_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

29) 우측벽체 : 1층(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

30) 우측벽체 : 1층(하부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 16.7EA = 3310.662 ㎟ ≥ 1800.000 ∴ O.K

31) 우측벽체 : 2층(상부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

32) 우측벽체 : 2층(중앙부)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

33) 우측벽체 : 2층(하부)_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

34) 우측벽체 : 2층(하부)_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 1700 × 0.0020 = 3400.00 ㎟

∴ Used As = H16 - 10EA = 1986.000 ㎟ ≥ 1800.000 ∴ O.K

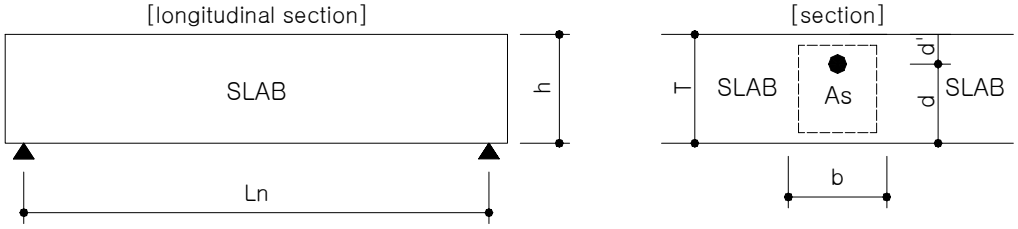
18. 거더,기둥검토,내측벽체 검토

18.1 거더 검토

(1) 거더 : JOINT 17

- 하부거더의 단면력 산정

1) Input Data



- 거더의 지간 : L = 4875.0 mm
- 거더의 순 지간 : Ln = 2600.0 mm
- 단면 폭 : b = 1500.0 mm
- 단면 높이 : h = 1800.0 mm
- 유효높이 : d = 1670.0 mm
- 슬래브 두께 : T = 1800.0 mm

- Ln / d = 1.56 < 4 ∴ 따라서 Deep Beam으로 계산

2) 하중계산

- W = 3359.550 kN/m

3) 단면력 산정

① 극한 모멘트 (지점부)

- $Mu = W \times Ln^2 / 9 = 3359.55 \times 2.60^2 / 9 = 2523.395$ kN.m

② 극한 모멘트 (중앙부)

- $Mu = W \times Ln^2 / 14 = 3359.55 \times 2.60^2 / 14 = 1622.183$ kN.m

③ 극한 전단력 (위험단면)

- $Vu = W \times Ln \times 1.15 / 2 = 3359.55 \times 2.60 \times 1.15 / 2 = 5022.527$ kN.m

※ Deep Beam 에서 전단에 대한 위험단면 : 등분포 하중의 경우 0.15Ln

0.15 × Ln = 390.00 mm

- Vu' = Vu - 0.15Ln × W

= 5022.527 - 0.390 × 3359.550 = 3712.303 kN

4) 단면검토 : 하부거더 지점부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1500.00	1800.00	1670.00	130.00	2523.40	3712.30

* 강도감소계수(Φ) 산정

T = As x fy = 7600.500 x 400.00 = 3040200.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1500.000 = 34425.000 x a

T = C 이므로, a = 88.314 mm, c = 88.314 / β1 = 88.314 / 0.85 = 103.899 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1670.00 - 103.899) / 103.899 = 0.04522

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 4515.083 \text{ mm}^2$$

* 사용철근량 = 7600.5 mm² (철근도심 : 130.0 mm), [사용률 = 1.683]

1단 : H25 - 15.0 EA (= 7600.5 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00303

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 88.314 mm

ΦMn = 0.85 x 7600.500 x 400 x (1670.00 - a/2) = 4201.455 kN.m

≥ Mu (= 2523.395 kN.m) ∴ O.K [안전률 1.665]

5) 깊은보에 대한 전단검토 : 하부거더 지점부

* 단면제원 및 설계가정

B(mm)	Ln(mm)	d(mm)	Vu(kN)	fck(MPa)	fy(MPa)
1500.00	2600.00	1670.00	3712.30	27.00	400.00

* 최대전단강도 검토

ΦMax Vn = Φ x 5 x √fck / 6 x b x d

= 0.75 x 5 x √27 / 6 x 1500.00 x 1670.00

= 8135.226 kN ≥ Vu(= 3712.303 kN) ∴ O.K

* 콘크리트의 전단강도

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1500.00 x 1670.00 = 1627.045 kN

< Vu (= 3712.303 kN) , 전단보강 필요.

* 전단철근의 전단강도

ⓐ 수직 전단철근

s = 200.00 mm ≤ d/5 또한 300 mm ∴ O.K

Av = H16 - 4.0 EA (=794.400 mm²) ≥ 0.0025 x b x s (=750.000 mm²) ∴ O.K

ⓑ 수평 전단철근

sh = 150.00 mm ≤ d/5 또한 300 mm ∴ O.K

Avh = H16 - 4.0 EA (=794.400 mm²) ≥ 0.0015 x b x sh (=337.500 mm²) ∴ O.K

→ Vs = [Av/s x (1+Ln/d)/12 + Avh/sh x (11-Ln/d)/12] x fy x d = 3349.279 kN

* 설계 전단강도

ΦVn = Φ x (Ss + Sc) = 0.75 x (3349.279 + 2169.394)

= 4139.004 kN ≥ Vu(= 3712.303 kN) ∴ O.K

6) 단면검토 : 하부거더 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1500.00	1800.00	1690.00	110.00	1622.18	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 7600.500 x 400.00 = 3040200.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1500.000 = 34425.000 x a

T = C 이므로, a = 88.314 mm, c = 88.314 / β1 = 88.314 / 0.85 = 103.899 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1690.00 - 103.899) / 103.899 = 0.04580

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2851.096 \text{ mm}^2$$

* 사용철근량 = 7600.5 mm² (철근도심 : 110.0 mm), [사용률 = 2.666]

1단 : H25 - 15.0 EA (= 7600.5 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00300

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 88.314 mm

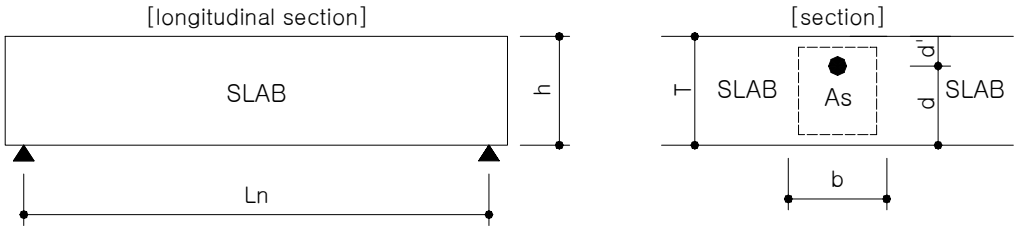
ΦMn = 0.85 x 7600.500 x 400 x (1690.00 - a/2) = 4253.138 kN.m

≥ Mu (= 1622.183 kN.m) ∴ O.K [안전률 2.622]

(2) 거더 : JOINT 93

- 중간거더의 단면력 산정

1) Input Data



- 거더의 지간 : L = 4875.0 mm
- 거더의 순 지간 : Ln = 2600.0 mm
- 단면 폭 : b = 1500.0 mm
- 단면 높이 : h = 1600.0 mm
- 유효높이 : d = 1490.0 mm
- 슬래브 두께 : T = 1800.0 mm

- Ln / d = 1.74 < 4 ∴ 따라서 Deep Beam으로 계산

2) 하중계산

- W = 1733.785 kN/m

3) 단면력 산정

① 극한 모멘트 (지점부)

- $Mu = W \times Ln^2 / 9 = 1733.78 \times 2.60^2 / 9 = 1302.265$ kN.m

② 극한 모멘트 (중앙부)

- $Mu = W \times Ln^2 / 14 = 1733.78 \times 2.60^2 / 14 = 837.170$ kN.m

③ 극한 전단력 (위험단면)

- $Vu = W \times Ln \times 1.15 / 2 = 1733.78 \times 2.60 \times 1.15 / 2 = 2592.008$ kN.m

※ Deep Beam 에서 전단에 대한 위험단면 : 등분포 하중의 경우 0.15Ln

0.15 × Ln = 390.00 mm

- Vu' = Vu - 0.15Ln × W

= 2592.008 - 0.390 × 1733.785 = 1915.832 kN

4) 단면검토 : 중간거더 지점부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1500.00	1600.00	1490.00	110.00	1302.27	1915.83

* 강도감소계수(Φ) 산정

T = As x fy = 5806.500 x 400.00 = 2322600.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1500.000 = 34425.000 x a

T = C 이므로, a = 67.468 mm, c = 67.468 / β1 = 67.468 / 0.85 = 79.375 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1490.00 - 79.375) / 79.375 = 0.05332

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 2596.894 \text{ mm}^2$$

* 사용철근량 = 5806.5 mm² (철근도심 : 110.0 mm), [사용률 = 2.236]

1단 : H22 - 15.0 EA (= 5806.5 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00260

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 67.468 mm

ΦMn = 0.85 x 5806.500 x 400 x (1490.00 - a/2) = 2874.974 kN.m

≥ Mu (= 1302.265 kN.m) ∴ O.K [안전률 2.208]

5) 깊은보에 대한 전단검토 : 중간거더 지점부

* 단면제원 및 설계가정

B(mm)	Ln(mm)	d(mm)	Vu(kN)	fck(MPa)	fy(MPa)
1500.00	2600.00	1490.00	1915.83	27.00	400.00

* 최대전단강도 검토

ΦMax Vn = Φ x 5 x √fck / 6 x b x d

= 0.75 x 5 x √27 / 6 x 1500.00 x 1490.00

= 7258.375 kN ≥ Vu(= 1915.832 kN) ∴ O.K

* 콘크리트의 전단강도

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1500.00 x 1490.00 = 1451.675 kN

< Vu (= 1915.832 kN) , 전단보강 필요.

* 전단철근의 전단강도

ⓐ 수직 전단철근

s = 200.00 mm ≤ d/5 또한 300 mm ∴ O.K

Av = H16 - 4.0 EA (=794.400 mm²) ≥ 0.0025 x b x s (=750.000 mm²) ∴ O.K

ⓑ 수평 전단철근

sh = 150.00 mm ≤ d/5 또한 300 mm ∴ O.K

Avh = H16 - 4.0 EA (=794.400 mm²) ≥ 0.0015 x b x sh (=337.500 mm²) ∴ O.K

→ Vs = [Av/s x (1+Ln/d)/12 + Avh/sh x (11-Ln/d)/12] x fy x d = 2975.911 kN

* 설계 전단강도

ΦVn = Φ x (Ss + Sc) = 0.75 x (2975.911 + 1935.567)

= 3683.608 kN ≥ Vu(= 1915.832 kN) ∴ O.K

6) 단면검토 : 중간거더 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1500.00	1600.00	1490.00	110.00	837.17	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 5806.500 x 400.00 = 2322600.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1500.000 = 34425.000 x a

T = C 이므로, a = 67.468 mm, c = 67.468 / β1 = 67.468 / 0.85 = 79.375 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (1490.00 - 79.375) / 79.375 = 0.05332

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1663.315 \text{ mm}^2$$

* 사용철근량 = 5806.5 mm² (철근도심 : 110.0 mm), [사용률 = 3.491]

1단 : H22 - 15.0 EA (= 5806.5 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00260

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 67.468 mm

ΦMn = 0.85 x 5806.500 x 400 x (1490.00 - a/2) = 2874.974 kN.m

≥ Mu (= 837.170 kN.m) ∴ O.K [안전률 3.434]

18.2 기둥 검토

(단위 : kN,m)

부재	폭	두께	높이	CTC	축력	모멘트	축력×CTC	모멘트×CTC	해석모델	조합
P1(1층)	1.30	1.30	3.67	4.875	3736.36	814.99	18214.78	3973.10	상시(ULT)	29
					3324.05	903.89	16204.74	4406.45	상시(ULT)	24
W1(2층)	1.00	1.70	4.84	-	3427.29	2247.66	3427.29	2247.66	상시	29
					803.68	1384.59	803.68	1384.59	지진(붕괴)	17

* 벽체와 기둥의 판별 (W1)

$0.4Agfck = 0.4 \times 1000 \times 1700 \times 27$

$= 18360000\ N = 18360.00\ kN \quad \geq 3427.29\ kN$

∴ 벽체로 검토한다

(1) 1층 기둥 1

1) 축력최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,300	1,300	80	1,181	18214.779	3973.096	218.1

* 철근비 검토

Ag = 1690000.00 mm² , Ast = 39805.60 mm² , Puse = 0.02355

- 1단 : H25 - 48EA (As=24321.600 mm²), d1 = 80.000 mm

- 2단 : H22 - 40EA (As=15484.000 mm²), d2 = 180.000 mm

ρmin (= 0.0100) ≤ ρuse (= 0.0236) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 708.44 mm, ab = k1 x cb = 602.18 mm

Cc = 0.85 x 27.0 x 602.176 x 1300.000 = 17965.924 kN

∑Csi = 6181.298 kN, ∑Tsi = 5554.357 kN

Pb = 17965.924 + 6181.298 - 5554.357 = 18592.865 kN

Mb = Cc x 348.912 + ∑(Csi*di) + ∑(Tsi*di) = 11763.146 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 632.670 mm, e = Mu/Pu = 218.125 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 1123.70 mm, a = k1 x c = 955.14 mm 를 사용.

Cc = 0.85 x 27.0 x 955.142 x 1300.000 = 28496.671 kN

∑Csi = 8114.703 kN, ∑Tsi = 339.422 kN

Pn = 28496.671 + 8114.703 - 339.422 = 36271.952 kN

Mn = Cc x 172.429 + ∑(Csi*di) + ∑(Tsi*di) = 7912.161 kN.m

- 편심오차 : |e - Mn/Pn(=218.134)| = 0.0096 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 1300.00 - 80.00 = 1220.000 mm

c = 1123.697 mm, a = k1 x c = 955.142 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1220.00-1123.70) / 1123.70 = 0.00026

εt ≤ εy 이므로 압축지배단면이며, Φ = 0.65 를 적용한다.

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 43035.361 kN ≥ Pn = 36271.952 kN

ΦPn = 0.65 x 36271.952 = 23576.769 kN ≥ Pu = 18214.779 kN ∴ O.K

ΦMn = ΦPn x 0.218 = 5142.679 kN.m ≥ Mu = 3973.096 kN.m ∴ O.K

2) 모멘트최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,300	1,300	80	1,181	16204.744	4406.446	271.9

* 철근비 검토

Ag = 1690000.00 mm² , Ast = 39805.60 mm² , Puse = 0.02355

- 1단 : H25 - 48EA (As=24321.600 mm²), d1 = 80.000 mm

- 2단 : H22 - 40EA (As=15484.000 mm²), d2 = 180.000 mm

ρmin (= 0.0100) ≤ ρuse (= 0.0236) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 708.44 mm, ab = k1 x cb = 602.18 mm

Cc = 0.85 x 27.0 x 602.176 x 1300.000 = 17965.924 kN

∑Csi = 6181.298 kN, ∑Tsi = 5554.357 kN

Pb = 17965.924 + 6181.298 - 5554.357 = 18592.865 kN

Mb = Cc x 348.912 + ∑(Csi*di) + ∑(Tsi*di) = 11763.146 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 632.670 mm, e = Mu/Pu = 271.923 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 1031.50 mm, a = k1 x c = 876.77 mm 를 사용.

Cc = 0.85 x 27.0 x 876.772 x 1300.000 = 26158.500 kN

∑Csi = 7679.292 kN, ∑Tsi = 996.591 kN

Pn = 26158.500 + 7679.292 - 996.591 = 32841.201 kN

Mn = Cc x 211.614 + ∑(Csi*di) + ∑(Tsi*di) = 8930.612 kN.m

- 편심오차 : |e - Mn/Pn(=271.933)| = 0.0100 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 1300.00 - 80.00 = 1220.000 mm

c = 1031.497 mm, a = k1 x c = 876.772 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1220.00-1031.50) / 1031.50 = 0.00055

εt ≤ εy 이므로 압축지배단면이며, Φ = 0.65 를 적용한다.

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 43035.361 kN ≥ Pn = 32841.201 kN

ΦPn = 0.65 x 32841.201 = 21346.781 kN ≥ Pu = 16204.744 kN ∴ O.K

ΦMn = ΦPn x 0.272 = 5804.685 kN.m ≥ Mu = 4406.446 kN.m ∴ O.K

3) 전단 검토

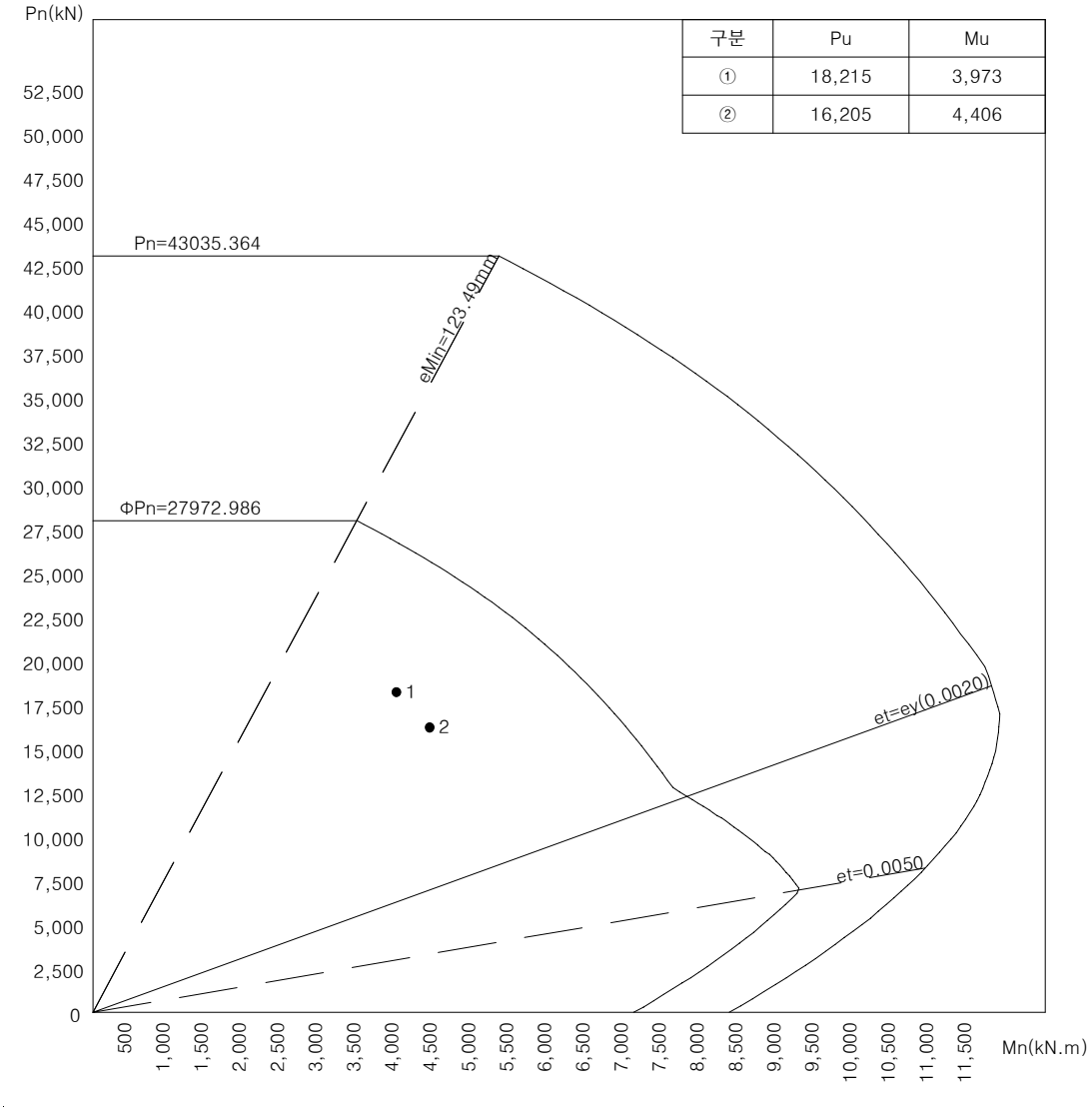
① 기둥에 발생하는 최대전단력
- V = 1714.257 kN

② 공칭전단력 Vn = Vc + Vs (Φ = 0.75)
- Vn = Vmax/Φ = 2285.676 kN

③ 압축부재에 의한 콘크리트 전단 Vc 및 필요철근 전단 Vs
- 인장철근들의 도심과 압축연단까지의 d
  h = 1300.000 mm, d' = 119.263 mm
  Zs = ∑(인장철근들의 면적 x 거리) / ∑(면적)
  = 381.206 mm
  d = h/2 + Zs
  = 1300.000/2 + 381.206
  = 1031.206 mm
- 압축부재의 콘크리트 전단력 Vc
  Vc = 1/6 x √(fck) x b x d
  = 1/6 x √(27) x 1300.000 x 1031.206
  = 1160.966 kN
- 필요철근 전단력 Vs
  Vc/2 = 580.483 ≤ Vn > Vc = 1160.966 ∴ 전단 철근 필요
  Vs = 1124.710 kN

④ 필요철근량 계산 Av
Av = Vs x s / (fy x d) = 409.003 mm² ∵ Vs = Av x fy x d / s ; 전단 철근 필요시
띠철근의 수직 간격 S = 150.00 mm d = 1031.206 mm fy = 400 MPa
사용철근량 : H16 x 4EA = 794.400 mm²
AvUse = 794.400 mm² ≥ 409.003 mm² ∴ O.K

4) PM 상관도


Pn(kN)
구분 Pu Mu
① 18,215 3,973
② 16,205 4,406
Pn=43035.364
eMin=123.49mm
ΦPn=27972.986
et=ey(0.0020)
et=0.0050
1
2
Mn(kN.m)

(3) 2층 벽체 1

1) 축력최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	3427.294	2247.664	655.8

* 철근비 검토

As = 4053.600 mm² (인장중심 = 80.00 mm), 1단 : H25- 8.0EA, d1 = 80.00 mm

Asf = 4053.600 mm² (압축중심 = 80.00 mm), 1단 : H25- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0048) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 1528.410 kN, ∑Tsi = 1621.440 kN

Pb = 18961.290 + 1528.410 - 1621.440 = 18868.260 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 10709.572 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 567.597 mm, e = Mu/Pu = 655.813 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 821.82 mm, a = k1 x c = 698.55 mm 를 사용.

Cc = 0.85 x 27.0 x 698548.679 = 16031.692 kN

∑Csi = 1528.410 kN, ∑Tsi = 1621.440 kN

Pn = 16031.692 + 1528.410 - 1621.440 = 15938.662 kN

Mn = Cc x 1270.726 + ∑(Csi*di) + ∑(Tsi*di) = 10452.864 kN.m

- 편심오차 : |e - Mn/Pn(=655.818)| = 0.0052 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 821.822 mm, a = k1 x c = 698.549 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-821.82) / 821.82 = 0.00291

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 33657.456 kN ≥ Pn = 15938.662 kN

ΦPn = 0.78 x 15938.662 = 12485.285 kN ≥ Pu = 3427.294 kN ∴ O.K

ΦMn = ΦPn x 0.656 = 8188.013 kN.m ≥ Mu = 2247.664 kN.m ∴ O.K

* 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1203.745 kN

< Vu (= 1310.661 kN) , 전단보강 필요.

Req Av = (1310.661 - 1203.745) x 300.00 / (400.0 x 1620.00 x Φ) = 65.998 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

Vs = 397.200 x 400.0 x 1620.00 / 300.00 = 857.952 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1620.00 = 5611.845 kN ≥ 857.952 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

ΦVn = 0.75 x (1604.993 + 857.952) = 1847.209 kN ≥ 1310.661 kN ∴ O.K

2) 모멘트최대

* 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	1,700	80	1,620	803.681	1384.586	1722.8

* 철근비 검토

As = 4053.600 mm² (인장중심 = 80.00 mm), 1단 : H25- 8.0EA, d1 = 80.00 mm

Asf = 4053.600 mm² (압축중심 = 80.00 mm), 1단 : H25- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0048) ≤ ρmax (= 0.0800) ∴ O.K

* 평형하중 산정

cb = 600 / (600 + fy) x d = 972.00 mm, ab = k1 x cb = 826.20 mm

Cc = 0.85 x 27.0 x 826200.000 = 18961.290 kN, ∑Csi = 1528.410 kN, ∑Tsi = 1621.440 kN

Pb = 18961.290 + 1528.410 - 1621.440 = 18868.260 kN

Mb = Cc x 1206.900 + ∑(Csi*di) + ∑(Tsi*di) = 10709.572 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 567.597 mm, e = Mu/Pu = 1722.806 mm)

* 공칭강도 산정

- 반복시산법을 이용하여 c = 161.32 mm, a = k1 x c = 137.12 mm 를 사용.

Cc = 0.85 x 27.0 x 137120.415 = 3146.914 kN

∑Csi = 1132.987 kN, ∑Tsi = 1621.440 kN

Pn = 3146.914 + 1132.987 - 1621.440 = 2658.460 kN

Mn = Cc x 1551.440 + ∑(Csi*di) + ∑(Tsi*di) = 4580.032 kN.m

- 편심오차 : |e - Mn/Pn(=1722.814)| = 0.0082 ≤ 0.010 ∴ 허용오차 만족

* 강도감소계수(Φ) 산정

dt = 1700.00 - 80.00 = 1620.000 mm

c = 161.318 mm, a = k1 x c = 137.120 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (1620.00-161.32) / 161.32 = 0.02713

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 33657.456 kN ≥ Pn = 2658.460 kN

ΦPn = 0.85 x 2658.460 = 2259.691 kN ≥ Pu = 803.681 kN ∴ O.K

ΦMn = ΦPn x 1.723 = 3893.009 kN.m ≥ Mu = 1384.586 kN.m ∴ O.K

* 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 1620.00 = 1087.752 kN

< Vu (= 1310.661 kN) , 전단보강 필요.

Req Av = (1310.661 - 1087.752) x 300.00 / (400.0 x 1620.00 x Φ) = 137.598 mm²

Use Av = 397.200 mm² (H16-2.0 EA, C.T.C 300 mm)

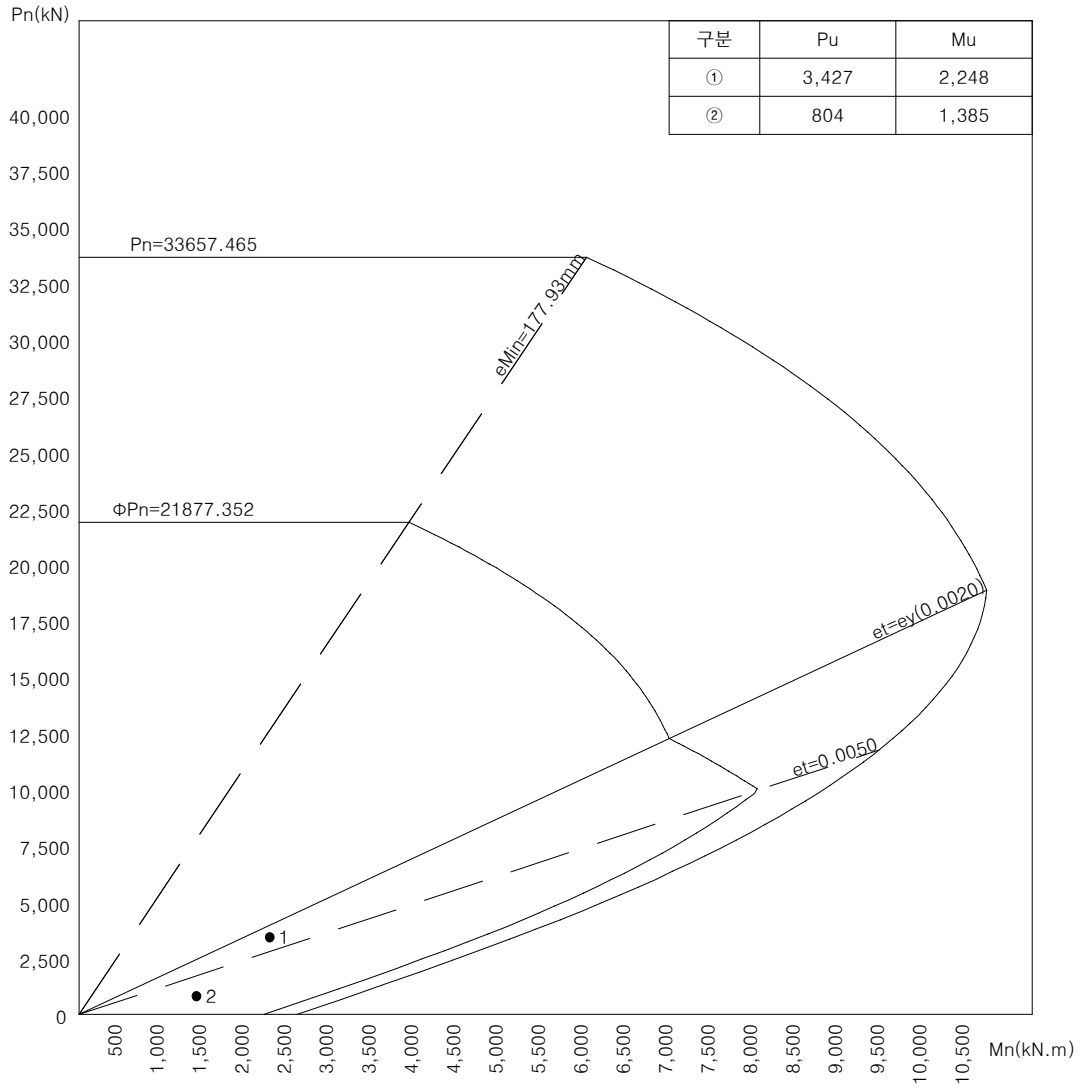
Vs = 397.200 x 400.0 x 1620.00 / 300.00 = 857.952 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 1620.00 = 5611.845 kN ≥ 857.952 kN ∴ O.K

s = 300.000 ≤ 600.000 (d/2, 600 mm 콘.설 7.4.2) ∴ O.K

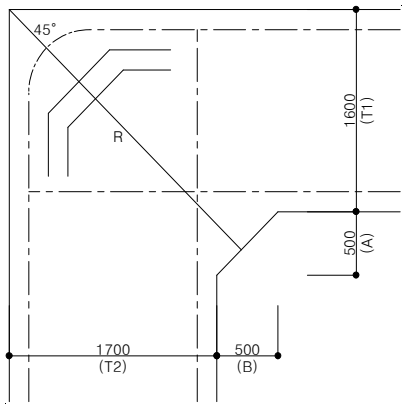
ΦVn = 0.75 x (1450.336 + 857.952) = 1731.216 kN ≥ 1310.661 kN ∴ O.K

4) PM 상관도



19. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 3711.930 kN.m
- 절점부 휨모멘트 : Mo = 3711.930 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 2687.006 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 5746.400 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 3711.93 \times 10^6}{2687.006^2 \times 1000} = 2.571 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 3711.93 \times 10^6}{2687.006 \times 180} = 15349.304 \text{ mm}$$

Asb = 5746.400 mm²

Req'd As = As - Asb

= 15349.304 mm² - 5746.400 mm²

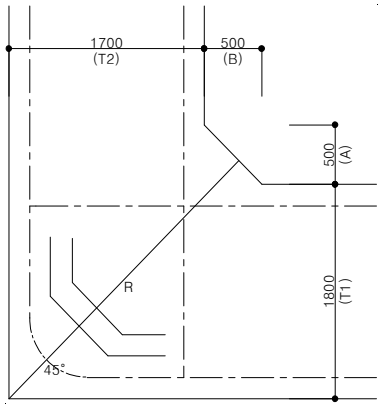
= 9602.904 mm²

- 사용보강철근

Use'd As = H29 - 8EA , H29 - 8EA

∴ Total As = 10278.400 mm² > Req'd As (= 9602.904 mm²) ----------> O.K !!!

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 4730.051 kN.m
- 절점부 휨모멘트 : Mo = 4730.051 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

= 2828.427 mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 5746.400 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 4730.05 \times 10^6}{2828.427^2 \times 1000} = 2.956 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 4730.05 \times 10^6}{2828.427 \times 180} = 18581.396 \text{ mm}$$

Asb = 5746.400 mm²

Req'd As = As - Asb

= 18581.396 mm² - 5746.400 mm²

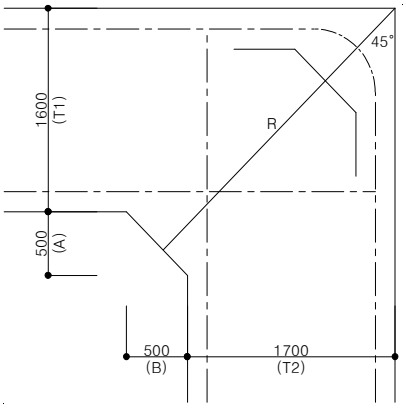
= 12834.996 mm²

- 사용보강철근

Use'd As = H29 - 8EA , H29 - 8EA , H29 - 8EA

∴ Total As = 15417.600 mm² > Req'd As (= 12834.996 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 1852.132 kN.m
- 절점부 휨모멘트 : Mo = 1852.132 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$= 2687.006$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H32 @250 - 4EA = 3176.800 mm²

∴ Total Asb = 3176.800 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 1852.13 \times 10^6}{2687.006^2 \times 1000} = 1.283 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 1852.13 \times 10^6}{2687.006 \times 180} = 7658.802 \text{ mm}^2$$

Asb = 3176.800 mm²

Req'd As = As - Asb

= 7658.802 mm² - 3176.800 mm²

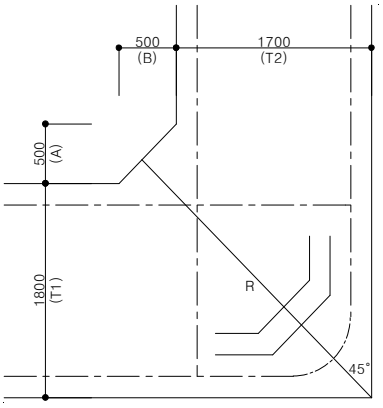
= 4482.002 mm²

- 사용보강철근

Use'd As = H29 - 8EA

∴ Total As = 5139.200 mm² > Req'd As (= 4482.002 mm²) ----------> O.K !!!

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 3675.157 kN.m
- 절점부 휨모멘트 : Mo = 3675.157 kN.m

$$R = \frac{(T1\times B + T2\times A + A\times B)}{(A + B)}\sqrt{2}$$

$= 2828.427$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H29 @250 - 4EA = 2569.600 mm²

H29 @250 - 4EA = 2569.600 mm²

∴ Total Asb = 5139.200 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 3675.16 \times 10^6}{2828.427^2 \times 1000} = 2.297 \text{ MPa} > 0.13\sqrt{fck}\ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 3675.16 \times 10^6}{2828.427 \times 180} = 14437.380 \text{ mm}$$

Asb = 5139.200 mm²

Req'd As = As - Asb

= 14437.380 mm² - 5139.200 mm²

= 9298.180 mm²

- 사용보강철근

Use'd As = H29 - 8EA , H29 - 8EA

∴ Total As = 10278.400 mm² > Req'd As (= 9298.180 mm²) ----------> O.K !!!

20. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	1622	H32 - 8.0EA + H29 - 8.0EA	125	236.294	O.K	1.890
		중앙부	2	1520	H32 - 8.0EA	125	218.307	O.K	1.746
		우측	3	1667	H32 - 8.0EA	125	240.157	O.K	1.921
	2경간	좌측	4	1667	H32 - 8.0EA	125	831.857	O.K	6.655
		중앙부	5	1520	H25 - 8.0EA	-	-	-	-
		우측	6	1667	H32 - 8.0EA	125	293.596	O.K	2.349
하부슬래브	1경간	좌측	7	1822	H32 - 8.0EA + H29 - 8.0EA	125	186.651	O.K	1.493
		중앙부	8	1670	H29 - 8.0EA + H29 - 8.0EA	125	309.784	O.K	2.478
		우측	9	1700	H29 - 8.0EA	125	214.694	O.K	1.718
	2경간	좌측	10	1700	H29 - 8.0EA	125	224.589	O.K	1.797
		중앙부	11	1720	H29 - 8.0EA	-	-	-	-
		우측	12	1817	H29 - 8.0EA + H29 - 8.0EA	125	218.804	O.K	1.750
중간슬래브	1경간	좌측	13	1687	H29 - 8.0EA	125	456.643	O.K	3.653
		중앙부	14	1520	H29 - 8.0EA	125	685.031	O.K	5.480
		우측	15	1520	H29 - 8.0EA	125	1067.694	O.K	8.542
	2경간	좌측	16	1520	H29 - 8.0EA	125	2374.410	O.K	18.995
		중앙부	17	1520	H29 - 8.0EA	125	789.914	O.K	6.319
		우측	18	1687	H29 - 8.0EA	125	2260.708	O.K	18.086

좌측벽체	1층	1층(상부)	19	1767	H25 - 8.0EA	125	783.900	O.K	6.271
		1층(상부)	19	1620	H32 - 8.0EA	125	342.095	O.K	2.737
		1층(중앙부)	20	1620	H32 - 8.0EA	125	815.023	O.K	6.520
		1층(하부)	21	1722	H32 - 8.0EA + H29 - 8.0EA	125	149.582	O.K	1.197
	2층	2층(상부)	22	1717	H32 - 4.0EA + H25 - 4.0EA + H29 - 8.0EA	125	195.183	O.K	1.561
		2층(중앙부)	23	1620	H32 - 8.0EA	125	272.648	O.K	2.181
		2층(하부)	24	1767	H25 - 8.0EA	-	-	-	-
		2층(하부)	24	1620	H32 - 8.0EA	125	165.569	O.K	1.325
우측벽체	1층	1층(상부)	25	1728	H25 - 8.0EA + H29 - 4.0EA	125	2673.717	O.K	21.390
		1층(상부)	25	1620	H29 - 8.0EA	125	203.147	O.K	1.625
		1층(중앙부)	26	1620	H29 - 8.0EA	125	401.620	O.K	3.213
		1층(하부)	27	1717	H29 - 8.0EA + H29 - 8.0EA	125	259.717	O.K	2.078
	2층	2층(상부)	28	1767	H25 - 4.0EA + H32 - 4.0EA	125	254.705	O.K	2.038
		2층(중앙부)	29	1620	H29 - 8.0EA	125	297.701	O.K	2.382
		2층(하부)	30	1767	H25 - 8.0EA	-	-	-	-
		2층(하부)	30	1620	H29 - 8.0EA	125	215.143	O.K	1.721

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 2994.021 x 1000000 / [11492.800 x (1621.950 - 436.699/3)]
= 176.453 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1621.9/(7x11492.800)]
= 436.699 mm

사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 176.45) - 2.5 x 84.00 = 236.29 mm
300 x (Kcr / fs) = 300 x (210 / 176.45) = 357.03 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 236.29 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 236.29 mm) ∴ O.K

2) 상부슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1866.662 x 1000000 / [6353.600 x (1520.000 - 325.907/3)]
= 208.164 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6353.600/1000.0 + 7x6353.600/1000.0 x √[(1 + 2x1000.0x1520.0/(7x6353.600)]
= 325.907 mm

사용철근량 = 6353.6 mm² (철근도심 : 80.0 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 208.16) - 2.5 x 64.00 = 218.31 mm
300 x (Kcr / fs) = 300 x (210 / 208.16) = 302.65 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 218.31 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 218.31 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1725.361 x 1000000 / [6353.600 x (1666.667 - 343.118/3)]
= 174.939 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6353.600/1000.0 + 7x6353.600/1000.0 x √[(1 + 2x1000.0x1666.7/(7x6353.600)]
= 343.118 mm

사용철근량 = 6353.6 mm² (철근도심 : 100.0 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 174.94) - 2.5 x 84.00 = 240.16 mm
300 x (Kcr / fs) = 300 x (210 / 174.94) = 360.13 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 240.16 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 240.16 mm) ∴ O.K

4) 상부슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 745.481 x 1000000 / [6353.600 x (1666.667 - 343.118/3)]
= 75.586 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6353.600/1000.0 + 7x6353.600/1000.0 x √[(1 + 2x1000.0x1666.7/(7x6353.600)]
= 343.118 mm

사용철근량 = 6353.6 mm² (철근도심 : 100.0 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 75.59) - 2.5 x 84.00 = 831.86 mm
300 x (Kcr / fs) = 300 x (210 / 75.59) = 833.49 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 831.86 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 831.86 mm) ∴ O.K

5) 상부슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1542.276 x 1000000 / [6353.600 x (1666.667 - 343.118/3)]
= 156.375 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6353.600/1000.0 + 7x6353.600/1000.0 x √[(1 + 2x1000.0x1666.7/(7x6353.600)]
= 343.118 mm

사용철근량 = 6353.6 mm² (철근도심 : 100.0 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 156.38) - 2.5 x 84.00 = 293.60 mm
300 x (Kcr / fs) = 300 x (210 / 156.38) = 402.88 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 293.60 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 293.60 mm) ∴ O.K

6) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 3802.092 x 1000000 / [11492.800 x (1821.950 - 466.928/3)]
= 198.537 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1821.9/(7x11492.800)]
= 466.928 mm

사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 198.54) - 2.5 x 84.00 = 186.65 mm
300 x (Kcr / fs) = 300 x (210 / 198.54) = 317.32 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 186.65 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 186.65 mm) ∴ O.K

7) 하부슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 2613.268 x 1000000 / [10278.400 x (1670.000 - 423.516/3)]
= 166.303 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10278.400/1000.0 + 7x10278.400/1000.0 x √[(1 + 2x1000.0x1670.0/(7x10278.400)]
= 423.516 mm

사용철근량 = 10278.4 mm² (철근도심 : 130.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 166.30) - 2.5 x 65.50 = 309.78 mm
300 x (Kcr / fs) = 300 x (210 / 166.30) = 378.83 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 309.78 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 309.78 mm) ∴ O.K

8) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1506.460 x 1000000 / [5139.200 x (1700.000 - 315.604/3)]
= 183.805 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1700.0/(7x5139.200)]
= 315.604 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 183.80) - 2.5 x 85.50 = 214.69 mm
300 x (Kcr / fs) = 300 x (210 / 183.80) = 342.76 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 214.69 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 214.69 mm) ∴ O.K

9) 하부슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1472.453 x 1000000 / [5139.200 x (1700.000 - 315.604/3)]
= 179.655 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1700.0/(7x5139.200)]
= 315.604 mm

사용철근량 = 5139.2 mm² (철근도심 : 100.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 179.66) - 2.5 x 85.50 = 224.59 mm
300 x (Kcr / fs) = 300 x (210 / 179.66) = 350.67 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 224.59 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 224.59 mm) ∴ O.K

10) 하부슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 3122.289 x 1000000 / [10278.400 x (1816.667 - 444.375/3)]
= 182.058 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10278.400/1000.0 + 7x10278.400/1000.0 x √[(1 + 2x1000.0x1816.7/(7x10278.400)]
= 444.375 mm

사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 182.06) - 2.5 x 85.50 = 218.80 mm
300 x (Kcr / fs) = 300 x (210 / 182.06) = 346.04 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 218.80 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 218.80 mm) ∴ O.K

11) 중간슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1031.962 x 1000000 / [5139.200 x (1686.667 - 314.237/3)]
= 126.936 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1686.7/(7x5139.200)]
= 314.237 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 126.94) - 2.5 x 65.50 = 456.64 mm
300 x (Kcr / fs) = 300 x (210 / 126.94) = 496.31 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 456.64 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 456.64 mm) ∴ O.K

12) 중간슬래브 1경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 671.665 x 1000000 / [5139.200 x (1520.000 - 296.676/3)]
= 91.967 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1520.0/(7x5139.200)]
= 296.676 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 91.97) - 2.5 x 65.50 = 692.54 mm
300 x (Kcr / fs) = 300 x (210 / 91.97) = 685.03 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 685.03 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 685.03 mm) ∴ O.K

13) 중간슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 430.939 x 1000000 / [5139.200 x (1520.000 - 296.676/3)]
= 59.006 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1520.0/(7x5139.200)]
= 296.676 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 59.01) - 2.5 x 65.50 = 1170.87 mm
300 x (Kcr / fs) = 300 x (210 / 59.01) = 1067.69 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1067.69 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1067.69 mm) ∴ O.K

14) 중간슬래브 2경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 193.779 x 1000000 / [5139.200 x (1520.000 - 296.676/3)]
= 26.533 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1520.0/(7x5139.200)]
= 296.676 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 26.53) - 2.5 x 65.50 = 2804.26 mm
300 x (Kcr / fs) = 300 x (210 / 26.53) = 2374.41 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 2374.41 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 2374.41 mm) ∴ O.K

15) 중간슬래브 2경간(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 582.483 x 1000000 / [5139.200 x (1520.000 - 296.676/3)]
= 79.756 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1520.0/(7x5139.200)]
= 296.676 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 79.76) - 2.5 x 65.50 = 823.64 mm
300 x (Kcr / fs) = 300 x (210 / 79.76) = 789.91 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 789.91 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 789.91 mm) ∴ O.K

16) 중간슬래브 2경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 226.556 x 1000000 / [5139.200 x (1686.667 - 314.237/3)]
= 27.867 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1686.7/(7x5139.200)]
= 314.237 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 27.87) - 2.5 x 65.50 = 2662.14 mm
300 x (Kcr / fs) = 300 x (210 / 27.87) = 2260.71 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 2260.71 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 2260.71 mm) ∴ O.K

17) 좌측벽체 1층(상부)_외측

① 응력 산정

fs = M / [As x (d - χ/3)] = 531.740 x 1000000 / [4053.600 x (1766.667 - 289.531/3)]
= 78.542 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x4053.600/1000.0 + 7x4053.600/1000.0 x √[(1 + 2x1000.0x1766.7/(7x4053.600)]
= 289.531 mm

사용철근량 = 4053.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 78.54) - 2.5 x 87.50 = 783.90 mm
300 x (Kcr / fs) = 300 x (210 / 78.54) = 802.12 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 783.90 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 783.90 mm) ∴ O.K

18) 좌측벽체 1층(상부)_내측

① 응력 산정

fs = M / [As x (d - χ/3)] = 1502.173 x 1000000 / [6353.600 x (1620.000 - 337.726/3)]
= 156.843 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6353.600/1000.0 + 7x6353.600/1000.0 x √[(1 + 2x1000.0x1620.0/(7x6353.600)]
= 337.726 mm

사용철근량 = 6353.6 mm² (철근도심 : 80.0 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 156.84) - 2.5 x 64.00 = 342.10 mm
300 x (Kcr / fs) = 300 x (210 / 156.84) = 401.68 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 342.10 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 342.10 mm) ∴ O.K

19) 좌측벽체 1층(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 740.331 x 1000000 / [6353.600 x (1620.000 - 337.726/3)]
= 77.298 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6353.600/1000.0 + 7x6353.600/1000.0 x √[(1 + 2x1000.0x1620.0/(7x6353.600)]
= 337.726 mm

사용철근량 = 6353.6 mm² (철근도심 : 80.0 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 77.30) - 2.5 x 64.00 = 858.78 mm
300 x (Kcr / fs) = 300 x (210 / 77.30) = 815.02 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 815.02 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 815.02 mm) ∴ O.K

20) 좌측벽체 1층(하부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 3954.854 x 1000000 / [11492.800 x (1721.950 - 452.028/3)]
= 219.004 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x11492.800/1000.0 + 7x11492.800/1000.0 x √[(1 + 2x1000.0x1721.9/(7x11492.800)]
= 452.028 mm

사용철근량 = 11492.8 mm² (철근도심 : 144.7 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 219.00) - 2.5 x 84.00 = 149.58 mm
300 x (Kcr / fs) = 300 x (210 / 219.00) = 287.67 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 149.58 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 149.58 mm) ∴ O.K

21) 좌측벽체 2층(상부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 3162.359 x 1000000 / [10342.800 x (1716.978 - 431.444/3)]
= 194.357 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10342.800/1000.0 + 7x10342.800/1000.0 x √[(1 + 2x1000.0x1717.0/(7x10342.800)]
= 431.444 mm

사용철근량 = 10342.8 mm² (철근도심 : 149.7 mm)
1단 : H32 - 4.0 EA, H25 - 4.0 EA (= 5203.6 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 194.36) - 2.5 x 84.00 = 195.18 mm
300 x (Kcr / fs) = 300 x (210 / 194.36) = 324.15 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 195.18 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 195.18 mm) ∴ O.K

22) 좌측벽체 2층(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1743.297 x 1000000 / [6353.600 x (1620.000 - 337.726/3)]
= 182.019 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6353.600/1000.0 + 7x6353.600/1000.0 x √[(1 + 2x1000.0x1620.0/(7x6353.600)]
= 337.726 mm

사용철근량 = 6353.6 mm² (철근도심 : 80.0 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 182.02) - 2.5 x 64.00 = 272.65 mm
300 x (Kcr / fs) = 300 x (210 / 182.02) = 346.12 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 272.65 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 272.65 mm) ∴ O.K

23) 좌측벽체 2층(하부)_내측

① 응력 산정

fs = M / [As x (d - χ/3)] = 2316.661 x 1000000 / [6353.600 x (1620.000 - 337.726/3)]
= 241.884 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6353.600/1000.0 + 7x6353.600/1000.0 x √[(1 + 2x1000.0x1620.0/(7x6353.600)]
= 337.726 mm

사용철근량 = 6353.6 mm² (철근도심 : 80.0 mm)
1단 : H32 - 8.0 EA (= 6353.6 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 32/2 = 64.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 241.88) - 2.5 x 64.00 = 165.57 mm
300 x (Kcr / fs) = 300 x (210 / 241.88) = 260.46 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 165.57 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 165.57 mm) ∴ O.K

24) 우측벽체 1층(상부)_외측

① 응력 산정

fs = M / [As x (d - χ/3)] = 251.103 x 1000000 / [6623.200 x (1727.870 - 356.584/3)]
= 23.563 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x6623.200/1000.0 + 7x6623.200/1000.0 x √[(1 + 2x1000.0x1727.9/(7x6623.200)]
= 356.584 mm

사용철근량 = 6623.2 mm² (철근도심 : 138.8 mm)
1단 : H25 - 8.0 EA (= 4053.6 mm²)
2단 : H29 - 4.0 EA (= 2569.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 25/2 = 87.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 23.56) - 2.5 x 87.50 = 3123.40 mm
300 x (Kcr / fs) = 300 x (210 / 23.56) = 2673.72 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 2673.72 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 2673.72 mm) ∴ O.K

25) 우측벽체 1층(상부)_내측

① 응력 산정

fs = M / [As x (d - χ/3)] = 1673.971 x 1000000 / [5139.200 x (1620.000 - 307.320/3)]
= 214.638 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1620.0/(7x5139.200)]
= 307.320 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 214.64) - 2.5 x 65.50 = 203.15 mm
300 x (Kcr / fs) = 300 x (210 / 214.64) = 293.52 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 203.15 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 203.15 mm) ∴ O.K

26) 우측벽체 1층(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1086.323 x 1000000 / [5139.200 x (1620.000 - 307.320/3)]
= 139.289 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1620.0/(7x5139.200)]
= 307.320 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 139.29) - 2.5 x 65.50 = 401.62 mm
300 x (Kcr / fs) = 300 x (210 / 139.29) = 452.30 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 401.62 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 401.62 mm) ∴ O.K

27) 우측벽체 1층(하부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 2689.578 x 1000000 / [10278.400 x (1716.667 - 430.247/3)]
= 166.326 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x10278.400/1000.0 + 7x10278.400/1000.0 x √[(1 + 2x1000.0x1716.7/(7x10278.400)]
= 430.247 mm

사용철근량 = 10278.4 mm² (철근도심 : 150.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)
2단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 29/2 = 85.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 166.33) - 2.5 x 85.50 = 259.72 mm
300 x (Kcr / fs) = 300 x (210 / 166.33) = 378.77 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 259.72 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 259.72 mm) ∴ O.K

28) 우측벽체 2층(상부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1462.586 x 1000000 / [5203.600 x (1766.667 - 324.170/3)]
= 169.462 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5203.600/1000.0 + 7x5203.600/1000.0 x √[(1 + 2x1000.0x1766.7/(7x5203.600)]
= 324.170 mm

사용철근량 = 5203.6 mm² (철근도심 : 100.0 mm)
1단 : H25 - 4.0 EA, H32 - 4.0 EA (= 5203.6 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 32/2 = 84.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 169.46) - 2.5 x 84.00 = 254.70 mm
300 x (Kcr / fs) = 300 x (210 / 169.46) = 371.76 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 254.70 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 254.70 mm) ∴ O.K

29) 우측벽체 2층(중앙부)

① 응력 산정

fs = M / [As x (d - χ/3)] = 1330.964 x 1000000 / [5139.200 x (1620.000 - 307.320/3)]
= 170.657 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1620.0/(7x5139.200)]
= 307.320 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 170.66) - 2.5 x 65.50 = 297.70 mm
300 x (Kcr / fs) = 300 x (210 / 170.66) = 369.16 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 297.70 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 297.70 mm) ∴ O.K

30) 우측벽체 2층(하부)_내측

① 응력 산정

fs = M / [As x (d - χ/3)] = 1620.972 x 1000000 / [5139.200 x (1620.000 - 307.320/3)]
= 207.842 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x5139.200/1000.0 + 7x5139.200/1000.0 x √[(1 + 2x1000.0x1620.0/(7x5139.200)]
= 307.320 mm

사용철근량 = 5139.2 mm² (철근도심 : 80.0 mm)
1단 : H29 - 8.0 EA (= 5139.2 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 29/2 = 65.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 207.84) - 2.5 x 65.50 = 215.14 mm
300 x (Kcr / fs) = 300 x (210 / 207.84) = 303.11 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 215.14 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 215.14 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 12.350 m
- fy = 400 MPa
- 부재두께(T) = 1.60 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28

T = 12.350 / 28

T = 0.441 m < 1.600 m ----------> O.K

21. 기초 지지력 검토

(1) 하중산정

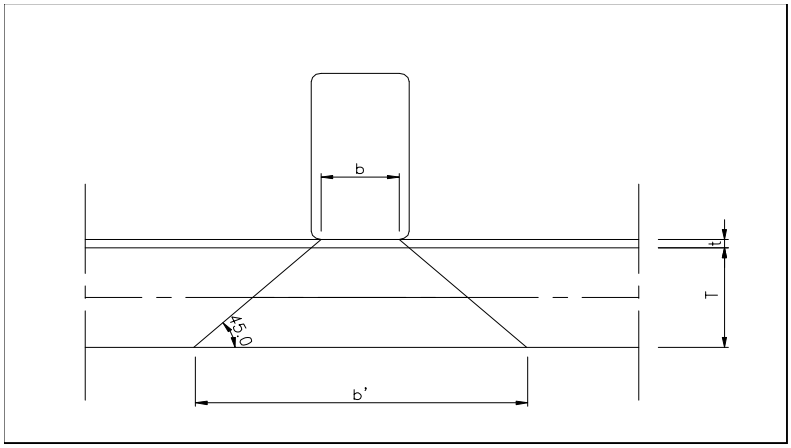
1) 고정하중

- 구체자중 = 3267.270 / 19.250 = 169.728 kN/m²
- 상부연직하중 = 203.400 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.04 × 23.00 = 0.920 kN/m²

2) 활하중

- 도로 노면 활하중 = 10.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중

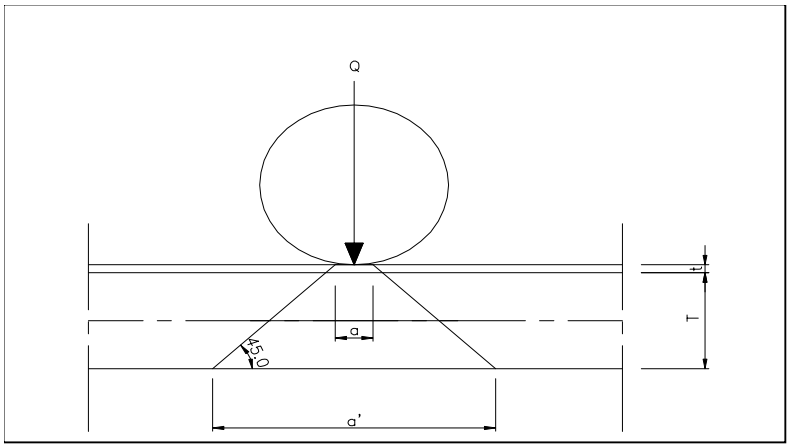


t = 40 mm (암거내부 포장두께)

T = 1800 mm (하부 슬래브 두께)

b' = 0.500 + 2 × (1.800 + 0.040) × cot 45°

= 4.180 m



a' = 0.200 + 2 × (1.800 + 0.040) × cot 45°

= 3.880 m

Qz = 96.0 / (4.180 × 3.880)= 5.919 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 169.73 + 203.40 + 10.00 + 0.92 + 5.92

= 389.968 kN/m²

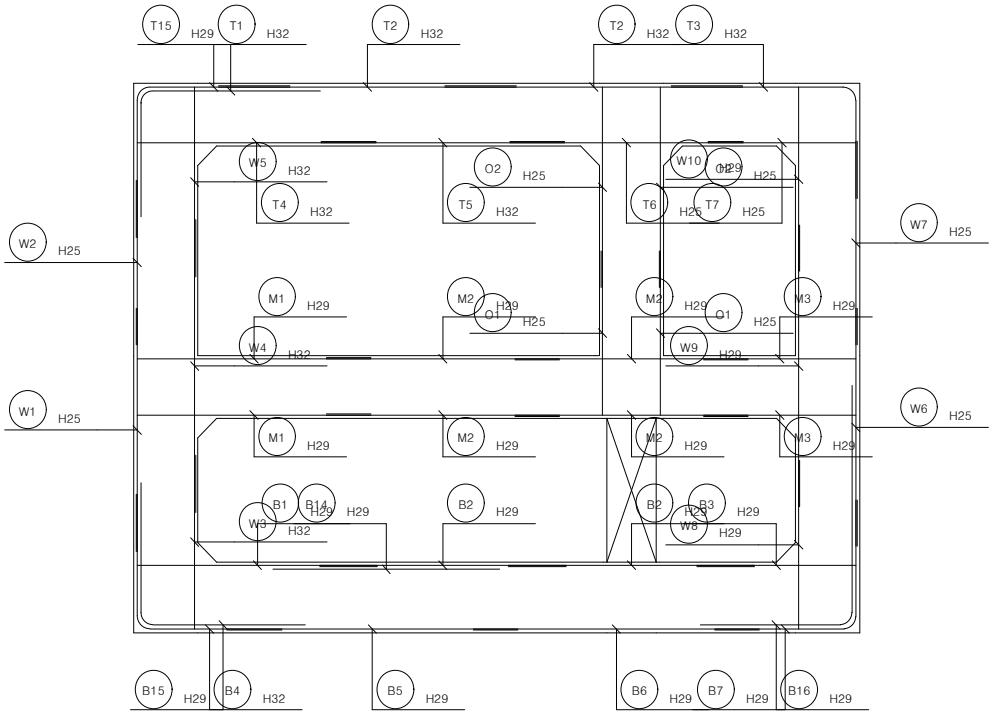
2) 지반의 허용연직지지력

Qa = 700.000 kN/m² ≥ Qmax = 389.968 kN/m² ..... O.K

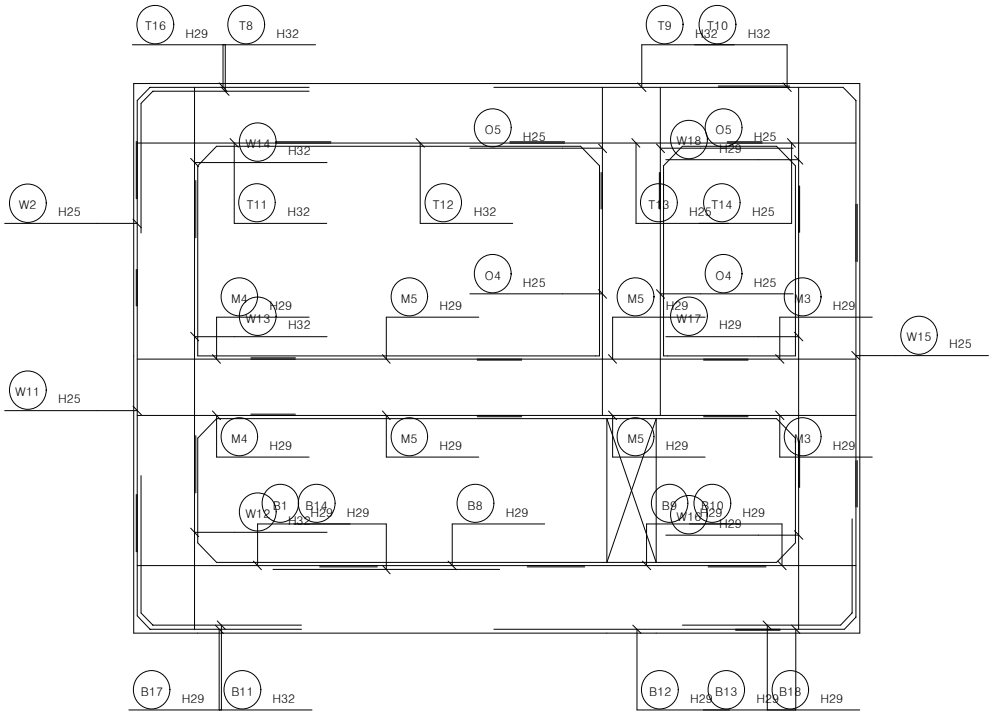
(지반조사 보고서 참조)

22. 주철근 조립도

CYCLE-1(@250)



CYCLE-2(@250)



2.2 점검통로 단면 A-A

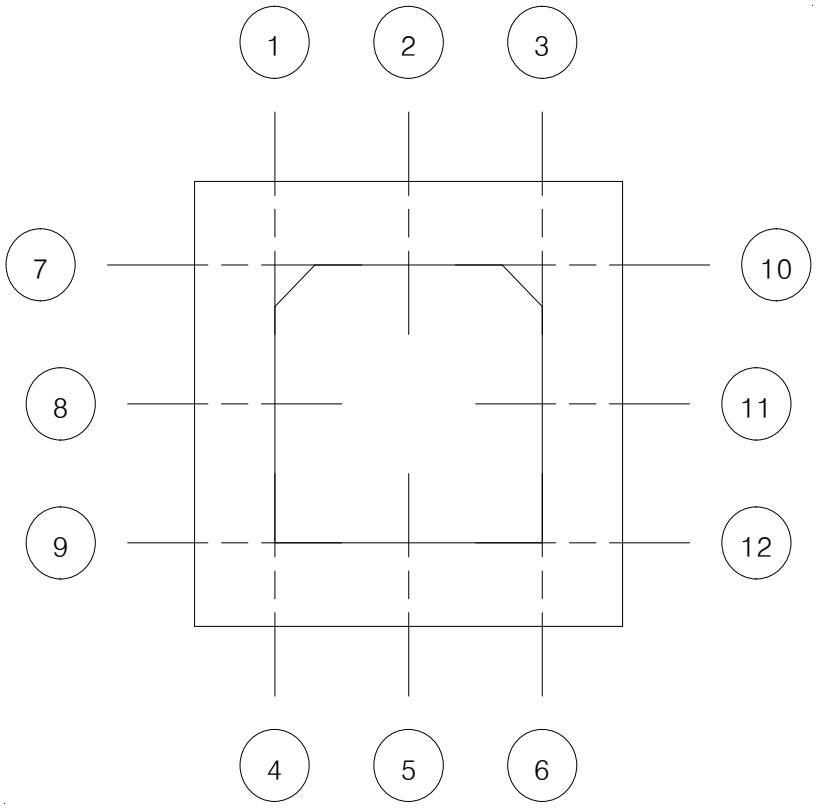
피난연결통로 구조계산서

▣ STA. 1K+230.300 (BLOCK1 : 단면 A-A)
▣ 토 피(FH) = 19.80 m ▣ 선 형 = ∞
▣ 지반 조건 : 토사
▣ 구조형식 : 지중 1 련
(내공 : 2M × 2M, 사각 : 90°)

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. 단면력정리
16. 단면검토 및 철근량 산정
17. 수평철근 검토
18. 절점부 검토
19. 사용성 검토
20. 기초 지지력 검토
21. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qu(kN)	Qa(kN)	비 고
직접기초	472.58	1828.825	700.0	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	704	2208.126	3.137	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	600	206.20	316.64	1026.10	H16 - 8.0EA	1588.80	1.54
		중앙부	2	1000	520	252.26	389.66	1462.65	H19 - 8.0EA	2292.00	1.54
		우측	3	1000	600	206.20	316.64	1026.10	H16 - 8.0EA	1588.80	1.54
하부슬래브	1경간	좌측	4	1000	500	197.73	374.07	1187.71	H19 - 8.0EA	2292.00	1.89
		중앙부	5	1000	520	246.97	389.66	1431.21	H19 - 8.0EA	2292.00	1.58
		우측	6	1000	500	197.73	374.07	1187.71	H19 - 8.0EA	2292.00	1.89
좌측벽체	1층	상부	7	1000	600	263.13	1190.86	-	H16 - 8.0EA	3880.80	4.53
		중앙부 (외측)	8	1000	500	71.07	740.66	-	H16 - 4.0EA	3086.40	10.42
		중앙부 (내측)	8	1000	520	140.36	990.89	-	H19 - 8.0EA	3086.40	7.06
		하부	9	1000	500	176.86	1067.32	-	H19 - 8.0EA	4584.00	6.04
우측벽체	1층	상부	10	1000	600	263.13	1190.86	-	H16 - 8.0EA	3880.80	4.53
		중앙부 (외측)	11	1000	500	71.07	740.66	-	H16 - 4.0EA	3086.40	10.42
		중앙부 (내측)	11	1000	520	140.36	990.89	-	H19 - 8.0EA	3086.40	7.06
		하부	12	1000	500	176.86	1067.32	-	H19 - 8.0EA	4584.00	6.04

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부 슬래브	1 경간	좌측	1	1200.0	1688.9	O.K	205.2	845.1	O.K
		중앙부	2	1200.0	1267.0	O.K	292.5	845.1	O.K
		우측	3	1200.0	1688.9	O.K	205.2	845.1	O.K
하부 슬래브	1 경간	좌측	4	1200.0	1688.9	O.K	237.5	845.1	O.K
		중앙부	5	1200.0	1267.0	O.K	286.2	845.1	O.K
		우측	6	1200.0	1688.9	O.K	237.5	845.1	O.K
좌측 벽체	1 층	상부	7	1200.0	1688.9	O.K	0.0	845.1	O.K
		중앙부	8	1200.0	1267.0	O.K	0.0	421.9	O.K
		중앙부	8	1200.0	1267.0	O.K	0.0	845.1	O.K
		하부	9	1200.0	1688.9	O.K	0.0	845.1	O.K
우측 벽체	1 층	상부	10	1200.0	1688.9	O.K	0.0	845.1	O.K
		중앙부	11	1200.0	1267.0	O.K	0.0	421.9	O.K
		중앙부	11	1200.0	1267.0	O.K	0.0	845.1	O.K
		하부	12	1200.0	1688.9	O.K	0.0	845.1	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	324.8	376.9	578.16	2.00	52.13	H13	150	253.40	O.K
		우측	3	324.8	376.9	578.16	2.00	52.13	H13	150	253.40	O.K
하부슬래브	1경간	좌측	4	324.8	357.4	578.16	2.00	32.61	H13	150	253.40	O.K
		중앙부	5	337.8	325.4	601.29	2.00	-	H13	150	253.40	O.K
		우측	6	324.8	357.4	578.16	2.00	32.61	H13	150	253.40	O.K
좌측벽체	1층	상부	7	354.9	517.5	608.27	2.00	162.60	H13	150	253.40	O.K
		하부	9	356.3	300.6	609.72	2.00	131.25	H13	150	253.40	O.K
우측벽체	1층	상부	10	354.9	517.5	608.27	2.00	162.60	H13	150	253.40	O.K
		하부	12	356.3	300.6	609.72	2.00	131.25	H13	150	253.40	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	600	H16 - 8.0EA	125	297.406	O.K	2.379
		중앙부	2	520	H19 - 8.0EA	125	271.784	O.K	2.174
		우측	3	600	H16 - 8.0EA	125	297.406	O.K	2.379
하부슬래브	1경간	좌측	4	500	H19 - 8.0EA	125	399.152	O.K	3.193
		중앙부	5	520	H19 - 8.0EA	125	293.373	O.K	2.347
		우측	6	500	H19 - 8.0EA	125	399.152	O.K	3.193
좌측벽체	1층	상부	7	600	H16 - 8.0EA	125	212.414	O.K	1.699
		중앙부	8	500	H16 - 4.0EA	250	278.623	O.K	1.114
		중앙부	8	520	H19 - 8.0EA	125	1777.095	O.K	14.217
		하부	9	500	H19 - 8.0EA	125	404.415	O.K	3.235
우측벽체	1층	상부	10	600	H16 - 8.0EA	125	212.414	O.K	1.699
		중앙부	11	500	H16 - 4.0EA	250	278.623	O.K	1.114
		중앙부	11	520	H19 - 8.0EA	125	1777.095	O.K	14.217
		하부	12	500	H19 - 8.0EA	125	404.415	O.K	3.235

2. 설 계 조 건

1) 구조형식

- 지중 1 련 피난연결통로 (내공 : 2M × 2M, 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (ω_c) = 25.00 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sc
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 10.000 kN/m² (∵ 토피 : 19.800 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

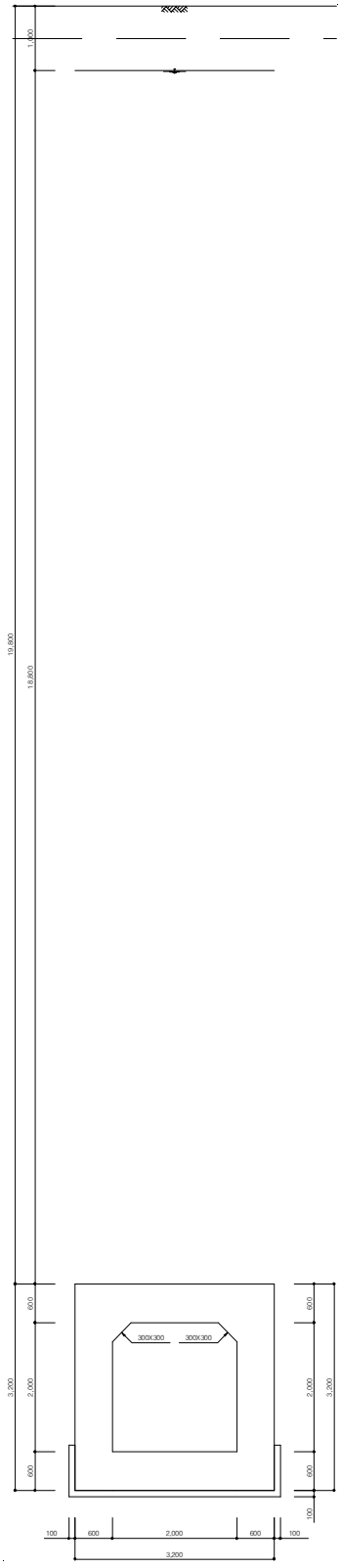
10) 사용프로그램 : SAP2000

11) 참고문헌

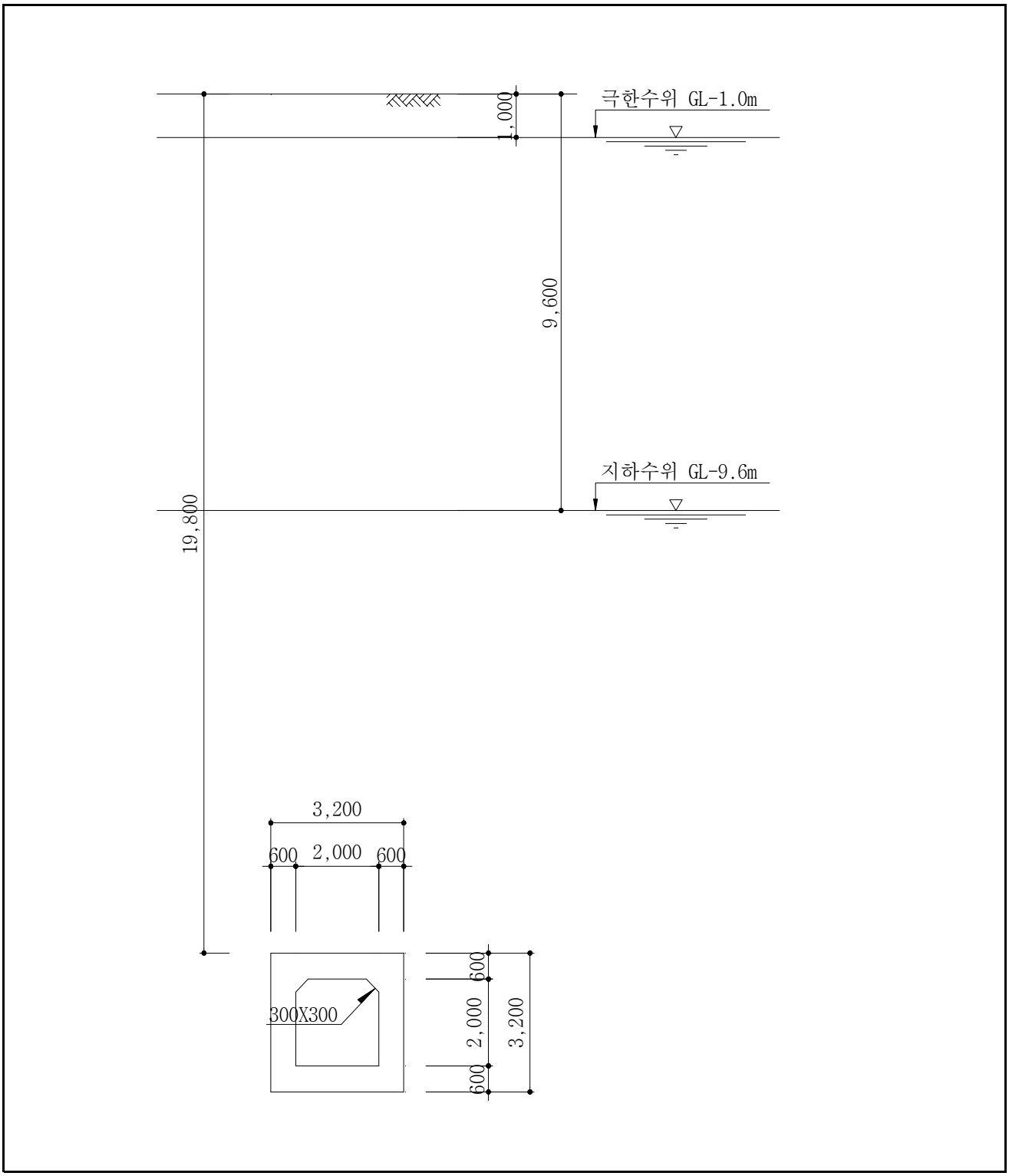
- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정

1) 단 면 가 정


1,000
19,800
18,800
600
2,000
600
3,200
300X300
300X300
600
2,000
600
3,200
100
100
600
2,000
600
100
3,200

4. 부력 검토



4.1 부력 검토 결과

구 분	작용력(kN/m)	저항력(kN/m)	비 고
시 공 중	32.000	108.000	지하수위를 3.068m 이하로 유지
완공후 (지하수위 G.L -9.6m)	428.800	2,589.090	F.S = 6.038 > 1.200 ------ O.K
완공후 (극한수위 G.L-1.0m)	704.000	2,208.126	F.S = 3.137 > 1.050 ------ O.K

4.2 시공중 부력 검토(상부슬래브 폐합전 단면 검토)

4.2.1 굴착고 : 23.000 m

4.2.2 부력 작용폭 : 3.200 m

4.2.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × Hw × 3.200 m = 32.000 Hw kN/m

= 10.000 × Hw × 0.000 m = 0.000 Hw kN/m

= 32.000 Hw

여기서, U : 부력 (kN/m)

μ : 단위 부력 (kN/m^2)

r_w : 물의 단위 중량 (kN/m^3)

Hw : 지하수위로부터 구조물 바닥슬래브 하면까지의 높이 (m)

B : 부력이 작용하는 구조물의 폭 (m)

4.2.4 작용력

$R = W_1 + W_2 + F$ = 108.000 + 0.000 + 0.000 = 108.000 kN/m

여기서, W_1 : 구체자중 (kN/m)

W_2 : 상재하중 (kN/m)

F : 주면마찰력 (kN/m) ⇒ 구조물 벽체와 주변뒷채움 흙과의 접촉불확실성을 고려하여 무시한다.

(1) W_1 (구체자중)

① 하부슬래브

(0.600 × 3.200)× 25.000 = 48.000 kN/m

② 벽체

(0.600 × 2.000)× 2 EA × 25.000 = 60.000 kN/m

소 계 = 108.000 kN/m

(2) W_2 (상재하중) : 없음

(3) F (주면마찰력) : 없음

4.2.5 안정검토

$$F_s = \frac{R}{U} = \frac{108.000}{32.000\ Hw} \geq 1.1 \Rightarrow H \leq 3.068\ m$$

∴ 시공중 지하수위 Hw는 하부슬래브 저면으로부터 3.068m이하로 유지.

4.3 완공후 부력 검토 (지하수위 : G.L-9.6m)

4.3.1 굴착고 : 23.000 m

4.3.2 부력 작용폭 : 3.200 m

4.3.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 13.400 × 3.200 = 428.800 KN/m

10.000 × 0.000 × 0.000 = 0.000 KN/m

= 428.800 KN/m

4.3.4 저항력

$R = W_1 + W_2 + F$ = 158.250 + 1245.680 + 1185.160 = 2589.090 KN/m

(1) W_1 (구체자중)

① 시공중부력검토 구체자중 = 108.000 KN/m

② 상부 슬래브

(0.600 × 3.200)× 25.000 = 48.000 kN/m

③ 헌치

(0.300 × 0.300)× 1/2 × 2 EA × 25.000 = 2.250 kN/m

소 계 = 158.250 kN/m

(2) W2 (상재하중)

① 아스팔트(램프)

(0.450 × 3.200)× 23.000 = 33.120 kN/m

② 상재토

지하수위 이상

되메움토 : (9.150 × 3.200)× 19.000 = 556.320 kN/m

지하수위 이하

되메움토 : (10.200 × 3.200)× 20.000 = 652.800 kN/m

③ 방수몰탈

(0.050 × 3.200)× 21.500 = 3.440 kN/m

TOTAL = 1245.680 kN/m

(3) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로 적용

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi = 1 - \sin 30$ = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 9.600 m

지하수위 이하 구간(H_2) = 10.200 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

= 2 × 0.0 × 0.000 + 0.500 ×(19.0 × 9.600 ² + 10.0 × 10.200 ²

+ 2 × 19.0 × 9.600 × 10.200)× tan 20° = 1185.160 kN/m

4.3.5 안정검토

$F_s = \frac{R}{U} = \frac{2589.090}{428.800} = 6.038 \geq 1.200$ ∴ O.K

4.4 완공후 부력 검토 (극한수위 : G.L - 1.000 m)

4.4.1 굴착고 : 23.000 m

4.4.2 부력 작용폭 : 3.200 m

4.4.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 22.000 × 3.200 = 704.000 KN/m

10.000 × 0.000 × 0.000 = 0.000 KN/m

= 704.000 KN/m

4.4.4 저항력

$R = W_1 + W_2 + F$ = 158.250 + 1273.200 + 776.676 = 2208.126 KN/m

(1) W_1 (구체자중)

① 실수위시 부력검토 구체자중 = 158.250 KN/m

TOTAL = 158.250 kN/m

(2) W_2 (상재하중)

① 아스팔트

(0.450 × 3.200)× 23.000 = 33.120 kN/m

② 상재토

지하수위 이상

되메움토 : (0.550 × 3.200)× 19.000 = 33.440 kN/m

지하수위 이하

되메움토 : (18.800 × 3.200)× 20.000 = 1203.200 kN/m

③ 방수몰탈

(0.050 × 3.200)× 21.500 = 3.440 kN/m

TOTAL = 1273.200 kN/m

(3) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로 적

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi =$ 1 − sin = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 1.000 m

지하수위 이하 구간(H_2) = 18.800 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

= 2 × 30.0 × 0.000 + 0.500 ×(19.0 × 1.000 ² + 10.0 × 18.800 ²

+ 2 × 19.0 × 1.000 × 18.800)× tan 20° = 776.676 kN/m

4.4.5 안정검토

$$F_s = \frac{R}{U} = \frac{2208.126}{704.000} = 3.137 \geq 1.050$$ ∴ O.K

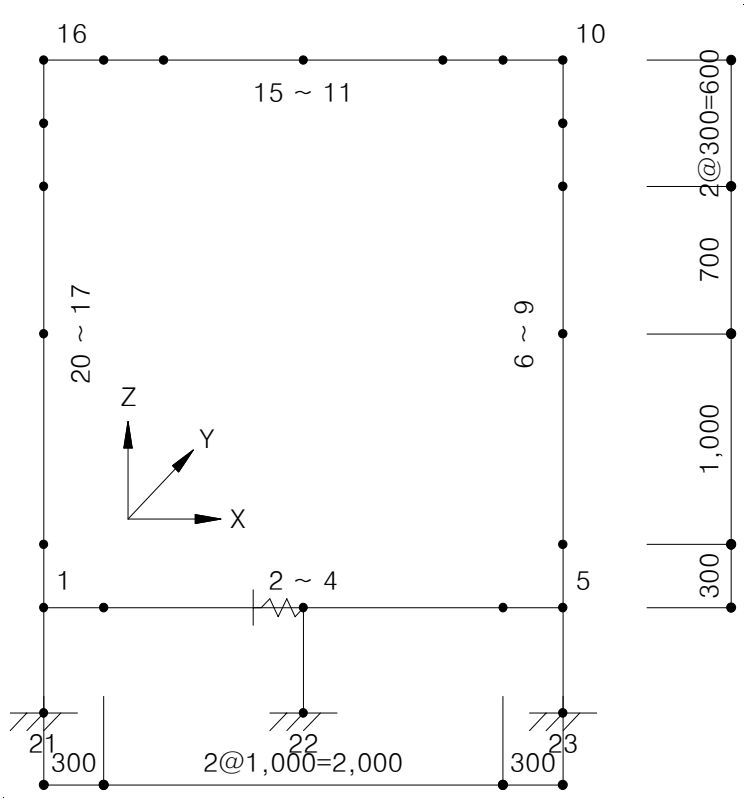
5. 해석모델 및 단면제원 (상시)

1) Modeling

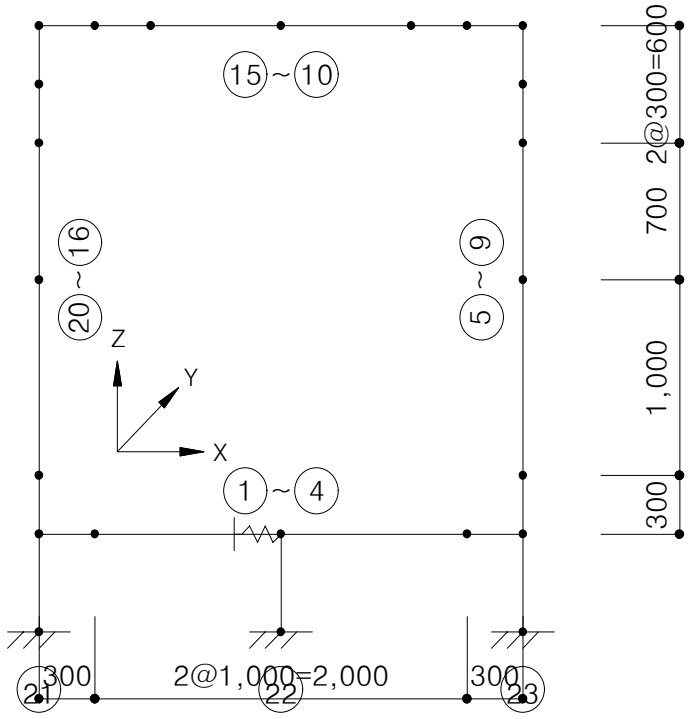
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)	I (m⁴)	부 재
1	0.600 × 1.000 = 0.600	0.01800	1~7,12~13,18~20
2	0.900 × 1.000 = 0.900	0.06075	9~10,15~16

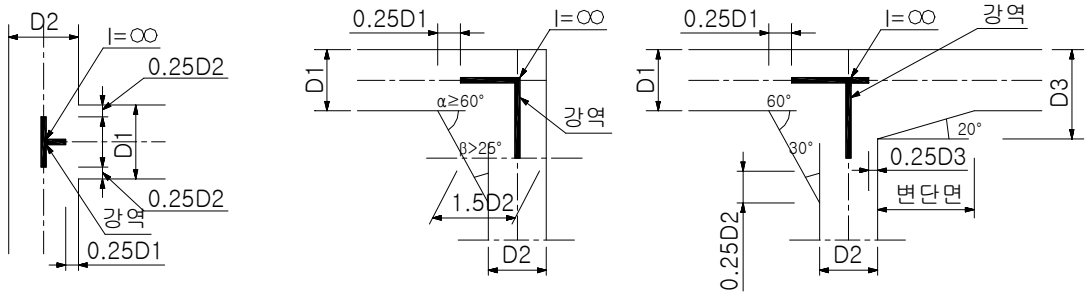
NO	Section(Tapper)	부 재
3	SEC 1 ~ 2	8,14
4	SEC 2 ~ 1	11,17

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	13	1.300	3.100
2	0.300	0.500	14	0.600	3.100
3	1.300	0.500	15	0.300	3.100
4	2.300	0.500	16	0.000	3.100
5	2.600	0.500	17	0.000	2.800
6	2.600	0.800	18	0.000	2.500
7	2.600	1.800	19	0.000	1.800
8	2.600	2.500	20	0.000	0.800
9	2.600	2.800	21	0.000	0.000
10	2.600	3.100	22	1.300	0.000
11	2.300	3.100	23	2.600	0.000
12	2.000	3.100			

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 16 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 600 / 2 + 300 - (600 × 300) / (2 × 300) = 300 mm

(2) 16 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 600 / 2 + 300 - (600 × 300) / (2 × 300) = 300 mm

(3) 10 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 600 / 2 + 300 - (600 × 300) / (2 × 300) = 300 mm

(4) 10 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 600 / 2 + 300 - (600 × 300) / (2 × 300) = 300 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 600 / 2 - 0.25 × 600 = 150 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 600 / 2 - 0.25 × 600 = 150 mm

(7) 5 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 600 / 2 - 0.25 × 600 = 150 mm

(8) 5 지점 - 슬래브 벽체 연결부

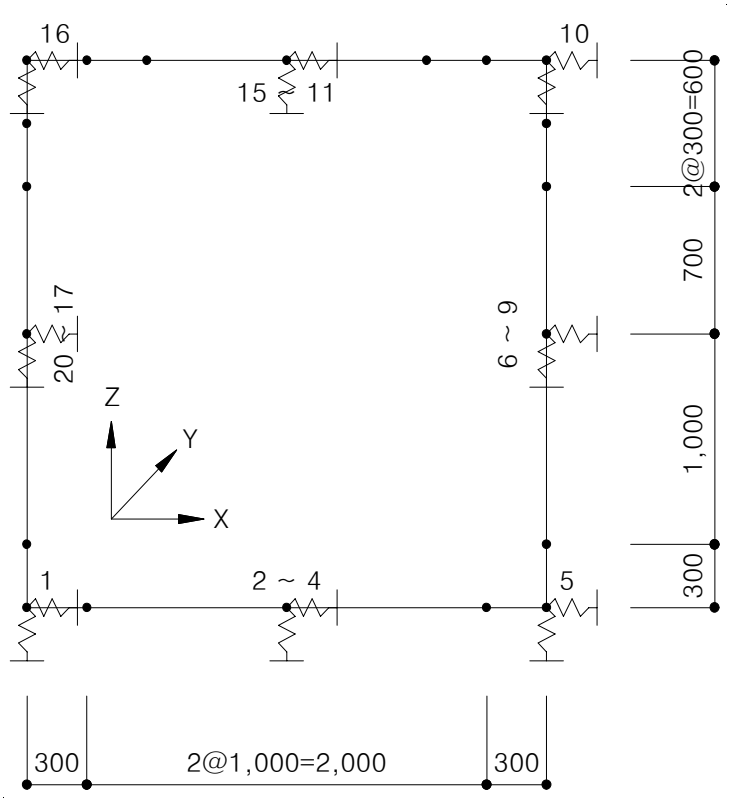
D2 / 2 - 0.25 × D1 = 600 / 2 - 0.25 × 600 = 150 mm

6. 해석모델 및 단면제원 (지진시)

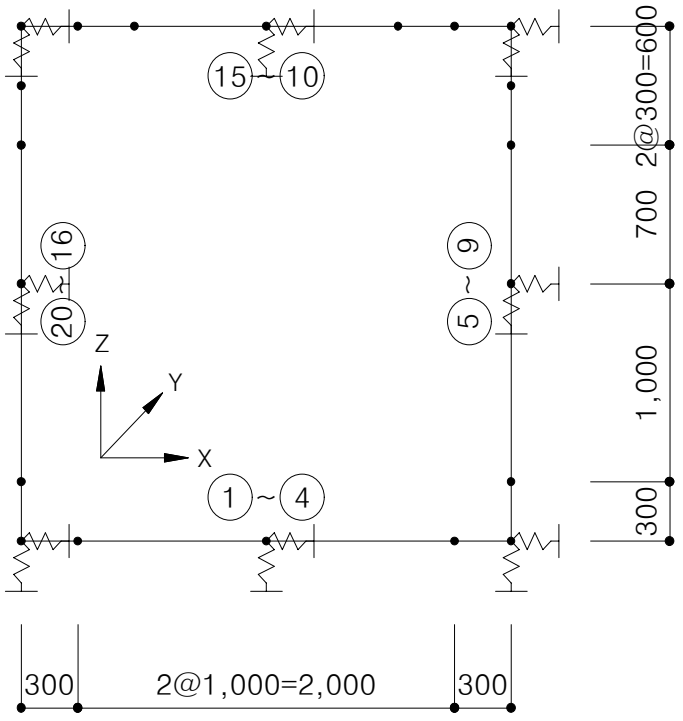
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)	I (m⁴)	부 재
1	0.600 × 1.000 = 0.600	0.01800	1~7,12~13,18~20
2	0.900 × 1.000 = 0.900	0.06075	9~10,15~16

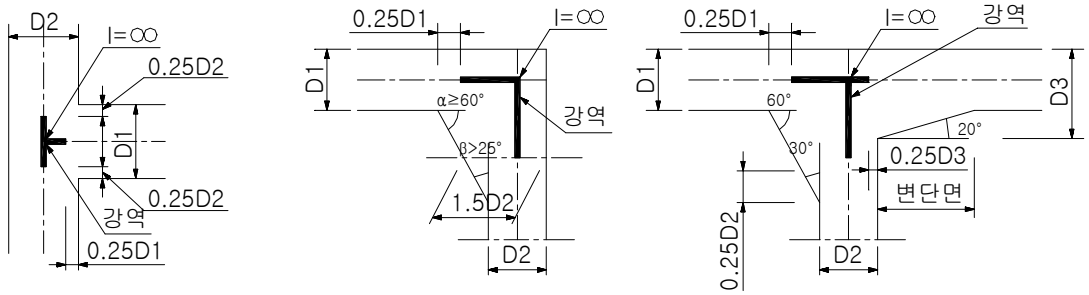
NO	Section(Tapper)	부 재
3	SEC 1 ~ 2	8,14
4	SEC 2 ~ 1	11,17

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.000	11	2.300	2.600
2	0.300	0.000	12	2.000	2.600
3	1.300	0.000	13	1.300	2.600
4	2.300	0.000	14	0.600	2.600
5	2.600	0.000	15	0.300	2.600
6	2.600	0.300	16	0.000	2.600
7	2.600	1.300	17	0.000	2.300
8	2.600	2.000	18	0.000	2.000
9	2.600	2.300	19	0.000	1.300
10	2.600	2.600	20	0.000	0.300

8) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 16 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 600 / 2 + 300 - (600 × 300) / (2 × 300) = 300 mm

(2) 16 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 600 / 2 + 300 - (600 × 300) / (2 × 300) = 300 mm

(3) 10 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 600 / 2 + 300 - (600 × 300) / (2 × 300) = 300 mm

(4) 10 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 600 / 2 + 300 - (600 × 300) / (2 × 300) = 300 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 600 / 2 - 0.25 × 600 = 150 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 600 / 2 - 0.25 × 600 = 150 mm

(7) 5 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 600 / 2 - 0.25 × 600 = 150 mm

(8) 5 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 600 / 2 - 0.25 × 600 = 150 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 300000.00 kN/m²

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

Bv = √(B × B) = √(3.200 × 3.200) = 3.200 m

Kvo = 1 / 0.3 × 1 × 300000 = 1000000.00 kN/m³

Kv(BxB) = 1000000.00 × (3.200 / 0.3)$^{-3/4}$ = 169425.38 kN/m³

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 169425.376 = 135540.30 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.600/2 + 1.300/2) = 128763 kN/m	1,5
Kv2	Kv x (1.300/2 + 1.300/2) = 176202 kN/m	3
Kh	1E10 kN/m (무한강성)	3

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 풍화암(WR) (EL. : 15.103 ~ -14.897, N=50)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 1.0 × Vo = 1.0 × 631.0 = 631.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 631.0² = 811745.0 kN/m²
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.3) × 811745.0 = 2110537.0 kN/m²

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 631.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 1.0 × Vo = 1.0 × 631.0 = 631.0 m/sec
- Gd (전단탄성계수) = w / g × Vs² (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 631.0² = 811745.0 kN/m²
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.3) × 811745.0 = 2110537.0 kN/m²

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제4토층 ,풍화암(WR)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

α = 1,L = 7.900m

Bv = √(B × B) = √(3.200 × 3.200) = 3.200 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kv(B×B) = 7035123.330 × (3.200 / 0.3)$^{-3/4}$ = 1191928.41 kN/m³

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 1191928.410 = 953542.73 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 953542.730 = 317847.58 kN/m³

(2) 하부슬래브 : 제4토층 , 풍화암(WR)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

α = 1,L = 7.900m

Bv = √(B × B) = √(3.200 × 3.200) = 3.200 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kv(B×B) = 7035123.330 × (3.200 / 0.3)$^{-3/4}$ = 1191928.41 kN/m³

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 1191928.410 = 953542.73 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 953542.730 = 317847.58 kN/m³

(3) 측벽 : 제4토층 , 풍화암(WR)

① 수평방향 지반반력계수

$$K_{(H\times L)} = K_{(H\times H)} \times \frac{(1+0.5\frac{H}{L})}{1.5}$$

α = 1,L = 7.900m

Bh = √(H × H) = √(3.200 × 3.200) = 3.200 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kh(H×H) = 7035123.330 × (3.200 / 0.3)$^{-3/4}$ = 1191928.41 kN/m³

Kh(HxL) = 0.800 × Kh(HxH) = 0.800 × 1191928.410 = 953542.73 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 953542.730 = 317847.58 kN/m³

(4) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.300/2 + 1.300/2) = 1239606 kN/m	13
Ksb1	Ksb x (1.300/2 + 1.300/2) = 413202 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.300/2 + 1.300/2) = 1239606 kN/m	7,19
Kss1	Kss x (1.300/2 + 1.300/2) = 413202 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.300/2 + 1.300/2) = 1239606 kN/m	3
Ksb1	Ksb x (1.300/2 + 1.300/2) = 413202 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.600/2 + 1.300/2) = 905866 kN/m	1,5
Ksb1	Kh x (1.300/2 + 0.600/2) = 905866 kN/m	
Kv2	Kv x (1.300/2 + 0.600/2) = 905866 kN/m	10,16
Ksb2	Kh x (1.300/2 + 0.600/2) = 905866 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제4토층 ,풍화암(WR)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$ α = 1,L = 7.900m

Bv = √(B × B) = √(3.200 × 3.200) = 3.200 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kv(B×B') = 7035123.330 × (3.200 / 0.3)$^{-3/4}$ = 1191928.41 kN/m³

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 1191928.410 = 953542.73 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 953542.730 = 317847.58 kN/m³

(2) 하부슬래브 : 제4토층 , 풍화암(WR)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$ α = 1,L = 7.900m

Bv = √(B × B) = √(3.200 × 3.200) = 3.200 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kv(B×B') = 7035123.330 × (3.200 / 0.3)$^{-3/4}$ = 1191928.41 kN/m³

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 1191928.410 = 953542.73 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 953542.730 = 317847.58 kN/m³

(3) 측벽 : 제4토층 , 풍화암(WR)

① 수평방향 지반반력계수

$$K_{(H\times L)} = K_{(H\times H)} \times \frac{(1+0.5\frac{H}{L})}{1.5}$$ α = 1,L = 7.900m

Bh = √(H × H) = √(3.200 × 3.200) = 3.200 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 2110537.0 = 7035123.33 kN/m³

Kh(H×H') = 7035123.330 × (3.200 / 0.3)$^{-3/4}$ = 1191928.41 kN/m³

Kh(HxL) = 0.800 × Kh(HxH' = 0.800 × 1191928.410 = 953542.73 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 953542.730 = 317847.58 kN/m³

(4) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.300/2 + 1.300/2) = 1239606 kN/m	13
Ksb1	Ksb x (1.300/2 + 1.300/2) = 413202 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.300/2 + 1.300/2) = 1239606 kN/m	7,19
Kss1	Kss x (1.300/2 + 1.300/2) = 413202 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.300/2 + 1.300/2) = 1239606 kN/m	3
Ksb1	Ksb x (1.300/2 + 1.300/2) = 413202 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.600/2 + 1.300/2) = 905866 kN/m	1,5
Ksb1	Kh x (1.300/2 + 0.600/2) = 905866 kN/m	
Kv2	Kv x (1.300/2 + 0.600/2) = 905866 kN/m	10,16
Ksb2	Kh x (1.300/2 + 0.600/2) = 905866 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

설계지진	성능기 / 준 재현주기	기 능 수 행	붕 괴 방 지
	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.13 = 0.074
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.13 = 0.182

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 토 사	: 19.300 × 19.00	=	366.700	kN/m²
	∴ Total Wd1	=	378.200	kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00	=	9.500	kN/m²
- 흙(지하수위 이하)	: 18.800 × 10.00	=	188.000	kN/m²
	∴ Total Wd2	=	209.000	kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

토피고(D,m)	도로면의 활하중 (kN/m²)	토피고(D,m)	도로면의 활하중 (kN/m²)
1.0	39.0	1.5	25.0
2.0	18.0	2.5	14.0
3.0	11.0	3.5	10.0
4.0	10.0	5.0	10.0
6.0	10.0	7.0	10.0
8.0	10.0	9.0	10.0
10.0	10.0		

주) 중간토피에 대한 것은 그 상위의 것을 취한다.

① 상부 슬래브에 작용하는 하중 (WI1) - 토피 4m 이상

- WI1 = 10.000 kN/m²

② 측벽에 작용하는 하중 (WI2)

- WI2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 19.600 × 19.000) × 0.500 = 191.950 kN/m²
Wh2 = 191.950 + 0.300 × 19.000 × 0.500 = 194.800 kN/m²
Wh3 = 194.800 + 0.300 × 19.000 × 0.500 = 197.650 kN/m²
Wh4 = 197.650 + 0.700 × 19.000 × 0.500 = 204.300 kN/m²
Wh5 = 204.300 + 1.000 × 19.000 × 0.500 = 213.800 kN/m²
Wh6 = 213.800 + 0.300 × 19.000 × 0.500 = 216.650 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 19.100 × 10.00 = 106.000 kN/m²
Wh2 = 106.000 + 0.300 × 10.000 × 0.500 = 107.500 kN/m²
Wh3 = 107.500 + 0.300 × 10.000 × 0.500 = 109.000 kN/m²
Wh4 = 109.000 + 0.700 × 10.000 × 0.500 = 112.500 kN/m²
Wh5 = 112.500 + 1.000 × 10.000 × 0.500 = 117.500 kN/m²
Wh6 = 117.500 + 0.300 × 10.000 × 0.500 = 119.000 kN/m²

6) 지하수압 (지하수위 : GL = -1.000 m)

① 상부슬래브에 작용하는 하중

- Ww1 = 18.800 × 10.000 = 188.000 kN/m²

② 측벽에 작용하는 하중

- Ww2 = 19.100 × 10.000 = 191.000 kN/m²
Ww3 = 191.000 + 0.300 × 10.000 = 194.000 kN/m²
Ww4 = 194.000 + 0.300 × 10.000 = 197.000 kN/m²
Ww5 = 197.000 + 0.700 × 10.000 = 204.000 kN/m²
Ww6 = 204.000 + 1.000 × 10.000 = 214.000 kN/m²
Ww7 = 214.000 + 0.300 × 10.000 = 217.000 kN/m²

③ 하부슬래브에 작용하는 하중

- Ww8 = (19.800 + 3.200 - 1.000) × 10.000 = 220.000 kN/m²

7) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

8) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 15 \times 10^{-5}$
- 온도선팽창 계수 $\alpha = 1.0 \times 10^{-5}$
- $\Delta T = -\frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
실트 섞인 모래(SM	2.200	156.000	124.800	20.000	0.056	0.071
모래(SP)	8.700	289.000	231.200	20.000	0.120	0.151
풍화 잔류토(RS)	3.100	424.000	424.000	20.000	0.029	0.029
풍화암(WR)	16.000	631.000	631.000	20.000	0.101	0.101
계					0.306	0.352

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.306 = 0.383	1.25 Tg' = 1.25 × 0.352 = 0.440

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.180/(2.5×0.130) = 0.554	Ts = Cv / (2.5 × Ca) = 0.180/(2.5×0.130) = 0.554
To(sec)	To = 0.2 × Ts = 0.2 × 0.554 = 0.111	To = 0.2 × Ts = 0.2 × 0.554 = 0.111

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $C_d = \frac{1.5}{40h+1} + 0.5$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa)

- 붕괴방지수준시(재현주기 1000년적용)

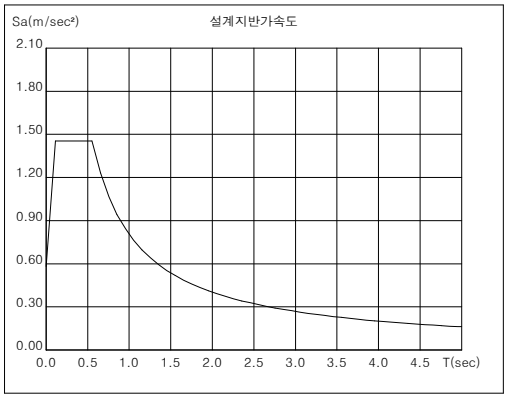
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 1.454 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 2.977 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg

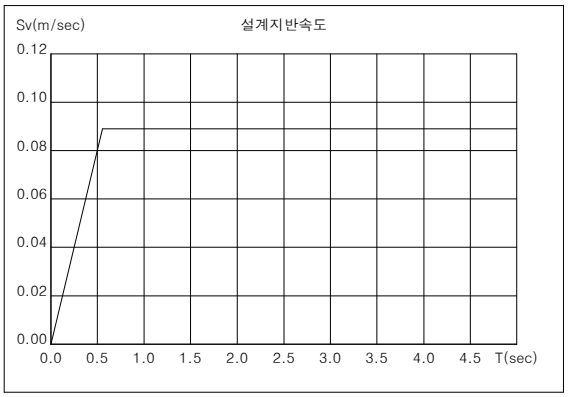
5) 속도 응답스펙트럼(Sv)　　- 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.383 / 2π × 1.454 = 0.089 m/s	Sv = Tg/2π × Sa = 0.440 / 2π × 2.977 = 0.208 m/s

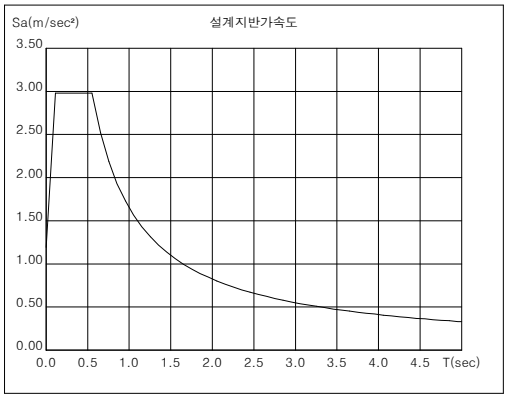
6) 설계응답 응답스펙트럼

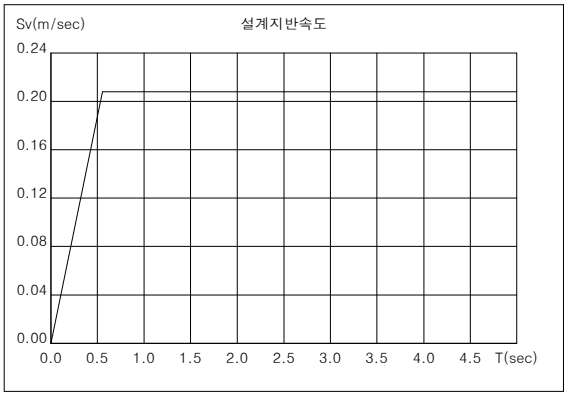
(1) 기능수행수준





(2) 붕괴방지수준





7) 층별 변위값 정리

- 제 1층의 두께(H1) = 14.000 m
- 제 2층의 두께(H2) = 16.000 m
- 제 1층의 습윤단위 체적중량(γ1) = 20.000 kN/m³
- 제 2층의 습윤단위 체적중량(γ2) = 20.000 kN/m³
- 제 1층의 평균전단파속도(Vsod1) = 257.171 m/sec
- 제 2층의 평균전단파속도(Vsod2) = 631.000 m/sec
- 제 1층과 제2층의 임피던스비(α)
  (γ1×Vsod1) / (γ2×Vsod2) = (20.000 × 257.171) / (20.000 × 631.000)
  = 0.408

- 지반의 설계 고유 진동수(Wo)

$(1+\alpha)\times\cos[Wo\times(H1/Vsod1 + H2/Vsod2)] + (1-\alpha)\times\cos[Wo\times(H1/Vsod1 - H2/Vsod2)] = 0$

$(1 + 0.408) \times \cos[Wo \times (14.000 / 257.171 + 16.000 / 631.000)] +$

$(1 - 0.408) \times \cos[Wo \times (14.000 / 257.171 - 16.000 / 631.000)] = 0$

에서 시행착오법으로 산정, Wo = 23.815

- 각 층별 변위 계산식

  - 제1층 변위 계산식

$Uh1 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times x1/Vsod1)$

  - 제2층 변위 계산식

$Uh2 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times H1/Vsod1) \times$

$[\cos(Wo \times x2/Vsod2) - \sin(Wo \times x2/Vsod2) / \tan(Wo \times H2/Vsod2)]$

8) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 6.100 m
- 하부슬래브 EL. = 22.700 m
- 기반암 심도(H) = 30.000 m

$Po = Ksb,top \times (U(Zu) - U(Zb))$

기능수행수준	붕괴방지수준
$Po = 317847.580 \times (0.001203 - 0.000897)$ $= 97.261\ kN/m^2$	$Po = 317847.580 \times (0.003230 - 0.002407)$ $= 261.589\ kN/m^2$

9) 측벽 지반변위 하중

$P(z) = Kh \times (Uh(z) - Uh(b))$

(1) 기능수행수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
6.100	953542.730	0.001203	0.000306	291.784
20.400	953542.730	0.001168	0.000271	258.410
20.700	953542.730	0.001133	0.000236	225.036
21.400	953542.730	0.001051	0.000154	146.846
22.400	953542.730	0.000932	0.000035	33.374
22.700	953542.730	0.000897	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
20.100	953542.730	0.003230	0.000823	784.766
20.400	953542.730	0.003136	0.000729	695.133
20.700	953542.730	0.003042	0.000635	605.500
21.400	953542.730	0.002822	0.000415	395.720
22.400	953542.730	0.002503	0.000096	91.540
22.700	953542.730	0.002407	0.000000	0.000

10) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

구분	기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
Vu	811745.000 × 0.000115 = 93.350	811745.000 × 0.000310 = 251.640
Vb	811745.000 × 0.000119 = 96.600	811745.000 × 0.000320 = 259.760
Vs	(93.350 + 96.600) / 2 = 94.980	(251.640 + 259.760) / 2 = 255.700

11) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fu = 0.600×25.000×0.074×(1 - 0.015×6.100) = 0.775	fu = 0.600×25.000×0.182×(1 - 0.015×6.100) = 1.907

② 하부슬래브

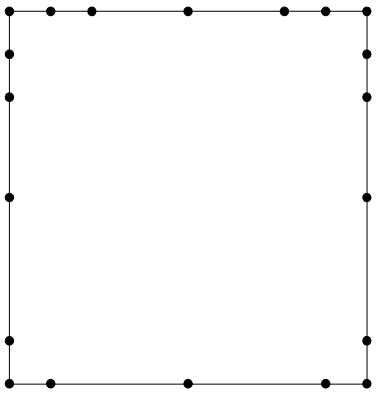
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fb = 0.600×25.000×0.074×(1 - 0.015×22.700) = 0.732	fb = 0.600×25.000×0.182×(1 - 0.015×22.700) = 1.800

③ 측벽

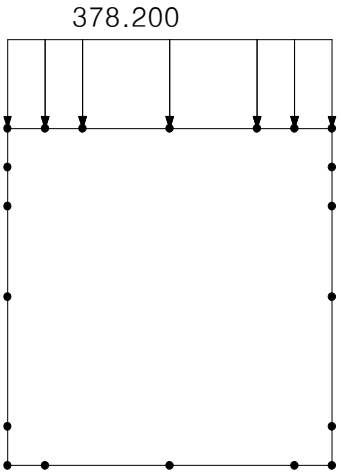
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
f1 = 0.600×25.000×0.074×(1-0.015×20.100) = 0.775	f1 = 0.600×25.000×0.182×(1-0.015×20.100) = 1.907
f2 = 0.600×25.000×0.074×(1-0.015×20.400) = 0.770	f2 = 0.600×25.000×0.182×(1-0.015×20.400) = 1.895
f3 = 0.600×25.000×0.074×(1-0.015×20.700) = 0.765	f3 = 0.600×25.000×0.182×(1-0.015×20.700) = 1.882
f4 = 0.600×25.000×0.074×(1-0.015×21.400) = 0.754	f4 = 0.600×25.000×0.182×(1-0.015×21.400) = 1.854
f5 = 0.600×25.000×0.074×(1-0.015×22.400) = 0.737	f5 = 0.600×25.000×0.182×(1-0.015×22.400) = 1.813
f6 = 0.600×25.000×0.074×(1-0.015×22.700) = 0.732	f6 = 0.600×25.000×0.182×(1-0.015×22.700) = 1.800

11. 하 중 재 하 (상시)

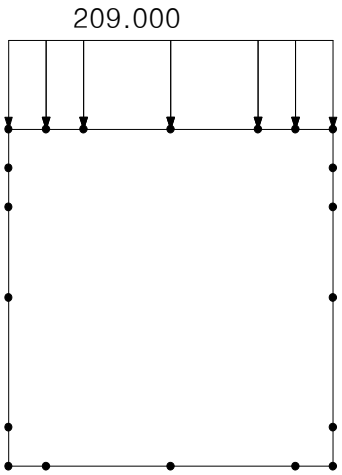
1) CASE1 - 구체자중(SW)



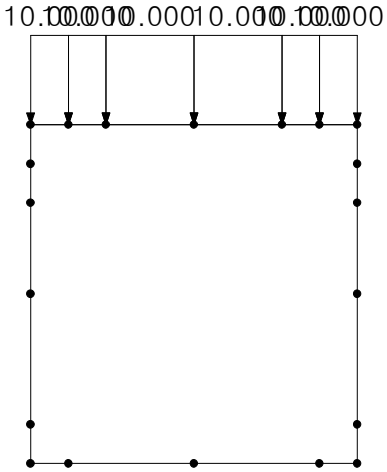
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



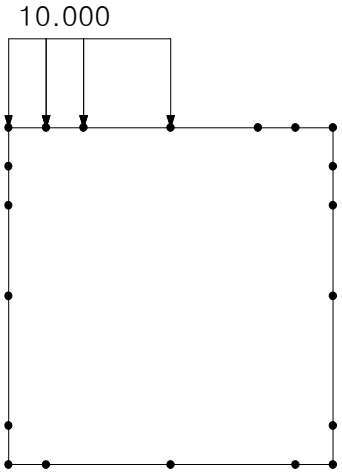
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



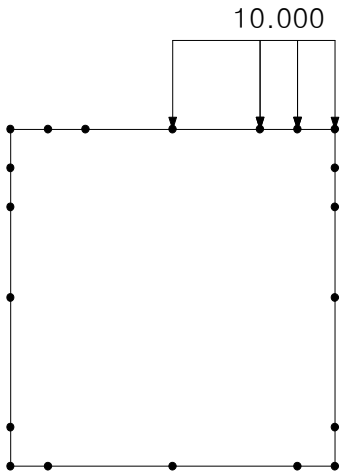
4) CASE4 - 만재활하중(LIVEFU)



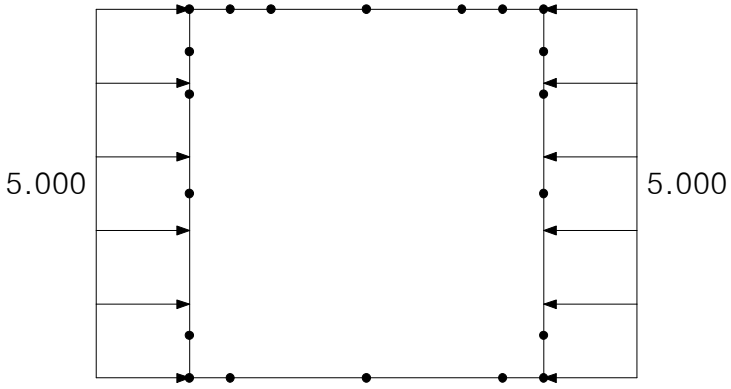
5) CASE5 - 편재활하중(좌측)(LIVELE)



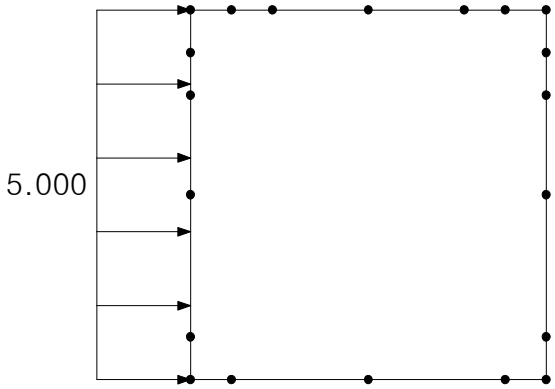
6) CASE6 - 편재활하중(우측)(LIVERI)



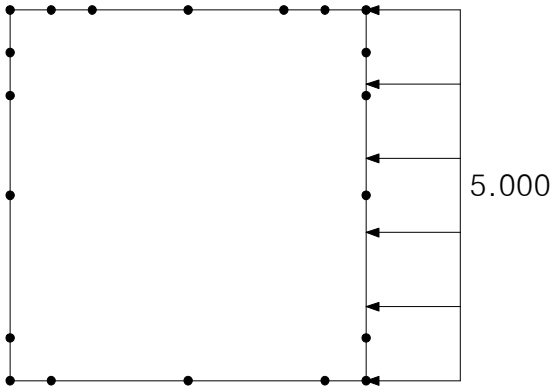
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



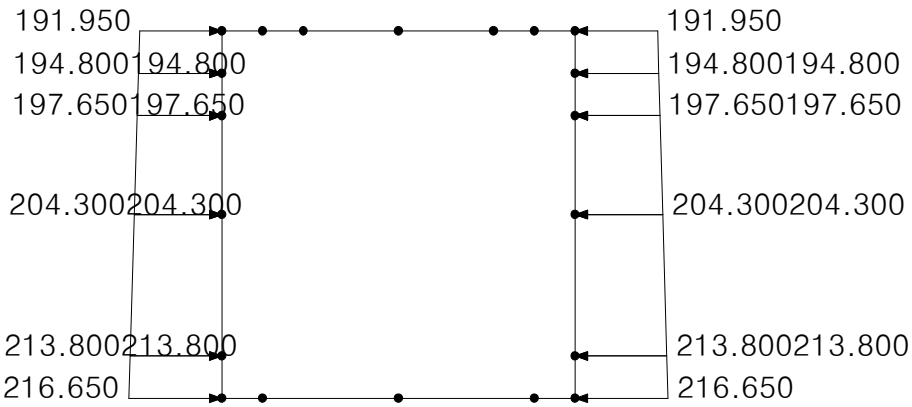
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



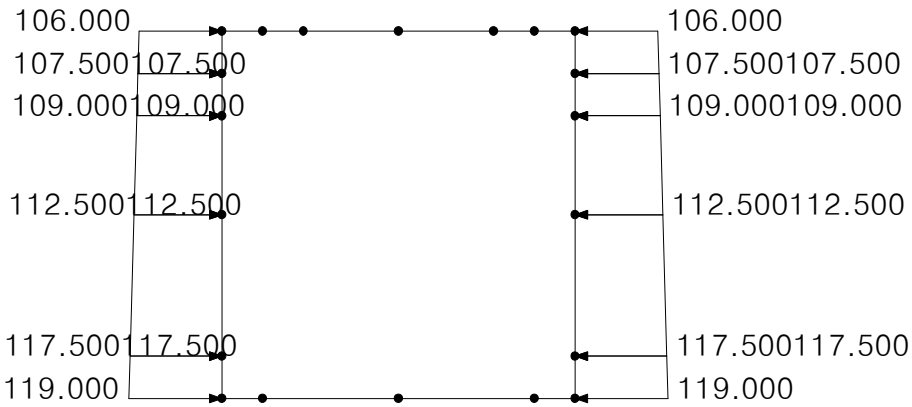
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



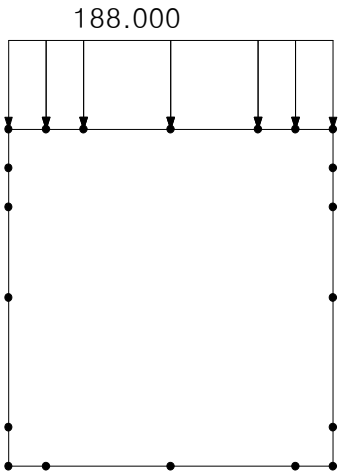
10) CASE10 - 양토압 : 지하수無(SOILB)



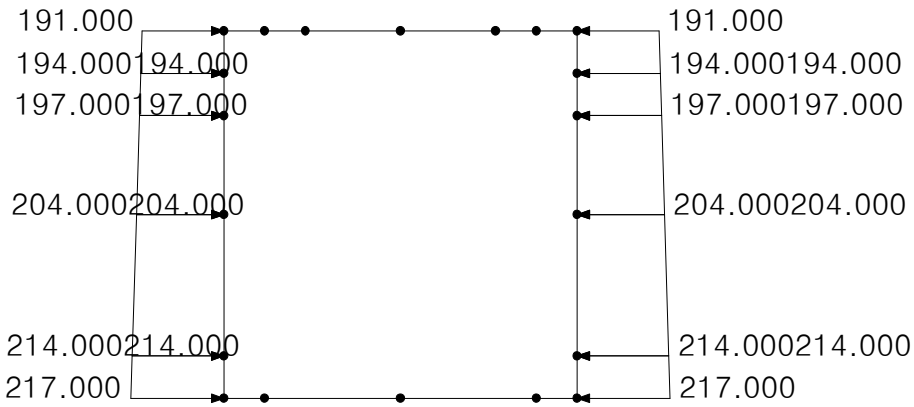
11) CASE11 - 양토압 : 지하수有(SOILBW)



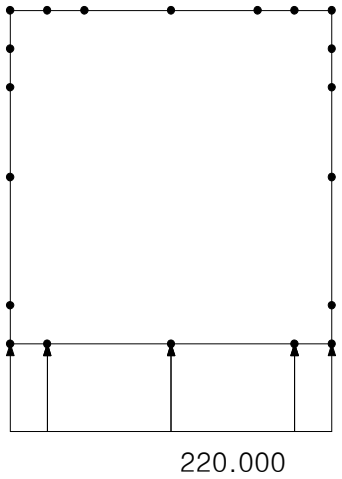
12) CASE12 - 연직수압(WATERV)



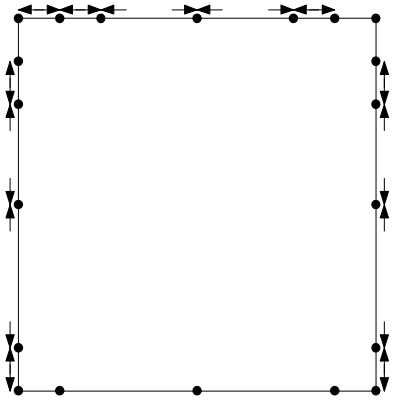
13) CASE13 - 수평수압(WATERH)



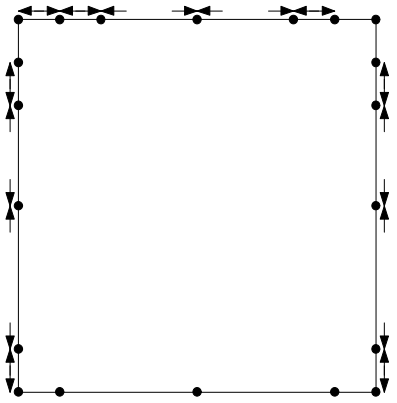
14) CASE14 - 부력(BUOYANCY)



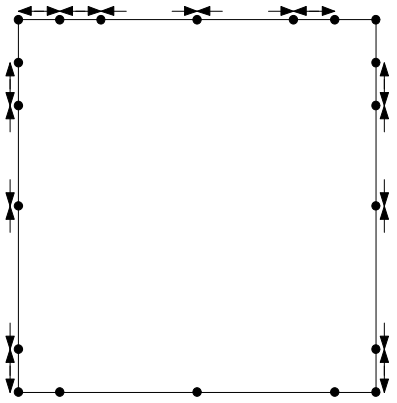
15) CASE15 - 온도변화(+) +10° C(TEMPPLUS)



16) CASE16 - 온도변화(-) -10° C(TEMPMINU)

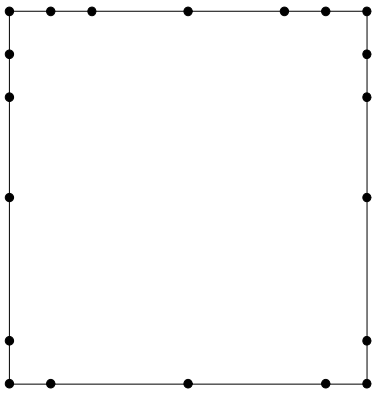


17) CASE17 - 건조수축 -15° C(SHRINK)

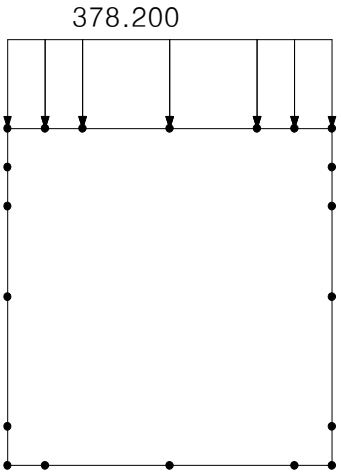


12. 하중 재하 (기능수행)

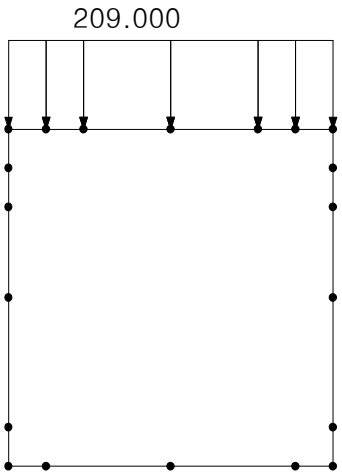
1) CASE1 - 구체자중(SW)



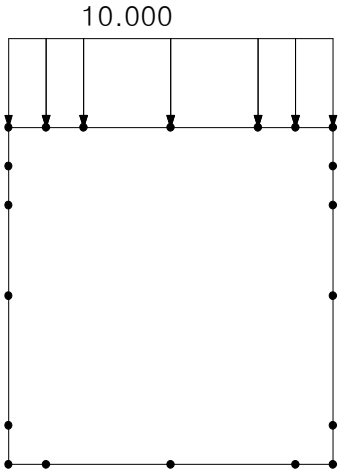
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



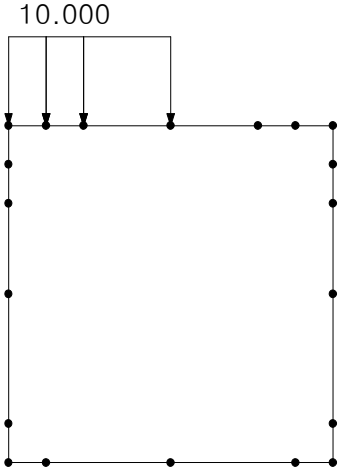
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



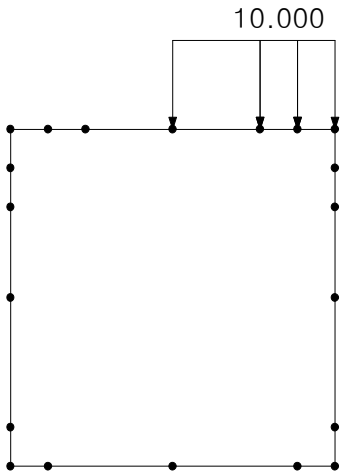
4) CASE4 - 지진시 만재활하중(LIVEFUE)



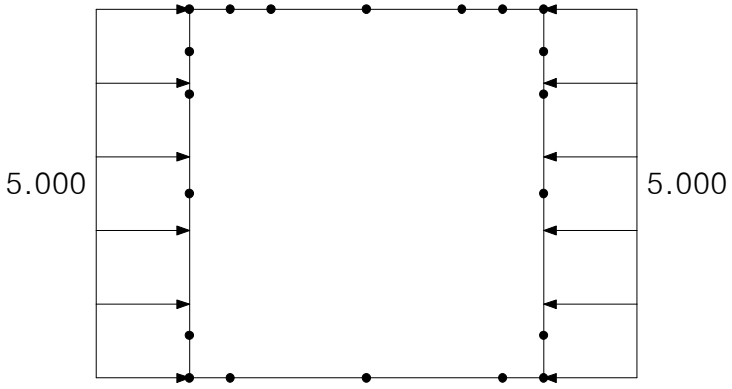
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



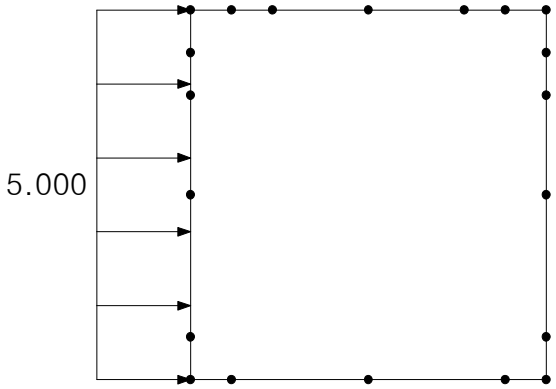
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



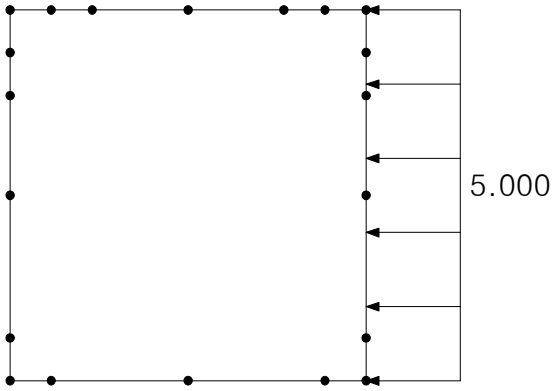
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



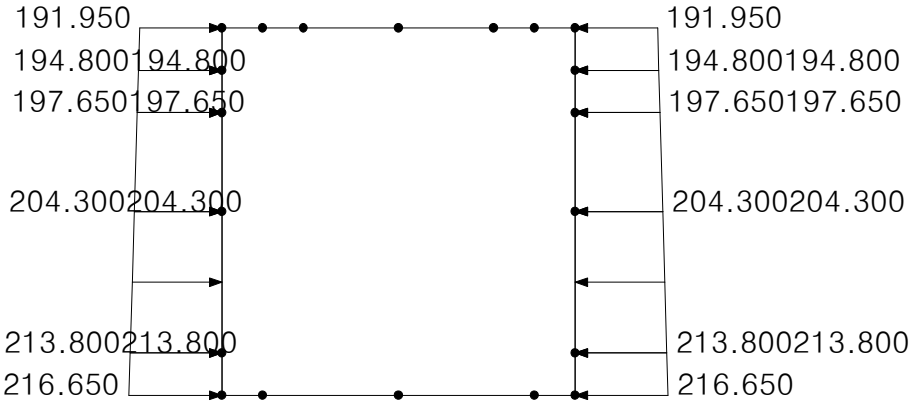
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



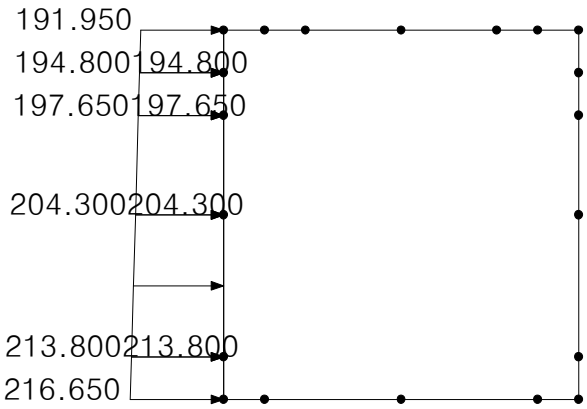
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



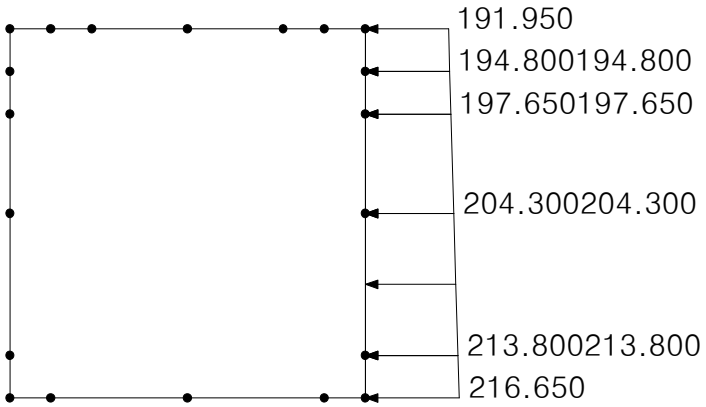
10) CASE10 - 지진시 양토압 2(SOILBE2)



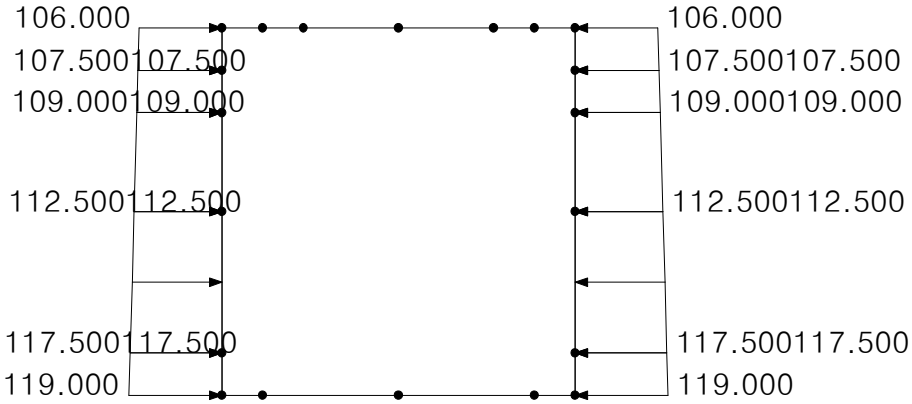
11) CASE11 - 지진시 편토압(좌측) 2(SOILLE2)



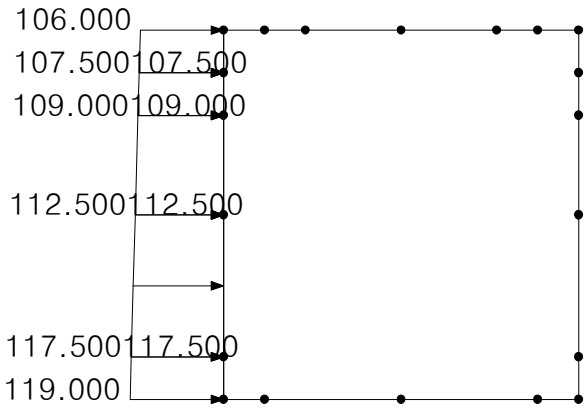
12) CASE12 - 지진시 편토압(우측) 2(SOILRE2)



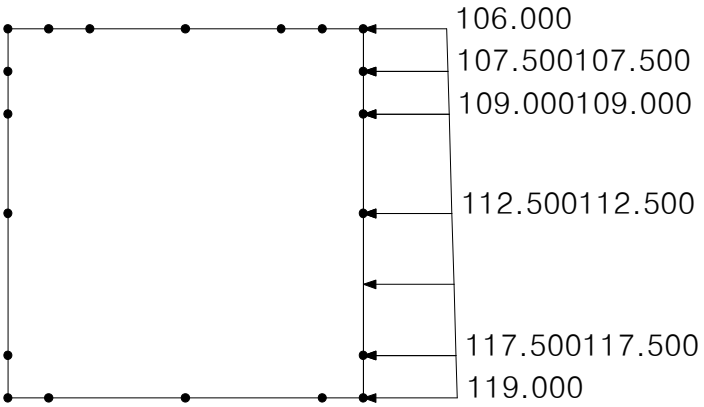
13) CASE13 - 지진시 양토압 2 : 지하수有(SOILBWE2)



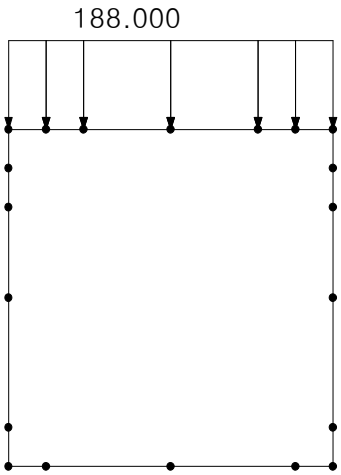
14) CASE14 - 지진시 편토압(좌측) 2 : 지하수有(SOILLWE2)



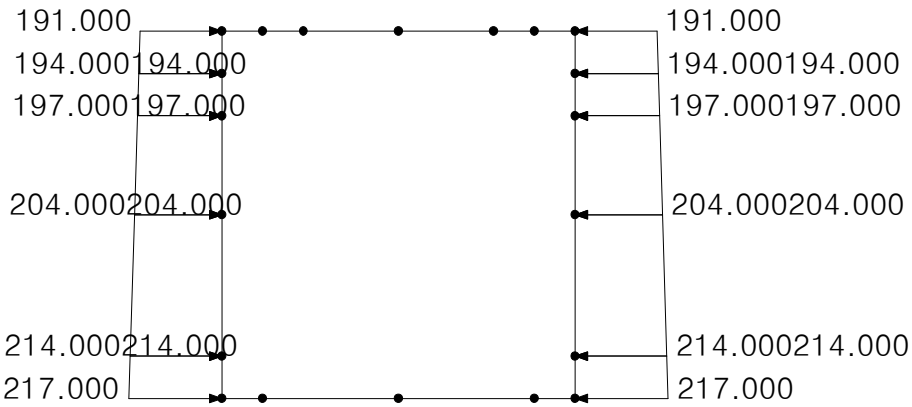
15) CASE15 - 지진시 편토압(우측) 2 : 지하수有(SOILRWE2)



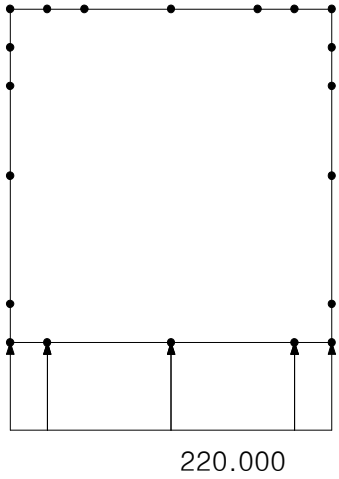
16) CASE16 - 연직수압(WATERV)



17) CASE17 - 수평수압(WATERH)

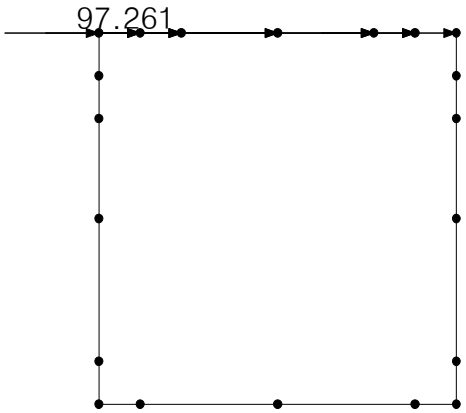


18) CASE18 - 부력(BUOYANCY)

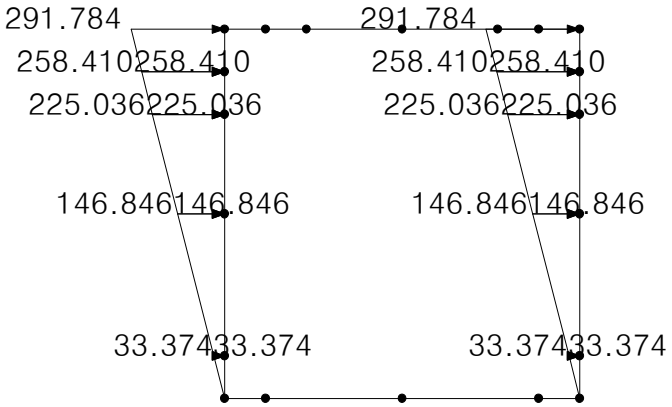


- 지진재하방향(좌측에서 우측으로)

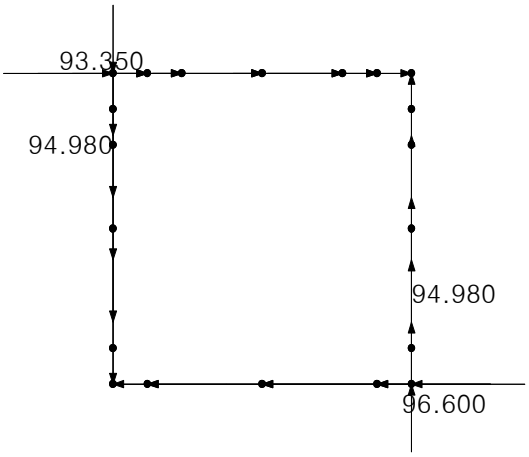
19) CASE19 - 슬래브 지반변위(기능수행)(FUNSLAB)



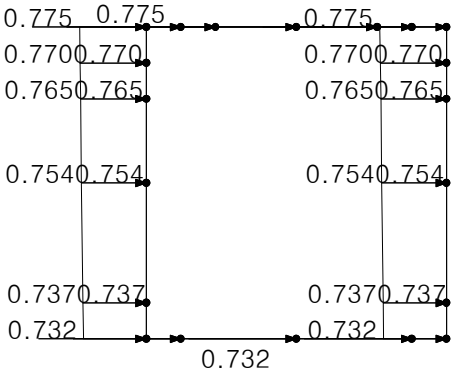
20) CASE20 - 벽체 지반변위(기능수행)(FUNWALL)



21) CASE21 - 주면전단력(기능수행)(FUNMS)

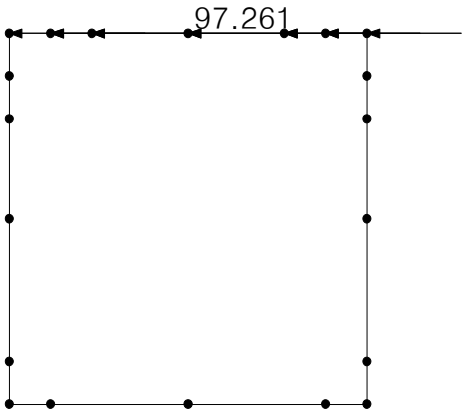


22) CASE22 - 구체 관성력(기능수행)(FUNINER)

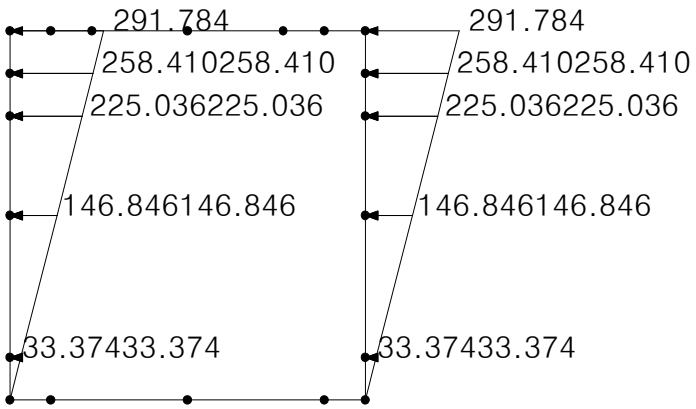


- 지진재하방향(우측에서 좌측으로)

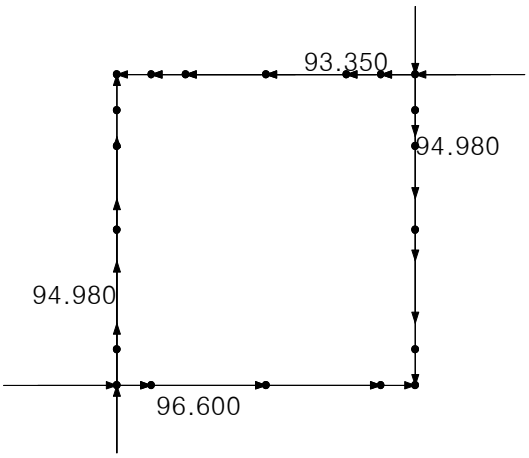
23) CASE23 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



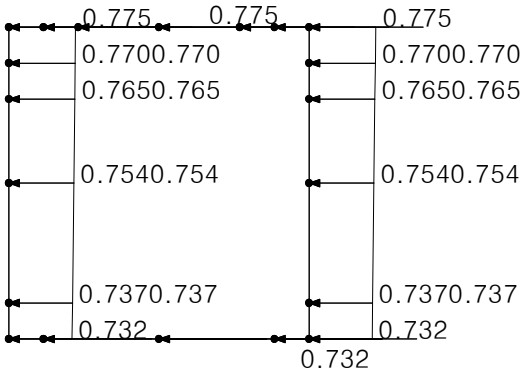
24) CASE24 - 벽체 지반변위(기능수행)2(FUNWALL2)



25) CASE25 - 주면전단력(기능수행)2(FUNMS2)

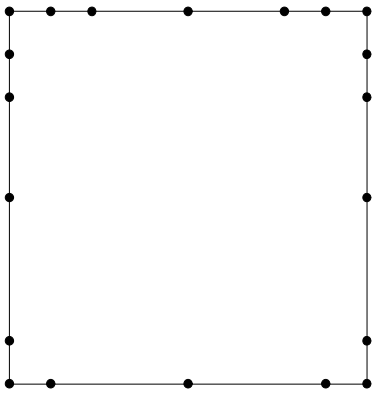


26) CASE26 - 구체 관성력(기능수행)2(FUNINER2)

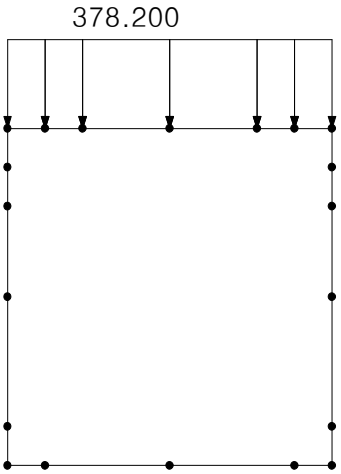


13. 하중 재하 (붕괴방지)

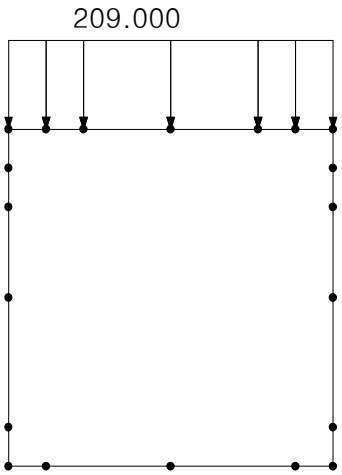
1) CASE1 - 구체자중(SW)



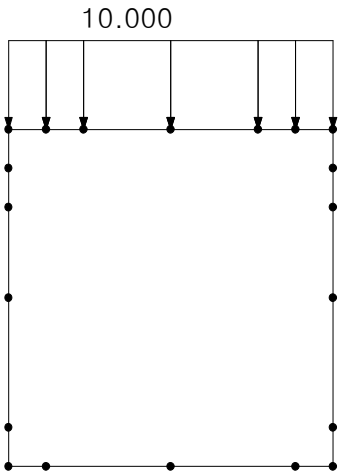
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



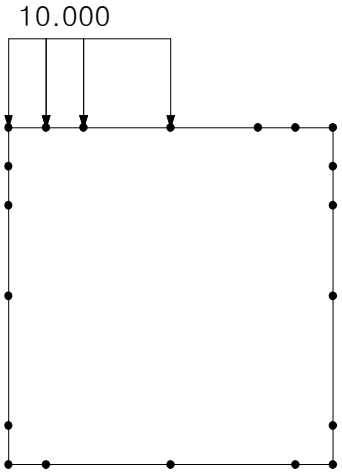
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



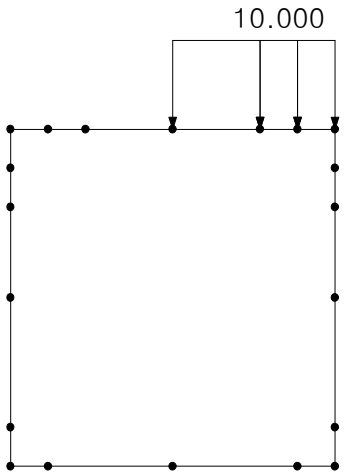
4) CASE4 - 지진시 만재활하중(LIVEFUE)



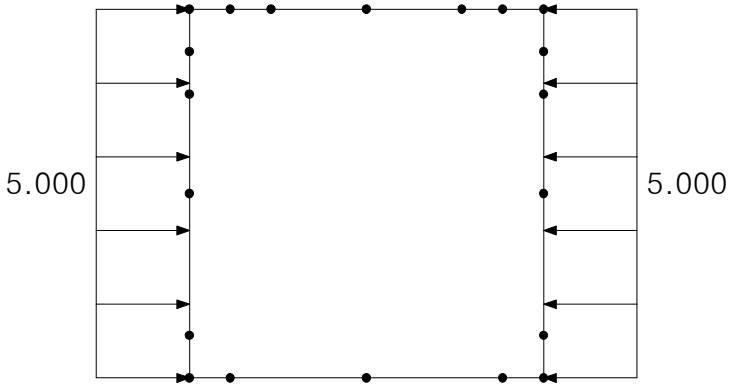
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



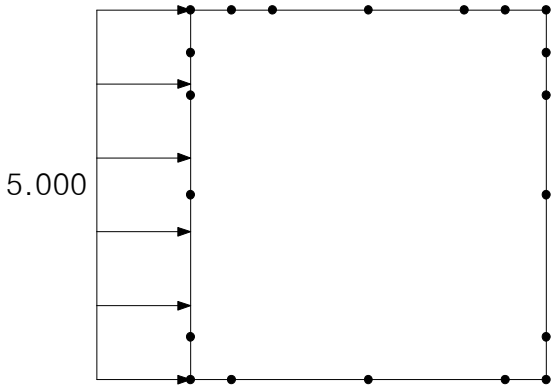
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



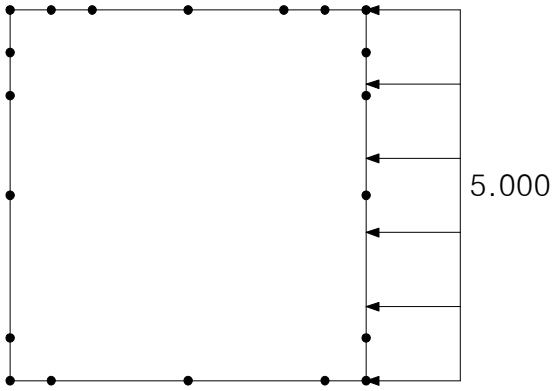
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



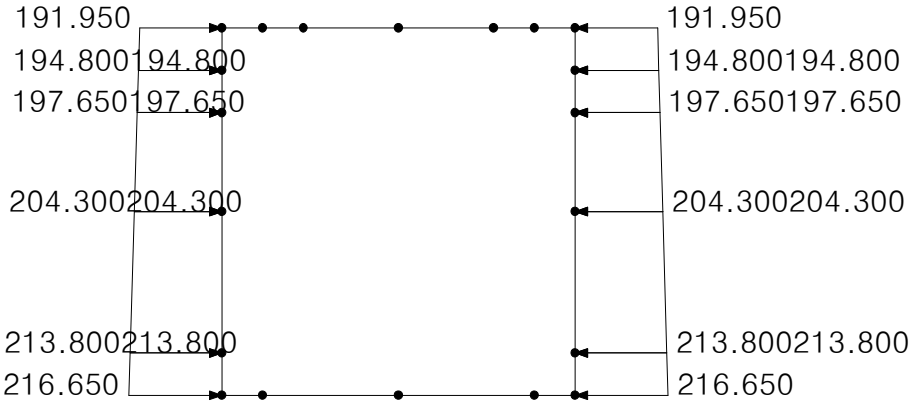
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



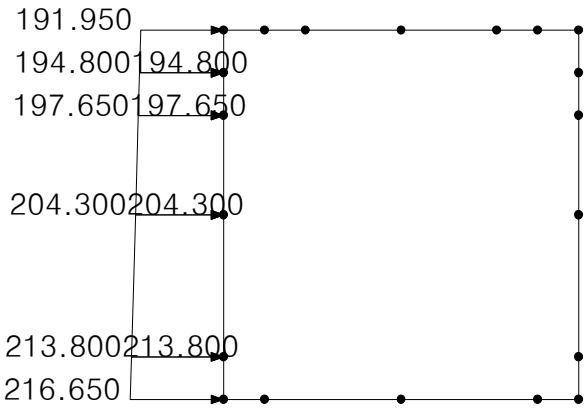
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



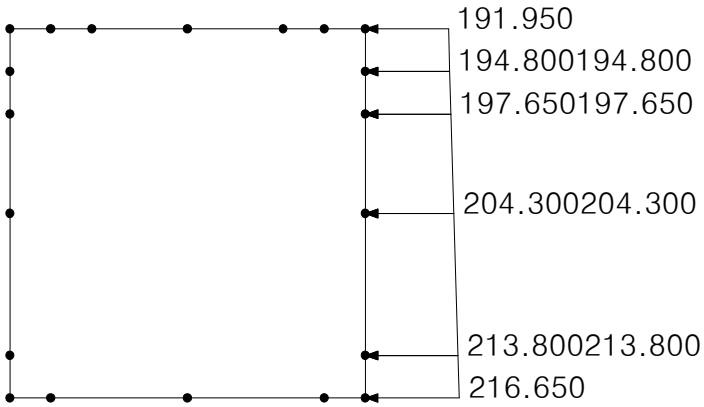
10) CASE10 - 지진시 양토압(SOILBE)



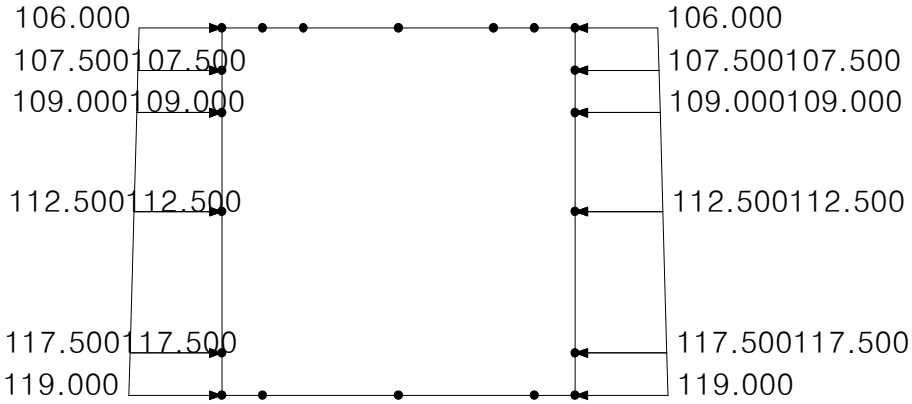
11) CASE11 - 지진시 편토압(좌측)(SOILLE)



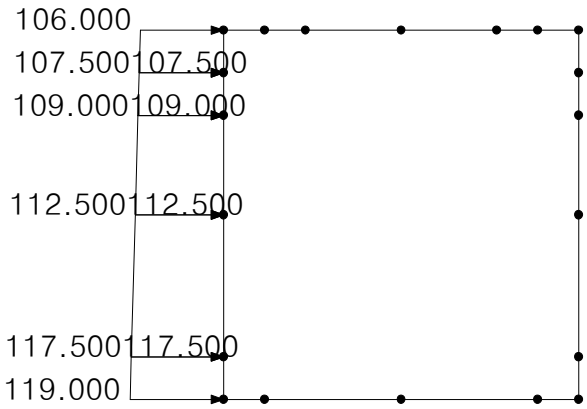
12) CASE12 - 지진시 편토압(우측)(SOILRE)



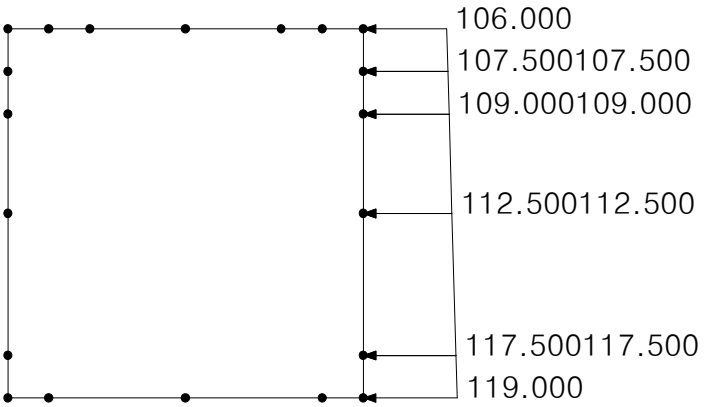
13) CASE13 - 지진시 양토압 : 지하수有(SOILBWE)



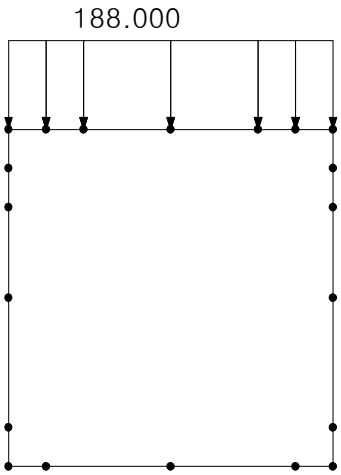
14) CASE14 - 지진시 편토압(좌측) : 지하수有(SOILLWE)



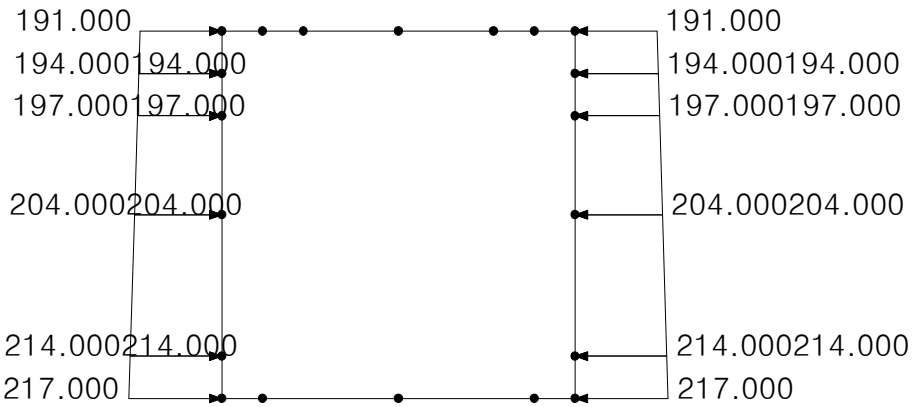
15) CASE15 - 지진시 편토압(우측) : 지하수有(SOILRWE)



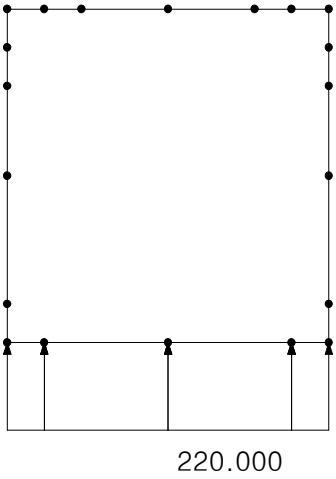
16) CASE16 - 연직수압(WATERV)



17) CASE17 - 수평수압(WATERH)

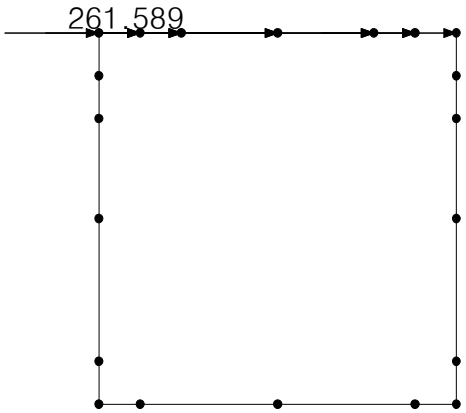


18) CASE18 - 부력(BUOYANCY)

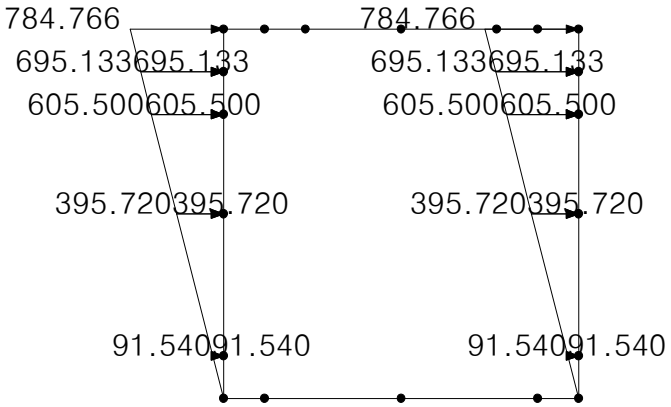


- 지진재하방향(좌측에서 우측으로)

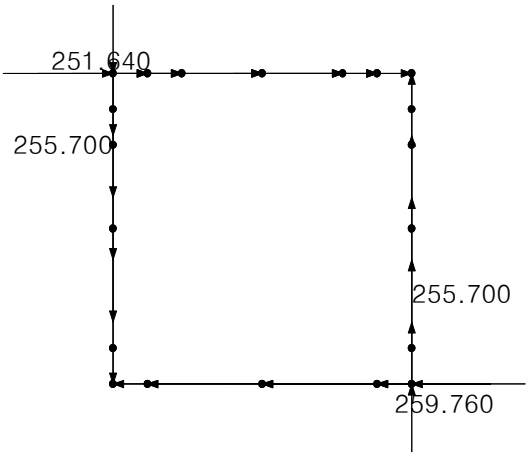
19) CASE19 - 슬래브 지반변위(붕괴방지)(COLSLAB)



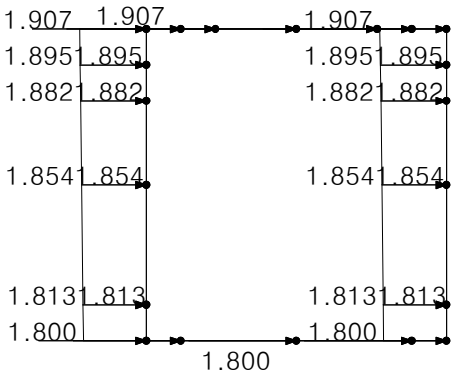
20) CASE20 - 벽체 지반변위(붕괴방지)(COLWALL)



21) CASE21 - 주면전단력(붕괴방지)(COLMS)

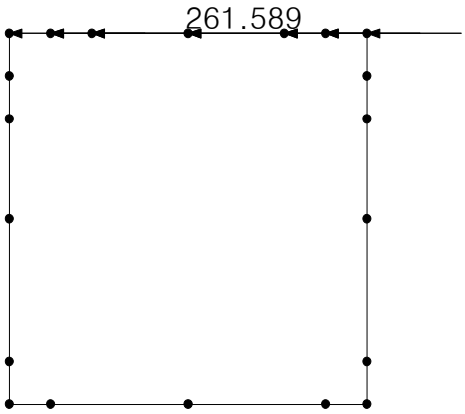


22) CASE22 - 구체 관성력(붕괴방지)(COLINER)

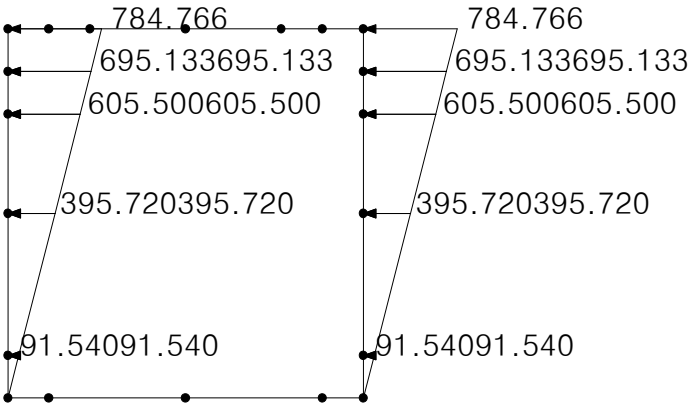


- 지진재하방향(우측에서 좌측으로)

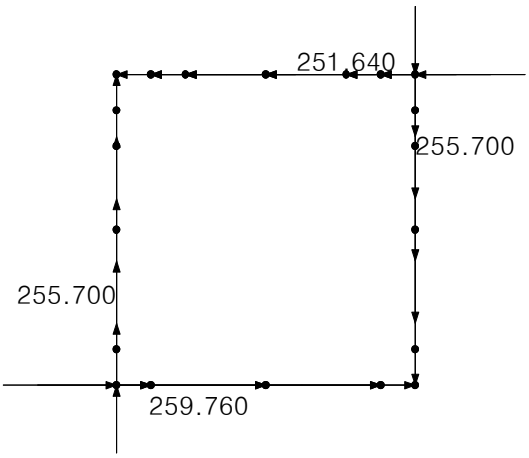
23) CASE23 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



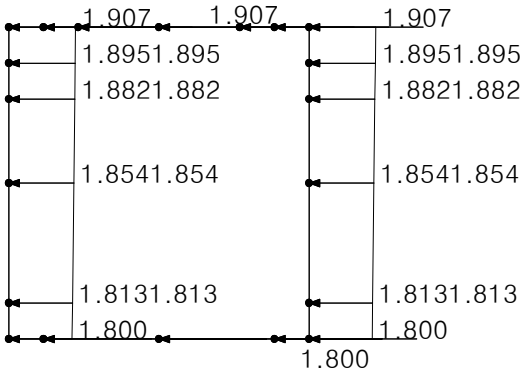
24) CASE24 - 벽체 지반변위(붕괴방지)2(COLWALL2)



25) CASE25 - 주면전단력(붕괴방지)2(COLMS2)



26) CASE26 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 0.875, h = 19.800 m

1) 계수하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.400						
LC2	1.200	1.400	1.600	1.600	1.200		
LC3	1.200		1.000				
LC4	1.200	1.400	1.600	0.800	1.200		
LC5	0.900	0.900		1.600			
LC6	0.900	0.900		0.800			
LC7	1.200	1.400	1.600	1.600	1.200	1.200	●
LC8	1.200	1.400	1.600	0.800	1.200	1.200	●
LC9	0.900	0.900		1.600			●
LC10	0.900	0.900		0.800			●

2) 사용하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.000						
LC2	1.000	1.000	1.000	1.000	1.000		
LC3	1.000		1.000				
LC4	1.000	1.000	1.000	0.500	1.000		
LC5	1.000	1.000		1.000			
LC6	1.000	1.000		0.500			
LC7	1.000	1.000	1.000	1.000	1.000	1.000	●
LC8	1.000	1.000	1.000	0.500	1.000	1.000	●
LC9	1.000	1.000		1.000			●
LC10	1.000	1.000		0.500			●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

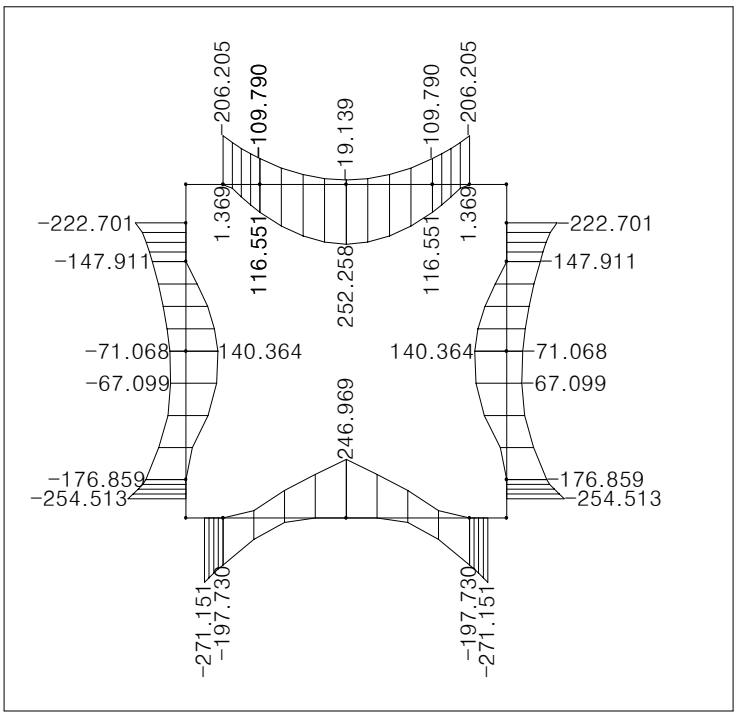
4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

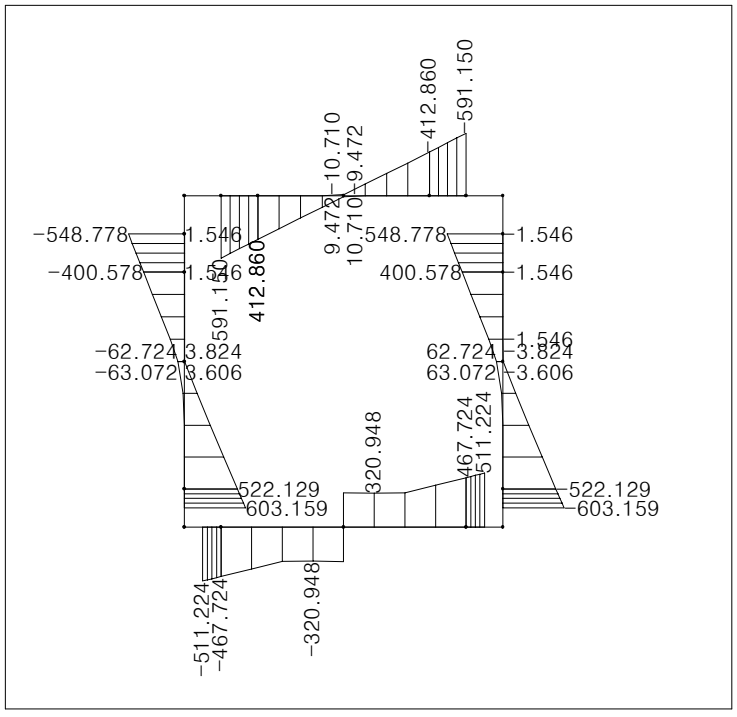
15. 단면력정리

15.1 상시

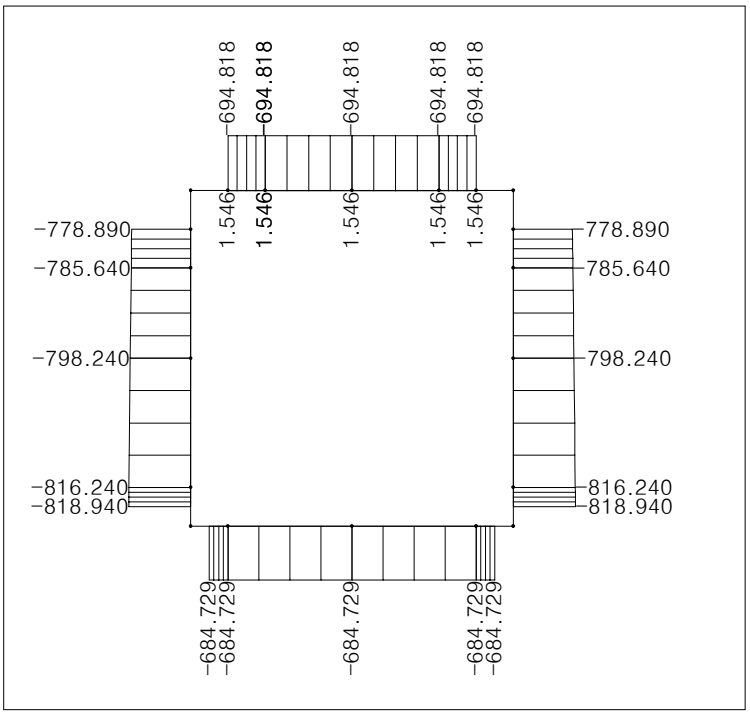
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



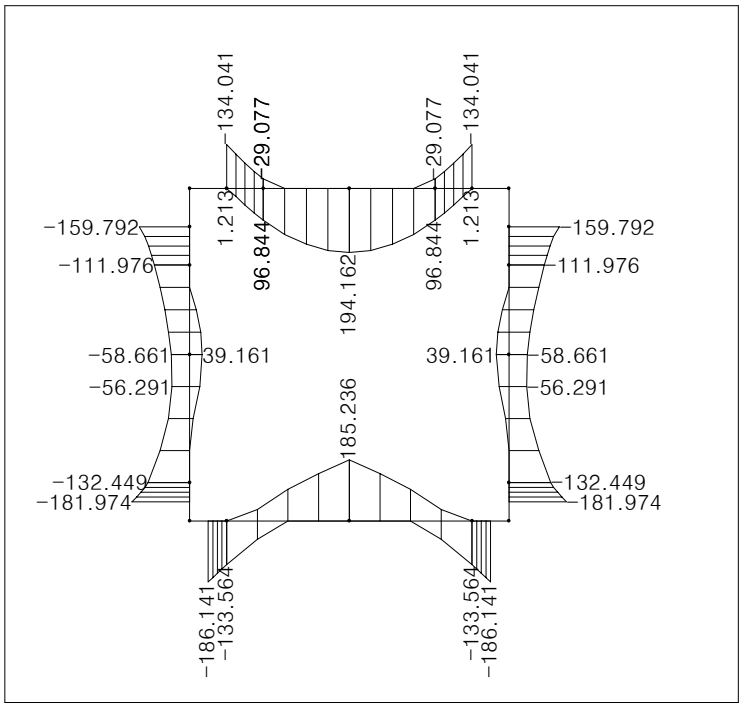
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

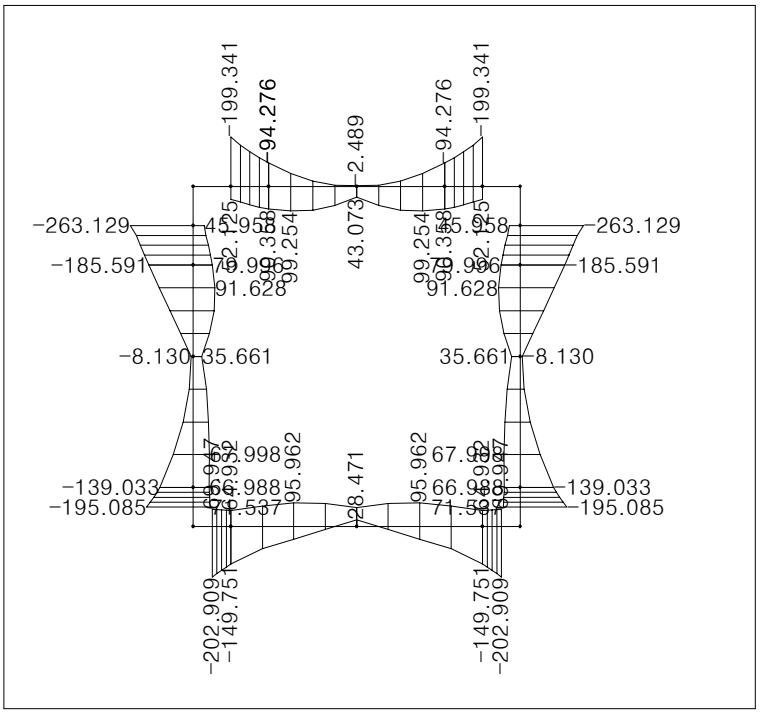


5) 단면력 정리

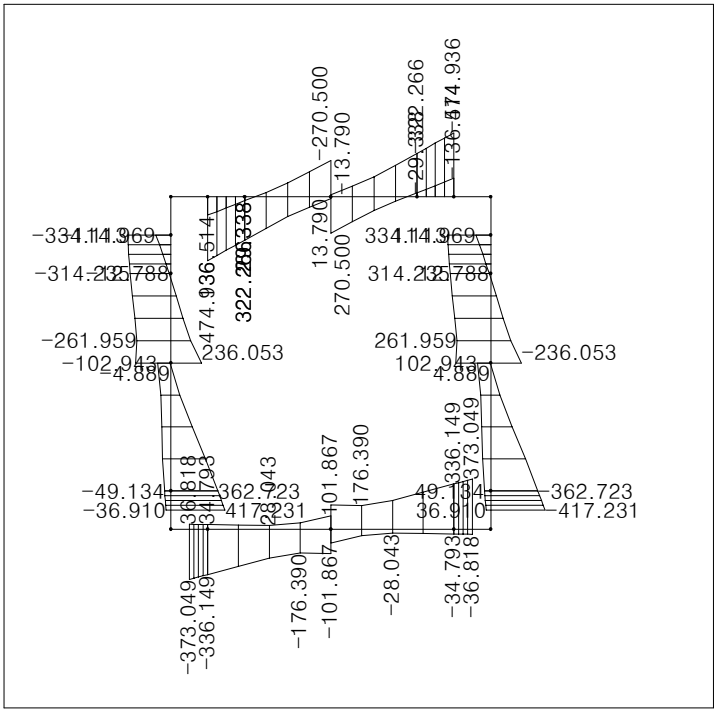
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	206.21	296.37	694.82	134.04	1000.00	700.00	
		중앙부	2	252.26	10.71	694.82	194.16	1000.00	600.00	
		우측	3	206.21	296.37	694.82	134.04	1000.00	700.00	
하부 슬래브	1 경간	좌측	4	197.73	322.72	684.73	133.56	1000.00	600.00	
		중앙부	5	246.97	325.45	684.73	185.24	1000.00	600.00	
		우측	6	197.73	322.72	684.73	133.56	1000.00	600.00	
좌측 벽체	1 층	상부	7	222.70	300.81	778.89	159.79	1000.00	700.00	
		중앙부 (외측)	8	71.07	63.07	798.24	58.66	1000.00	600.00	
		중앙부 (내측)	9	140.36	63.07	798.24	39.16	1000.00	600.00	
		하부	10	176.86	255.93	816.24	132.45	1000.00	600.00	
우측 벽체	1 층	상부	11	222.70	300.81	778.89	159.79	1000.00	700.00	
		중앙부 (외측)	12	71.07	63.07	798.24	58.66	1000.00	600.00	
		중앙부 (내측)	13	140.36	63.07	798.24	39.16	1000.00	600.00	
		하부	14	176.86	255.93	816.24	132.45	1000.00	600.00	

15.2 지진시(기능수행)

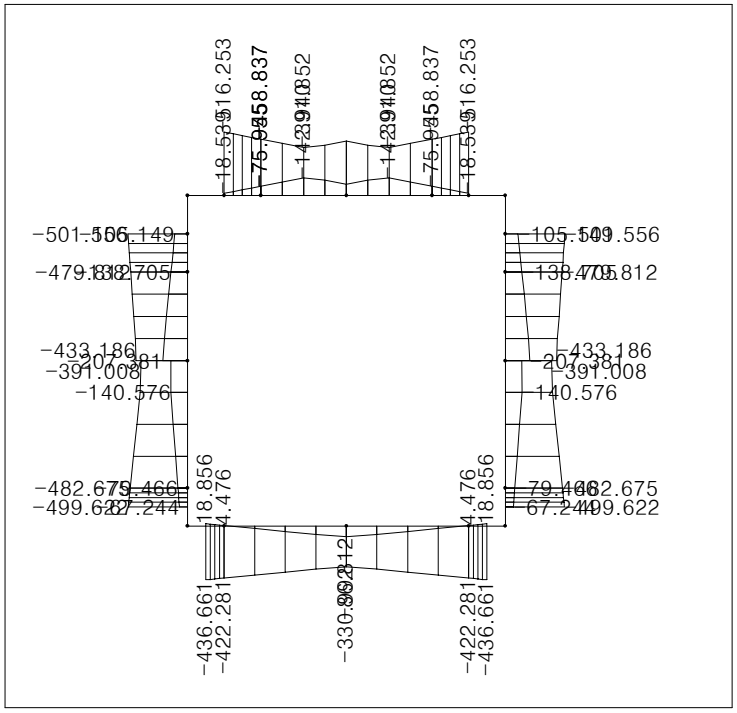
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

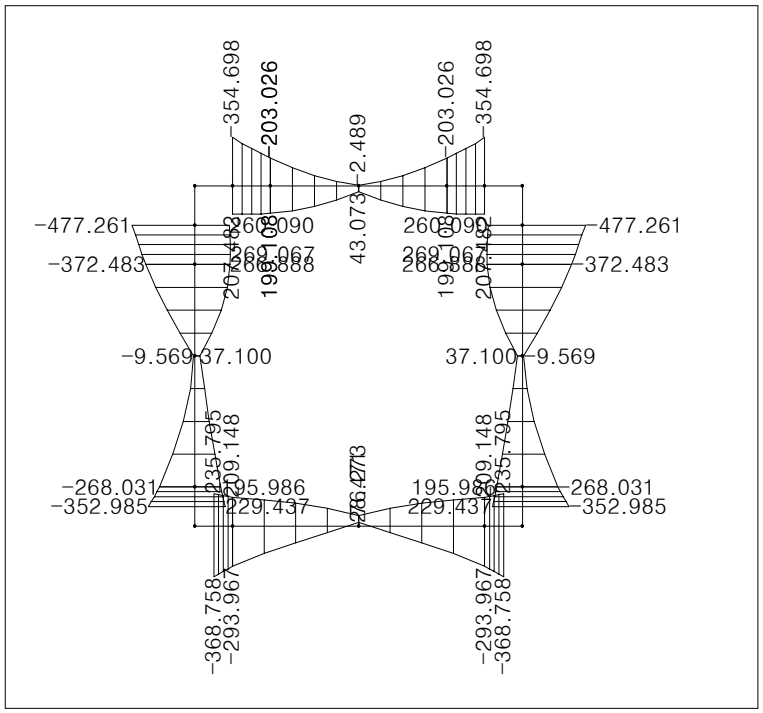


4) 단면력 정리

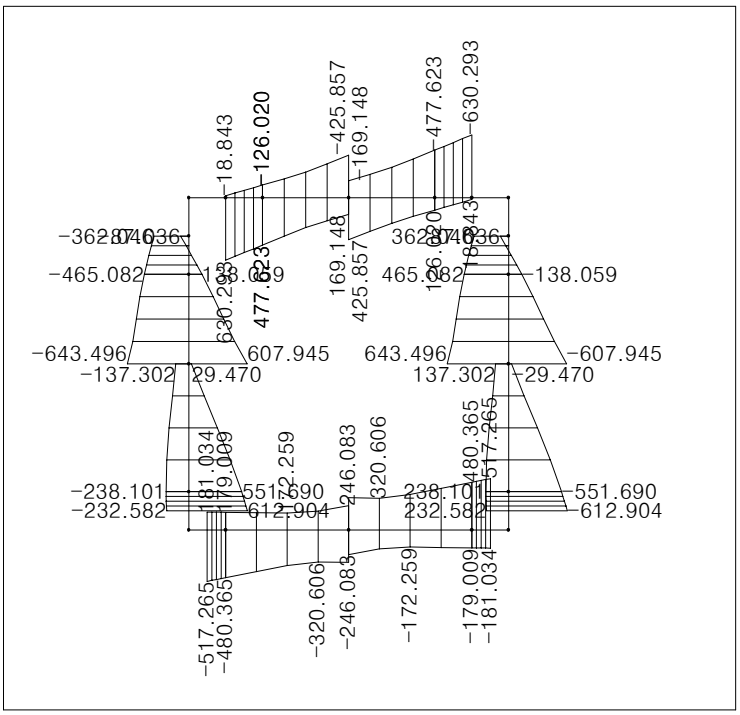
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	199.34	221.54	516.25	1000.00	700.00	
		중앙부	2	43.07	270.50	443.19	1000.00	600.00	
		우측	3	199.34	221.54	516.25	1000.00	700.00	
하부 슬래브	1 경간	좌측	4	149.75	213.15	422.28	1000.00	600.00	
		중앙부	5	76.27	180.89	330.99	1000.00	600.00	
		우측	6	149.75	213.15	422.28	1000.00	600.00	
좌측 벽체	1 층	상부	7	263.13	294.42	501.56	1000.00	700.00	
		중앙부 (외측)	8	8.13	271.60	433.19	1000.00	600.00	
		중앙부 (내측)	9	35.66	271.60	433.19	1000.00	600.00	
		하부	10	139.03	165.11	482.68	1000.00	600.00	
우측 벽체	1 층	상부	11	263.13	294.42	501.56	1000.00	700.00	
		중앙부 (외측)	12	8.13	271.60	391.01	1000.00	600.00	
		중앙부 (내측)	13	35.66	271.60	391.01	1000.00	600.00	
		하부	14	139.03	165.11	482.68	1000.00	600.00	

15.3 지진시(붕괴방지)

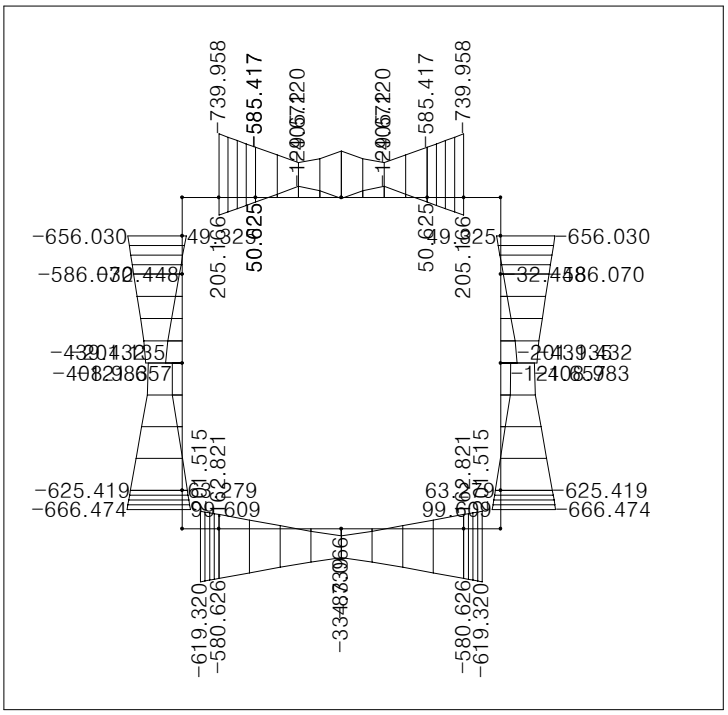
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중				B	H	비고
				모멘트	응답계수	전단력	축력			
				kN.m	kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	354.70	118.23	376.89	739.96	1000.00	700.00	
		중앙부	2	43.07	14.36	425.86	543.23	1000.00	600.00	
		우측	3	354.70	118.23	376.89	739.96	1000.00	700.00	
하부 슬래브	1 경간	좌측	4	293.97	97.99	357.37	580.63	1000.00	600.00	
		중앙부	5	76.27	25.42	325.11	334.74	1000.00	600.00	
		우측	6	293.97	97.99	357.37	580.63	1000.00	600.00	
좌측 벽체	1 층	상부	7	477.26	159.09	517.47	656.03	1000.00	700.00	
		중앙부 (외측)	8	9.57	3.19	643.50	439.43	1000.00	600.00	
		중앙부 (내측)	9	37.10	12.37	643.50	439.43	1000.00	600.00	
		하부	10	268.03	89.34	300.61	625.42	1000.00	600.00	
우측 벽체	1 층	상부	11	477.26	159.09	517.47	656.03	1000.00	700.00	
		중앙부 (외측)	12	9.57	3.19	643.50	408.98	1000.00	600.00	
		중앙부 (내측)	13	37.10	12.37	643.50	408.98	1000.00	600.00	
		하부	14	268.03	89.34	300.61	625.42	1000.00	600.00	

15.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-206.21	-	-118.23	-199.34	-206.21	
		중앙부	2	252.26	-	14.36	43.07	252.26	
		우측	3	-206.21	-	-118.23	-199.34	-206.21	
하부 슬래브	1 경간	좌측	4	-197.73	-	-97.99	-149.75	-197.73	
		중앙부	5	246.97	-	25.42	76.27	246.97	
		우측	6	-197.73	-	-97.99	-149.75	-197.73	
좌측 벽체	1 층	상부	7	-222.70	-	-159.09	-263.13	-263.13	
		중앙부 (외측)	8	-71.07	-	-3.19	-8.13	-71.07	
		중앙부 (내측)	9	140.36	-	12.37	35.66	140.36	
		하부	10	-176.86	-	-89.34	-139.03	-176.86	
우측 벽체	1 층	상부	11	-222.70	-	-159.09	-263.13	-263.13	
		중앙부 (외측)	12	-71.07	-	-3.19	-8.13	-71.07	
		중앙부 (내측)	13	140.36	-	12.37	35.66	140.36	
		하부	14	-176.86	-	-89.34	-139.03	-176.86	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	296.37	-	376.89	221.54	376.89	
		중앙부	2	10.71	-	425.86	270.50	425.86	
		우측	3	-296.37	-	-376.89	-221.54	-376.89	
하부 슬래브	1 경간	좌측	4	-322.72	-	-357.37	-213.15	-357.37	
		중앙부	5	-325.45	-	-325.11	-180.89	-325.45	
		우측	6	322.72	-	357.37	213.15	357.37	
좌측 벽체	1 층	상부	7	-300.81	-	-517.47	-294.42	-517.47	
		중앙부 (외측)	8	-63.07	-	-643.50	-271.60	-643.50	
		중앙부 (내측)	9	-63.07	-	-643.50	-271.60	-643.50	
		하부	10	255.93	-	300.61	165.11	300.61	
우측 벽체	1 층	상부	11	300.81	-	517.47	294.42	517.47	
		중앙부 (외측)	12	63.07	-	643.50	271.60	643.50	
		중앙부 (내측)	13	63.07	-	643.50	271.60	643.50	
		하부	14	-255.93	-	-300.61	-165.11	-300.61	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-694.82	-	-739.96	-516.25	-739.96	
		중앙부	2	-694.82	-	-543.23	-443.19	-694.82	
		우측	3	-694.82	-	-739.96	-516.25	-739.96	
하부 슬래브	1 경간	좌측	4	-684.73	-	-580.63	-422.28	-684.73	
		중앙부	5	-684.73	-	-334.74	-330.99	-684.73	
		우측	6	-684.73	-	-580.63	-422.28	-684.73	
좌측 벽체	1 층	상부	7	-778.89	-	-656.03	-501.56	-778.89	
		중앙부 (외측)	8	-798.24	-	-439.43	-433.19	-798.24	
		중앙부 (내측)	9	-798.24	-	-439.43	-433.19	-798.24	
		하부	10	-816.24	-	-625.42	-482.68	-816.24	
우측 벽체	1 층	상부	11	-778.89	-	-656.03	-501.56	-778.89	
		중앙부 (외측)	12	-798.24	-	-408.98	-391.01	-798.24	
		중앙부 (내측)	13	-798.24	-	-408.98	-391.01	-798.24	
		하부	14	-816.24	-	-625.42	-482.68	-816.24	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-134.04	-	-	-	-134.04	
		중앙부	2	194.16	-	-	-	194.16	
		우측	3	-134.04	-	-	-	-134.04	
하부 슬래브	1 경간	좌측	4	-133.56	-	-	-	-133.56	
		중앙부	5	185.24	-	-	-	185.24	
		우측	6	-133.56	-	-	-	-133.56	
좌측 벽체	1 층	상부	7	-159.79	-	-	-	-159.79	
		중앙부 (외측)	8	-58.66	-	-	-	-58.66	
		중앙부 (내측)	9	39.16	-	-	-	39.16	
		하부	10	-132.45	-	-	-	-132.45	
우측 벽체	1 층	상부	11	-159.79	-	-	-	-159.79	
		중앙부 (외측)	12	-58.66	-	-	-	-58.66	
		중앙부 (내측)	13	39.16	-	-	-	39.16	
		하부	14	-132.45	-	-	-	-132.45	

16. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	600	206.20	316.64	1026.10	H16 - 8.0EA	1588.80	1.54
		중앙부	2	1000	520	252.26	389.66	1462.65	H19 - 8.0EA	2292.00	1.54
		우측	3	1000	600	206.20	316.64	1026.10	H16 - 8.0EA	1588.80	1.54
하부슬래브	1경간	좌측	4	1000	500	197.73	374.07	1187.71	H19 - 8.0EA	2292.00	1.89
		중앙부	5	1000	520	246.97	389.66	1431.21	H19 - 8.0EA	2292.00	1.58
		우측	6	1000	500	197.73	374.07	1187.71	H19 - 8.0EA	2292.00	1.89
좌측벽체	1층	상부	7	1000	600	263.13	1190.86	-	H16 - 8.0EA	3880.80	4.53
		중앙부 (외측)	8	1000	500	71.07	740.66	-	H16 - 4.0EA	3086.40	10.42
		중앙부 (내측)	8	1000	520	140.36	990.89	-	H19 - 8.0EA	3086.40	7.06
		하부	9	1000	500	176.86	1067.32	-	H19 - 8.0EA	4584.00	6.04
우측벽체	1층	상부	10	1000	600	263.13	1190.86	-	H16 - 8.0EA	3880.80	4.53
		중앙부 (외측)	11	1000	500	71.07	740.66	-	H16 - 4.0EA	3086.40	10.42
		중앙부 (내측)	11	1000	520	140.36	990.89	-	H19 - 8.0EA	3086.40	7.06
		하부	12	1000	500	176.86	1067.32	-	H19 - 8.0EA	4584.00	6.04

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	324.8	376.9	578.16	2.00	52.13	H13	150	253.40	O.K
		우측	3	324.8	376.9	578.16	2.00	52.13	H13	150	253.40	O.K
하부슬래브	1경간	좌측	4	324.8	357.4	578.16	2.00	32.61	H13	150	253.40	O.K
		중앙부	5	337.8	325.4	601.29	2.00	-	H13	150	253.40	O.K
		우측	6	324.8	357.4	578.16	2.00	32.61	H13	150	253.40	O.K
좌측벽체	1층	상부	7	354.9	517.5	608.27	2.00	162.60	H13	150	253.40	O.K
		하부	9	356.3	300.6	609.72	2.00	131.25	H13	150	253.40	O.K
우측벽체	1층	상부	10	354.9	517.5	608.27	2.00	162.60	H13	150	253.40	O.K
		하부	12	356.3	300.6	609.72	2.00	131.25	H13	150	253.40	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	700.00	600.00	100.00	206.21	376.89

* 강도감소계수(Φ) 산정

T = As x fy = 1588.800 x 400.00 = 635520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 27.692 mm, c = 27.692 / β1 = 27.692 / 0.85 = 32.578 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (600.00 - 32.578) / 32.578 = 0.05225

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1026.100 \text{ mm}^2$$

* 사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm) , [사용률 = 1.548]

1단 : H16 - 8.0 EA (= 1588.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00265

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 27.692 mm

ΦMn = 0.85 x 1588.800 x 400 x (600.00 - a/2) = 316.636 kN.m

≥ Mu (= 206.205 kN.m) ∴ O.K [안전률 1.536]

* 전단에 대한 검토 (d = 500.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 500.00 = 324.760 kN

< Vu (= 376.894 kN) , 전단보강 필요.

Av_req = (376.894-324.760) x 150.00 / (400x500.00xΦ) x 1000 = 52.135 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 500.00 / 150.00 x 1000 = 337.867 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 500.00 / 1000 = 1732.051 kN ≥ 337.867 kN ∴ O.K

ΦVn = 0.75 x (433.013 + 337.867) = 578.160 kN ≥ 376.894 kN ∴ O.K

▣ TITLE : 상부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	600.00	520.00	80.00	252.26	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (520.00 - 46.997) / 46.997 = 0.03019

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1462.651 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm), [사용률 = 1.567]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00441

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (520.00 - a/2) = 389.660 kN.m

≥ Mu (= 252.258 kN.m) ∴ O.K [안전률 1.545]

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	700.00	600.00	100.00	206.21	376.89

* 강도감소계수(Φ) 산정

T = As x fy = 1588.800 x 400.00 = 635520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 27.692 mm, c = 27.692 / β1 = 27.692 / 0.85 = 32.578 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (600.00 - 32.578) / 32.578 = 0.05225

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1026.100 \text{ mm}^2$$

* 사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm) , [사용률 = 1.548]

1단 : H16 - 8.0 EA (= 1588.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00265

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 27.692 mm

ΦMn = 0.85 x 1588.800 x 400 x (600.00 - a/2) = 316.636 kN.m

≥ Mu (= 206.205 kN.m) ∴ O.K [안전률 1.536]

* 전단에 대한 검토 (d = 500.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 500.00 = 324.760 kN

< Vu (= 376.894 kN) , 전단보강 필요.

Av_req = (376.894-324.760) x 150.00 / (400x500.00xΦ) x 1000 = 52.135 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 500.00 / 150.00 x 1000 = 337.867 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 500.00 / 1000 = 1732.051 kN ≥ 337.867 kN ∴ O.K

ΦVn = 0.75 x (433.013 + 337.867) = 578.160 kN ≥ 376.894 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	600.00	500.00	100.00	197.73	357.37

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (500.00 - 46.997) / 46.997 = 0.02892

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1187.705 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 100.0 mm) , [사용률 = 1.930]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00458

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (500.00 - a/2) = 374.075 kN.m

≥ Mu (= 197.730 kN.m) ∴ O.K [안전률 1.892]

* 전단에 대한 검토 (d = 500.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 500.00 = 324.760 kN

< Vu (= 357.365 kN) , 전단보강 필요.

Av_req = (357.365-324.760) x 150.00 / (400x500.00xΦ) x 1000 = 32.606 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 500.00 / 150.00 x 1000 = 337.867 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 500.00 / 1000 = 1732.051 kN ≥ 337.867 kN ∴ O.K

ΦVn = 0.75 x (433.013 + 337.867) = 578.160 kN ≥ 357.365 kN ∴ O.K

▣ TITLE : 하부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	600.00	520.00	80.00	246.97	325.45

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (520.00 - 46.997) / 46.997 = 0.03019

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1431.213 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm), [사용률 = 1.601]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00441

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (520.00 - a/2) = 389.660 kN.m

≥ Mu (= 246.969 kN.m) ∴ O.K [안전률 1.578]

* 전단에 대한 검토 (d = 520.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 520.00 = 337.750 kN

≥ Vu (= 325.448 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	600.00	500.00	100.00	197.73	357.37

* 강도감소계수(Φ) 산정

T = As x fy = 2292.000 x 400.00 = 916800.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 39.948 mm, c = 39.948 / β1 = 39.948 / 0.85 = 46.997 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (500.00 - 46.997) / 46.997 = 0.02892

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

$Mu / \Phi = As \times fy \times (d - a/2)$ ---------- ①

$a = As \times fy / (0.85 \times fck \times b)$ ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 1187.705 \text{ mm}^2$$

* 사용철근량 = 2292.0 mm² (철근도심 : 100.0 mm) , [사용률 = 1.930]

1단 : H19 - 8.0 EA (= 2292.0 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00458

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 39.948 mm

ΦMn = 0.85 x 2292.000 x 400 x (500.00 - a/2) = 374.075 kN.m

≥ Mu (= 197.730 kN.m) ∴ O.K [안전률 1.892]

* 전단에 대한 검토 (d = 500.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 500.00 = 324.760 kN

< Vu (= 357.365 kN) , 전단보강 필요.

Av_req = (357.365-324.760) x 150.00 / (400x500.00xΦ) x 1000 = 32.606 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 500.00 / 150.00 x 1000 = 337.867 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 500.00 / 1000 = 1732.051 kN ≥ 337.867 kN ∴ O.K

ΦVn = 0.75 x (433.013 + 337.867) = 578.160 kN ≥ 357.365 kN ∴ O.K

▣ TITLE : 좌측벽체 상부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	700	100	600	778.89	263.129	337.8

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0065) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 700.0 x 1000.0 = 16065000.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 916800.0 N

Xp = (16065000.0 x 350.00 + 635520.0 x 100.000 + 916800.0 x 620.000) / 17617320.0

= 355.032 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 360.00 mm, ab = k1 x cb = 306.00 mm

Cc = 0.85 x 27.0 x 306000.000 = 7022.700 kN, ∑Csi = 864.199 kN, ∑Tsi = 635.520 kN

Pb = 7022.700 + 864.199 - 635.520 = 7251.379 kN

Mb = Cc x 447.000 + ∑(Csi*di) + ∑(Tsi*di) = 1739.194 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 239.843 mm, e = Mu/Pu = 337.826 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 204.90 mm, a = k1 x c = 174.16 mm 를 사용.

Cc = 0.85 x 27.0 x 174160.767 = 3996.990 kN

∑Csi = 785.660 kN, ∑Tsi = 635.520 kN

Pn = 3996.990 + 785.660 - 635.520 = 4147.130 kN

Mn = Cc x 512.920 + ∑(Csi*di) + ∑(Tsi*di) = 1401.026 kN.m

- 편심오차 : |e - Mn/Pn(=337.830)| = 0.0042 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 700.00 - 100.00 = 600.000 mm

c = 204.895 mm, a = k1 x c = 174.161 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (600.00-204.90) / 204.90 = 0.00578

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 12186.605 kN ≥ Pn = 4147.130 kN

ΦPn = 0.85 x 4147.130 = 3525.060 kN ≥ Pu = 778.890 kN ∴ O.K

ΦMn = ΦPn x 0.338 = 1190.857 kN.m ≥ Mu = 263.129 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 500.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 500.00 = 354.873 kN

< Vu (= 517.474 kN) , 전단보강 필요.

Req Av = (517.474 - 354.873) x 150.00 / (400.0 x 500.00 x Φ) = 162.601 mm²

Use Av = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 500.00 / 150.00 = 337.867 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 500.00 = 1732.051 kN ≥ 337.867 kN ∴ O.K

ΦVn = 0.75 x (473.164 + 337.867) = 608.273 kN ≥ 517.474 kN ∴ O.K

▣ TITLE : 좌측벽체 중앙부_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	600	100	500	798.24	71.068	89

㉯ 철근비 검토

As = 794.400 mm² (인장중심 = 100.00 mm), 1단 : H16- 4.0EA, d1 = 100.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0051) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 600.0 x 1000.0 = 13770000.0 N

Cs = As x fy = 317760.0 N, Cs' = Asf x fy = 916800.0 N

Xp = (13770000.0 x 300.00 + 317760.0 x 100.000 + 916800.0 x 520.000) / 15004560.0

= 309.207 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 300.00 mm, ab = k1 x cb = 255.00 mm

Cc = 0.85 x 27.0 x 255000.000 = 5852.250 kN, ∑Csi = 864.199 kN, ∑Tsi = 317.760 kN

Pb = 5852.250 + 864.199 - 317.760 = 6398.689 kN

Mb = Cc x 372.500 + ∑(Csi*di) + ∑(Tsi*di) = 1204.277 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 188.207 mm, e = Mu/Pu = 89.031 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 500.11 mm, a = k1 x c = 425.09 mm 를 사용.

Cc = 0.85 x 27.0 x 425090.790 = 9755.834 kN

∑Csi = 864.300 kN, ∑Tsi = 0.000 kN

Pn = 9755.834 + 864.300 - 0.000 = 10620.134 kN

Mn = Cc x 287.455 + ∑(Csi*di) + ∑(Tsi*di) = 945.518 kN.m

- 편심오차 : |e - Mn/Pn(=89.031)| = 0.0001 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 600.00 - 100.00 = 500.000 mm

c = 500.107 mm, a = k1 x c = 425.091 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (500.00-500.11) / 500.11 = -0.00000

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 11946.982 kN ≥ Pn = 10620.134 kN

ΦPn = 0.78 x 10620.134 = 8319.105 kN ≥ Pu = 798.240 kN ∴ O.K

ΦMn = ΦPn x 0.089 = 740.657 kN.m ≥ Mu = 71.068 kN.m ∴ O.K

▣ TITLE : 좌측벽체 중앙부_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	600	80	520	798.24	140.364	175.8

㉯ 철근비 검토

As = 2292.000 mm² (인장중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

Asf = 794.400 mm² (압축중심 = 100.00 mm), 1단 : H16- 4.0EA, d1 = 100.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0051) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 600.0 x 1000.0 = 13770000.0 N

Cs = As x fy = 916800.0 N, Cs' = Asf x fy = 317760.0 N

Xp = (13770000.0 x 300.00 + 916800.0 x 80.000 + 317760.0 x 500.000) / 15004560.0

= 290.793 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 312.00 mm, ab = k1 x cb = 265.20 mm

Cc = 0.85 x 27.0 x 265200.000 = 6086.340 kN, ∑Csi = 299.529 kN, ∑Tsi = 916.800 kN

Pb = 6086.340 + 299.529 - 916.800 = 5469.069 kN

Mb = Cc x 387.400 + ∑(Csi*di) + ∑(Tsi*di) = 1330.808 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 243.334 mm, e = Mu/Pu = 175.842 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 379.51 mm, a = k1 x c = 322.58 mm 를 사용.

Cc = 0.85 x 27.0 x 322583.923 = 7403.301 kN

∑Csi = 299.529 kN, ∑Tsi = 509.080 kN

Pn = 7403.301 + 299.529 - 509.080 = 7193.750 kN

Mn = Cc x 358.708 + ∑(Csi*di) + ∑(Tsi*di) = 1265.032 kN.m

- 편심오차 : |e - Mn/Pn(=175.852)| = 0.0097 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 600.00 - 80.00 = 520.000 mm

c = 379.510 mm, a = k1 x c = 322.584 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (520.00-379.51) / 379.51 = 0.00111

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 11946.982 kN ≥ Pn = 7193.750 kN

ΦPn = 0.78 x 7193.750 = 5635.104 kN ≥ Pu = 798.240 kN ∴ O.K

ΦMn = ΦPn x 0.176 = 990.887 kN.m ≥ Mu = 140.364 kN.m ∴ O.K

▣ TITLE : 좌측벽체 하부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	600	100	500	816.24	176.859	216.7

㉯ 철근비 검토

As = 2292.000 mm² (인장중심 = 100.00 mm), 1단 : H19- 8.0EA, d1 = 100.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0076) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 600.0 x 1000.0 = 13770000.0 N

Cs = As x fy = 916800.0 N, Cs' = Asf x fy = 916800.0 N

Xp = (13770000.0 x 300.00 + 916800.0 x 100.000 + 916800.0 x 520.000) / 15603600.0

= 301.175 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 300.00 mm, ab = k1 x cb = 255.00 mm

Cc = 0.85 x 27.0 x 255000.000 = 5852.250 kN, ∑Csi = 864.199 kN, ∑Tsi = 916.800 kN

Pb = 5852.250 + 864.199 - 916.800 = 5799.649 kN

Mb = Cc x 372.500 + ∑(Csi*di) + ∑(Tsi*di) = 1376.182 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 237.287 mm, e = Mu/Pu = 216.675 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 318.30 mm, a = k1 x c = 270.55 mm 를 사용.

Cc = 0.85 x 27.0 x 270553.589 = 6209.205 kN

∑Csi = 864.199 kN, ∑Tsi = 785.037 kN

Pn = 6209.205 + 864.199 - 785.037 = 6288.366 kN

Mn = Cc x 364.723 + ∑(Csi*di) + ∑(Tsi*di) = 1362.542 kN.m

- 편심오차 : |e - Mn/Pn(=216.677)| = 0.0018 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 600.00 - 100.00 = 500.000 mm

c = 318.298 mm, a = k1 x c = 270.554 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (500.00-318.30) / 318.30 = 0.00171

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 12398.718 kN ≥ Pn = 6288.366 kN

ΦPn = 0.78 x 6288.366 = 4925.887 kN ≥ Pu = 816.240 kN ∴ O.K

ΦMn = ΦPn x 0.217 = 1067.316 kN.m ≥ Mu = 176.859 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 500.00 = 356.317 kN

ΦVc/2 < Vu (= 300.611 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 ㎟

Av_use = H13 - 2.0 EA = 253.400 ㎟ ∴ O.K

▣ TITLE : 우측벽체 상부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	700	100	600	778.89	263.129	337.8

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0065) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 700.0 x 1000.0 = 16065000.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 916800.0 N

Xp = (16065000.0 x 350.00 + 635520.0 x 100.000 + 916800.0 x 620.000) / 17617320.0

= 355.032 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 360.00 mm, ab = k1 x cb = 306.00 mm

Cc = 0.85 x 27.0 x 306000.000 = 7022.700 kN, ∑Csi = 864.199 kN, ∑Tsi = 635.520 kN

Pb = 7022.700 + 864.199 - 635.520 = 7251.379 kN

Mb = Cc x 447.000 + ∑(Csi*di) + ∑(Tsi*di) = 1739.194 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 239.843 mm, e = Mu/Pu = 337.826 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 204.90 mm, a = k1 x c = 174.16 mm 를 사용.

Cc = 0.85 x 27.0 x 174160.767 = 3996.990 kN

∑Csi = 785.660 kN, ∑Tsi = 635.520 kN

Pn = 3996.990 + 785.660 - 635.520 = 4147.130 kN

Mn = Cc x 512.920 + ∑(Csi*di) + ∑(Tsi*di) = 1401.026 kN.m

- 편심오차 : |e - Mn/Pn(=337.830)| = 0.0042 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 700.00 - 100.00 = 600.000 mm

c = 204.895 mm, a = k1 x c = 174.161 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (600.00-204.90) / 204.90 = 0.00578

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 12186.605 kN ≥ Pn = 4147.130 kN

ΦPn = 0.85 x 4147.130 = 3525.060 kN ≥ Pu = 778.890 kN ∴ O.K

ΦMn = ΦPn x 0.338 = 1190.857 kN.m ≥ Mu = 263.129 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 500.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 500.00 = 354.873 kN

< Vu (= 517.474 kN) , 전단보강 필요.

Req Av = (517.474 - 354.873) x 150.00 / (400.0 x 500.00 x Φ) = 162.601 mm²

Use Av = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 500.00 / 150.00 = 337.867 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 500.00 = 1732.051 kN ≥ 337.867 kN ∴ O.K

ΦVn = 0.75 x (473.164 + 337.867) = 608.273 kN ≥ 517.474 kN ∴ O.K

▣ TITLE : 우측벽체 중앙부_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	600	100	500	798.24	71.068	89

㉯ 철근비 검토

As = 794.400 mm² (인장중심 = 100.00 mm), 1단 : H16- 4.0EA, d1 = 100.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0051) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 600.0 x 1000.0 = 13770000.0 N

Cs = As x fy = 317760.0 N, Cs' = Asf x fy = 916800.0 N

Xp = (13770000.0 x 300.00 + 317760.0 x 100.000 + 916800.0 x 520.000) / 15004560.0

= 309.207 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 300.00 mm, ab = k1 x cb = 255.00 mm

Cc = 0.85 x 27.0 x 255000.000 = 5852.250 kN, ∑Csi = 864.199 kN, ∑Tsi = 317.760 kN

Pb = 5852.250 + 864.199 - 317.760 = 6398.689 kN

Mb = Cc x 372.500 + ∑(Csi*di) + ∑(Tsi*di) = 1204.277 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 188.207 mm, e = Mu/Pu = 89.031 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 500.11 mm, a = k1 x c = 425.09 mm 를 사용.

Cc = 0.85 x 27.0 x 425090.790 = 9755.834 kN

∑Csi = 864.300 kN, ∑Tsi = 0.000 kN

Pn = 9755.834 + 864.300 - 0.000 = 10620.134 kN

Mn = Cc x 287.455 + ∑(Csi*di) + ∑(Tsi*di) = 945.518 kN.m

- 편심오차 : |e - Mn/Pn(=89.031)| = 0.0001 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 600.00 - 100.00 = 500.000 mm

c = 500.107 mm, a = k1 x c = 425.091 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (500.00-500.11) / 500.11 = -0.00000

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 11946.982 kN ≥ Pn = 10620.134 kN

ΦPn = 0.78 x 10620.134 = 8319.105 kN ≥ Pu = 798.240 kN ∴ O.K

ΦMn = ΦPn x 0.089 = 740.657 kN.m ≥ Mu = 71.068 kN.m ∴ O.K

▣ TITLE : 우측벽체 중앙부_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	600	80	520	798.24	140.364	175.8

㉯ 철근비 검토

As = 2292.000 mm² (인장중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

Asf = 794.400 mm² (압축중심 = 100.00 mm), 1단 : H16- 4.0EA, d1 = 100.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0051) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 600.0 x 1000.0 = 13770000.0 N

Cs = As x fy = 916800.0 N, Cs' = Asf x fy = 317760.0 N

Xp = (13770000.0 x 300.00 + 916800.0 x 80.000 + 317760.0 x 500.000) / 15004560.0

= 290.793 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 312.00 mm, ab = k1 x cb = 265.20 mm

Cc = 0.85 x 27.0 x 265200.000 = 6086.340 kN, ∑Csi = 299.529 kN, ∑Tsi = 916.800 kN

Pb = 6086.340 + 299.529 - 916.800 = 5469.069 kN

Mb = Cc x 387.400 + ∑(Csi*di) + ∑(Tsi*di) = 1330.808 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 243.334 mm, e = Mu/Pu = 175.842 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 379.51 mm, a = k1 x c = 322.58 mm 를 사용.

Cc = 0.85 x 27.0 x 322583.923 = 7403.301 kN

∑Csi = 299.529 kN, ∑Tsi = 509.080 kN

Pn = 7403.301 + 299.529 - 509.080 = 7193.750 kN

Mn = Cc x 358.708 + ∑(Csi*di) + ∑(Tsi*di) = 1265.032 kN.m

- 편심오차 : |e - Mn/Pn(=175.852)| = 0.0097 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 600.00 - 80.00 = 520.000 mm

c = 379.510 mm, a = k1 x c = 322.584 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (520.00-379.51) / 379.51 = 0.00111

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 11946.982 kN ≥ Pn = 7193.750 kN

ΦPn = 0.78 x 7193.750 = 5635.104 kN ≥ Pu = 798.240 kN ∴ O.K

ΦMn = ΦPn x 0.176 = 990.887 kN.m ≥ Mu = 140.364 kN.m ∴ O.K

▣ TITLE : 우측벽체 하부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	600	100	500	816.24	176.859	216.7

㉯ 철근비 검토

As = 2292.000 mm² (인장중심 = 100.00 mm), 1단 : H19- 8.0EA, d1 = 100.00 mm

Asf = 2292.000 mm² (압축중심 = 80.00 mm), 1단 : H19- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0015) ≤ ρuse (= 0.0076) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 600.0 x 1000.0 = 13770000.0 N

Cs = As x fy = 916800.0 N, Cs' = Asf x fy = 916800.0 N

Xp = (13770000.0 x 300.00 + 916800.0 x 100.000 + 916800.0 x 520.000) / 15603600.0

= 301.175 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 300.00 mm, ab = k1 x cb = 255.00 mm

Cc = 0.85 x 27.0 x 255000.000 = 5852.250 kN, ∑Csi = 864.199 kN, ∑Tsi = 916.800 kN

Pb = 5852.250 + 864.199 - 916.800 = 5799.649 kN

Mb = Cc x 372.500 + ∑(Csi*di) + ∑(Tsi*di) = 1376.182 kN.m

eb > e → 압축 파괴 (eb = Mb/Pb = 237.287 mm, e = Mu/Pu = 216.675 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 318.30 mm, a = k1 x c = 270.55 mm 를 사용.

Cc = 0.85 x 27.0 x 270553.589 = 6209.205 kN

∑Csi = 864.199 kN, ∑Tsi = 785.037 kN

Pn = 6209.205 + 864.199 - 785.037 = 6288.366 kN

Mn = Cc x 364.723 + ∑(Csi*di) + ∑(Tsi*di) = 1362.542 kN.m

- 편심오차 : |e - Mn/Pn(=216.677)| = 0.0018 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 600.00 - 100.00 = 500.000 mm

c = 318.298 mm, a = k1 x c = 270.554 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (500.00-318.30) / 318.30 = 0.00171

→ 계수축력이 0.10*fck*Ag보다 작으므로 εt는 최소허용변형률 이상이어야 한다.

최소허용변형률은 fy가 400 MPa 이하이므로 0.00400를 적용한다.

εy < εt < 0.00500 이므로 변화구간단면이며, Φ = 0.78 를 적용한다.

Φ = 0.650 + (0.0040-0.0020) x (0.850-0.650) / (0.00500-0.00200) = 0.783

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 12398.718 kN ≥ Pn = 6288.366 kN

ΦPn = 0.78 x 6288.366 = 4925.887 kN ≥ Pu = 816.240 kN ∴ O.K

ΦMn = ΦPn x 0.217 = 1067.316 kN.m ≥ Mu = 176.859 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 500.00 = 356.317 kN

ΦVc/2 < Vu (= 300.611 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 ㎟

Av_use = H13 - 2.0 EA = 253.400 ㎟ ∴ O.K

17. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1200.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1026.100 × 0.20 = 205.22 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 205.220 ∴ O.K

2) 상부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 10EA = 1267.000 ㎟ ≥ 1200.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1462.651 × 0.20 = 292.53 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 292.530 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1200.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1026.100 × 0.20 = 205.22 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 205.220 ∴ O.K

4) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1200.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1187.705 × 0.20 = 237.54 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 237.541 ∴ O.K

5) 하부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 10EA = 1267.000 ㎟ ≥ 1200.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1431.213 × 0.20 = 286.24 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 286.243 ∴ O.K

6) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1200.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 1187.705 × 0.20 = 237.54 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 237.541 ∴ O.K

7) 좌측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1200.000 ∴ O.K

8) 좌측벽체 : 중앙부_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 10EA = 1267.000 ㎟ ≥ 1200.000 ∴ O.K

9) 좌측벽체 : 중앙부_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 10EA = 1267.000 ㎟ ≥ 1200.000 ∴ O.K

10) 좌측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1200.000 ∴ O.K

11) 우측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1200.000 ∴ O.K

12) 우측벽체 : 중앙부_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 10EA = 1267.000 ㎟ ≥ 1200.000 ∴ O.K

13) 우측벽체 : 중앙부_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 10EA = 1267.000 ㎟ ≥ 1200.000 ∴ O.K

14) 우측벽체 : 하부

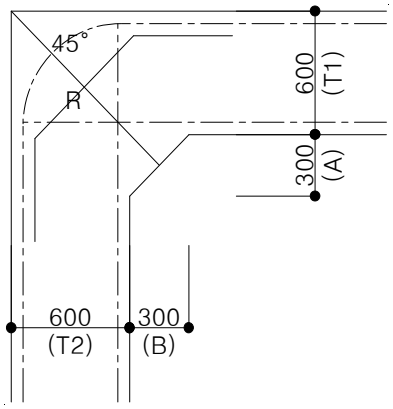
① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 600 × 0.0020 = 1200.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1200.000 ∴ O.K

18. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 159.792 kN.m
- 절점부 휨모멘트 : Mo = 159.792 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 1060.660 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H16 @250 - 4EA = 794.400 mm²

∴ Total Asb = 794.400 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 159.79 \times 10^6}{1060.660^2 \times 1000} = 0.710 \text{ MPa} > 0.13\sqrt{fck}\ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 159.79 \times 10^6}{1060.660 \times 180} = 1673.928 \text{ mm}^2$$

Asb = 794.400 mm²

Req'd As = As - Asb

= 1673.928 mm² - 794.400 mm²

= 879.528 mm²

- 사용보강철근

Use'd As = H16 - 8EA

∴ Total As = 1588.800 mm² > Req'd As (= 879.528 mm²) ----------> O.K !!!

② 내측인장 휨모멘트 보강검토

- 수평부재 내측에 배근된 주철근량 : 2292 ㎟

k = -np + √(2 x np + (np)²) [∵ n = 7]

= - 7 x 0.0044077 + √(2 x 0.0309 + (0.0309)²) = 0.219

j = 1 - k / 3 = 1 - 0.219 /3 = 0.927

fs = Mo / (As x d x j) = 1213251.000 / (2292.000 x 520.000 x 0.927)

= 1.098 MPa

인장력 Th1 = fs x As = 1.098 x 2292.000 = 2517.331 N

- 연직부재 내측에 배근된 주철근량 : 2292 ㎟

k = -np + √(2 x np + (np)²) [∵ n = 7]

= - 7 x 0.0044077 + √(2 x 0.0309 + (0.0309)²) = 0.219

j = 1 - k / 3 = 1 - 0.219 /3 = 0.927

fs = Mo / (As x d x j) = 1213251.000 / (2292.000 x 520.000 x 0.927)

= 1.098 MPa

인장력 Th2 = fs x As = 1.098 x 2292.000 = 2517.331 N

- 보강철근량 산정

T = √(Th1² + Th2²) = fsa x As T : 대각선 방향의 인장력

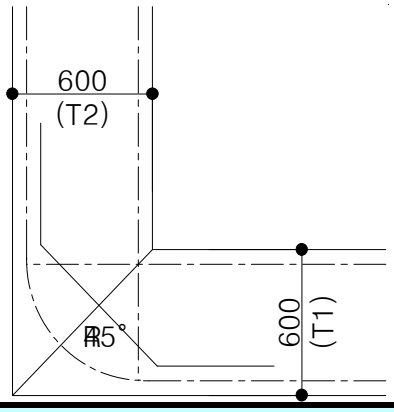
Th : 수평부재 또는 연직부재에 작용하는 인장력

As = √(Th1² + Th2²) / fsa = √(2517.331² + 2517.331²) / 180.0

As = 19.778 ㎟

사용철근량 : H16 @ 500, 2EA = 794.400 ㎟ ∴ O.K

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 186.141 kN.m
- 절점부 휨모멘트 : Mo = 186.141 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 848.528$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H19 @250 - 4EA = 1146.000 mm²

∴ Total Asb = 1146.000 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 186.14 \times 10^6}{848.528^2 \times 1000} = 1.293 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 186.14 \times 10^6}{848.528 \times 180} = 2437.441 \text{ mm}^2$$

Asb = 1146.000 mm²

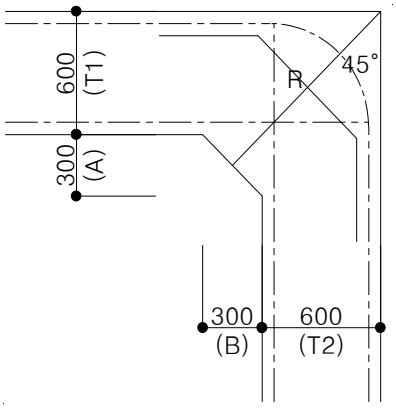
Req'd As = As - Asb
= 2437.441 mm² - 1146.000 mm²
= 1291.441 mm²

- 사용보강철근

Use'd As = H19 - 8EA

∴ Total As = 2292.000 mm² > Req'd As (= 1291.441 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 159.792 kN.m
- 절점부 휨모멘트 : Mo = 159.792 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 1060.660 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H16 @250 - 4EA = 794.400 mm²

∴ Total Asb = 794.400 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 159.79 \times 10^6}{1060.660^2 \times 1000} = 0.710 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 159.79 \times 10^6}{1060.660 \times 180} = 1673.928 \text{ mm}^2$$

Asb = 794.400 mm²

Req'd As = As - Asb
= 1673.928 mm² - 794.400 mm²
= 879.528 mm²

- 사용보강철근

Use'd As = H16 - 8EA

∴ Total As = 1588.800 mm² > Req'd As (= 879.528 mm²) ----------> O.K !!!

② 내측인장 휨모멘트 보강검토

- 수평부재 내측에 배근된 주철근량 : 2292 ㎟

k = -np + √(2 x np + (np)²) [∵ n = 7]

= - 7 x 0.0044077 + √(2 x 0.0309 + (0.0309)²) = 0.219

j = 1 - k / 3 = 1 - 0.219 /3 = 0.927

fs = Mo / (As x d x j) = 1213251.000 / (2292.000 x 520.000 x 0.927)

= 1.098 MPa

인장력 Th1 = fs x As = 1.098 x 2292.000 = 2517.331 N

- 연직부재 내측에 배근된 주철근량 : 2292 ㎟

k = -np + √(2 x np + (np)²) [∵ n = 7]

= - 7 x 0.0044077 + √(2 x 0.0309 + (0.0309)²) = 0.219

j = 1 - k / 3 = 1 - 0.219 /3 = 0.927

fs = Mo / (As x d x j) = 1213251.000 / (2292.000 x 520.000 x 0.927)

= 1.098 MPa

인장력 Th2 = fs x As = 1.098 x 2292.000 = 2517.331 N

- 보강철근량 산정

T = √(Th1² + Th2²) = fsa x As T : 대각선 방향의 인장력

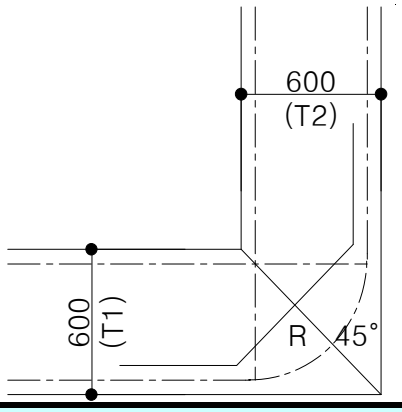
Th : 수평부재 또는 연직부재에 작용하는 인장력

As = √(Th1² + Th2²) / fsa = √(2517.331² + 2517.331²) / 180.0

As = 19.778 ㎟

사용철근량 : H16 @ 500, 2EA = 794.400 ㎟ ∴ O.K

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 186.141 kN.m
- 절점부 휨모멘트 : Mo = 186.141 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 848.528$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H19 @250 - 4EA = 1146.000 mm²

∴ Total Asb = 1146.000 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 186.14 \times 10^6}{848.528^2 \times 1000} = 1.293 \text{ MPa} > 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 186.14 \times 10^6}{848.528 \times 180} = 2437.441 \text{ mm}^2$$

Asb = 1146.000 mm²

Req'd As = As - Asb
= 2437.441 mm² - 1146.000 mm²
= 1291.441 mm²

- 사용보강철근

Use'd As = H19 - 8EA

∴ Total As = 2292.000 mm² > Req'd As (= 1291.441 mm²) ----------> O.K !!!

19. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	600	H16 - 8.0EA	125	297.406	O.K	2.379
		중앙부	2	520	H19 - 8.0EA	125	271.784	O.K	2.174
		우측	3	600	H16 - 8.0EA	125	297.406	O.K	2.379
하부슬래브	1경간	좌측	4	500	H19 - 8.0EA	125	399.152	O.K	3.193
		중앙부	5	520	H19 - 8.0EA	125	293.373	O.K	2.347
		우측	6	500	H19 - 8.0EA	125	399.152	O.K	3.193
좌측벽체	1층	상부	7	600	H16 - 8.0EA	125	212.414	O.K	1.699
		중앙부	8	500	H16 - 4.0EA	250	278.623	O.K	1.114
		중앙부	8	520	H19 - 8.0EA	125	1777.095	O.K	14.217
		하부	9	500	H19 - 8.0EA	125	404.415	O.K	3.235
우측벽체	1층	상부	10	600	H16 - 8.0EA	125	212.414	O.K	1.699
		중앙부	11	500	H16 - 4.0EA	250	278.623	O.K	1.114
		중앙부	11	520	H19 - 8.0EA	125	1777.095	O.K	14.217
		하부	12	500	H19 - 8.0EA	125	404.415	O.K	3.235

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 134.041 x 1000000 / [1588.800 x (600.000 - 104.937/3)]
= 149.316 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x600.0/(7x1588.800)]
= 104.937 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 149.32) - 2.5 x 92.00 = 297.41 mm
300 x (Kcr / fs) = 300 x (210 / 149.32) = 421.92 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 297.41 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 297.41 mm) ∴ O.K

2) 상부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 194.162 x 1000000 / [2292.000 x (520.000 - 114.122/3)]
= 175.768 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x2292.000/1000.0 + 7x2292.000/1000.0 x √[(1 + 2x1000.0x520.0/(7x2292.000)]
= 114.122 mm

사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm)
1단 : H19 - 8.0 EA (= 2292.0 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 19/2 = 70.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 175.77) - 2.5 x 70.50 = 271.78 mm
300 x (Kcr / fs) = 300 x (210 / 175.77) = 358.43 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 271.78 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 271.78 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 134.041 x 1000000 / [1588.800 x (600.000 - 104.937/3)]
= 149.316 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x600.0/(7x1588.800)]
= 104.937 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 149.32) - 2.5 x 92.00 = 297.41 mm
300 x (Kcr / fs) = 300 x (210 / 149.32) = 421.92 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 297.41 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 297.41 mm) ∴ O.K

4) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 133.564 x 1000000 / [2292.000 x (500.000 - 111.633/3)]
= 125.919 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x2292.000/1000.0 + 7x2292.000/1000.0 x √[(1 + 2x1000.0x500.0/(7x2292.000)]
= 111.633 mm

사용철근량 = 2292.0 mm² (철근도심 : 100.0 mm)
1단 : H19 - 8.0 EA (= 2292.0 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 19/2 = 90.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 125.92) - 2.5 x 90.50 = 399.15 mm
300 x (Kcr / fs) = 300 x (210 / 125.92) = 500.32 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 399.15 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 399.15 mm) ∴ O.K

5) 하부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 185.236 x 1000000 / [2292.000 x (520.000 - 114.122/3)]
= 167.688 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x2292.000/1000.0 + 7x2292.000/1000.0 x √[(1 + 2x1000.0x520.0/(7x2292.000)]
= 114.122 mm

사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm)
1단 : H19 - 8.0 EA (= 2292.0 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 19/2 = 70.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 167.69) - 2.5 x 70.50 = 293.37 mm
300 x (Kcr / fs) = 300 x (210 / 167.69) = 375.70 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 293.37 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 293.37 mm) ∴ O.K

6) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 133.564 x 1000000 / [2292.000 x (500.000 - 111.633/3)]
= 125.919 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x2292.000/1000.0 + 7x2292.000/1000.0 x √[(1 + 2x1000.0x500.0/(7x2292.000)]
= 111.633 mm

사용철근량 = 2292.0 mm² (철근도심 : 100.0 mm)
1단 : H19 - 8.0 EA (= 2292.0 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 19/2 = 90.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 125.92) - 2.5 x 90.50 = 399.15 mm
300 x (Kcr / fs) = 300 x (210 / 125.92) = 500.32 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 399.15 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 399.15 mm) ∴ O.K

7) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 159.792 x 1000000 / [1588.800 x (600.000 - 104.937/3)]
= 178.001 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x600.0/(7x1588.800)]
= 104.937 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 178.00) - 2.5 x 92.00 = 212.41 mm
300 x (Kcr / fs) = 300 x (210 / 178.00) = 353.93 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 212.41 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 212.41 mm) ∴ O.K

8) 좌측벽체 중앙부_외측

① 응력 산정

fs = M / [As x (d - χ/3)] = 58.661 x 1000000 / [794.400 x (500.000 - 69.217/3)]
= 154.830 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x794.400/1000.0 + 7x794.400/1000.0 x √[(1 + 2x1000.0x500.0/(7x794.400)]
= 69.217 mm

사용철근량 = 794.4 mm² (철근도심 : 100.0 mm)
1단 : H16 - 4.0 EA (= 794.4 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 154.83) - 2.5 x 92.00 = 278.62 mm
300 x (Kcr / fs) = 300 x (210 / 154.83) = 406.90 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 278.62 mm 를 적용
S = 1000.00 / 4.0 EA = 250.00 ≤ Sa (= 278.62 mm) ∴ O.K

9) 좌측벽체 중앙부_내측

① 응력 산정

fs = M / [As x (d - χ/3)] = 39.161 x 1000000 / [2292.000 x (520.000 - 114.122/3)]
= 35.451 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x2292.000/1000.0 + 7x2292.000/1000.0 x √[(1 + 2x1000.0x520.0/(7x2292.000)]
= 114.122 mm

사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm)
1단 : H19 - 8.0 EA (= 2292.0 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 19/2 = 70.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 35.45) - 2.5 x 70.50 = 2045.12 mm
300 x (Kcr / fs) = 300 x (210 / 35.45) = 1777.10 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1777.10 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1777.10 mm) ∴ O.K

10) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 132.449 x 1000000 / [2292.000 x (500.000 - 111.633/3)]
= 124.868 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x2292.000/1000.0 + 7x2292.000/1000.0 x √[(1 + 2x1000.0x500.0/(7x2292.000)]
= 111.633 mm

사용철근량 = 2292.0 mm² (철근도심 : 100.0 mm)
1단 : H19 - 8.0 EA (= 2292.0 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 19/2 = 90.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 124.87) - 2.5 x 90.50 = 404.41 mm
300 x (Kcr / fs) = 300 x (210 / 124.87) = 504.53 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 404.41 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 404.41 mm) ∴ O.K

11) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 159.792 x 1000000 / [1588.800 x (600.000 - 104.937/3)]
= 178.001 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x600.0/(7x1588.800)]
= 104.937 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 178.00) - 2.5 x 92.00 = 212.41 mm
300 x (Kcr / fs) = 300 x (210 / 178.00) = 353.93 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 212.41 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 212.41 mm) ∴ O.K

12) 우측벽체 중앙부_외측

① 응력 산정

fs = M / [As x (d - χ/3)] = 58.661 x 1000000 / [794.400 x (500.000 - 69.217/3)]
= 154.830 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x794.400/1000.0 + 7x794.400/1000.0 x √[(1 + 2x1000.0x500.0/(7x794.400)]
= 69.217 mm

사용철근량 = 794.4 mm² (철근도심 : 100.0 mm)
1단 : H16 - 4.0 EA (= 794.4 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 154.83) - 2.5 x 92.00 = 278.62 mm
300 x (Kcr / fs) = 300 x (210 / 154.83) = 406.90 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 278.62 mm 를 적용
S = 1000.00 / 4.0 EA = 250.00 ≤ Sa (= 278.62 mm) ∴ O.K

13) 우측벽체 중앙부_내측

① 응력 산정

fs = M / [As x (d - χ/3)] = 39.161 x 1000000 / [2292.000 x (520.000 - 114.122/3)]
= 35.451 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x2292.000/1000.0 + 7x2292.000/1000.0 x √[(1 + 2x1000.0x520.0/(7x2292.000)]
= 114.122 mm

사용철근량 = 2292.0 mm² (철근도심 : 80.0 mm)
1단 : H19 - 8.0 EA (= 2292.0 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 19/2 = 70.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 35.45) - 2.5 x 70.50 = 2045.12 mm
300 x (Kcr / fs) = 300 x (210 / 35.45) = 1777.10 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1777.10 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1777.10 mm) ∴ O.K

14) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 132.449 x 1000000 / [2292.000 x (500.000 - 111.633/3)]
= 124.868 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x2292.000/1000.0 + 7x2292.000/1000.0 x √[(1 + 2x1000.0x500.0/(7x2292.000)]
= 111.633 mm

사용철근량 = 2292.0 mm² (철근도심 : 100.0 mm)
1단 : H19 - 8.0 EA (= 2292.0 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 19/2 = 90.50 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 124.87) - 2.5 x 90.50 = 404.41 mm
300 x (Kcr / fs) = 300 x (210 / 124.87) = 504.53 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 404.41 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 404.41 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 2.600 m
- fy = 400 MPa
- 부재두께(T) = 0.60 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28

T = 2.600 / 28

T = 0.093 m < 0.600 m ----------> O.K

20. 기초 지지력 검토

(1) 하중산정

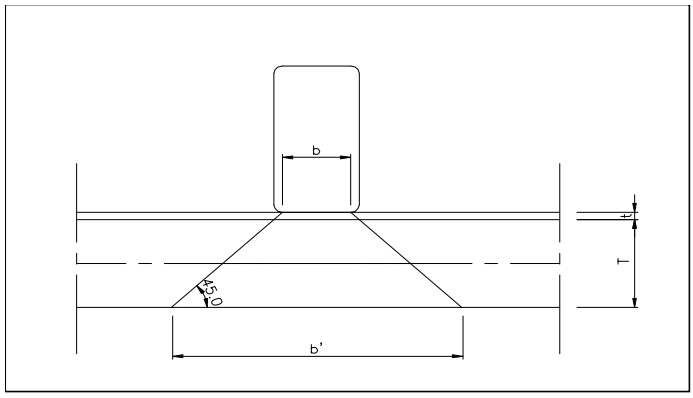
1) 고정하중

- 구체자중 = 158.250 / 3.200 = 49.453 kN/m²
- 상부연직하중 = 378.200 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.08 × 23.00 = 1.840 kN/m²

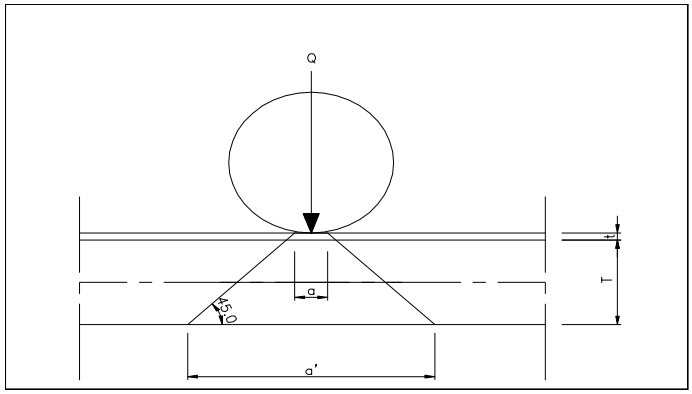
2) 활하중

- 도로 노면 활하중 = 10.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중



t = 80 mm (암거내부 포장두께)
T = 600 mm (하부 슬래브 두께)
b' = 0.500 + 2 × (0.600 + 0.080) × cot 45°
= 1.860 m



a' = 0.200 + 2 × (0.600 + 0.080) × cot 45°
= 1.560 m

Qz = 96.0 / (1.860 × 1.560)= 33.085 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 49.45 + 378.20 + 10.00 + 1.84 + 33.09

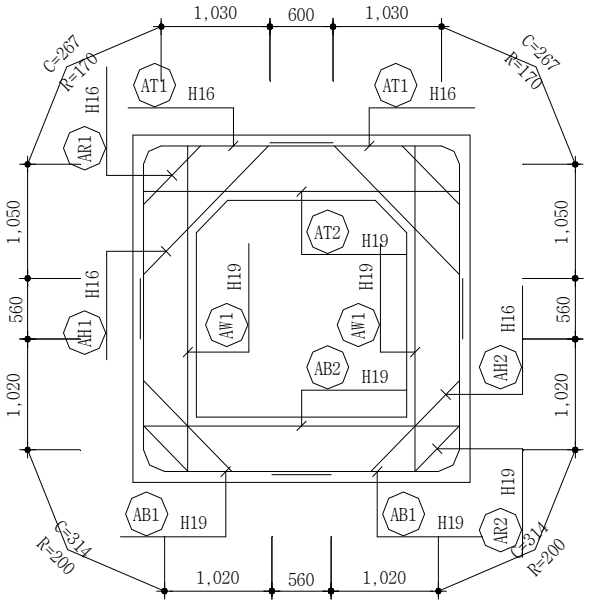
= 472.58 kN/m²

Qa' = 700.000 kN/m² > Qmax = 472.58 kN/m² ..... O.K !!!

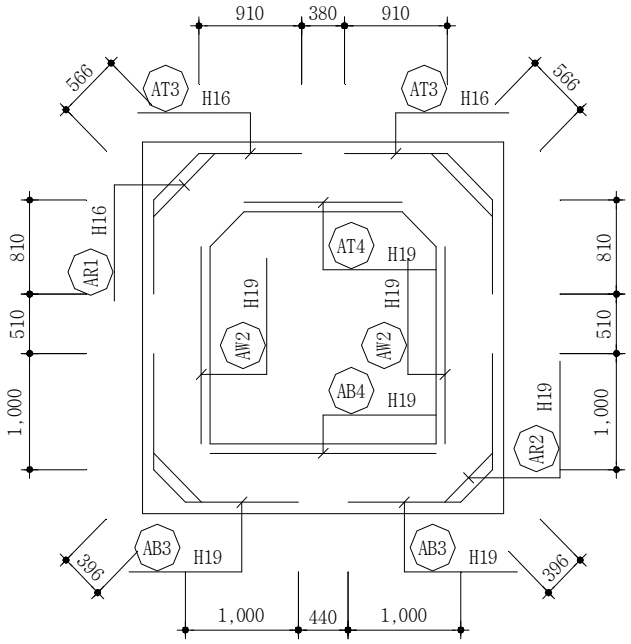
(지반조사 보고서 참조)

21. 주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



2.3 점검통로 단면 C-C

목 차

1. 설계개요 및 조건

2. 단면가정

3. 구조해석모델링

4. 하중산정

5. 하중조합

6. 구조해석결과

7. 단면설계

8. 단면설계 요약

9. 우각부보강설계

10. 사용성검토

11. 주철근조립도

12. 배력철근 검토

1. 설계개요 및 조건

1.1 개요

• Plane Strain의 단위길이당 평면 뼈대요소로 해석

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 단위중량

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	24.5	아스팔트 포장	23.0
흙(지하수위 이상)	20.0	흙(지하수위 이하)	11.0
물	10.0	모르타르	21.5
기계실하중	25.0	무근콘크리트	23.0

(3) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,700 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(4) 토사 내부마찰각 : Φ = 30°

(5) 토압 : K_o = 0.500

1.4 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

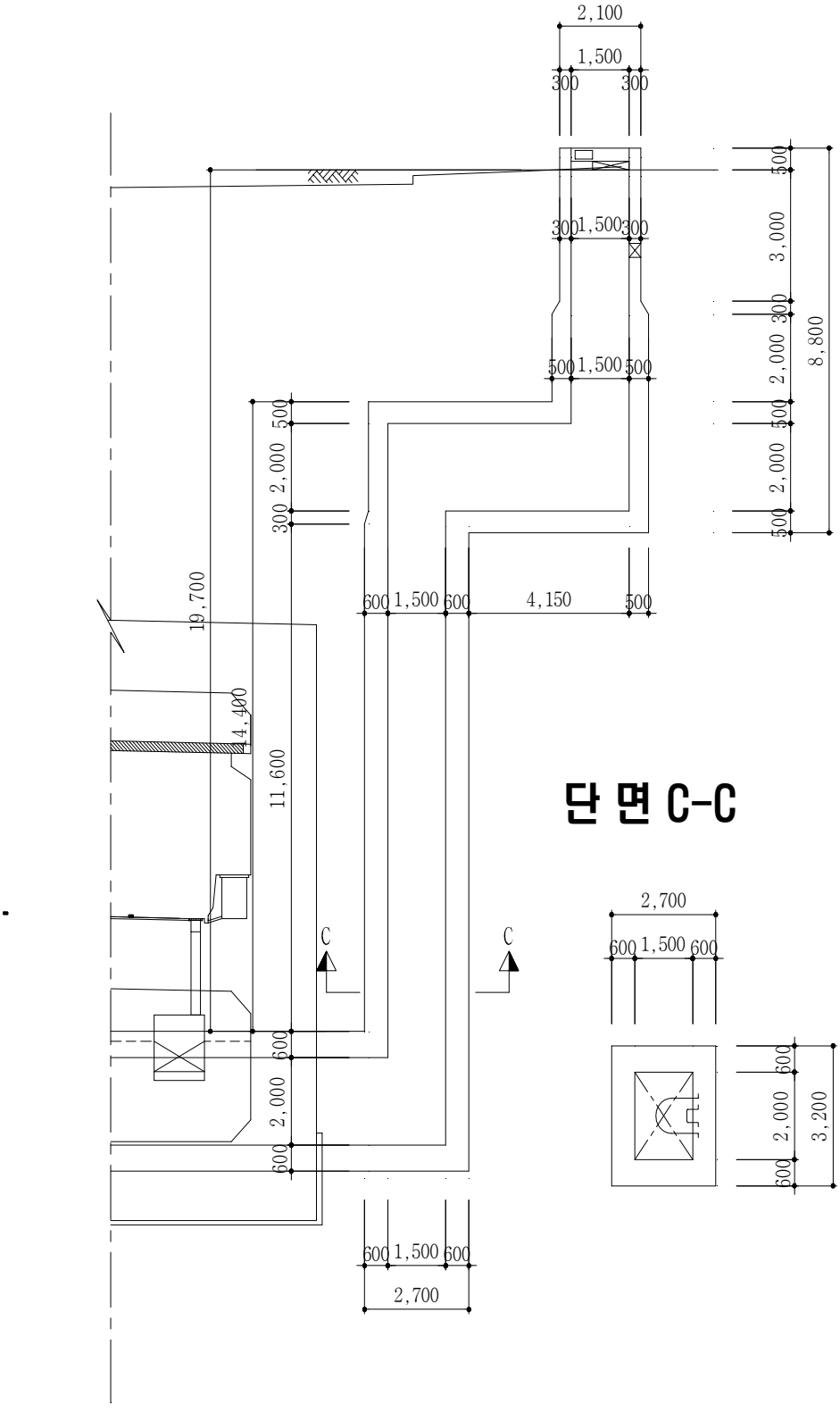
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면가정

설계적용 토피 = 19.700 m



2.1 강역 설정

1) 강역설정기준(콘크리트구조기준 2012)

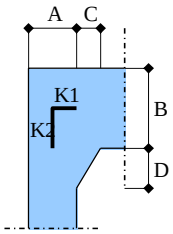
CASE 1 : 부재단부가 다른 부재와 접합할 때는 부재단에서 부재두께의 1/4 안쪽점에서 절점까지

CASE 2 : 부재가 그 축선에 대해 25° 이상 60° 미만인 경사진 헌치를 갖는 경우에는 부재두께가 1.5배가 되는 점에서 부터 절점까지

CASE 3 : 헌치의 경사가 60° 이상의 경우는 헌치의 시점에서 부재두께의 1/4 안쪽 점에서부터 절점까지

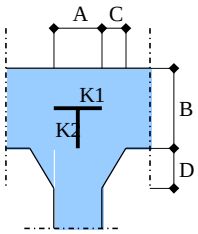
2) 강역설정

① 단부



A	=	0.60	m
B	=	0.60	m
C	=	0.00	m
D	=	0.00	m
K1	=	0.15	m
K2	=	0.15	m

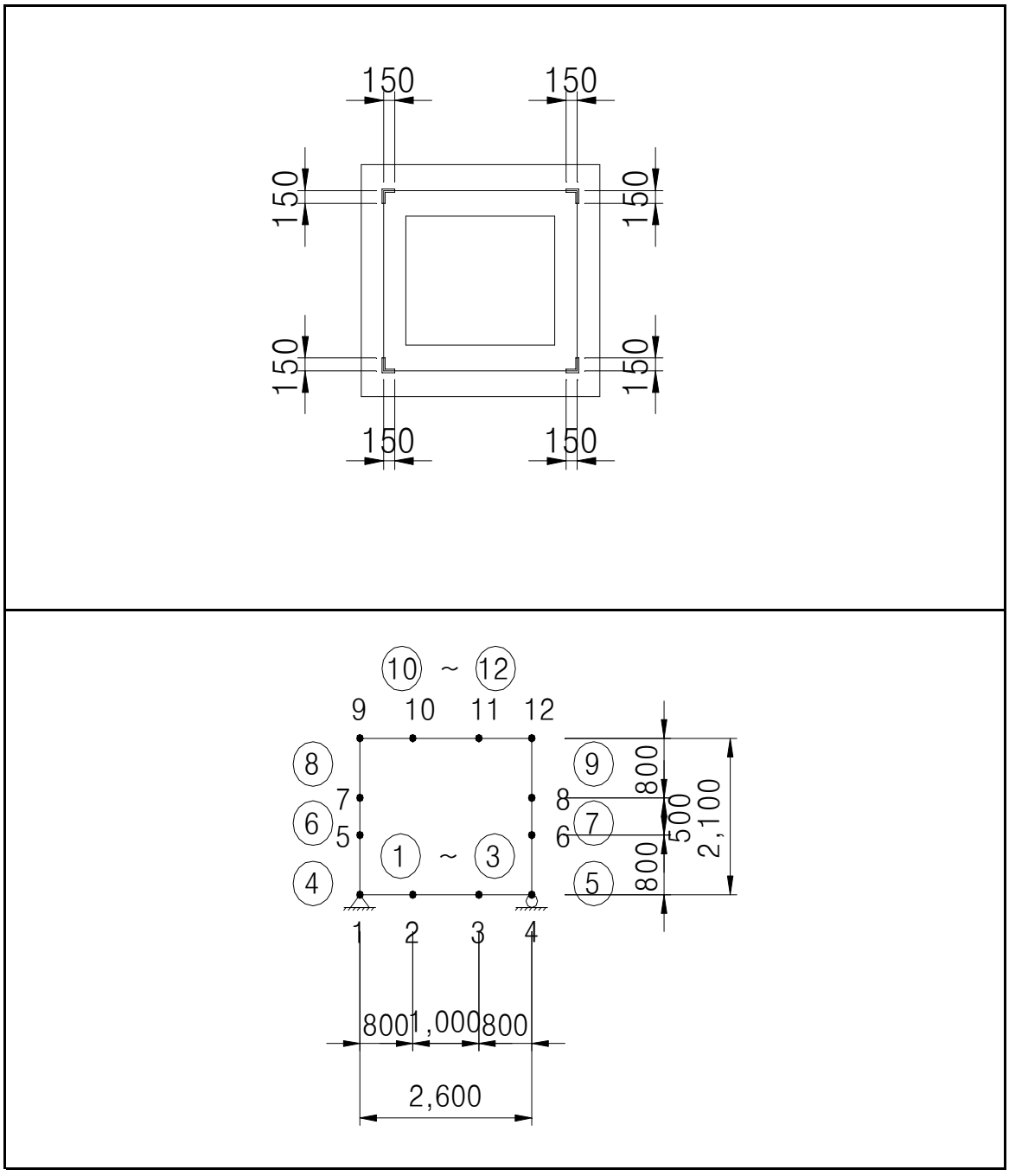
② 내부 지점부



A	=	0.00	m
B	=	0.00	m
C	=	0.00	m
D	=	0.00	m
K1	=	0.00	m
K2	=	0.00	m

3. 구조해석 모델링

3.1 해석모형



3.2 단면제원

번 호	폭(m)	높이(m)	단면적(m²)	단면2차모멘트(m⁴)	비 고
1	1.00	0.60	0.600	0.018000	장 지 간
2	1.00	0.60	0.600	0.018000	단 지 간

4. 하중산정

4.1 활하중에 의한 측압 (만재하시) ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중(Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 19.700 / 3.200 = 6.156
- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

Lh1 = 0.500 × 10.000 = 5.000 kN/m²

4.2 활하중에 의한 측압 (편재하시) ---------- LC 2, 3

Lh1 = 0.500 × 10.000 = 5.000 kN/m²

4.4 수평토압(지하수 無) ---------- LC 4

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + (19.200 + 0.000 / 2) × 20.000)

= 197.750 kN/m²

4.5 수평 토압(지하수 有) ---------- LC 5

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 +

(18.700 + 0.000 / 2) × 11.000) = 113.600 kN/m²

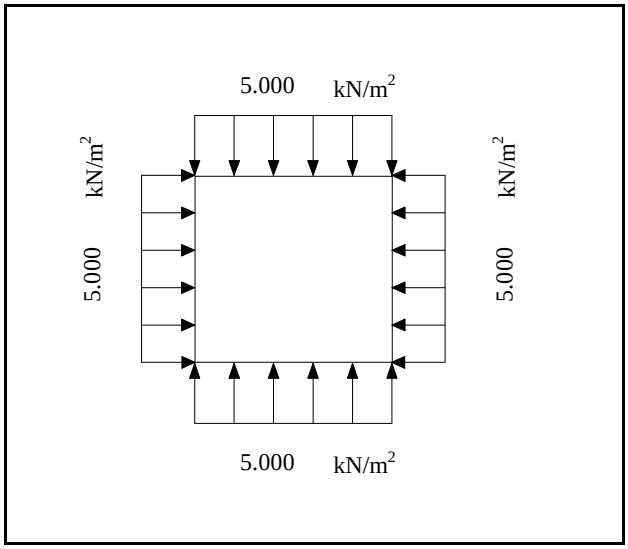
4.6 수평 수압(지하수 有) ---------- LC 6

1) 벽체

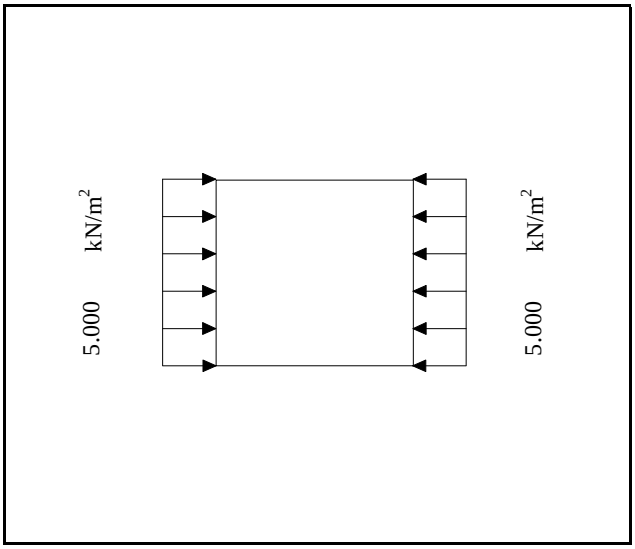
q_{W1} = 10.000 × (18.700 + 0.000 / 2) = 187.000 kN/m²

4.7 하중재하도

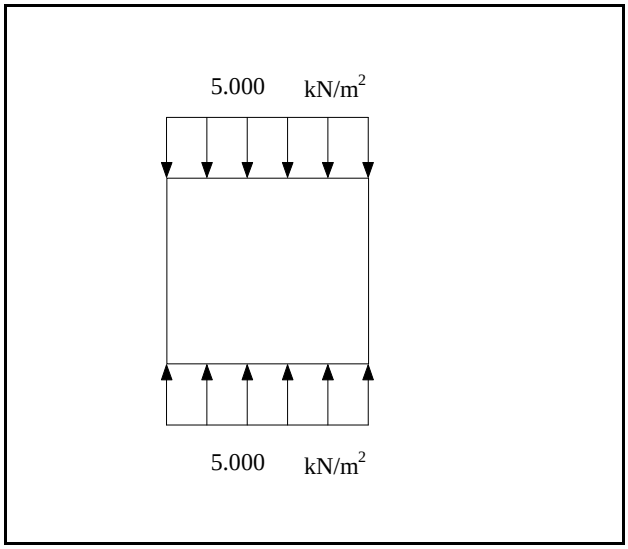
1) 활하중에 의한 측압(만재하시) ------- LC 1



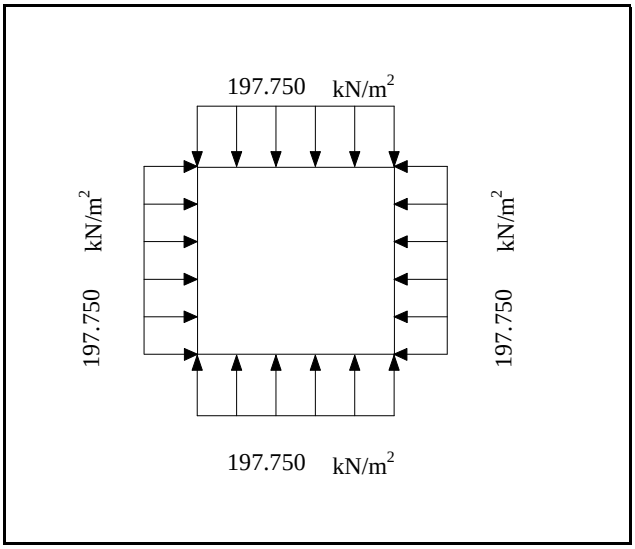
2) 활하중에 의한 측압(편재하시-1) ------- LC 2



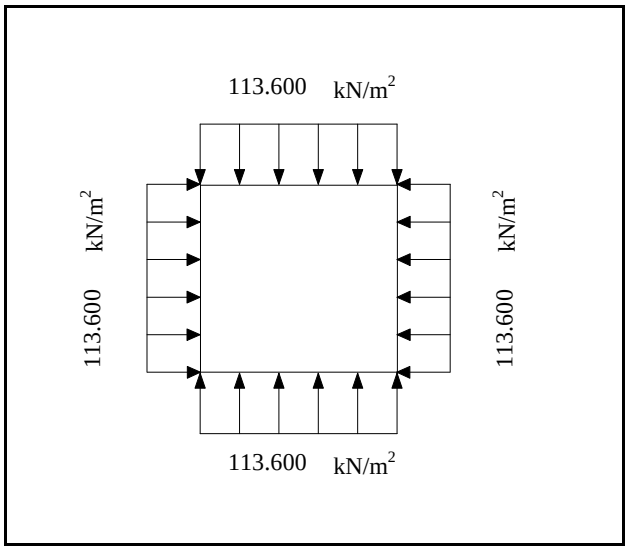
3) 활하중에 의한 측압(편재하시-2) ------- LC 3



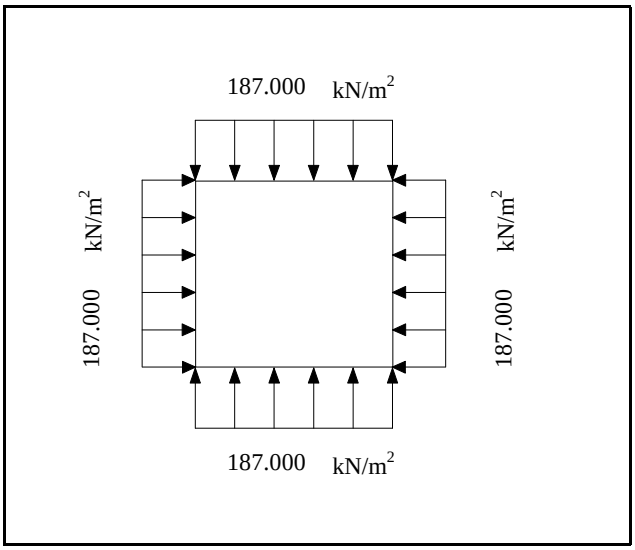
4) 수평 토압(지하수 무) ------- LC 4



5) 수평 토압(지하수 유) ------- LC 5



6) 수평 수압(지하수 유) ------- LC 6



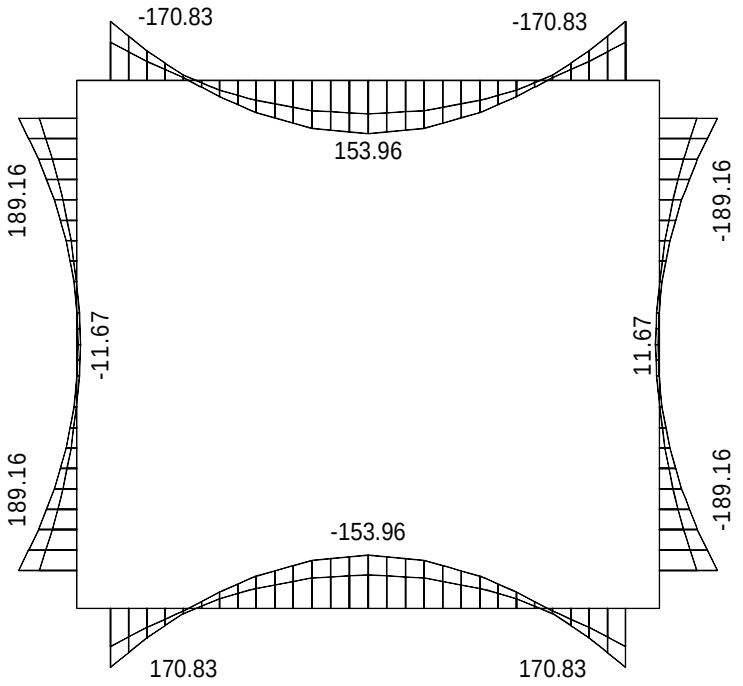
5. 하중조합

하중 조합	활하중			지하수 없을때	지하수 있을때		비고
	만재하	편재하					
	수평	수평		수평 토압	수평 토압	수평 수압	
		상하	좌우				
	LC01	LC02	LC03	LC04	LC05	LC06	
CB01	1.60			1.60			극한하중조합
CB02		1.60		1.60			
CB03			1.60	1.60			
CB04				1.60			
CB05	1.60				1.60	1.60	
CB6		1.60			1.60	1.60	
CB7			1.60		1.60	1.60	
CB8					1.60	1.60	
CB9	1.00			1.00			사용하중조합
CB10		1.00		1.00			
CB11			1.00	1.00			
CB12				1.00			
CB13	1.00				1.00	1.00	
CB14		1.00			1.00	1.00	
CB15			1.00		1.00	1.00	
CB16					1.00	1.00	

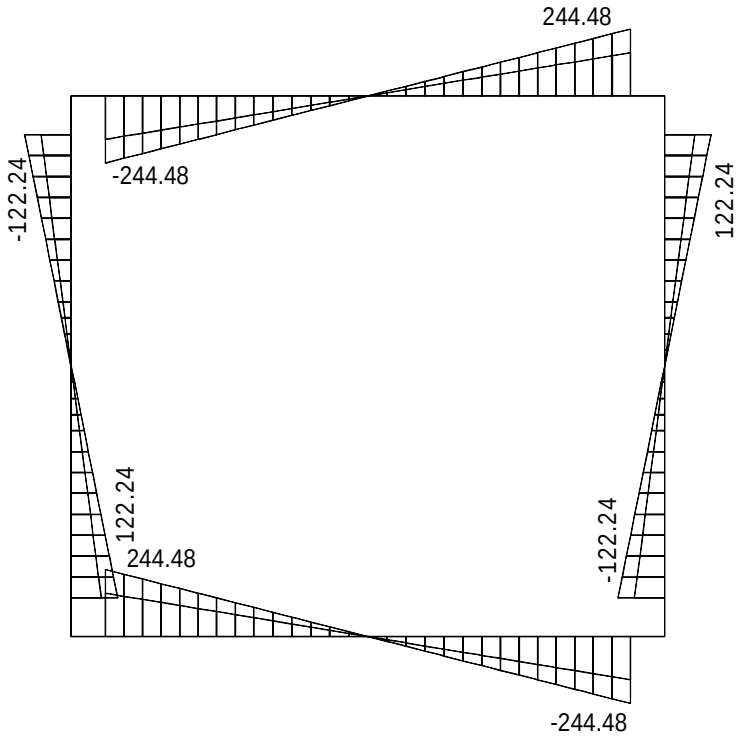
6. 구조해석 결과

6.1 부재력도

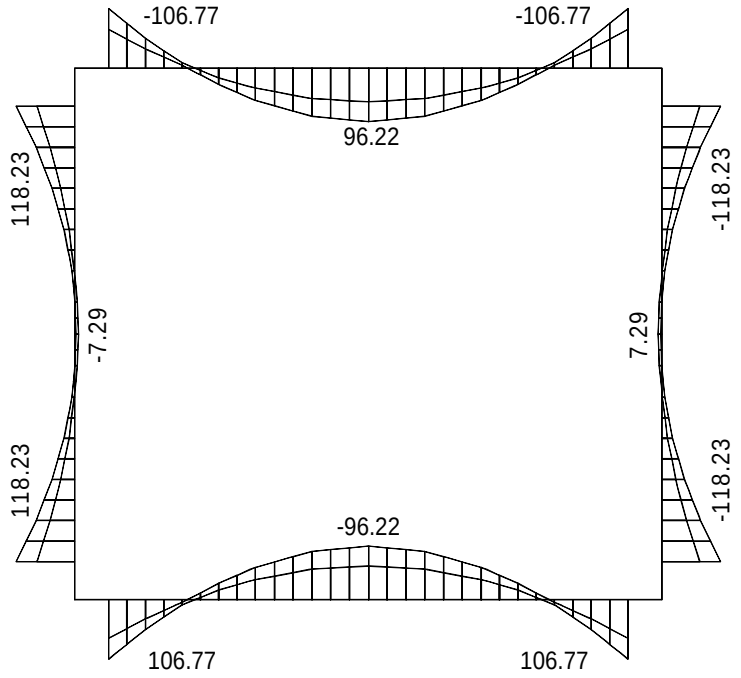
B.M.D (계수하중) [kN·m]



S.F.D (계수하중) [kN]



B.M.D (사용하중) [kN·m]



6.2 부재력 집계

구분		계수하중			사용하중	
		Mu(kN·m)	Pu(kN)	Vu(kN)	Mo(kN·m)	Po(kN)
슬래브 장지간	단 부	170.830		244.480	106.770	
	중앙부	153.960			96.220	
슬래브 단지간	단 부	189.160		122.240	118.230	
	중앙부	11.670			7.290	

7. 단면검토

1) 슬래브 장지간 단부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 1364.169 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	106.8
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	500.0	100.0	170.830	244.480

전단설계시 단면의 유효높이 ds = 500.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 8ea = 1588.800 ㎟

∴ P = As / (B × D) = 0.00318

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 27.692 mm

최외단 인장철근 변형률 εt = 0.04304 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 262616502 N·mm

= 262.617 kN·m > 170.830 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a / 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 1023.127 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 324.760 kN

1/2 x Φv x Vc = 162.380 kN ≤ Vu ≤Φv x Vc ∴ 최소전단 철근을 배근하는것이 좋다.

Req Av = 0.35×bw×s / fy = 0.35×1,000.0×150.0 / 400.0

= 131.250 ㎟

Use Av = 253.400 ㎟ (H13×2 EA, 간격 s = 150.0 mm) ≥ req.Av ----- ∴ O.K.

s = 150.0 mm < Min (600, 0.5D) = 250.0 mm ----- ∴ O.K.

2) 슬래브 장지간 중앙부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 1178.544 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	96.2
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	520.0	80.0	153.960	0.000

전단설계시 단면의 유효높이 ds = 520.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 8ea = 1588.800 ㎟

∴ P = As / (B × D) = 0.00306

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 27.692 mm

최외단 인장철근 변형률 εt = 0.04488 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 273420342 N·mm

= 273.420 kN·m > 153.960 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 883.908 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 337.750 kN

∴ 전단철근이 필요없음.

3) 슬래브 단지간 단부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 1513.554 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	118.2
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	500.0	100.0	189.160	122.240

전단설계시 단면의 유효높이 ds = 500.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 8ea = 1588.800 ㎟

∴ P = As / (B × D) = 0.00318

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 27.692 mm

최외단 인장철근 변형률 εt = 0.04304 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 262616502 N·mm

= 262.617 kN·m > 189.160 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 1135.165 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 324.760 kN

∴ 전단철근이 필요없음.

4) 슬래브 단지간 중앙부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 88.107 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	7.3
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	520.0	80.0	11.670	0.000

전단설계시 단면의 유효높이 ds = 520.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 8ea = 1588.800 ㎟

∴ P = As / (B × D) = 0.00306

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 27.692 mm

최외단 인장철근 변형률 εt = 0.04488 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 273420342 N·mm

= 273.420 kN·m > 11.670 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 66.080 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 337.750 kN

∴ 전단철근이 필요없음.

8. 단면설계요약

1) 휨설계 요약

구분		Mu (kN·m)	Pu (kN)	사용철근				ΦMn (kN·m)	ΦPn (kN)	안전율	비고
				1단		2단					
슬래브 장지간	단 부	170.830		H16	125	H0	0	262.617		1.54	O.K
	중앙부	153.960		H16	125	H0	0	273.420		1.78	O.K
슬래브 단지간	단 부	189.160		H16	125	H0	0	262.617		1.39	O.K
	중앙부	11.670		H16	125	H0	0	273.420		23.43	O.K

2) 전단설계 요약

구분		Vu (kN·m)	사용철근			ΦVn (kN·m)	안전율	비고
			직경	개수	간격			
슬래브 장지간	단 부	244.480	H13	2.0EA	150	578.160	2.36	O.K
	중앙부	0.000	H13	2.0EA	300	전단철근 불필요		
슬래브 단지간	단 부	122.240	H13	2.0EA	150	전단철근 불필요		
	중앙부	0.000	H13	2.0EA	300	전단철근 불필요		

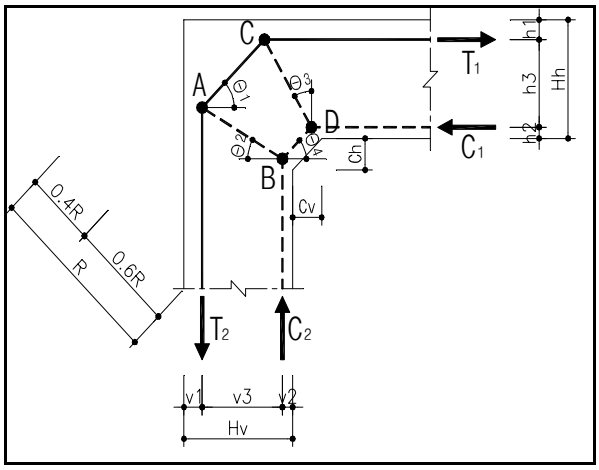
9. 라멘 우각부 보강 설계 (스트럿-타이 모델 해석에 의한 라멘접합부 보강)

9.1 슬래브

(1) 계산조건

슬래브두께	H_h	=	600.00 mm	벽체 높이	H_v	=	600.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	420.00 mm	벽체측 우력 거리	v_3	=	420.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	189.160 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 848.53 mm

② 사잇각

Θ_1 = 45.00°

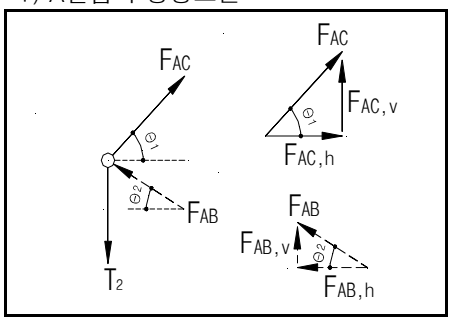
Θ_2 = 23.20°

Θ_3 = 23.20°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

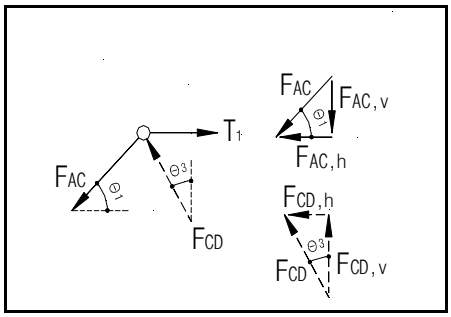
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\Theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\Theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\epsilon = F_{CD} \cdot \cos\Theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{189.160}{0.420} =$ 450.381 kN

$T_2 = \frac{M_u}{v_3} = \frac{189.160}{0.420} =$ 450.381 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 445.854 kN

식 ⑥ 으로부터

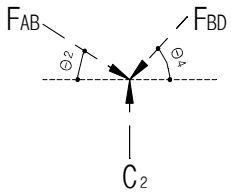
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 445.854 kN

따라서 F_{AC} = **445.854** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 343.000 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 445.854 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 343.000 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	**445.854**	타이
AB	**-343.000**	스트럿
BD	**-445.854**	스트럿
CD	**-343.000**	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 445.854 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{445,854.396}{0.85 \times 400} = 1,311.34 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	250	=	0.00	mm^2	(1 cycle)
	= H	16	@	250	=	794.40	mm^2	(2 cycle)
우각부철근 As	= H	16	@	250	=	794.40	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**1,588.80**	mm^2	

$A_{s,used}$ = 1,588.80 mm^2 > 1,311.34 mm^2 ……O.K

5) 스트럿과 절점영역의 강도검토

- 스트럿의 유효강도와 절점의 유효강도 중 작은 값을 스트럿의 유효강도로 설정함.
  스트럿의 유효강도를 이용해 필요 유효폭을 계산하고 구조물의 기하학적 형상을 벗어나는지 검토함.
  이 때 추가적인 절점영역의 강도 검토과정은 수행할 필요가 없음.

- 스트럿의 필요 유효폭

$$w_{req} = \frac{Fu}{\Phi_c f_{max}\, b}$$

여기서, Fu = 스트럿의 단면력 (N)

f_{max} = 0.85 β_s f_{ck} ; 계산된 스트럿의 유효강도값(MPa)

b = 부재 폭(1000mm)

Φ_c = 0.75

- 스트럿과 절점영역 강도검토 결과

스트럿 요소	요소종류	β_s	$\Phi_c f_{max}$		Fu (kN)	w_{req}(mm)	안전여부
AB	스트럿 AB	0.60	0.75 x 0.85 β_s f_{ck}	10.33	343.000	33.212	O.K
	절점A- CTT	0.60		10.33			
	절점B- CCC	1.00		17.21			
BD	스트럿 BD	0.60	0.75 x 0.85 β_s f_{ck}	10.33	445.854	43.172	O.K
	절점B- CCC	1.00		17.21			
	절점D- CCC	1.00		17.21			
CD	스트럿 CD	0.60	0.75 x 0.85 β_s f_{ck}	10.33	343.000	33.212	O.K
	절점C- CTT	0.60		10.33			
	절점D- CCC	1.00		17.21			

▶ 필요유효폭 안전여부

$$\frac{w_{req_BD}}{2} = 21.586 \text{ mm} < 0.1R = 84.853 \text{ mm}$$ ····· O.K

10. 사용성 검토

10.1 처짐 검토

1) 장지간 슬래브 : 최소부재두께 적용

철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	2.000	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.083	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.083m	<	H	=	0.600m	(처짐검토 생략)

2) 단지간 슬래브 : 최소부재두께 적용

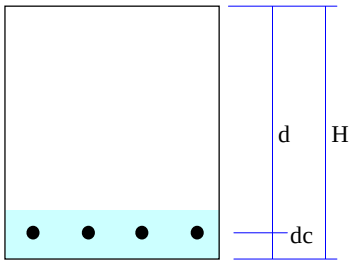
철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	1.500	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.063	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.063m	<	H	=	0.600m	(처짐검토 생략)

10.2 균열 검토

1) 슬래브 장지간 단부 (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	500.00	mm,	dc =	100.00	mm ,
Mo =	106.770	kN· m,	As =	1588.800	mm^2
N =	8		n =	7	

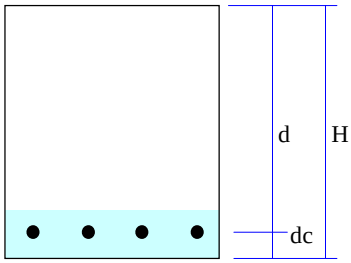
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	94.922	mm
f s = M / (As (d - x / 3))	=	143.483	mm
f st = fs (H -Dc_min - x) / (D - x)	=	143.483	mm

- 철근의 최대 중심간격

Cc =	100	-	16	/	2	=	92.000	mm	
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]						=	318.845	mm	
최외단철근 평균배근간격;	1000	/	8	=	125	mm	<	318.845	mm	O.K!!

2) 슬래브 장지간 중앙부 (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	520.00	mm,	dc =	80.00	mm ,
Mo =	96.220	kN· m,	As =	1588.800	mm^2
N =	8		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 96.999 mm

f s = M / (As (d - x / 3)) = 124.186 mm

f st = fs (H -Dc_min - x) / (D - x) = 124.186 mm

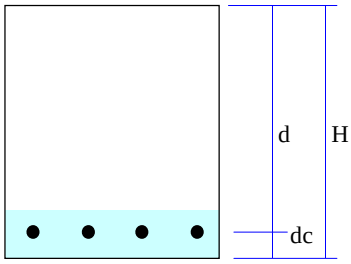
- 철근의 최대 중심간격

Cc = 80 - 16 / 2 = 72.000 mm

S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)] = 665.505 mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 665.505 mm **O.K!!**

3) 슬래브 단지간 단부 (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	500.00	mm,	dc =	100.00	mm ,
Mo =	118.230	kN· m,	As =	1588.800	mm^2
N =	8		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 94.922 mm

f s = M / (As (d - x / 3)) = 158.884 mm

f st = fs (H -Dc_min - x) / (D - x) = 158.884 mm

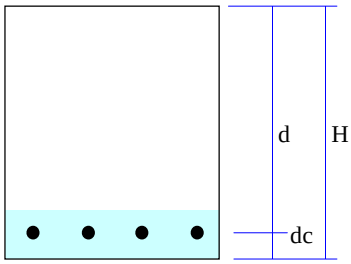
- 철근의 최대 중심간격

Cc = 100 - 16 / 2 = 92.000 mm

S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)] = 265.646 mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 265.646 mm **O.K!!**

4) 슬래브 단지간 중앙부 (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	520.00	mm,	dc =	80.00	mm ,
Mo =	7.290	kN· m,	As =	1588.800	mm^2
N =	8		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	96.999	mm
f s = M / (As (d - x / 3))	=	9.409	mm
f st = fs (H -Dc_min - x) / (D - x)	=	9.409	mm

- 철근의 최대 중심간격

Cc = 80 - 16 / 2	=	72.000	mm
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]	=	8927.796	mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 8927.796 mm **O.K!!**

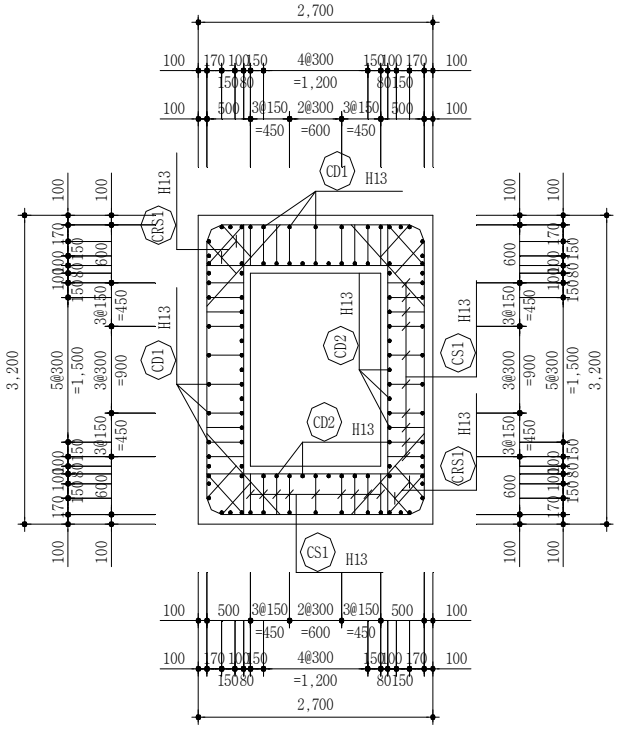
10.3 사용성검토 요약

1) 균열검토 요약

구분		Mo (kN·m)	주철근 (mm)	fs (Mpa)	Cc (mm)	S (mm)	Smin (mm)	비고
슬래브 장지간	단부	106.770	H16	143	92.0	125	319	**O.K**
	중앙부	96.220	H16	124	72.0	125	666	**O.K**
슬래브 단지간	단부	118.230	H16	159	92.0	125	266	**O.K**
	중앙부	7.290	H16	9	72.0	125	8928	**O.K**

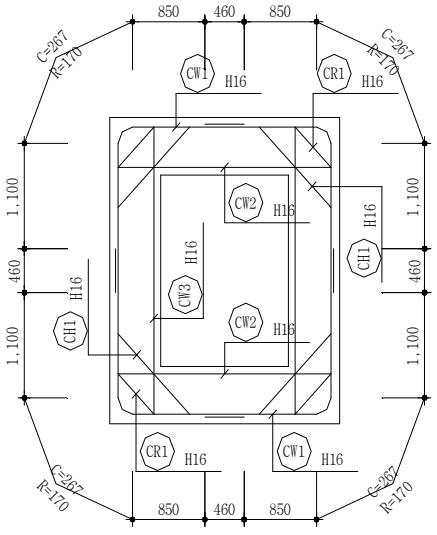
11. 주철근 조립도

표준단면도

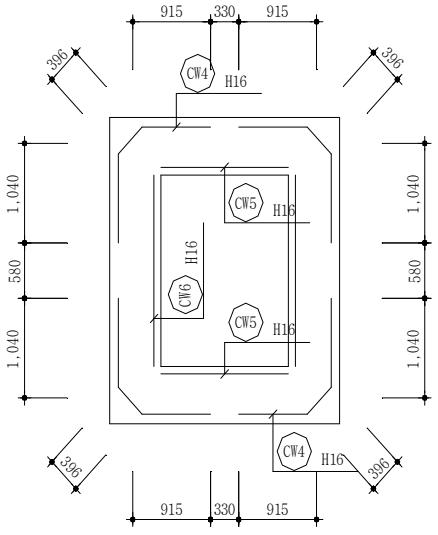


주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



12. 배력철근 검토

(1) 온도, 수축철근

-벽　체 : ρmin = 0.0020

-슬 래 브 : ρmin = 0.0020

- 주철근량 미만

(2) 배력철근

- 주철근의 20%이상

(3) 부재별 온도 / 배력철근

12.1 슬래브 장지간

구 분	사용주철근 (mm^2)	필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)	검토
단부	H 16@ 125 = 1588.800 0@ 0 0.000	317.760	1200.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**
중앙부	H 16@ 125 = 1588.800 0@ 0 0.000	317.760	1200.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**

12.2 슬래브 단지간

구 분	사용주철근 (mm^2)	필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)	검토
단부	H 16@ 125 = 1588.800 0@ 0 0.000	317.760	1200.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**
중앙부	H 16@ 125 = 1588.800 0@ 0 0.000	317.760	1200.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**

2.4 점검통로 단면 D-D

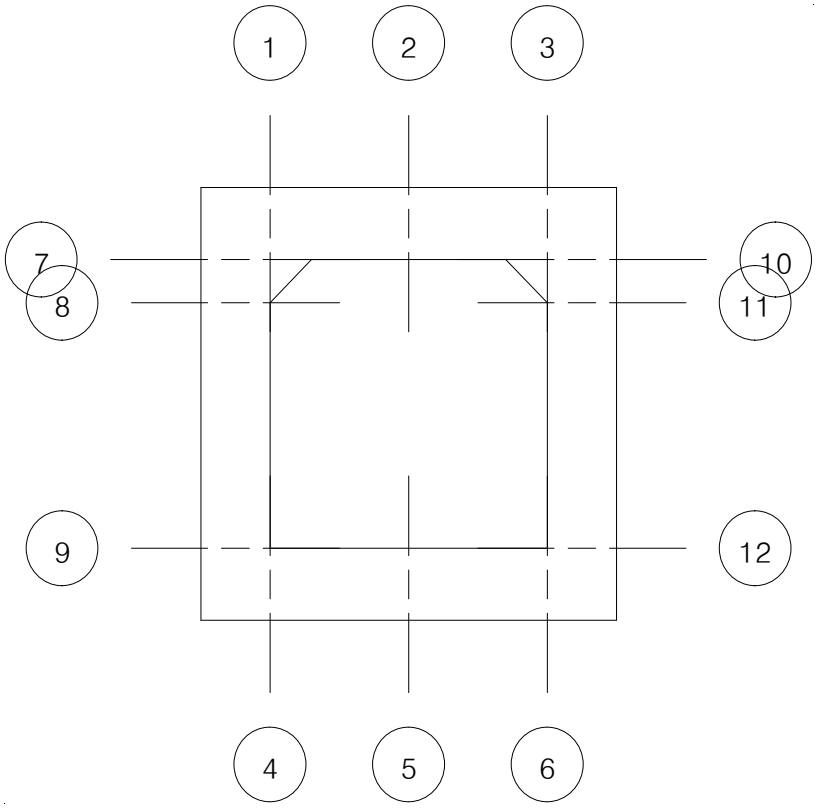
집수정 점검통로 구조계산서

▣ STA. 1K+230.300 (BLOCK1 : 단면 D-D)
▣ 토 피(FH) = 5.30 m ▣ 선 형 = ∞
▣ 지반 조건 : 토사
▣ 구조형식 : 지중 1 련
(내공 : 2M × 2M, 사각 : 90°)

목 차

1. 설계요약표
2. 설계조건
3. 단면가정
4. 부력검토
5. 해석모델 및 단면제원(상시)
6. 해석모델 및 단면제원(지진시)
7. 지반반력계수(상시)
8. 지반반력계수(지진시)
9. 하중계산(상시)
10. 하중계산(지진시)
11. 하중재하도(상시)
12. 하중재하도(기능수행)
13. 하중재하도(붕괴방지)
14. 하중계수 및 하중조합
15. 단면력정리
16. 단면검토 및 철근량 산정
17. 수평철근 검토
18. 절점부 검토
19. 사용성 검토
20. 기초 지지력 검토
21. 주철근 조립도

1. 해석설계 요약



■ 기초 검토

구분	Qmax(kN)	Qu(kN)	Qa(kN)	비 고
직접기초	199.48	167.994	400.0	O.K

■ 부력 검토

구분	B(양압력)	R(저항력)	SF	비 고
직접기초	219	517.718	2.364	O.K

■ 단면 휨 설계

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	483	143.47	253.61	887.21	H16 - 8.0EA	1588.80	1.77
		중앙부	2	1000	420	95.57	219.40	678.82	H16 - 8.0EA	1588.80	2.30
		우측	3	1000	483	143.47	253.61	887.21	H16 - 8.0EA	1588.80	1.77
하부슬래브	1경간	좌측	4	1000	400	130.19	208.60	978.13	H16 - 8.0EA	1588.80	1.60
		중앙부	5	1000	420	85.32	219.40	605.09	H16 - 8.0EA	1588.80	2.57
		우측	6	1000	400	130.19	208.60	978.13	H16 - 8.0EA	1588.80	1.60
좌측벽체	1층	상부	7	1000	483	183.48	408.66	-	H16 - 8.0EA	3177.60	2.23
		중앙부 (외측)	8	1000	400	150.50	322.76	-	H16 - 8.0EA	3177.60	2.15
		중앙부 (내측)	8	1000	420	115.37	395.10	-	H16 - 8.0EA	3177.60	3.42
		하부	9	1000	400	118.98	385.83	-	H16 - 8.0EA	3177.60	3.24
우측벽체	1층	상부	10	1000	483	183.48	408.66	-	H16 - 8.0EA	3177.60	2.23
		중앙부 (외측)	11	1000	400	150.50	322.76	-	H16 - 8.0EA	3177.60	2.15
		중앙부 (내측)	11	1000	420	115.37	395.10	-	H16 - 8.0EA	3177.60	3.42
		하부	12	1000	400	118.98	385.83	-	H16 - 8.0EA	3177.60	3.24

■ 수평철근 검토

구분	부재 위치			단면적비			주철근 20%		
				필요철근량	사용철근량	비고	필요철근량	사용철근량	비고
상부 슬래브	1 경간	좌측	1	1000.0	1688.9	O.K	177.4	845.1	O.K
		중앙부	2	1000.0	1267.0	O.K	135.8	845.1	O.K
		우측	3	1000.0	1688.9	O.K	177.4	845.1	O.K
하부 슬래브	1 경간	좌측	4	1000.0	1688.9	O.K	195.6	845.1	O.K
		중앙부	5	1000.0	1267.0	O.K	121.0	845.1	O.K
		우측	6	1000.0	1688.9	O.K	195.6	845.1	O.K
좌측 벽체	1 층	상부	7	1000.0	1688.9	O.K	0.0	845.1	O.K
		중앙부	8	1000.0	1688.9	O.K	0.0	845.1	O.K
		중앙부	8	1000.0	1688.9	O.K	0.0	845.1	O.K
		하부	9	1000.0	1688.9	O.K	0.0	845.1	O.K
우측 벽체	1 층	상부	10	1000.0	1688.9	O.K	0.0	845.1	O.K
		중앙부	11	1000.0	1688.9	O.K	0.0	845.1	O.K
		중앙부	11	1000.0	1688.9	O.K	0.0	845.1	O.K
		하부	12	1000.0	1688.9	O.K	0.0	845.1	O.K

■ 전단철근 검토

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	259.8	284.2	462.53	2.00	30.45	H13	150	253.40	O.K
		우측	3	259.8	284.2	361.17	2.00	60.90	H13	300	253.40	O.K
하부슬래브	1경간	좌측	4	259.8	261.0	462.53	2.00	1.49	H13	150	253.40	O.K
		중앙부	5	272.8	239.3	379.23	2.00	-	H13	300	253.40	O.K
		우측	6	259.8	261.0	361.17	2.00	2.97	H13	300	253.40	O.K
좌측벽체	1층	상부	7	270.2	286.2	472.90	2.00	20.07	H13	150	253.40	O.K
		중앙부	8	269.1	262.4	471.87	2.00	131.25	H13	150	253.40	O.K
		하부	9	270.1	274.9	472.77	2.00	6.03	H13	150	253.40	O.K
우측벽체	1층	상부	10	270.2	286.2	472.90	2.00	20.07	H13	150	253.40	O.K
		중앙부	11	269.1	262.4	471.87	2.00	131.25	H13	150	253.40	O.K
		하부	12	270.1	274.9	472.77	2.00	6.03	H13	150	253.40	O.K

■ 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	483	H16 - 8.0EA	125	1273.107	O.K	10.185
		중앙부	2	420	H16 - 8.0EA	125	488.368	O.K	3.907
		우측	3	483	H16 - 8.0EA	125	1273.107	O.K	10.185
하부슬래브	1경간	좌측	4	400	H16 - 8.0EA	125	552.722	O.K	4.422
		중앙부	5	420	H16 - 8.0EA	125	611.957	O.K	4.896
		우측	6	400	H16 - 8.0EA	125	552.722	O.K	4.422
좌측벽체	1층	상부	7	483	H16 - 8.0EA	125	1054.463	O.K	8.436
		중앙부	8	400	H16 - 8.0EA	125	1175.974	O.K	9.408
		중앙부	8	420	H16 - 8.0EA	125	41535.943	O.K	332.288
		하부	9	400	H16 - 8.0EA	125	622.084	O.K	4.977
우측벽체	1층	상부	10	483	H16 - 8.0EA	125	1054.463	O.K	8.436
		중앙부	11	400	H16 - 8.0EA	125	1175.974	O.K	9.408
		중앙부	11	420	H16 - 8.0EA	125	41535.943	O.K	332.288
		하부	12	400	H16 - 8.0EA	125	622.084	O.K	4.977

2. 설 계 조 건

1) 구조형식

- 지중 1 련 집수정 점검통로 (내공 : 2M × 2M, 사각 : 90°)

2) 지하수위

- GL 에서 -1.000 m

3) 재료 중량

- 철근콘크리트 (ω_c) = 25.00 kN/m³
- 포 장 (γ_{asp}) = 23.00 kN/m³
- 지 하 수 (γ_w) = 10.00 kN/m³

4) 사용재료의 강도

- 콘크리트 강도 (fck) = 27 MPa
- 콘크리트 탄성계수 (Ec) = 26702 MPa
- 철근(SD400) (fy) = 400 MPa
- 철근의 탄성계수 (Es) = 200000 MPa

5) 토압계산에 사용되는 흙의 단위중량

: 입도배합이 양호한 모래, 자갈, 경암 및 일반적인 모래

- 일 반 (γ_t) = 19.0 kN/m³
- 수 중 (γ_{sub}) = 10.0 kN/m³

6) 지진계수

- 내진등급 : I 등급 (위험도 계수 - 기능수행 : 0.570, 붕괴방지 : 1.400)
- 지진구역 : I 구역 (지진구역계수 : 0.110)
- 지반종류 : Sd
- 기능수행수준, 붕괴방지수준

7) 노면활하중 (DB-24 적용) = 10.000 kN/m² (∵ 토피 : 5.300 m)

8) 토 사

- 흙의 습윤 단위중량 (γ_t) = 19.0 kN/m³
- 흙의 수중 단위중량 (γ_{sub}) = 10.0 kN/m³
- 흙의 내부마찰각 (ϕ) = 30.0°
- 정지토압계수 (Ko) = 1-sinΦ = 0.500

9) 설계방법

- 강도설계법 : 부재의 단면검토 (슬래브, 벽체, 보, 기둥)
- 허용응력 설계법 : 사용성 검토 (처짐, 균열, 절점부보강 등)

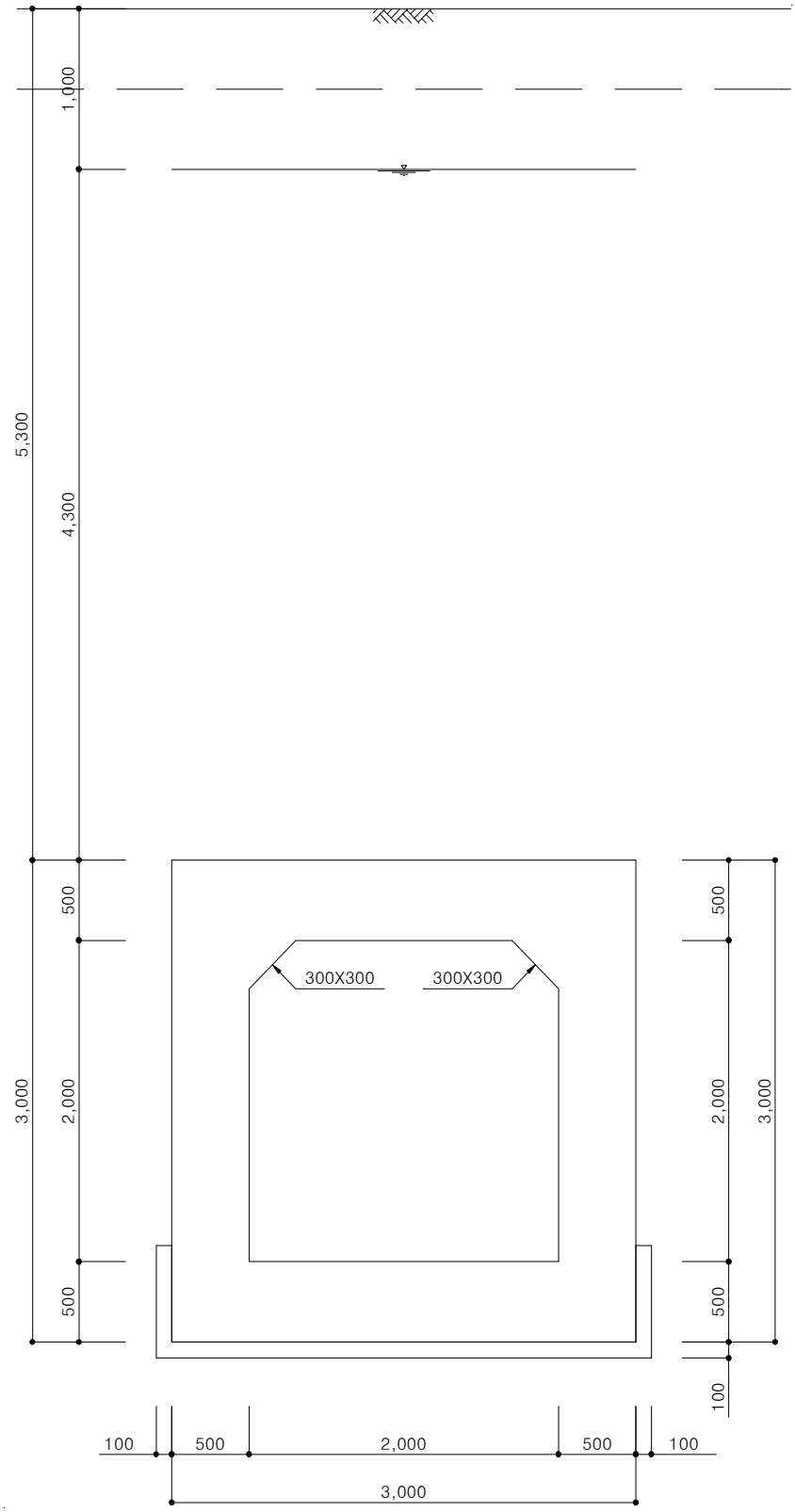
10) 사용프로그램 : SAP2000

11) 참고문헌

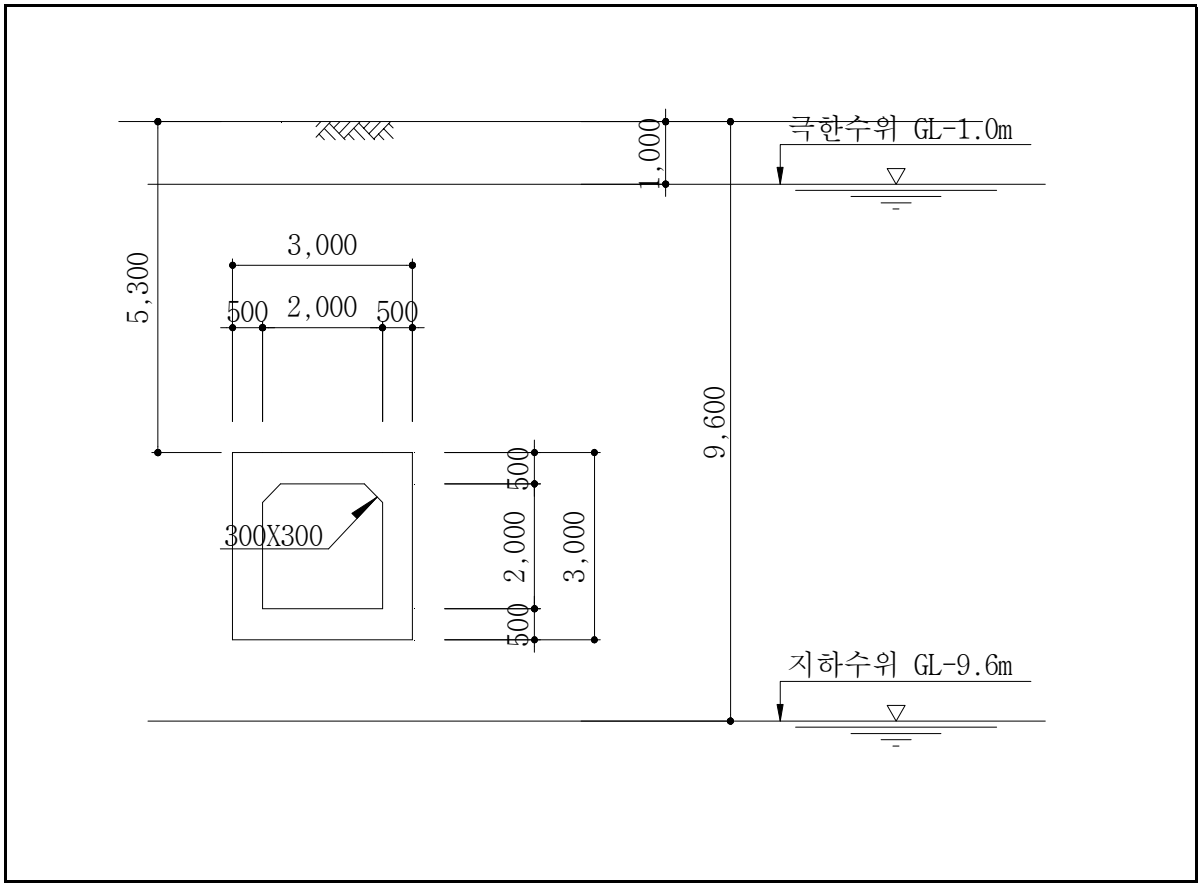
- 콘크리트 구조기준.해설 : 한국콘크리트학회(2012)
- 도로교 설계기준 : 건설교통부(2005)

3. 단 면 가 정

1) 단 면 가 정


1,000
5,300
4,300
500
3,000
2,000
500
300X300
300X300
500
2,000
3,000
500
100
100
500
2,000
500
100
3,000

4. 부력 검토



4.1 부력 검토 결과

구 분	작용력(kN/m)	저항력(kN/m)	비 고
완공후 (극한수위 G.L-1.0m)	219.000	517.718	F.S = 2.364 > 1.050 ------ O.K

4.2 시공중 부력 검토 (지하수위 : G.L -9.6m) **∴ 시공중 부력검토 불필요** : 지하수위가 구조물 아래에 위치

4.3 완공후 부력 검토 (지하수위 : G.L -9.6m) **∴ 완공후 부력검토 불필요** : 지하수위가 구조물 아래에 위치

4.4 완공후 부력 검토 (극한수위 : G.L - 1.000 m)

4.4.1 굴착고 : 8.300 m

4.4.2 부력 작용폭 : 3.000 m

4.4.3 부력

$U = \mu \times B = r_w \times Hw \times B$ = 10.000 × 7.300 × 3.000 = 219.000 KN/m

4.4.4 저항력

$R = W_1 + W_2 + F$ = 127.250 + 323.625 + 66.843 = 517.718 KN/m

(1) W_1 (구체자중)

① 하부슬래브

(0.500 × 3.000)× 25.000 = 37.500 kN/m

② 벽체

(0.500 × 2.000)× 2 EA × 25.000 = 50.000 kN/m

③ 상부 슬래브

(0.500 × 3.000)× 25.000 = 37.500 kN/m

④ 헌치

(0.300 × 0.300)× 1/2 × 2 EA × 25.000 = 2.250 kN/m

TOTAL = 127.250 kN/m

(2) W_2 (상재하중)

① 아스팔트

(0.450 × 3.000)× 23.000 = 31.050 kN/m

② 상재토

지하수위 이상

되메움토 : (0.550 × 3.000)× 19.000 = 31.350 kN/m

지하수위 이하

되메움토 : (4.300 × 3.000)× 20.000 = 258.000 kN/m

③ 방수몰탈

(0.050 × 3.000)× 21.500 = 3.225 kN/m

TOTAL = 323.625 kN/m

(3) F (주면마찰력)

$P_o = 2 \times C \times D + K_o \times \gamma_{sub} \times H^2 \times \tan\Phi$

; 되메움토 점착력(C) = 0.0 kN/m²

되메움토 내부마찰각(Φ) = 30.0 ° δ=2/3Φ = 20.0 °

※ 파괴면이 비교적 구조물 벽면에 인접하여 있으므로 구조물과 지반의 상대마찰각으로 생각하여 δ=2/3×ϕ로 ?

되메움토 단위중량(γ_t) = 19.0 kN/m³

(γ_{sub}) = 10.0 kN/m³

$K_o = 1 - \sin\Phi$ = 1 − sin = 0.500

점착력 작용 구간(D) = 0.000 m

지하수위 이상 구간(H_1) = 1.000 m

지하수위 이하 구간(H_2) = 4.300 m

$P_o = 2 \times C \times D + K_o \times \gamma \times H^2 \times \tan\Phi$

= 2 × 30.0 × 0.000 + 0.500 ×(19.0 × 1.000 ² + 10.0 × 4.300 ²

+ 2 × 19.0 × 1.000 × 4.300)× tan 20° = 66.843 kN/m

4.4.5 안정검토

$F_s = \frac{R}{U} = \frac{517.718}{219.000} = 2.364 \geq 1.050$ ∴ O.K

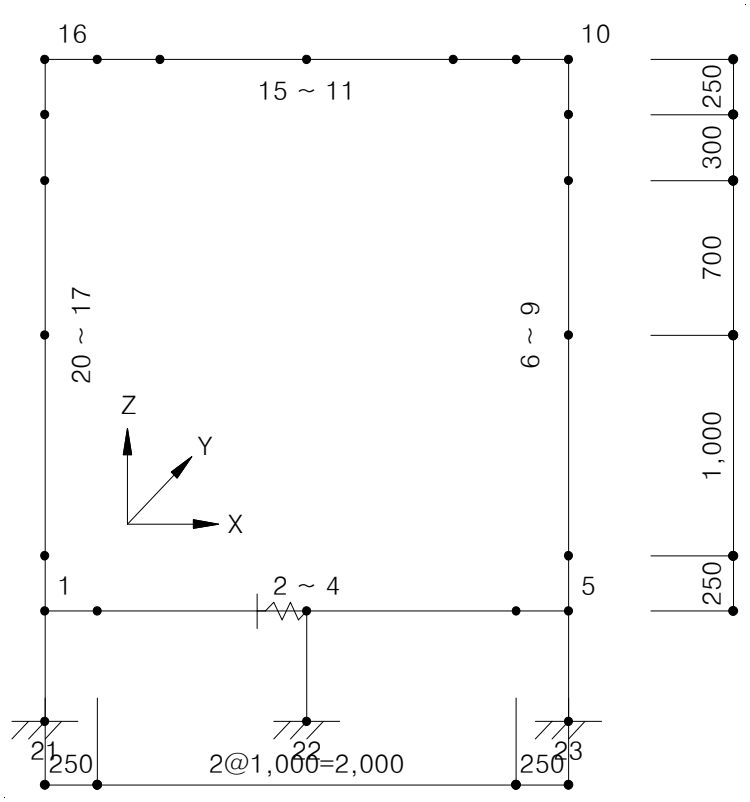
5. 해석모델 및 단면제원 (상시)

1) Modeling

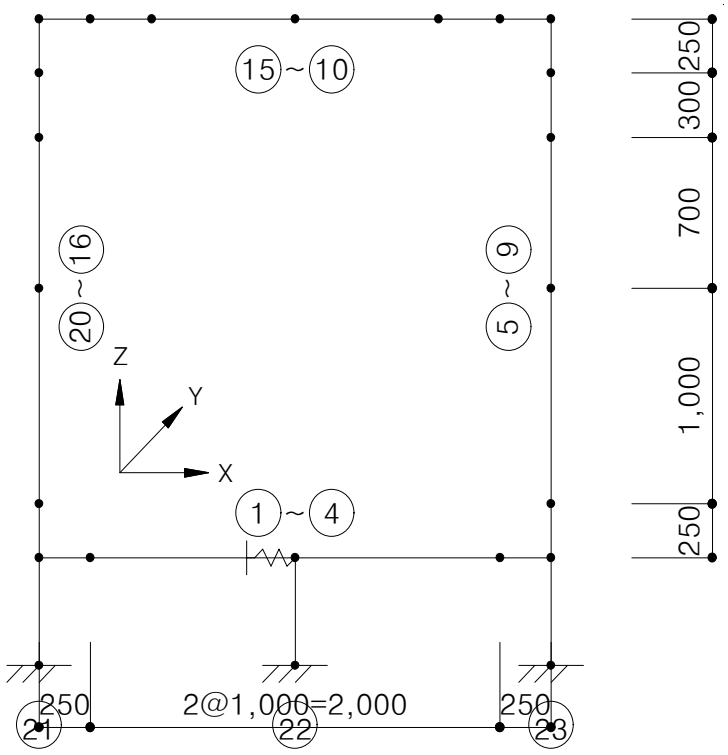
본 구조물과 같은 지하 박스는 종방향으로 동일한 패턴이 반복·지속되므로 평면 해석이 가능하다. 따라서 구조해석용 프로그램인 SAP2000을 이용하여 2차원 보요소를 사용하여 구조해석을 수행하도록 한다. 해석 모델에서 하부슬래브와 지반이 접하는 부분은 NLLink요소로 모델링을 하였는데, 지반반력 스프링의 특성이 압축에만 저항하고 인장에는 저항하지 못하기 때문에 이를 해석에서 반영하기 위하여 압축에만 저항하는 GAP 특성을 이용하여 모형화 하였다.

이와같은 모형화 기법은 하부슬래브의 지지지반을 탄성체로 보고 해석하기 위한 것으로, 그 이론적 근거는 BEF(Beams on Elastic Foundation) Analogy에 바탕을 두고 있다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)	I (m⁴)	부 재
1	0.500 × 1.000 = 0.500	0.01042	1~7,12~13,18~20
2	0.800 × 1.000 = 0.800	0.04267	9~10,15~16

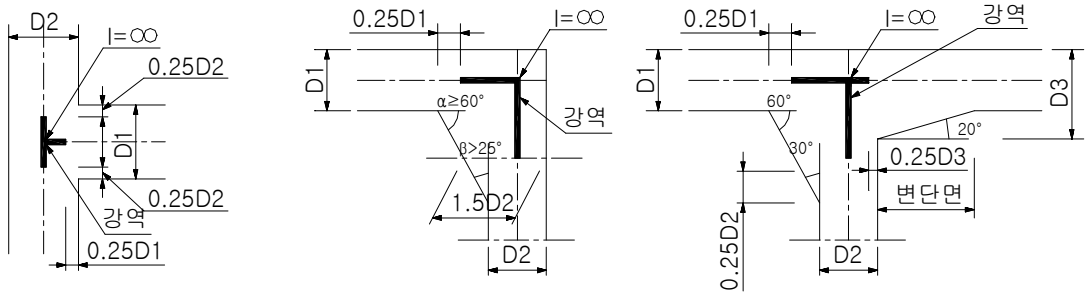
NO	Section(Tapper)	부 재
3	SEC 1 ~ 2	8,14
4	SEC 2 ~ 1	11,17

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.500	13	1.250	3.000
2	0.250	0.500	14	0.550	3.000
3	1.250	0.500	15	0.250	3.000
4	2.250	0.500	16	0.000	3.000
5	2.500	0.500	17	0.000	2.750
6	2.500	0.750	18	0.000	2.450
7	2.500	1.750	19	0.000	1.750
8	2.500	2.450	20	0.000	0.750
9	2.500	2.750	21	0.000	0.000
10	2.500	3.000	22	1.250	0.000
11	2.250	3.000	23	2.500	0.000
12	1.950	3.000			

4) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 16 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 300 - (500 × 300) / (2 × 300) = 300 mm

(2) 16 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 500 / 2 + 300 - (500 × 300) / (2 × 300) = 300 mm

(3) 10 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 300 - (500 × 300) / (2 × 300) = 300 mm

(4) 10 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 500 / 2 + 300 - (500 × 300) / (2 × 300) = 300 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 500 = 125 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 500 = 125 mm

(7) 5 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 500 = 125 mm

(8) 5 지점 - 슬래브 벽체 연결부

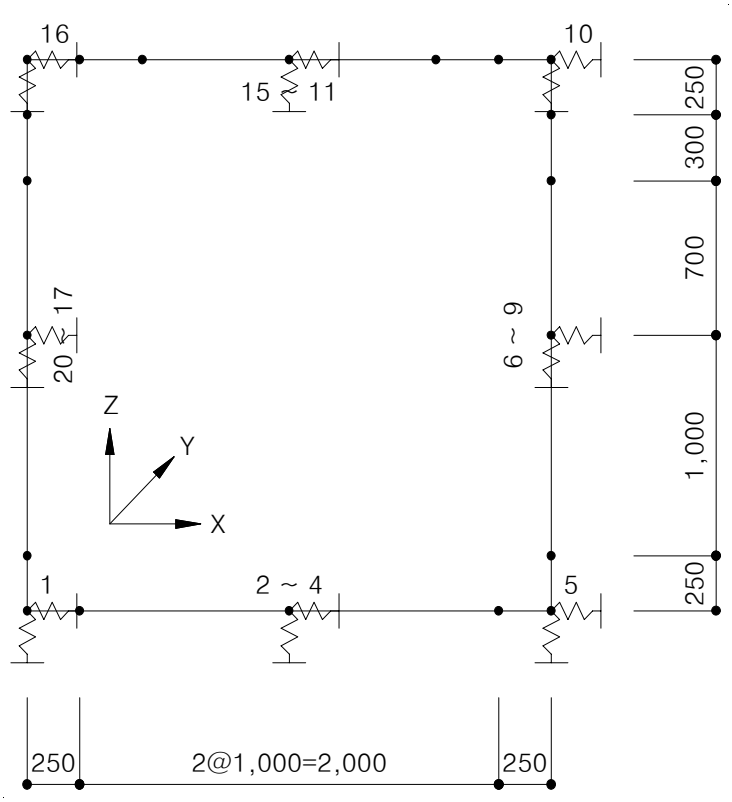
D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 500 = 125 mm

6. 해석모델 및 단면제원 (지진시)

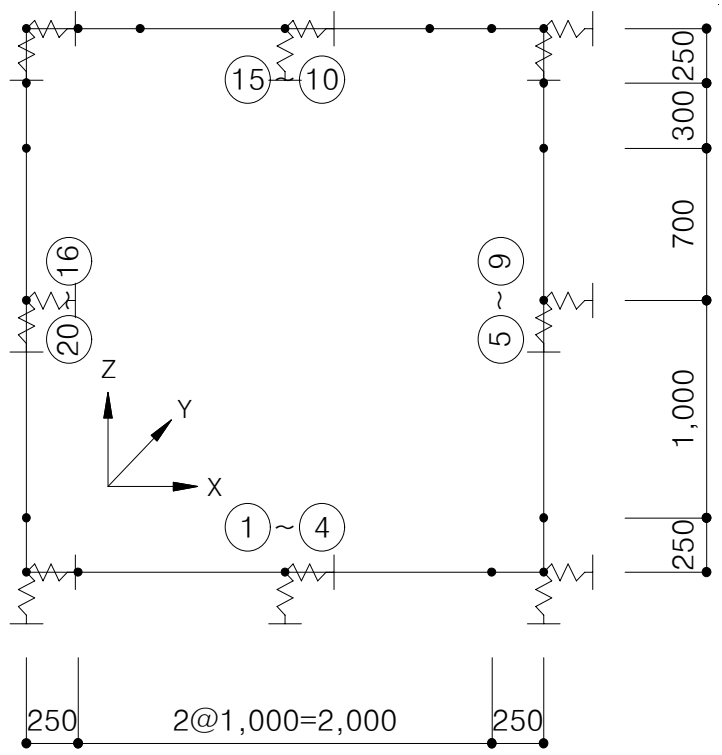
1) Modeling

지중구조물의 경우 구조물의 겉보기 중량이 주변지반의 중량과 비교하여 가볍거나 혹은 같은 정도이고 지중구조물의 대부분이 주위가 지반으로 둘러 싸여 있음으로 인하여 발산감쇠(Radiation damping)가 커서 진동이 발생하여도 짧은 시간 안에 진정되는 특성을 갖고있다. 이 때문에 지중구조물의 경우 관성력에 의한 응답의 증폭은 크지 않으며, 주변 지반의 움직임에 따라서 거동하게 된다. 따라서, 지중구조물에 발생하는 응력은 관성력에 의한 영향보다도 구조물 주변지반의 상대적인 변위에 의해 크게 영향을 받게 된다.이와같은 사실에 근거하여, 지진시에 발생하는 지반의 변위를 구조물에 작용시켜서 지중구조물에 발생하는 응력을 정적으로 구하는 방법인 응답변위법을 적용한다.

① 절점삽도



② 부재삽도



2) 단면제원

NO	A (m²)	I (m⁴)	부 재
1	0.500 × 1.000 = 0.500	0.01042	1~7,12~13,18~20
2	0.800 × 1.000 = 0.800	0.04267	9~10,15~16

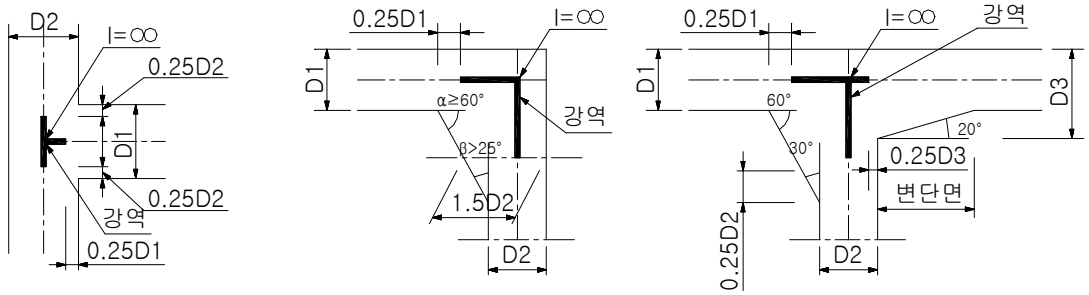
NO	Section(Tapper)	부 재
3	SEC 1 ~ 2	8,14
4	SEC 2 ~ 1	11,17

3) 단면좌표

(단위 : m)

절점번호	X	Z	절점번호	X	Z
1	0.000	0.000	11	2.250	2.500
2	0.250	0.000	12	1.950	2.500
3	1.250	0.000	13	1.250	2.500
4	2.250	0.000	14	0.550	2.500
5	2.500	0.000	15	0.250	2.500
6	2.500	0.250	16	0.000	2.500
7	2.500	1.250	17	0.000	2.250
8	2.500	1.950	18	0.000	1.950
9	2.500	2.250	19	0.000	1.250
10	2.500	2.500	20	0.000	0.250

8) 강역설정



(가) 등단면의 경우 (나) 변단면의 경우(1) (다) 변단면의 경우(2)

∴ B = 헌치폭 (mm), H = 헌치높이 (mm)

(1) 16 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 300 - (500 × 300) / (2 × 300) = 300 mm

(2) 16 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 500 / 2 + 300 - (500 × 300) / (2 × 300) = 300 mm

(3) 10 지점 - 슬래브 상면

D2 / 2 + B - (D1 × B) / (2 × H) = 500 / 2 + 300 - (500 × 300) / (2 × 300) = 300 mm

(4) 10 지점 - 슬래브 벽체 연결부

D1 / 2 + H - (D2 × H) / (2 × B) = 500 / 2 + 300 - (500 × 300) / (2 × 300) = 300 mm

(5) 1 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 500 = 125 mm

(6) 1 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 500 = 125 mm

(7) 5 지점 - 슬래브 하면

D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 500 = 125 mm

(8) 5 지점 - 슬래브 벽체 연결부

D2 / 2 - 0.25 × D1 = 500 / 2 - 0.25 × 500 = 125 mm

7. 지반반력계수 (상시)

< 연직방향 지반반력계수 >

- 사질토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1/2}$

- 사질토와 점성토의 혼합층인 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$

- 점성토층이 우세한 경우 $K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-1}$

α = Eo 의 산정방법에 대한 보정계수

Eo = 지반의 탄성계수

- 연직방향 지반반력계수 (Kv)

$$K_V = K_{V0}\left(\frac{B_v}{0.3}\right)^{-3/4}$$

여기서, $K_{vo} = \frac{1}{0.3} \times \alpha \times E_0$

Eo : 지반탄성계수 (kN/m²)

α = 1

Eo = 28000.00 kN/m²

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

Bv = √(B × B) = √(3.000 × 3.000) = 3.000 m

Kvo = 1 / 0.3 × 1 × 28000 = 93330.00 kN/m³

Kv(BxB) = 93330.00 × (3.000 / 0.3) $^{-3 / 4}$ = 16596.68 kN/m³

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 16596.682 = 13277.35 kN/m³

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.500/2 + 1.250/2) = 11618 kN/m	1,5
Kv2	Kv x (1.250/2 + 1.250/2) = 16597 kN/m	3
Kh	1E10 kN/m (무한강성)	3

8. 지반반력계수 (지진시)

1) 지반탄성계수의 산정

(1) 모래(SP) (EL. : 0.503 ~ -10.397, N=5)

① 기능수행 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (기능수행수준의 전단파 속도) = 1.0 × Vo = 1.0 × 289.0 = 289.0 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20 / 9.810 × 289.0^2 = 170277.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 170277.0 = 449531.3 kN/m^2

② 붕괴방지 수준

- Vo (초기상태 전단파 속도) = 289.0 m/sec
- Vs (붕괴방지수준의 전단파 속도) = 0.8 × Vo = 0.8 × 289.0 = 231.2 m/sec
- Gd (전단탄성계수) = w / g × Vs^2 (w : 흙의 단위중량, g : 중력계수)
  = 20.0 / 9.810 × 231.2^2 = 108977.0 kN/m^2
- Ed (탄성계수) = 2 × (1 + v) × Gd (v : 흙의 포아슨 비)
  = 2 × (1 + 0.32) × 108977.0 = 287699.3 kN/m^2

2) 지반반력계수의 산정(기능수행수준)

(1) 상부슬래브 : 제2토층 ,모래(SP)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

α = 1,L = 7.250m

Bv = √(B × B) = √(3.000 × 3.000) = 3.000 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 449531.3 = 1498437.67 kN/m^3

Kv(B×B) = 1498437.670 × (3.000 / 0.3)$^{-3/4}$ = 266464.09 kN/m^3

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 266464.090 = 213171.27 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 213171.270 = 71057.09 kN/m^3

(2) 하부슬래브 : 제2토층 , 모래(SP)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$

α = 1,L = 7.250m

Bv = √(B × B) = √(3.000 × 3.000) = 3.000 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 449531.3 = 1498437.67 kN/m^3

Kv(B×B) = 1498437.670 × (3.000 / 0.3)$^{-3/4}$ = 266464.09 kN/m^3

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 266464.090 = 213171.27 kN/m^3

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 213171.270 = 71057.09 kN/m^3

(3) 측벽 : 제2토층 , 모래(SP)

① 수평방향 지반반력계수

$$K_{(H\times L)} = K_{(H\times H)} \times \frac{(1+0.5\frac{H}{L})}{1.5}$$

α = 1,L = 7.250m

Bh = √(H × H) = √(3.000 × 3.000) = 3.000 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 449531.3 = 1498437.67 kN/m³

Kh(H×H) = 1498437.670 × (3.000 / 0.3)$^{-3/4}$ = 266464.09 kN/m³

Kh(HxL) = 0.800 × Kh(HxH) = 0.800 × 266464.090 = 213171.27 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 213171.270 = 71057.09 kN/m³

(4) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.250/2 + 1.250/2) = 266464 kN/m	13
Ksb1	Ksb x (1.250/2 + 1.250/2) = 88821 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.250/2 + 1.250/2) = 266464 kN/m	7,19
Kss1	Kss x (1.250/2 + 1.250/2) = 88821 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.250/2 + 1.250/2) = 266464 kN/m	3
Ksb1	Ksb x (1.250/2 + 1.250/2) = 88821 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.500/2 + 1.250/2) = 186525 kN/m	1,5
Ksb1	Kh x (1.250/2 + 0.500/2) = 186525 kN/m	
Kv2	Kv x (1.250/2 + 0.500/2) = 186525 kN/m	10,16
Ksb2	Kh x (1.250/2 + 0.500/2) = 186525 kN/m	

3) 지반반력계수의 산정(붕괴방지수준)

(1) 상부슬래브 : 제2토층 ,모래(SP)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$ α = 1,L = 7.250m

Bv = √(B × B) = √(3.000 × 3.000) = 3.000 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 287699.3 = 958997.67 kN/m³

Kv(B×B) = 958997.670 × (3.000 / 0.3)$^{-3/4}$ = 170536.58 kN/m³

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 170536.580 = 136429.26 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 136429.260 = 45476.42 kN/m³

(2) 하부슬래브 : 제2토층 , 모래(SP)

① 연직방향 지반반력계수

$$K_{(B\times L)} = K_{(B\times B)} \times \frac{(1+0.5\frac{B}{L})}{1.5}$$ α = 1,L = 7.250m

Bv = √(B × B) = √(3.000 × 3.000) = 3.000 m

Kvo = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 287699.3 = 958997.67 kN/m³

Kv(B×B) = 958997.670 × (3.000 / 0.3)$^{-3/4}$ = 170536.58 kN/m³

Kv(BxL) = 0.80 × Kv(BxB) = 0.80 × 170536.580 = 136429.26 kN/m³

② 전단 지반반력계수

Ksb = λ × Kv = 1/3.0 × 136429.260 = 45476.42 kN/m³

(3) 측벽 : 제2토층 , 모래(SP)

① 수평방향 지반반력계수

$$K_{(H\times L)} = K_{(H\times H)} \times \frac{(1+0.5\frac{H}{L})}{1.5}$$ α = 1,L = 7.250m

Bh = √(H × H) = √(3.000 × 3.000) = 3.000 m

Kho = 1 / 0.3 × α × Ed = 1 / 0.3 × 1 × 287699.3 = 958997.67 kN/m³

Kh(H×H) = 958997.670 × (3.000 / 0.3)$^{-3/4}$ = 170536.58 kN/m³

Kh(HxL) = 0.800 × Kh(HxH) = 0.800 × 170536.580 = 136429.26 kN/m³

② 전단 지반반력계수

Kss = λ × Kh = 1/3.0 × 136429.260 = 45476.42 kN/m³

(4) 적용 지반반력계수

- 상부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.250/2 + 1.250/2) = 170537 kN/m	13
Ksb1	Ksb x (1.250/2 + 1.250/2) = 56846 kN/m	

- 측벽

지반반력계수	계 산 식	해당 절점
Kh1	Kh x (1.250/2 + 1.250/2) = 170537 kN/m	7,19
Kss1	Kss x (1.250/2 + 1.250/2) = 56846 kN/m	

- 하부슬래브

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (1.250/2 + 1.250/2) = 170537 kN/m	3
Ksb1	Ksb x (1.250/2 + 1.250/2) = 56846 kN/m	

- 우각부

지반반력계수	계 산 식	해당 절점
Kv1	Kv x (0.500/2 + 1.250/2) = 119376 kN/m	1,5
Ksb1	Kh x (1.250/2 + 0.500/2) = 119376 kN/m	
Kv2	Kv x (1.250/2 + 0.500/2) = 119376 kN/m	10,16
Ksb2	Kh x (1.250/2 + 0.500/2) = 119376 kN/m	

4) 지반계수 산정

① 위험도 계수 (I)

- 내진성능 목표

설계지진	성능기 / 준 재현주기	기 능 수 행	붕 괴 방 지
	50년	II 등급	
	100년	I 등급	
	200년	특 등급	
	500년		II 등급
	1000년		I 등급
	2400년		특 등급

- 위험도 계수

재현주기 (년)	50	100	200	500	1000	2400
위험도계수,I	0.40	0.57	0.73	1.00	1.40	2.00

② 지진구역 계수(Z)

- 지진구역 구분

지진구역	행정구역		구역계수, Z
I	시	서울특별시, 인천광역시, 대전광역시, 부산광역시, 대구광역시, 울산광역시, 광주광역시	0.11
	도	경기도, 강원도 남부, 충청북도, 충청남도, 경상북도, 경상남도, 전라북도, 전라남도 북동부	
II	도	강원도 북부, 전라남도 남서부, 제주도	0.07

③ 설계 지반 종류

지반 분류	지반종류의 호칭	상부 30m 에 대한 평균 지반 특성		
		전단파 속도 Z(m/s)	표준관입시험 N(Nch) (blow/foot)	비배수전단강도 Su(kPa)
Sa	경암지반	1500초과	-	-
Sb	보통암지반	760에서 1500		
Sc	매우 조밀한 토사지반 또는 연암지반	360에서 760	> 50	> 100
Sd	단단한 토사지반	180에서 360	15에서 50	50에서 100
Se	연약한 토사지반	180미만	< 15	< 50
Sf	부지 고유의 특성평가가 요구되는 지반			

④ 지진계수 Ca, Cv

지역계수	지반종류	지진계수	
		Ca	Cv
1	Sa	0.09	0.09
	Sb	0.11	0.11
	Sc	0.13	0.18
	Sd	0.16	0.23
	Se	0.22	0.37
2	Sa	0.05	0.05
	Sb	0.07	0.07
	Sc	0.08	0.11
	Sd	0.11	0.16
	Se	0.17	0.23

⑤ 설계 수평 지진계수 (KH)

- 지표면의 설계 수평지진 계수(기능수행수준) : KH = I × Ca = 0.57 × 0.16 = 0.091
- 지표면의 설계 수평지진 계수(붕괴방지수준) : KH = I × Ca = 1.40 × 0.16 = 0.224

9. 하 중 계 산 (상시)

1) 구체자중 - 프로그램내에서 자동계산

2) 고정하중

① 고정하중 (지하수가 없을 경우)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 토 사	: 4.800 × 19.00	=	91.200	kN/m²
	∴ Total Wd1	=	102.700	kN/m²

② 고정하중 (지하수가 있을 경우 : GL = -1.000 m)

- ASPHALT 포장하중	: 0.500 × 23.00	=	11.500	kN/m²
- 흙(지하수위 이상)	: 0.500 × 19.00	=	9.500	kN/m²
- 흙(지하수위 이하)	: 4.300 × 10.00	=	43.000	kN/m²
	∴ Total Wd2	=	64.000	kN/m²

3) 활하중

- 노면 활하중 (DB-24 적용)

토피고(D,m)	도로면의 활하중 (kN/m²)	토피고(D,m)	도로면의 활하중 (kN/m²)
1.0	39.0	1.5	25.0
2.0	18.0	2.5	14.0
3.0	11.0	3.5	10.0
4.0	10.0	5.0	10.0
6.0	10.0	7.0	10.0
8.0	10.0	9.0	10.0
10.0	10.0		

주) 중간토피에 대한 것은 그 상위의 것을 취한다.

① 상부 슬래브에 작용하는 하중 (WI1) - 토피 4m 이상

- WI1 = 10.000 kN/m²

② 측벽에 작용하는 하중 (WI2)

- WI2 = 10.000 × 0.500 = 5.000 kN/m²

4) 토압 (지하수가 없을 경우)

Wh1 = (0.500 × 23.000 + 5.050 × 19.000) × 0.500 = 53.725 kN/m²

Wh2 = 53.725 + 0.250 × 19.000 × 0.500 = 56.100 kN/m²

Wh3 = 56.100 + 0.300 × 19.000 × 0.500 = 58.950 kN/m²

Wh4 = 58.950 + 0.700 × 19.000 × 0.500 = 65.600 kN/m²

Wh5 = 65.600 + 1.000 × 19.000 × 0.500 = 75.100 kN/m²

Wh6 = 75.100 + 0.250 × 19.000 × 0.500 = 77.475 kN/m²

5) 토압 (지하수가 있을 경우)

Wh1 = (0.500 × 23.000 + 0.500 × 19.000 + 4.550 × 10.000 = 33.250 kN/m²

Wh2 = 33.250 + 0.250 × 10.000 × 0.500 = 34.500 kN/m²

Wh3 = 34.500 + 0.300 × 10.000 × 0.500 = 36.000 kN/m²

Wh4 = 36.000 + 0.700 × 10.000 × 0.500 = 39.500 kN/m²

Wh5 = 39.500 + 1.000 × 10.000 × 0.500 = 44.500 kN/m²

Wh6 = 44.500 + 0.250 × 10.000 × 0.500 = 45.750 kN/m²

6) 지하수압 (지하수위 : GL = -1.000 m)

① 상부슬래브에 작용하는 하중

- Ww1 = 4.300 × 10.000 = 43.000 kN/m²

② 측벽에 작용하는 하중

- Ww2 = 4.550 × 10.000 = 45.500 kN/m²

Ww3 = 45.500 + 0.250 × 10.000 = 48.000 kN/m²

Ww4 = 48.000 + 0.300 × 10.000 = 51.000 kN/m²

Ww5 = 51.000 + 0.700 × 10.000 = 58.000 kN/m²

Ww6 = 58.000 + 1.000 × 10.000 = 68.000 kN/m²

Ww7 = 68.000 + 0.250 × 10.000 = 70.500 kN/m²

③ 하부슬래브에 작용하는 하중

- Ww8 = (5.300 + 3.000 - 1.000) × 10.000 = 73.000 kN/m²

7) 온도하중

- 온도의 승강은 ± 10° C로 한다.
- 콘크리트 및 철근의 열팽창계수 α = 0.00001 으로 한다.

8) 건조수축

- 15° C의 온도하중으로 변환 설계.

- 건조수축계수 $\varepsilon = 15 \times 10^{-5}$
- 온도선팽창 계수 $\alpha = 1.0 \times 10^{-5}$
- $\Delta T = -\frac{\varepsilon}{\alpha}$ = 15° C

10. 하 중 계 산 (지진시)

1) 고유주기(Tg)

$$T_{G'} = \sum_{i=1}^{N} \frac{4Hi}{Vsi}$$

지 반	Hi(m)	Vsi(m/sec)		γ(kN/m³)	Tg'(sec)	
		기능수행수준	붕괴방지수준		기능수행수준	붕괴방지수준
실트 섞인 모래(SM	2.200	156.000	124.800	20.000	0.056	0.071
모래(SP)	8.700	289.000	231.200	20.000	0.120	0.151
풍화 잔류토(RS)	3.100	424.000	424.000	20.000	0.029	0.029
풍화암(WR)	16.000	631.000	631.000	20.000	0.101	0.101
계					0.306	0.352

구 분	기능수행수준	붕괴방지수준
Tg(sec)	1.25Tg' = 1.25 × 0.306 = 0.383	1.25 Tg' = 1.25 × 0.352 = 0.440

2) 통제주기(Ts)

구 분	기능수행수준	붕괴방지수준
Ts(sec)	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575	Ts = Cv / (2.5 × Ca) = 0.230/(2.5×0.160) = 0.575
To(sec)	To = 0.2 × Ts = 0.2 × 0.575 = 0.115	To = 0.2 × Ts = 0.2 × 0.575 = 0.115

3) 감쇠율에 대한 보정계수(Cd)

① 성능수준별 감쇠율(h)

- 기능수행수준 : h = 0.1
- 붕괴방지수준 : h = 0.2

② 보정계수 $$C_d = \frac{1.5}{40h+1} + 0.5$$

구 분	기능수행수준	붕괴방지수준
Cd	0.800	0.667

단,별도의 합리적인 해석에 의하여 구한 값을 적용할 수 있다.

4) 가속도 응답스펙트럼(Sa)

- 붕괴방지수준시(재현주기 1000년적용)

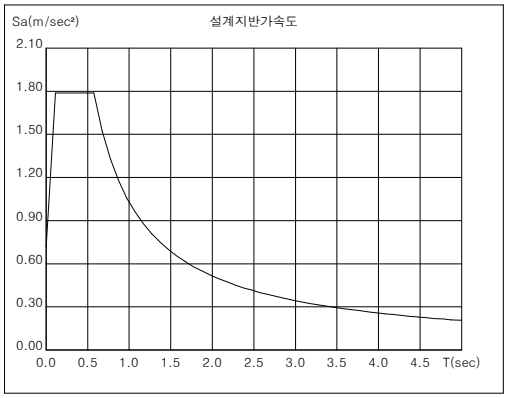
기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 1.789 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg	- 0 ≤ Tg < To 일때 Sa = [Ca+(2.5×Ca-Ca)/To×Tg]×g×I×Cd - To ≤ Tg < Ts 일때 Sa = 2.5×Ca×g×I×Cd = 3.664 m/s² - Tg ≥ Ts 일때 Sa = Cv×g×I×Cd/Tg

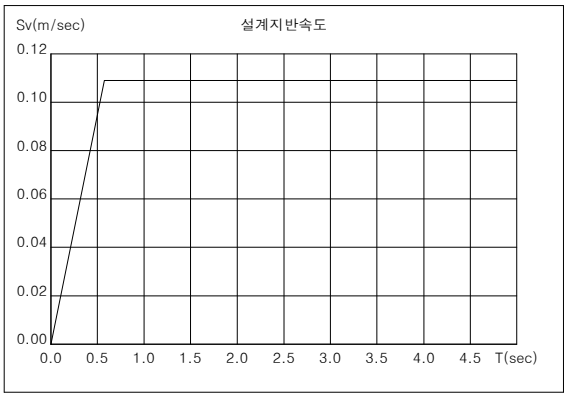
5) 속도 응답스펙트럼(Sv)　　- 붕괴방지수준시(재현주기 1000년적용)

기능수행수준시(재현주기 100년적용)	붕괴방지수준시(재현주기 1000년적용)
Sv = Tg/2π × Sa = 0.383 / 2π × 1.789 = 0.109 m/s	Sv = Tg/2π × Sa = 0.440 / 2π × 3.664 = 0.257 m/s

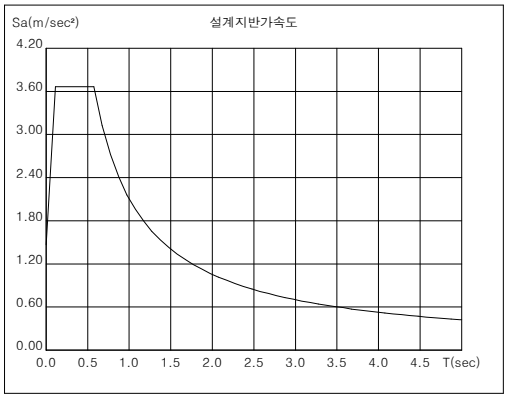
6) 설계응답 응답스펙트럼

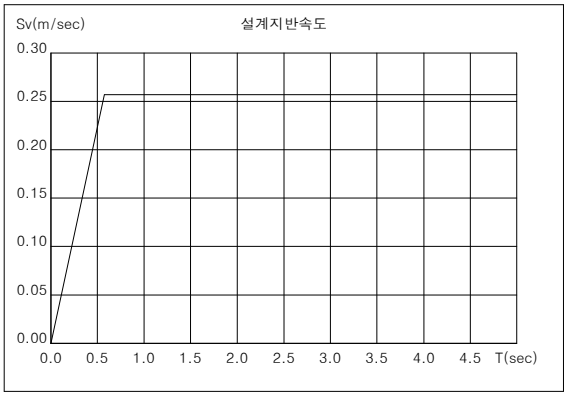
(1) 기능수행수준





(2) 붕괴방지수준





7) 층별 변위값 정리

- 제 1층의 두께(H1) = 14.000 m
- 제 2층의 두께(H2) = 16.000 m
- 제 1층의 습윤단위 체적중량(γ1) = 20.000 kN/m³
- 제 2층의 습윤단위 체적중량(γ2) = 20.000 kN/m³
- 제 1층의 평균전단파속도(Vsod1) = 257.171 m/sec
- 제 2층의 평균전단파속도(Vsod2) = 631.000 m/sec
- 제 1층과 제2층의 임피던스비(α)
  (γ1×Vsod1) / (γ2×Vsod2) = (20.000 × 257.171) / (20.000 × 631.000)
  = 0.408

- 지반의 설계 고유 진동수(Wo)

$(1+\alpha)\times\cos[Wo\times(H1/Vsod1 + H2/Vsod2)] + (1-\alpha)\times\cos[Wo\times(H1/Vsod1 - H2/Vsod2)] = 0$

$(1 + 0.408) \times \cos[Wo \times (14.000 / 257.171 + 16.000 / 631.000)] +$

$(1 - 0.408) \times \cos[Wo \times (14.000 / 257.171 - 16.000 / 631.000)] = 0$

에서 시행착오법으로 산정, Wo = 23.815

- 각 층별 변위 계산식

  - 제1층 변위 계산식

$Uh1 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times x1/Vsod1)$

  - 제2층 변위 계산식

$Uh2 = 2/\pi^2 \times Sv \times Tg \times \cos(Wo \times H1/Vsod1) \times$

$[\cos(Wo \times x2/Vsod2) - \sin(Wo \times x2/Vsod2) / \tan(Wo \times H2/Vsod2)]$

8) 상부슬래브 지반변위 하중

- 상부슬래브 EL. = 5.550 m
- 하부슬래브 EL. = 8.050 m
- 기반암 심도(H) = 30.000 m

$Po = Ksb,top \times (U(Zu) - U(Zb))$

기능수행수준	붕괴방지수준
$Po = 71057.090 \times (0.007367 - 0.006216)$ $= 81.787\ kN/m^2$	$Po = 45476.420 \times (0.019954 - 0.016837)$ $= 141.750\ kN/m^2$

9) 측벽 지반변위 하중

$P(z) = Kh \times (Uh(z) - Uh(b))$

(1) 기능수행수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
5.550	213171.270	0.007367	0.001151	245.360
5.800	213171.270	0.007269	0.001053	224.469
6.100	213171.270	0.007146	0.000930	198.249
6.800	213171.270	0.006837	0.000621	132.379
7.800	213171.270	0.006347	0.000131	27.925
8.050	213171.270	0.006216	0.000000	0.000

(2) 붕괴방지수준

z(m)	Kh (kN/m³)	U(Zh) (m)	U(Zh) - U(Zb) (m)	P(z) (kN/m²)
5.550	136429.260	0.019954	0.003117	425.250
5.800	136429.260	0.019688	0.002851	388.960
6.100	136429.260	0.019355	0.002518	343.529
6.800	136429.260	0.018520	0.001683	229.610
7.800	136429.260	0.017193	0.000356	48.569
8.050	136429.260	0.016837	0.000000	0.000

10) 주면 전단력

Vu = Gd × Uh1, Vb = Gd × Uh2, Vs = (Vu + Vb) / 2

구분	기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
Vu	170277.000 × 0.000369 = 62.830	108977.000 × 0.001000 = 108.980
Vb	170277.000 × 0.000518 = 88.200	108977.000 × 0.001403 = 152.890
Vs	(62.830 + 88.200) / 2 = 75.520	(108.980 + 152.890) / 2 = 130.940

11) 구체 관성력

fi = Ai × rcon'c × KH × (1 - 0.015 × Zi)

① 상부슬래브

기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fu = 0.500×25.000×0.091×(1 - 0.015×5.550) = 1.043	fu = 0.500×25.000×0.224×(1 - 0.015×5.550) = 2.567

② 하부슬래브

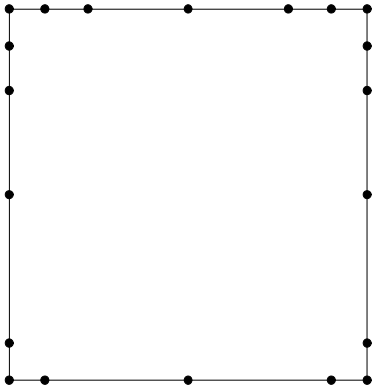
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
fb = 0.500×25.000×0.091×(1 - 0.015×8.050) = 1.000	fb = 0.500×25.000×0.224×(1 - 0.015×8.050) = 2.462

③ 측벽

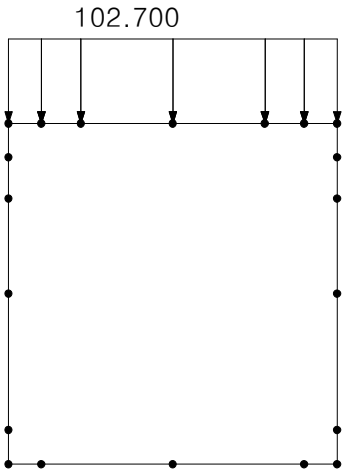
기능수행수준(kN/㎡)	붕괴방지수준(kN/㎡)
f1 = 0.500×25.000×0.091×(1-0.015×5.550) = 1.043	f1 = 0.500×25.000×0.224×(1-0.015×5.550) = 2.567
f2 = 0.500×25.000×0.091×(1-0.015×5.800) = 1.039	f2 = 0.500×25.000×0.224×(1-0.015×5.800) = 2.556
f3 = 0.500×25.000×0.091×(1-0.015×6.100) = 1.033	f3 = 0.500×25.000×0.224×(1-0.015×6.100) = 2.544
f4 = 0.500×25.000×0.091×(1-0.015×6.800) = 1.021	f4 = 0.500×25.000×0.224×(1-0.015×6.800) = 2.514
f5 = 0.500×25.000×0.091×(1-0.015×7.800) = 1.004	f5 = 0.500×25.000×0.224×(1-0.015×7.800) = 2.472
f6 = 0.500×25.000×0.091×(1-0.015×8.050) = 1.000	f6 = 0.500×25.000×0.224×(1-0.015×8.050) = 2.462

11. 하 중 재 하 (상시)

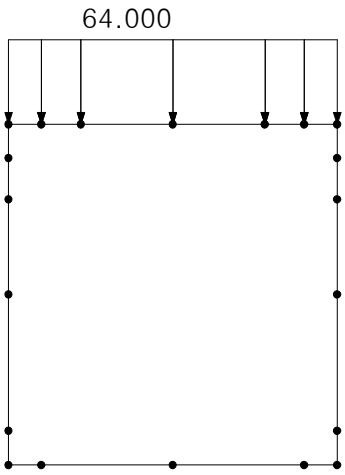
1) CASE1 - 구체자중(SW)



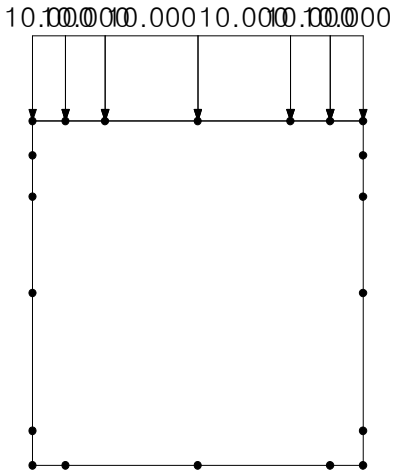
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



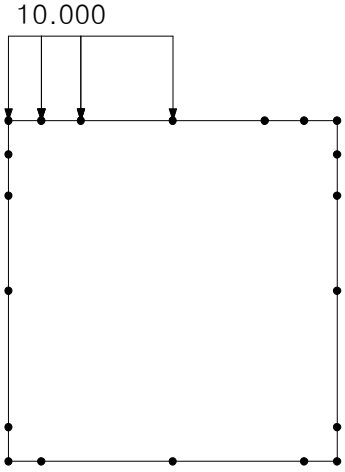
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



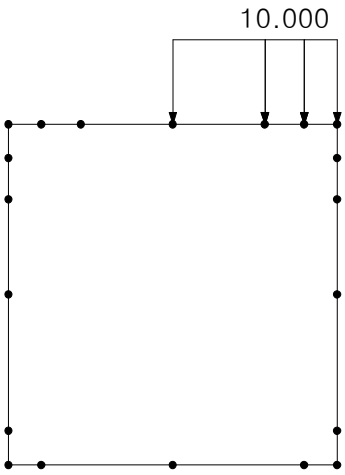
4) CASE4 - 만재활하중(LIVEFU)



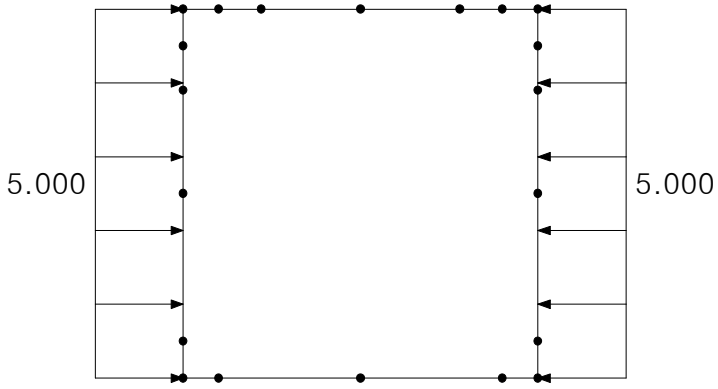
5) CASE5 - 편재활하중(좌측)(LIVELE)



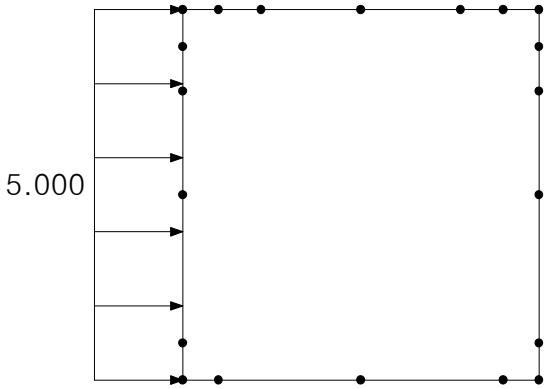
6) CASE6 - 편재활하중(우측)(LIVERI)



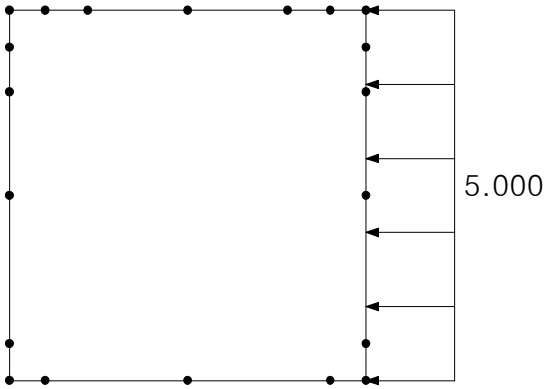
7) CASE7 - 만재활하중에 의한 수평하중(LIVEFUH)



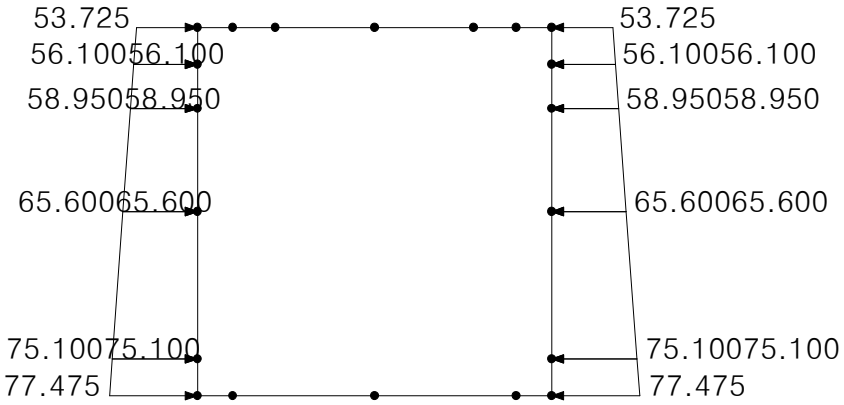
8) CASE8 - 편재활하중에 의한 수평하중(좌측)(LIVELEH)



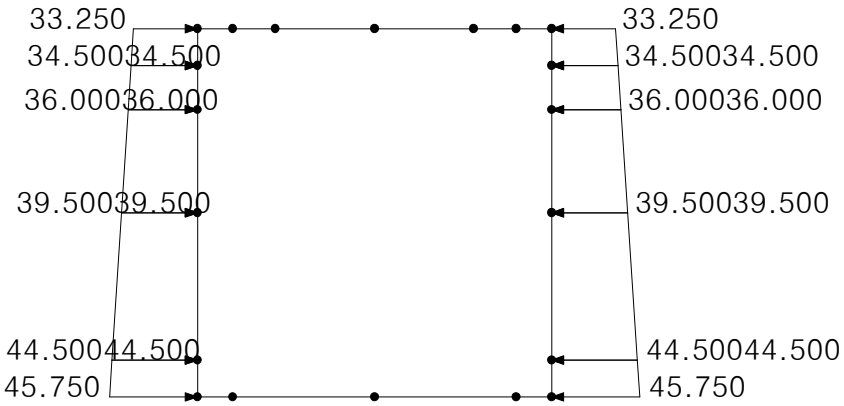
9) CASE9 - 편재활하중에 의한 수평하중(우측)(LIVERIH)



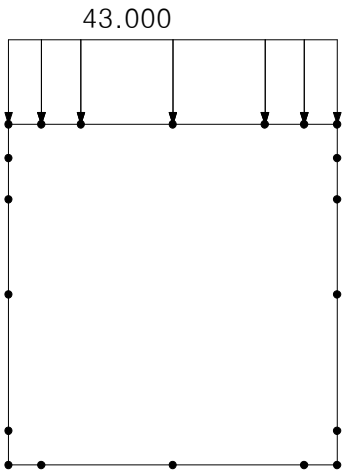
10) CASE10 - 양토압 : 지하수無(SOILB)



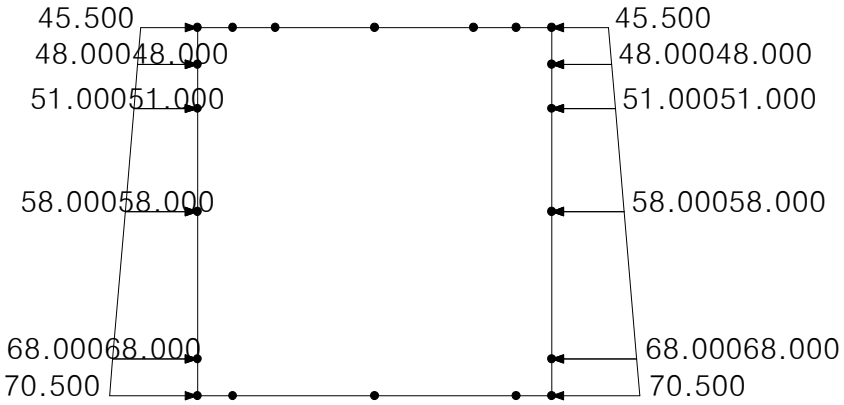
11) CASE11 - 양토압 : 지하수有(SOILBW)



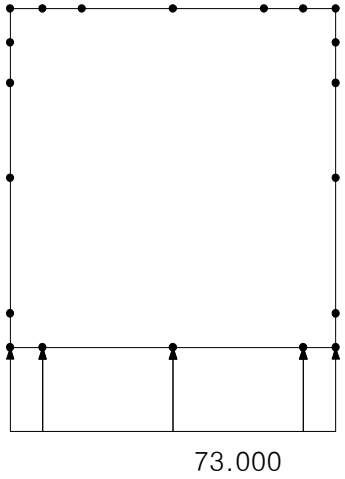
12) CASE12 - 연직수압(WATERV)



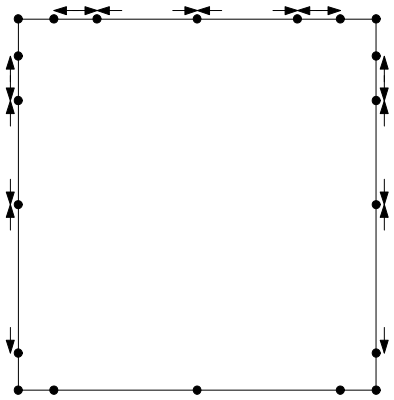
13) CASE13 - 수평수압(WATERH)



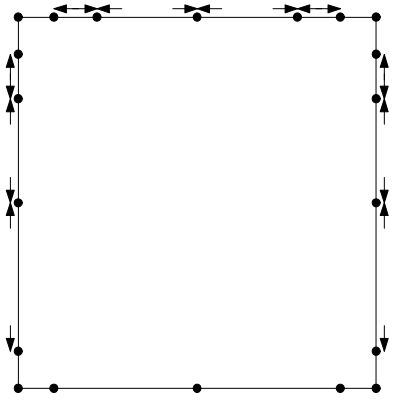
14) CASE14 - 부력(BUOYANCY)



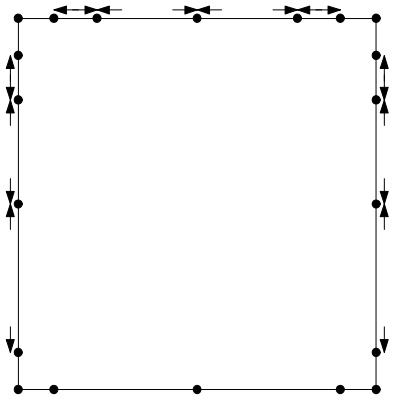
15) CASE15 - 온도변화(+) +10° C(TEMPPLUS)



16) CASE16 - 온도변화(-) -10° C(TEMPMINU)

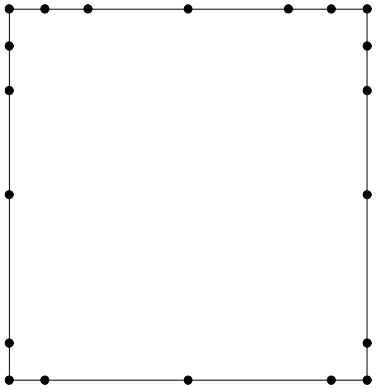


17) CASE17 - 건조수축 -15° C(SHRINK)

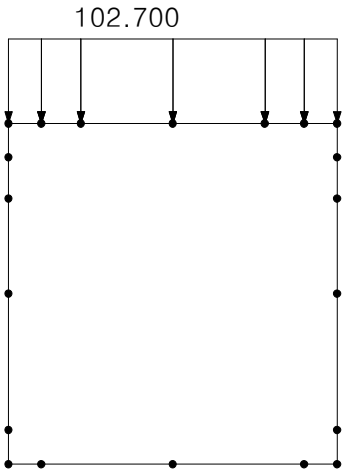


12. 하중 재하 (기능수행)

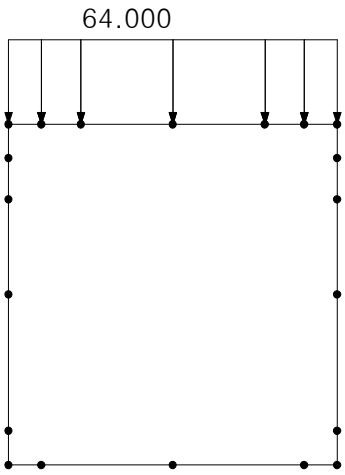
1) CASE1 - 구체자중(SW)



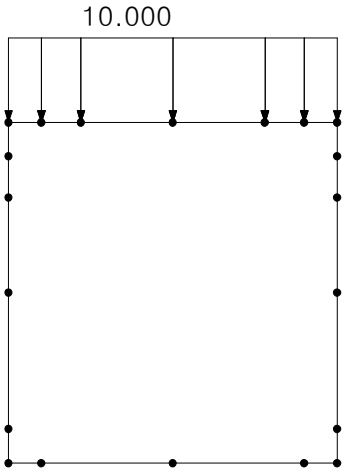
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



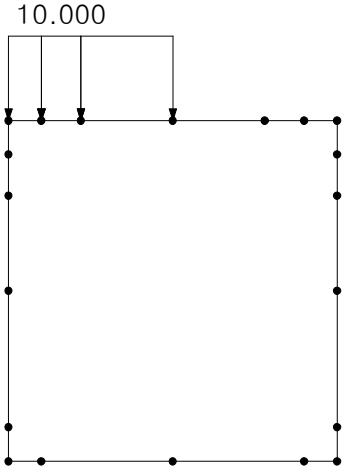
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



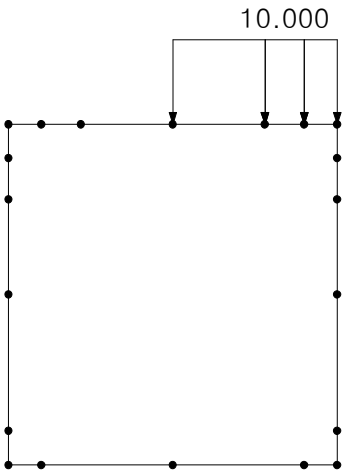
4) CASE4 - 지진시 만재활하중(LIVEFUE)



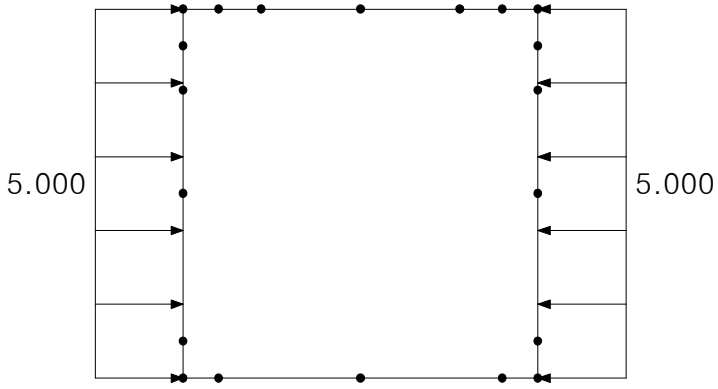
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



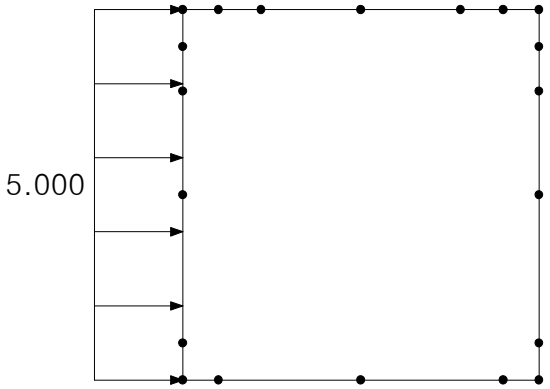
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



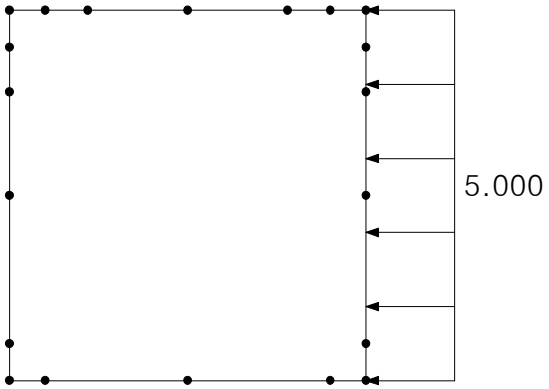
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



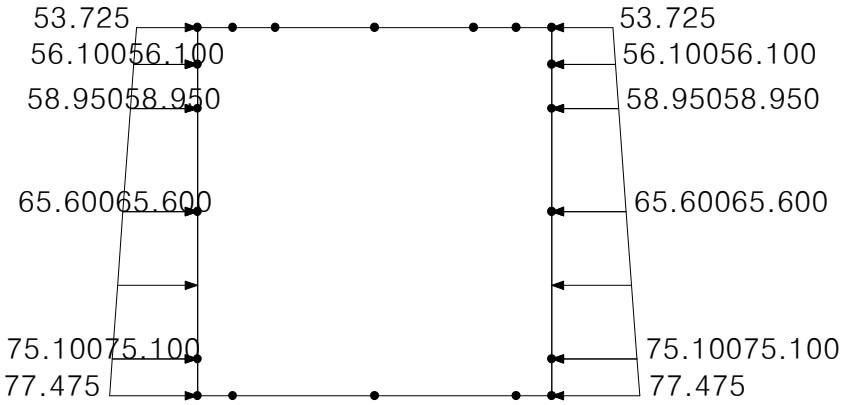
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



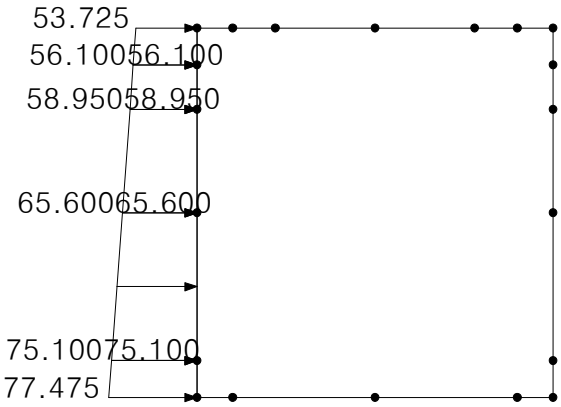
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



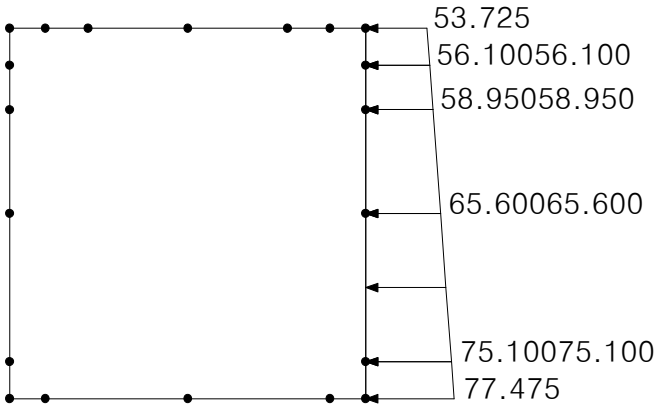
10) CASE10 - 지진시 양토압 2(SOILBE2)



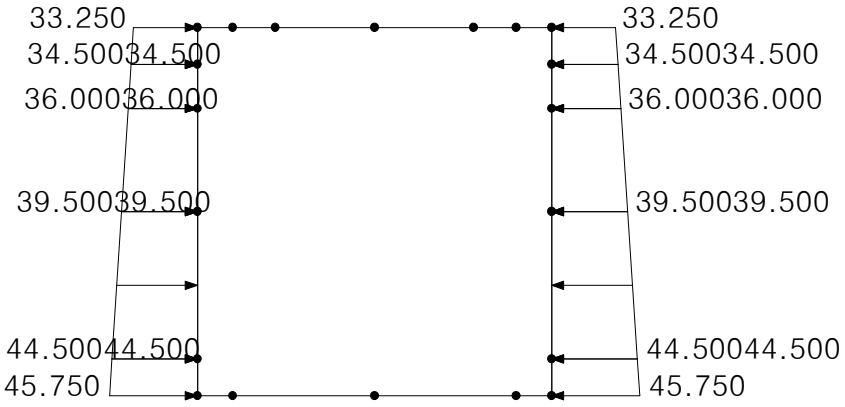
11) CASE11 - 지진시 편토압(좌측) 2(SOILLE2)



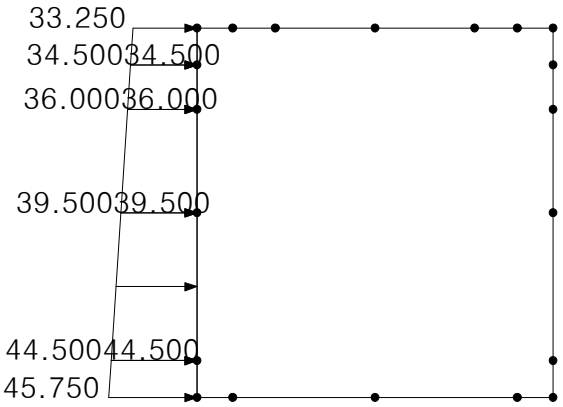
12) CASE12 - 지진시 편토압(우측) 2(SOILRE2)



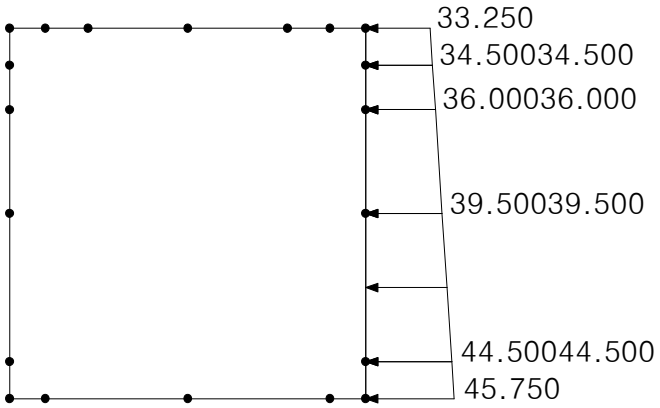
13) CASE13 - 지진시 양토압 2 : 지하수有(SOILBWE2)



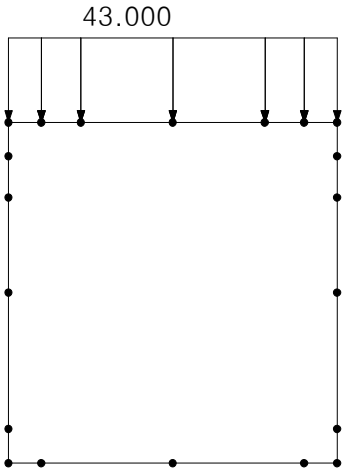
14) CASE14 - 지진시 편토압(좌측) 2 : 지하수有(SOILLWE2)



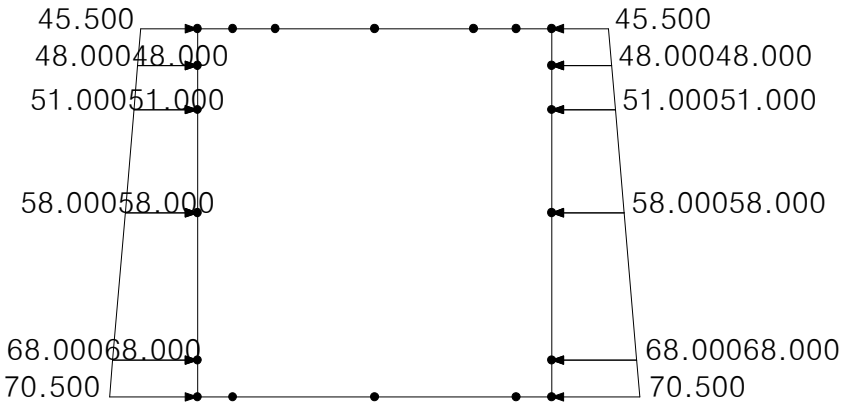
15) CASE15 - 지진시 편토압(우측) 2 : 지하수有(SOILRWE2)



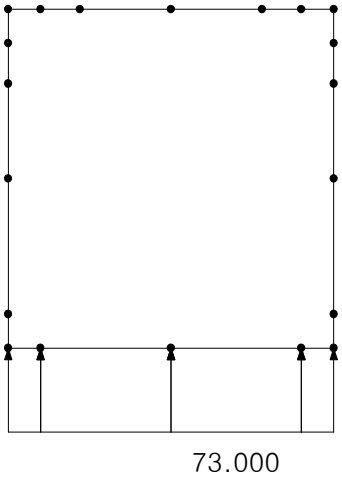
16) CASE16 - 연직수압(WATERV)



17) CASE17 - 수평수압(WATERH)

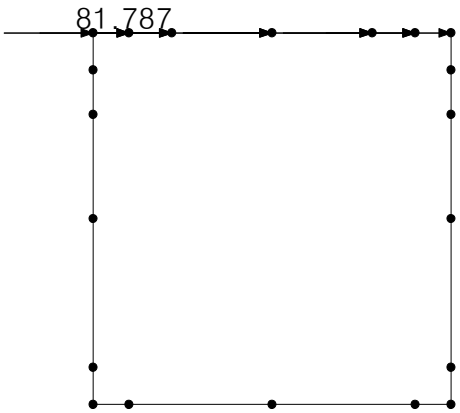


18) CASE18 - 부력(BUOYANCY)

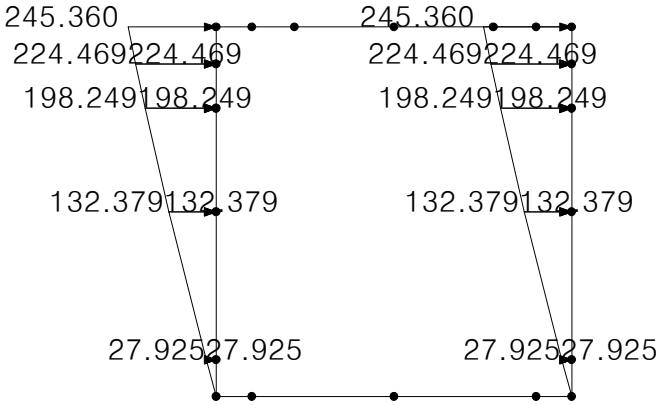


- 지진재하방향(좌측에서 우측으로)

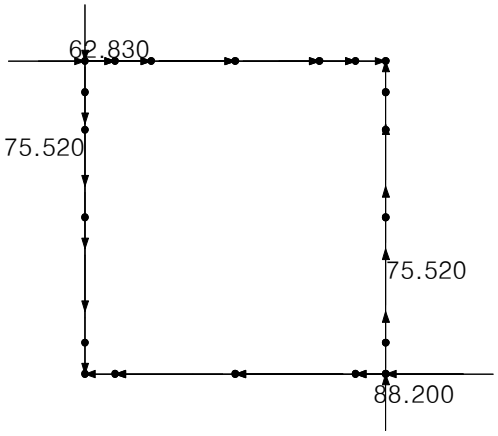
19) CASE19 - 슬래브 지반변위(기능수행)(FUNSLAB)



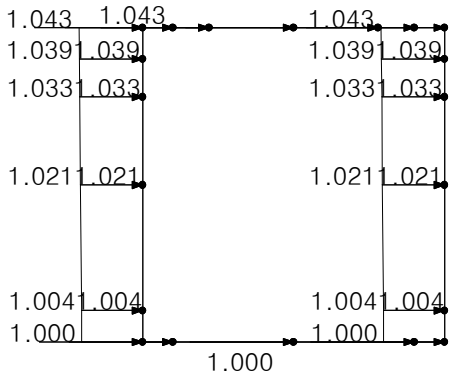
20) CASE20 - 벽체 지반변위(기능수행)(FUNWALL)



21) CASE21 - 주면전단력(기능수행)(FUNMS)

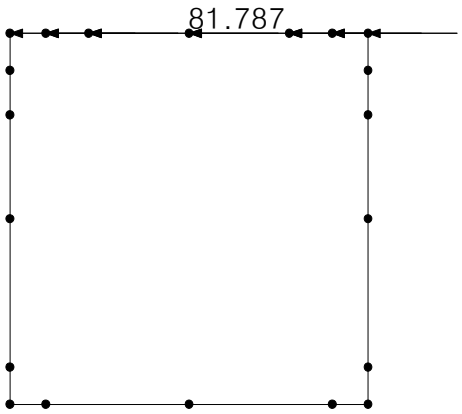


22) CASE22 - 구체 관성력(기능수행)(FUNINER)

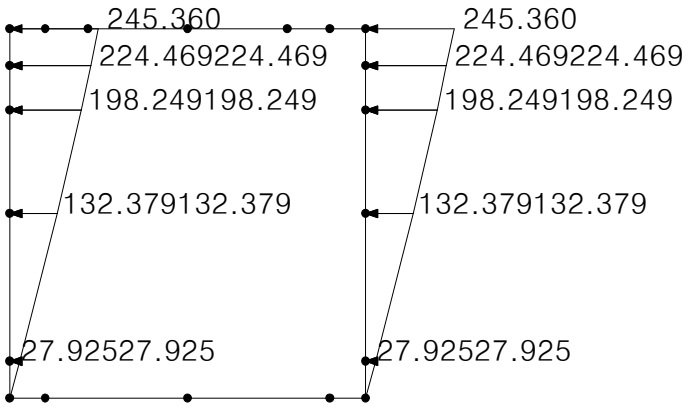


- 지진재하방향(우측에서 좌측으로)

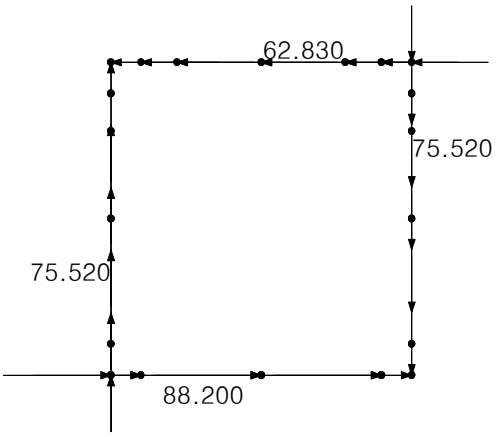
23) CASE23 - 슬래브 지반변위(기능수행)2(FUNSLAB2)



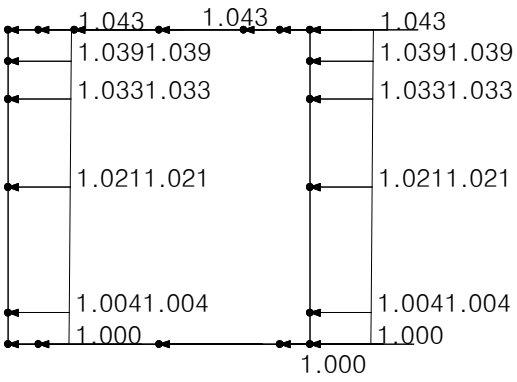
24) CASE24 - 벽체 지반변위(기능수행)2(FUNWALL2)



25) CASE25 - 주면전단력(기능수행)2(FUNMS2)

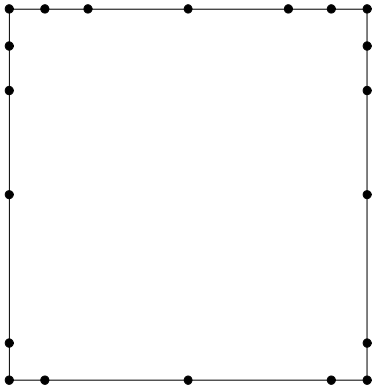


26) CASE26 - 구체 관성력(기능수행)2(FUNINER2)

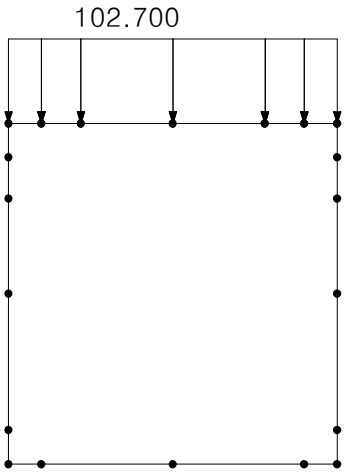


13. 하중 재하 (붕괴방지)

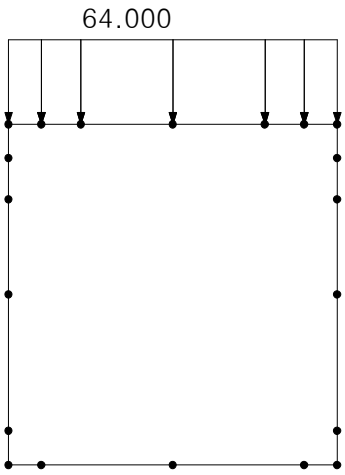
1) CASE1 - 구체자중(SW)



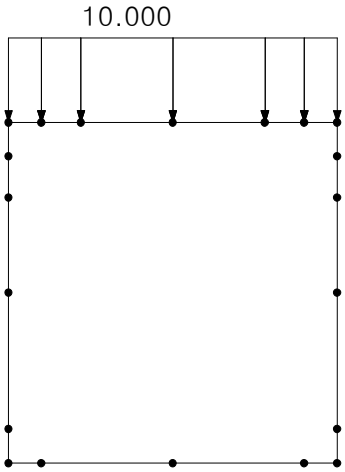
2) CASE2 - 상부고정하중 : 지하수無(PAVE)



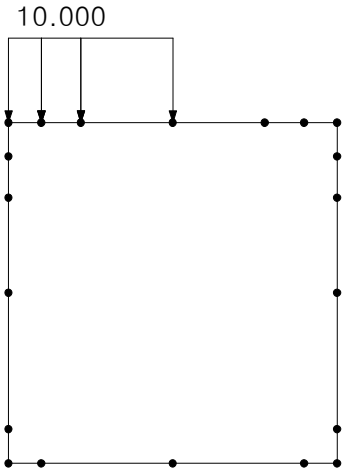
3) CASE3 - 상부고정하중 : 지하수有(PAVEW)



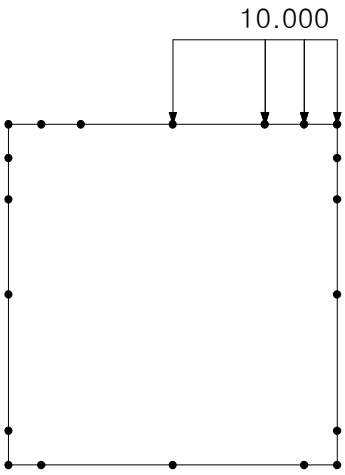
4) CASE4 - 지진시 만재활하중(LIVEFUE)



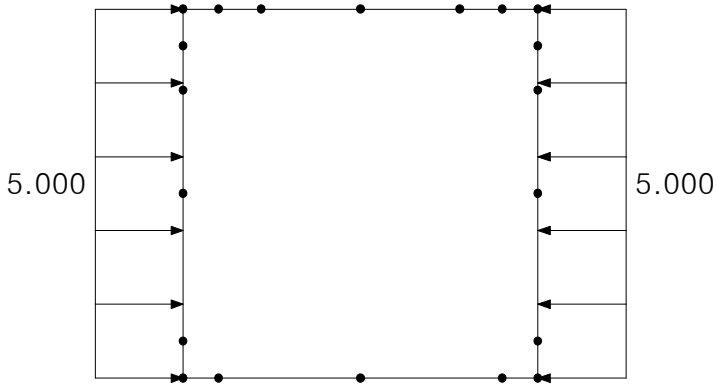
5) CASE5 - 지진시 편재활하중(좌측)(LIVELEE)



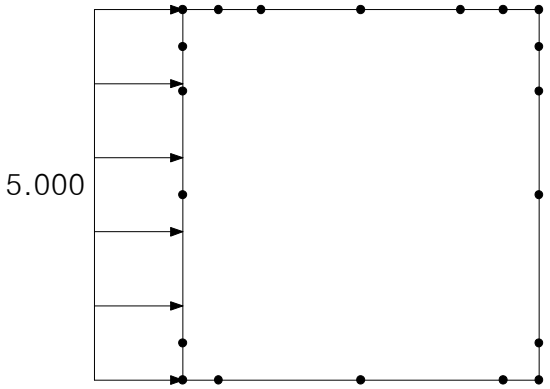
6) CASE6 - 지진시 편재활하중(우측)(LIVERIE)



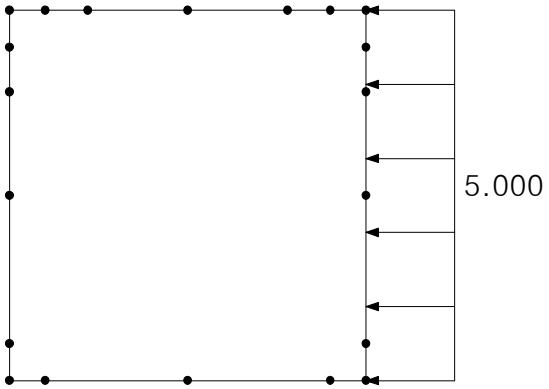
7) CASE7 - 지진시 만재활하중에 의한 수평하중(LIVEFUHE)



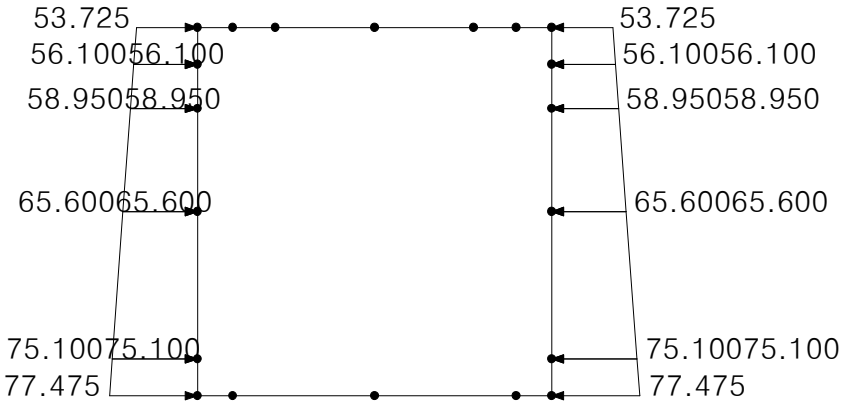
8) CASE8 - 지진시 편재활하중에 의한 수평하중(좌측)(LIVELEHE)



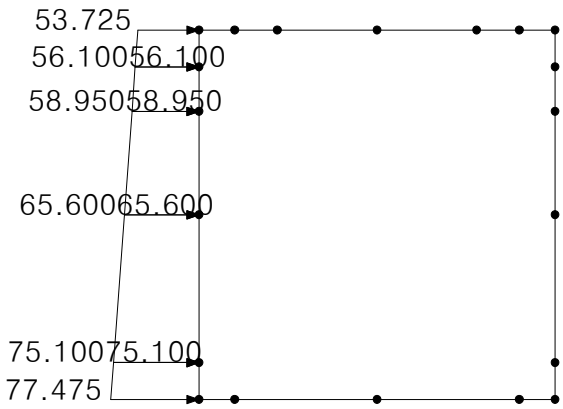
9) CASE9 - 지진시 편재활하중에 의한 수평하중(우측)(LIVERIHE)



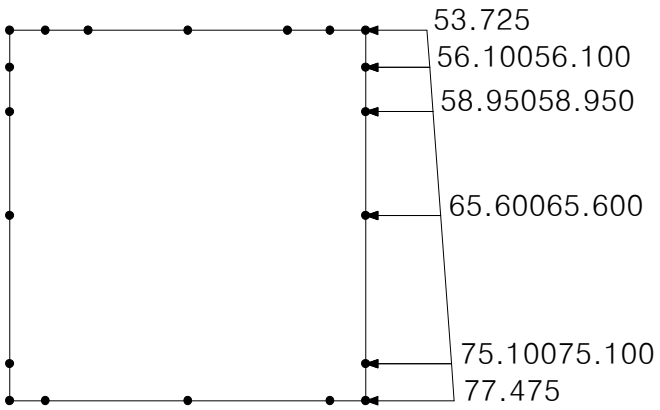
10) CASE10 - 지진시 양토압(SOILBE)



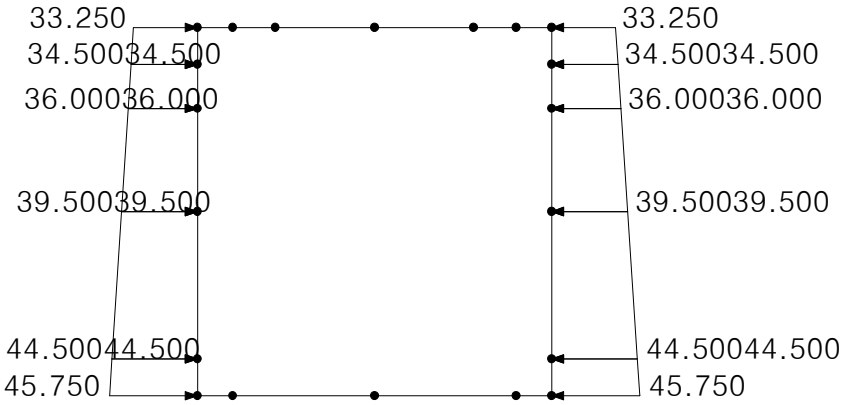
11) CASE11 - 지진시 편토압(좌측)(SOILLE)



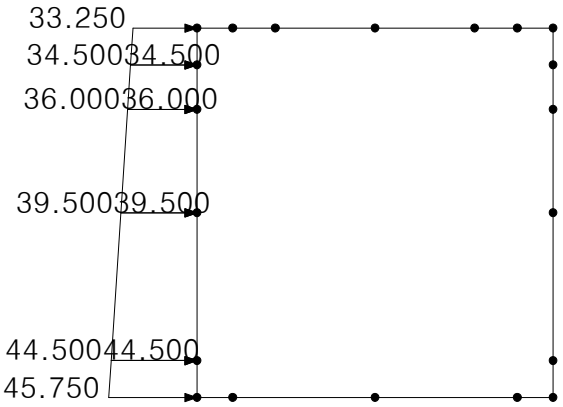
12) CASE12 - 지진시 편토압(우측)(SOILRE)



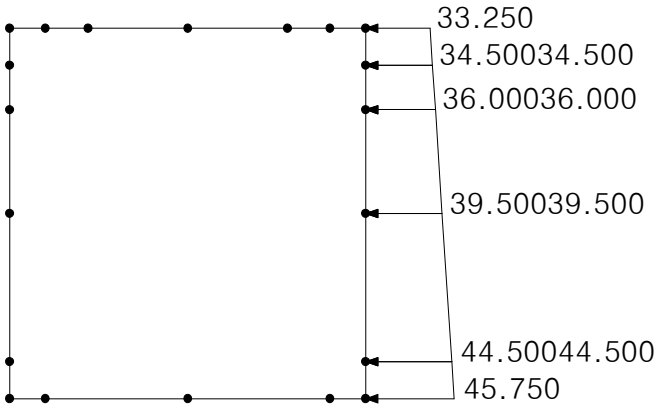
13) CASE13 - 지진시 양토압 : 지하수有(SOILBWE)



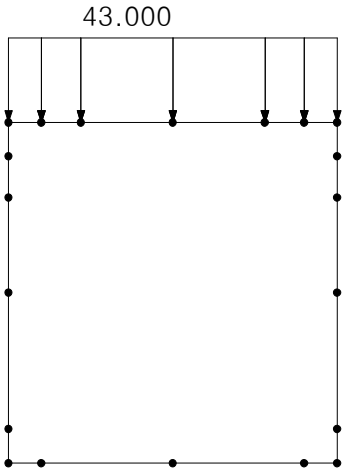
14) CASE14 - 지진시 편토압(좌측) : 지하수有(SOILLWE)



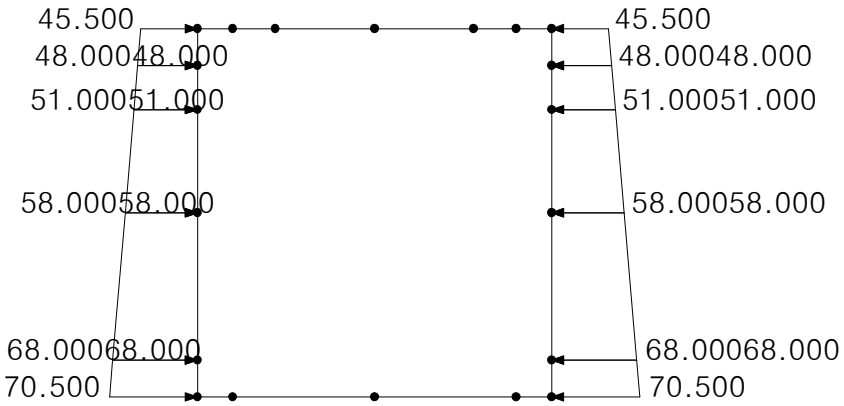
15) CASE15 - 지진시 편토압(우측) : 지하수有(SOILRWE)



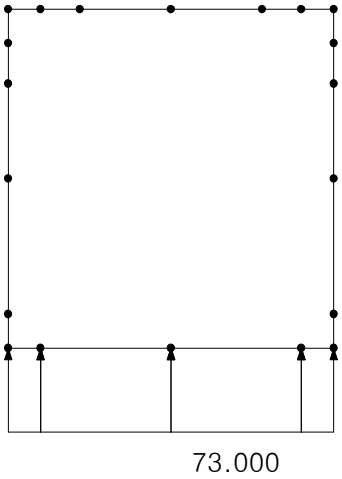
16) CASE16 - 연직수압(WATERV)



17) CASE17 - 수평수압(WATERH)

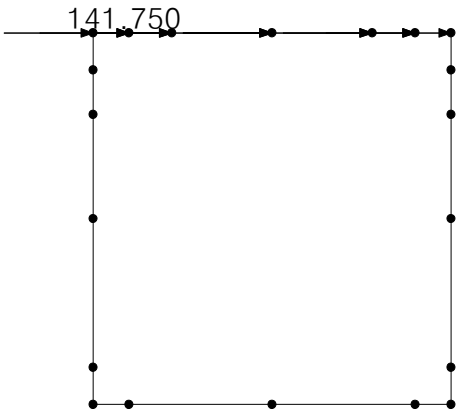


18) CASE18 - 부력(BUOYANCY)

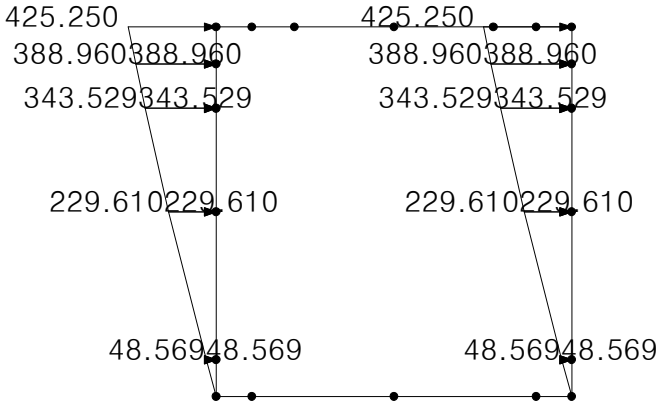


- 지진재하방향(좌측에서 우측으로)

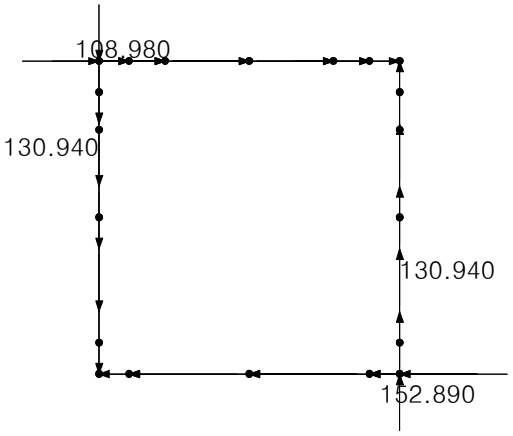
19) CASE19 - 슬래브 지반변위(붕괴방지)(COLSLAB)



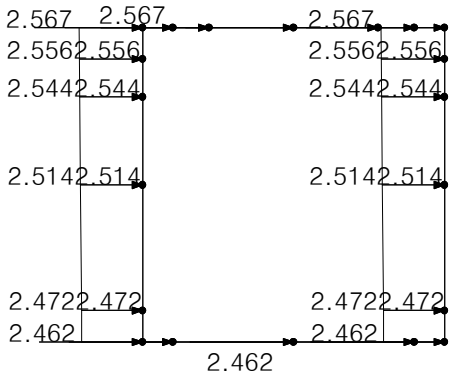
20) CASE20 - 벽체 지반변위(붕괴방지)(COLWALL)



21) CASE21 - 주면전단력(붕괴방지)(COLMS)

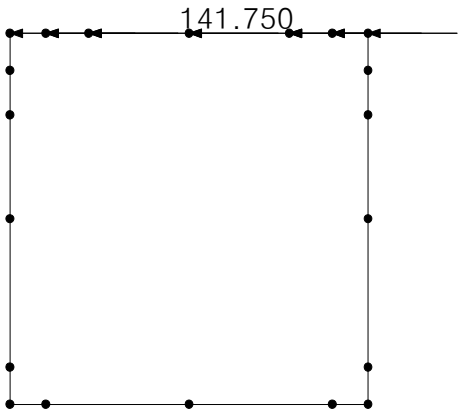


22) CASE22 - 구체 관성력(붕괴방지)(COLINER)

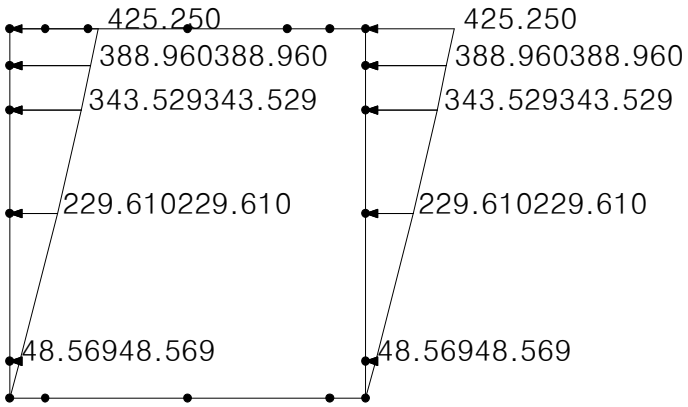


- 지진재하방향(우측에서 좌측으로)

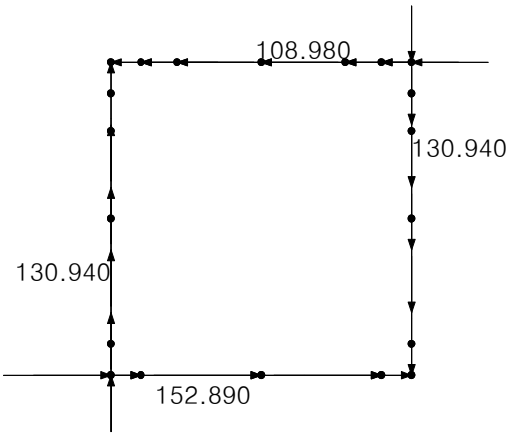
23) CASE23 - 슬래브 지반변위(붕괴방지)2(COLSLAB2)



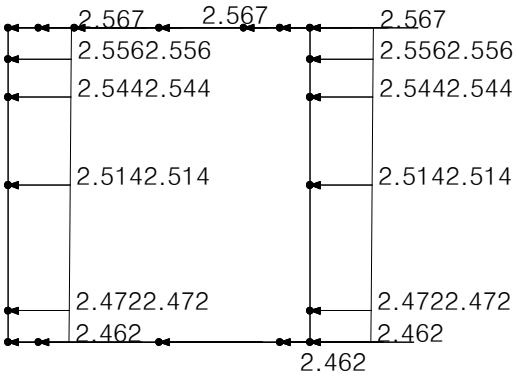
24) CASE24 - 벽체 지반변위(붕괴방지)2(COLWALL2)



25) CASE25 - 주면전단력(붕괴방지)2(COLMS2)



26) CASE26 - 구체 관성력(붕괴방지)2(COLINER2)



14. 하중계수 및 하중조합

αH : 토피의 두께에 따른 연직방향 하중Hv에 대한 보정계수

h ≤ 2.0 m 에 대해서, αH = 1.0

h > 2.0 m 에 대해서, αH = 1.05 - 0.025h (≥ 0.875) = 0.915, h = 5.300 m

1) 계수하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.400						
LC2	1.200	1.464	1.600	1.600	1.200		
LC3	1.200		1.000				
LC4	1.200	1.464	1.600	0.800	1.200		
LC5	0.900	0.900		1.600			
LC6	0.900	0.900		0.800			
LC7	1.200	1.464	1.600	1.600	1.200	1.200	●
LC8	1.200	1.464	1.600	0.800	1.200	1.200	●
LC9	0.900	0.900		1.600			●
LC10	0.900	0.900		0.800			●

2) 사용하중

구 분	D	Hv	L	Hh	T	F	지하수 고려
LC1	1.000						
LC2	1.000	1.000	1.000	1.000	1.000		
LC3	1.000		1.000				
LC4	1.000	1.000	1.000	0.500	1.000		
LC5	1.000	1.000		1.000			
LC6	1.000	1.000		0.500			
LC7	1.000	1.000	1.000	1.000	1.000	1.000	●
LC8	1.000	1.000	1.000	0.500	1.000	1.000	●
LC9	1.000	1.000		1.000			●
LC10	1.000	1.000		0.500			●

3) 지진시(붕괴방지수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

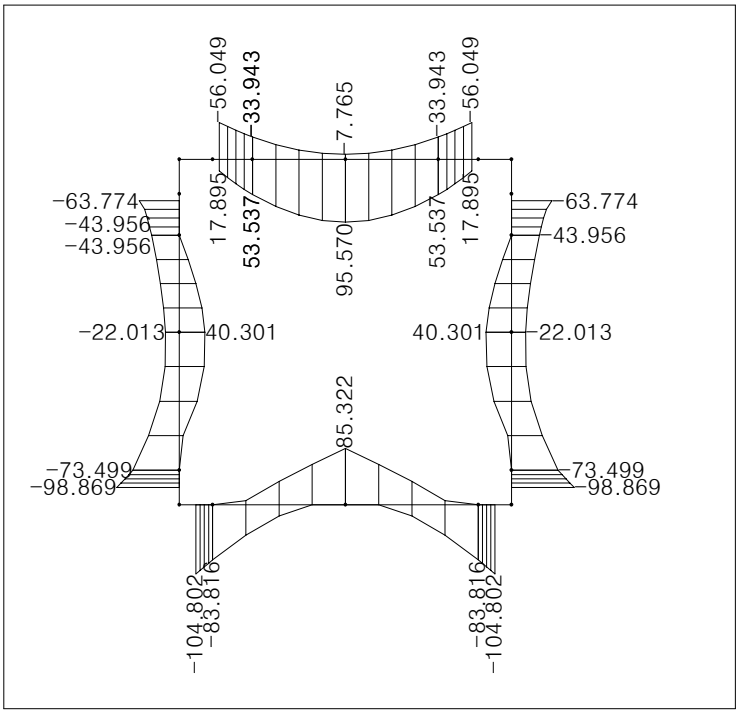
4) 지진시(기능수행수준)

구 분	D	Hv	L	Hh	T	F	E	지하수 고려
LC1	1.200	1.200	1.000	1.000			1.000	
LC2	1.200	1.200	1.000	0.500			1.000	
LC3	0.900	0.900		1.000			1.000	
LC4	0.900	0.900		0.500			1.000	
LC5	1.200	1.200	1.000	1.000			1.000	●
LC6	1.200	1.200	1.000	0.500			1.000	●
LC7	0.900	0.900		1.000			1.000	●
LC8	0.900	0.900		0.500			1.000	●

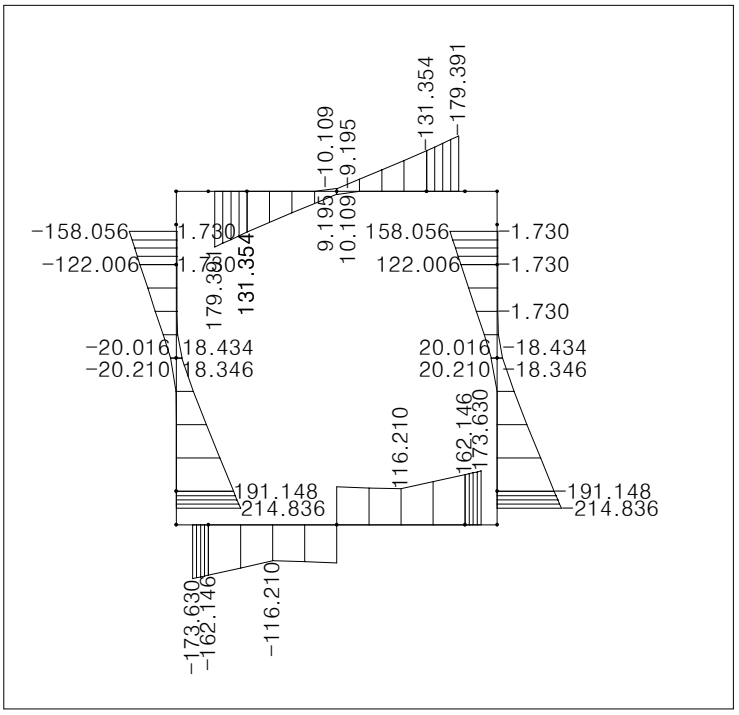
15. 단면력정리

15.1 상시

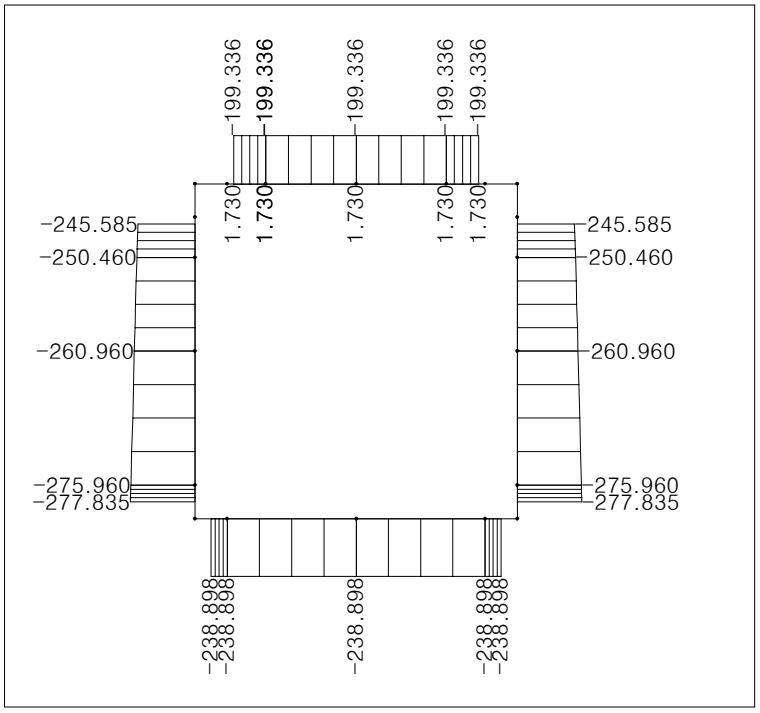
1) 계수하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



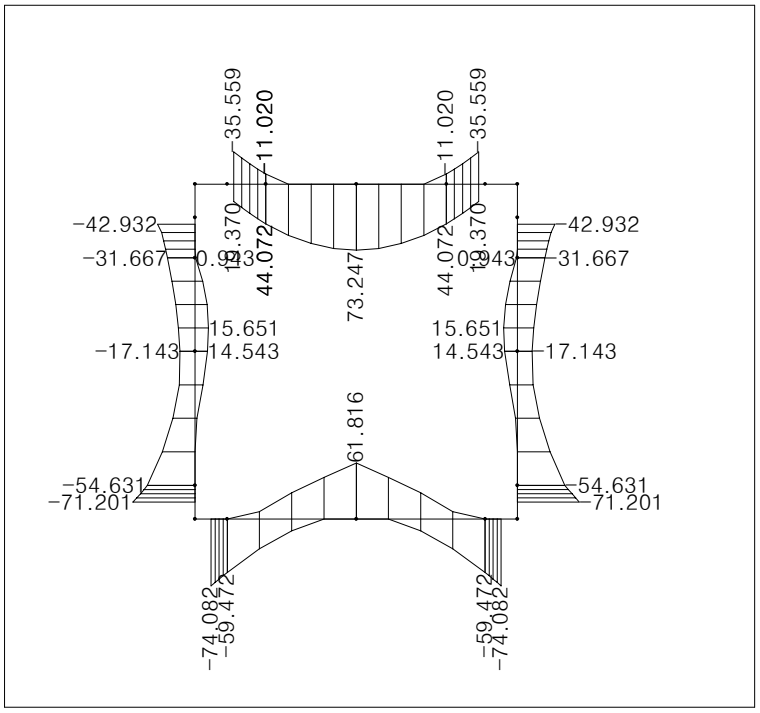
2) 계수하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 계수하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 사용하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)

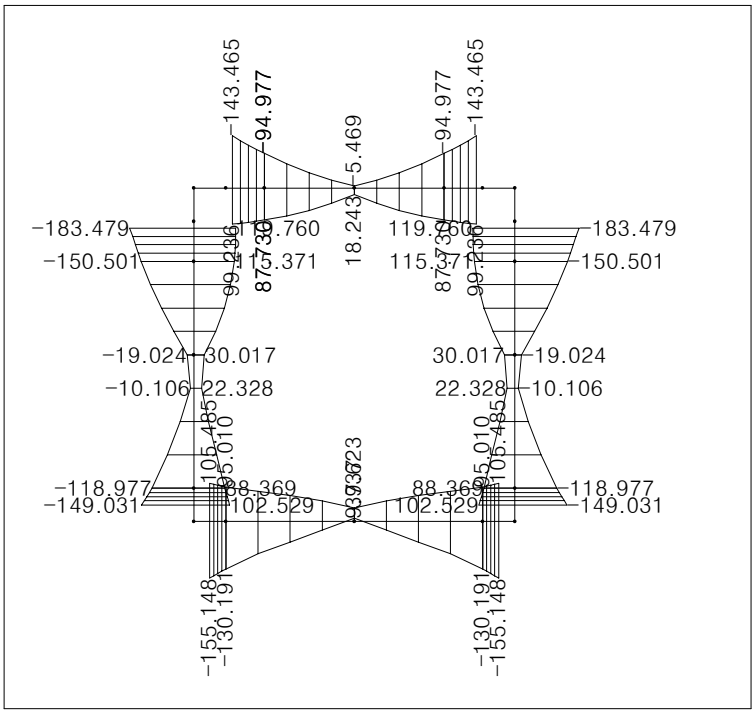


5) 단면력 정리

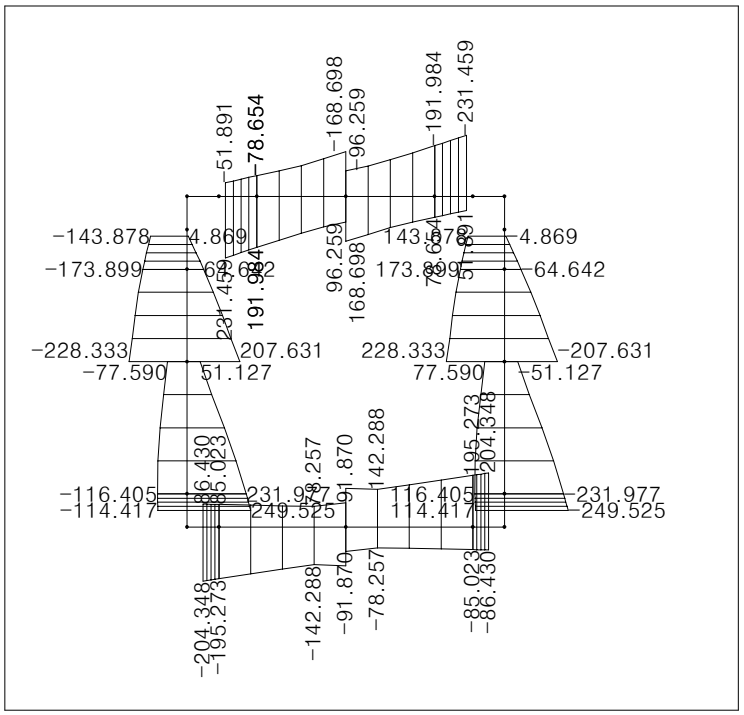
구분	위 치			계수하중			사용하중 모멘트	B	H	비고
				모멘트	전단력	축력				
				kN.m	kN	kN	kN.m	mm	mm	
상부 슬래브	1 경간	좌측	1	56.05	113.04	199.34	35.56	1000.00	583.33	
		중앙부	2	95.57	10.11	199.34	73.25	1000.00	500.00	
		우측	3	56.05	113.04	199.34	35.56	1000.00	583.33	
하부 슬래브	1 경간	좌측	4	83.82	125.40	238.90	59.47	1000.00	500.00	
		중앙부	5	85.32	122.63	238.90	61.82	1000.00	500.00	
		우측	6	83.82	125.40	238.90	59.47	1000.00	500.00	
좌측 벽체	1 층	상부	7	63.77	107.08	245.59	42.93	1000.00	583.33	
		중앙부 (외측)	8	43.96	122.01	250.46	31.67	1000.00	500.00	
		중앙부 (내측)	9	0.00	122.01	250.46	0.94	1000.00	500.00	
		하부	10	73.50	118.05	275.96	54.63	1000.00	500.00	
우측 벽체	1 층	상부	11	63.77	107.08	245.59	42.93	1000.00	583.33	
		중앙부 (외측)	12	43.96	122.01	250.46	31.67	1000.00	500.00	
		중앙부 (내측)	13	0.00	122.01	250.46	0.94	1000.00	500.00	
		하부	14	73.50	118.05	275.96	54.63	1000.00	500.00	

15.2 지진시(기능수행)

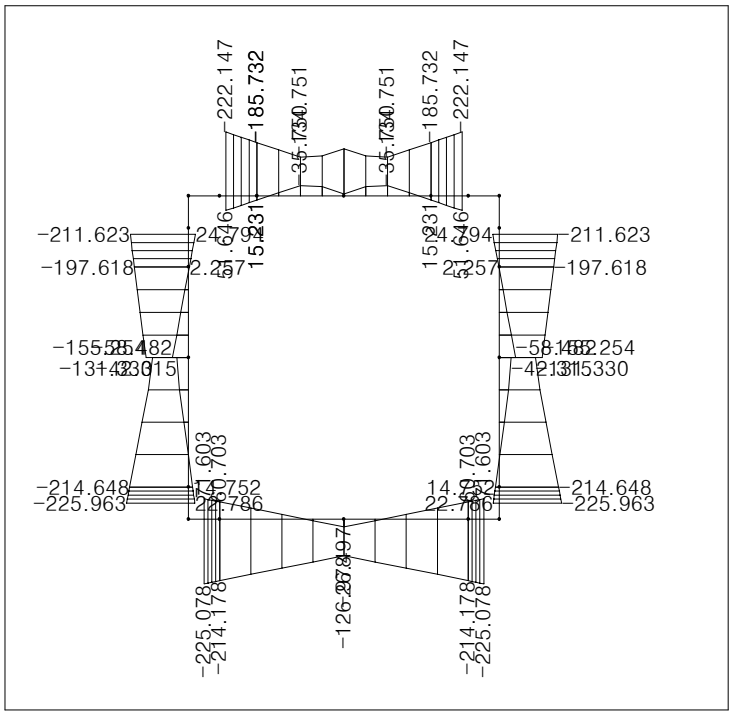
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN

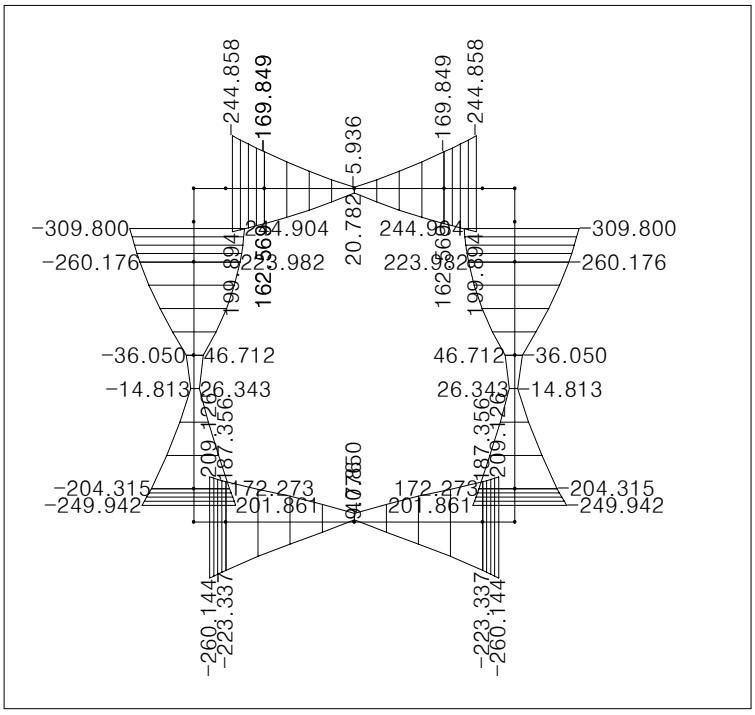


4) 단면력 정리

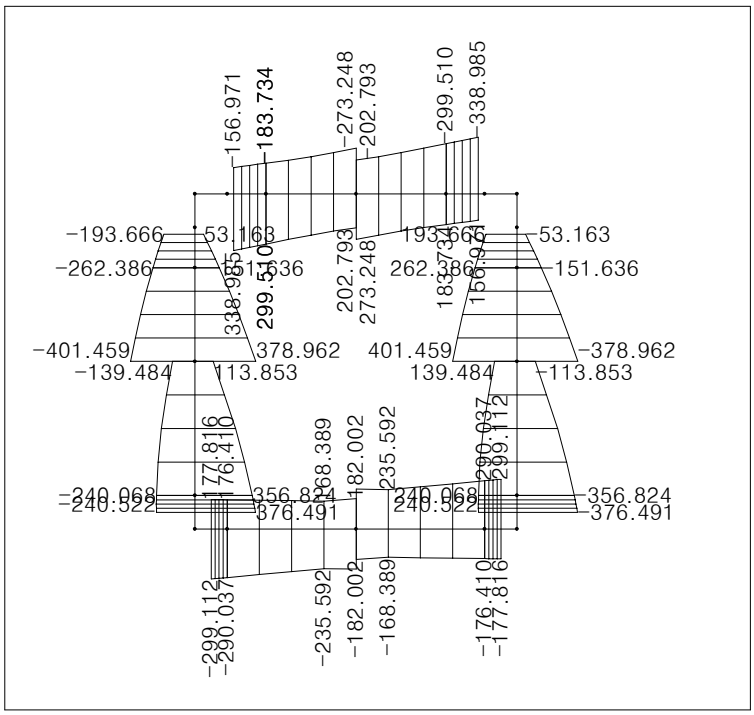
구분	위 치			계수하중			B	H	비고
				모멘트	전단력	축력			
				kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	143.47	176.64	222.15	1000.00	583.33	
		중앙부	2	18.24	168.70	164.17	1000.00	500.00	
		우측	3	143.47	176.64	222.15	1000.00	583.33	
하부 슬래브	1 경간	좌측	4	130.19	166.23	214.18	1000.00	500.00	
		중앙부	5	37.62	146.04	126.98	1000.00	500.00	
		우측	6	130.19	166.23	214.18	1000.00	500.00	
좌측 벽체	1 층	상부	7	183.48	183.67	211.62	1000.00	583.33	
		중앙부 (외측)	8	150.50	173.90	197.62	1000.00	500.00	
		중앙부 (내측)	9	115.37	173.90	197.62	1000.00	500.00	
		하부	10	118.98	165.58	214.65	1000.00	500.00	
우측 벽체	1 층	상부	11	183.48	183.67	211.62	1000.00	583.33	
		중앙부 (외측)	12	150.50	173.90	197.62	1000.00	500.00	
		중앙부 (내측)	13	115.37	173.90	197.62	1000.00	500.00	
		하부	14	118.98	165.58	214.65	1000.00	500.00	

15.3 지진시(붕괴방지)

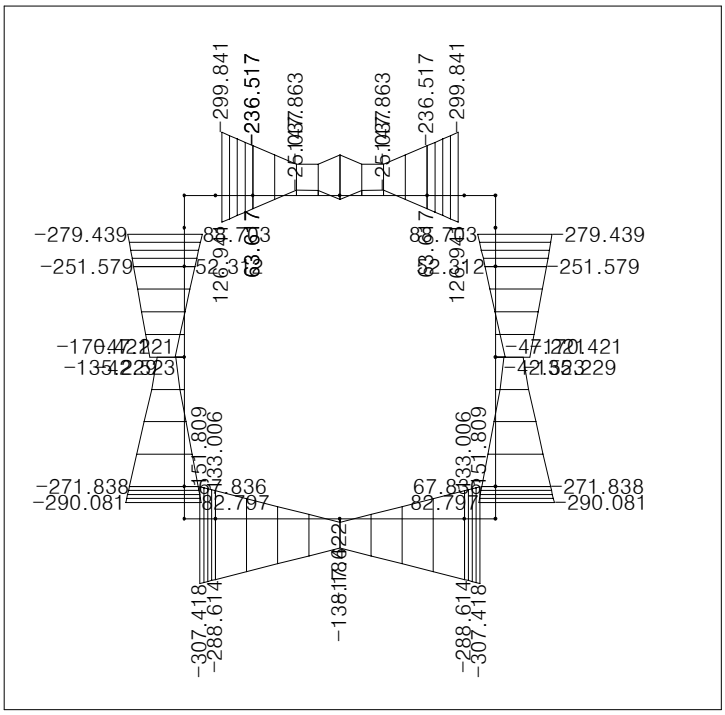
1) 지진하중 검토시 : 최대 휨 모멘트도(B.M.D - Unit : kN.m)



2) 지진하중 검토시 : 최대 전단력도(S.F.D - Unit : kN)



3) 지진하중 검토시 : 최대 축력도(A.F.D) - Unit : kN



4) 단면력 정리

구분	위 치			계수하중				B	H	비고
				모멘트	응답계수	전단력	축력			
				kN.m	kN.m	kN	kN	mm	mm	
상부 슬래브	1 경간	좌측	1	244.86	81.62	284.17	299.84	1000.00	583.33	
		중앙부	2	20.78	6.93	273.25	192.60	1000.00	500.00	
		우측	3	244.86	81.62	284.17	299.84	1000.00	583.33	
하부 슬래브	1 경간	좌측	4	223.34	74.45	261.00	288.61	1000.00	500.00	
		중앙부	5	40.85	13.62	239.34	138.19	1000.00	500.00	
		우측	6	223.34	74.45	261.00	288.61	1000.00	500.00	
좌측 벽체	1 층	상부	7	309.80	103.27	286.24	279.44	1000.00	583.33	
		중앙부 (외측)	8	260.18	86.73	262.39	251.58	1000.00	500.00	
		중앙부 (내측)	9	223.98	74.66	262.39	251.58	1000.00	500.00	
		하부	10	204.32	68.11	274.88	271.84	1000.00	500.00	
우측 벽체	1 층	상부	11	309.80	103.27	286.24	279.44	1000.00	583.33	
		중앙부 (외측)	12	260.18	86.73	262.39	251.58	1000.00	500.00	
		중앙부 (내측)	13	223.98	74.66	262.39	251.58	1000.00	500.00	
		하부	14	204.32	68.11	274.88	271.84	1000.00	500.00	

15.4 단면력 비교

1) 극한모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-56.05	-	-81.62	-143.47	-143.47	
		중앙부	2	95.57	-	6.93	18.24	95.57	
		우측	3	-56.05	-	-81.62	-143.47	-143.47	
하부 슬래브	1 경간	좌측	4	-83.82	-	-74.45	-130.19	-130.19	
		중앙부	5	85.32	-	13.62	37.62	85.32	
		우측	6	-83.82	-	-74.45	-130.19	-130.19	
좌측 벽체	1 층	상부	7	-63.77	-	-103.27	-183.48	-183.48	
		중앙부 (외측)	8	-43.96	-	-86.73	-150.50	-150.50	
		중앙부 (내측)	9	-	-	74.66	115.37	115.37	
		하부	10	-73.50	-	-68.11	-118.98	-118.98	
우측 벽체	1 층	상부	11	-63.77	-	-103.27	-183.48	-183.48	
		중앙부 (외측)	12	-43.96	-	-86.73	-150.50	-150.50	
		중앙부 (내측)	13	-	-	74.66	115.37	115.37	
		하부	14	-73.50	-	-68.11	-118.98	-118.98	

2) 전단력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	113.04	-	284.17	176.64	284.17	
		중앙부	2	10.11	-	273.25	168.70	273.25	
		우측	3	-113.04	-	-284.17	-176.64	-284.17	
하부 슬래브	1 경간	좌측	4	-125.40	-	-261.00	-166.23	-261.00	
		중앙부	5	-122.63	-	-239.34	-146.04	-239.34	
		우측	6	125.40	-	261.00	166.23	261.00	
좌측 벽체	1 층	상부	7	-107.08	-	-286.24	-183.67	-286.24	
		중앙부 (외측)	8	-122.01	-	-262.39	-173.90	-262.39	
		중앙부 (내측)	9	-122.01	-	-262.39	-173.90	-262.39	
		하부	10	118.05	-	274.88	165.58	274.88	
우측 벽체	1 층	상부	11	107.08	-	286.24	183.67	286.24	
		중앙부 (외측)	12	122.01	-	262.39	173.90	262.39	
		중앙부 (내측)	13	122.01	-	262.39	173.90	262.39	
		하부	14	-118.05	-	-274.88	-165.58	-274.88	

3) 축력 (kN)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-199.34	-	-299.84	-222.15	-299.84	
		중앙부	2	-199.34	-	-192.60	-164.17	-199.34	
		우측	3	-199.34	-	-299.84	-222.15	-299.84	
하부 슬래브	1 경간	좌측	4	-238.90	-	-288.61	-214.18	-288.61	
		중앙부	5	-238.90	-	-138.19	-126.98	-238.90	
		우측	6	-238.90	-	-288.61	-214.18	-288.61	
좌측 벽체	1 층	상부	7	-245.59	-	-279.44	-211.62	-279.44	
		중앙부 (외측)	8	-250.46	-	-251.58	-197.62	-251.58	
		중앙부 (내측)	9	-250.46	-	-251.58	-197.62	-251.58	
		하부	10	-275.96	-	-271.84	-214.65	-275.96	
우측 벽체	1 층	상부	11	-245.59	-	-279.44	-211.62	-279.44	
		중앙부 (외측)	12	-250.46	-	-251.58	-197.62	-251.58	
		중앙부 (내측)	13	-250.46	-	-251.58	-197.62	-251.58	
		하부	14	-275.96	-	-271.84	-214.65	-275.96	

4) 사용모멘트 (kN.m)

구분	위 치			상시		지진시		적용값	비고
				2D	3D	붕괴	기능		
상부 슬래브	1 경간	좌측	1	-35.56	-	-	-	-35.56	
		중앙부	2	73.25	-	-	-	73.25	
		우측	3	-35.56	-	-	-	-35.56	
하부 슬래브	1 경간	좌측	4	-59.47	-	-	-	-59.47	
		중앙부	5	61.82	-	-	-	61.82	
		우측	6	-59.47	-	-	-	-59.47	
좌측 벽체	1 층	상부	7	-42.93	-	-	-	-42.93	
		중앙부 (외측)	8	-31.67	-	-	-	-31.67	
		중앙부 (내측)	9	0.94	-	-	-	0.94	
		하부	10	-54.63	-	-	-	-54.63	
우측 벽체	1 층	상부	11	-42.93	-	-	-	-42.93	
		중앙부 (외측)	12	-31.67	-	-	-	-31.67	
		중앙부 (내측)	13	0.94	-	-	-	0.94	
		하부	14	-54.63	-	-	-	-54.63	

16. 단면검토 및 철근량 산정

(1) 주철근 요약

구분	부재 위치			b	d	Mu	ΦMn	req'd As	BAR	use'd As	S.F
				mm	mm	kN.m	kN.m	mm²		mm²	
상부슬래브	1경간	좌측	1	1000	483	143.47	253.61	887.21	H16 - 8.0EA	1588.80	1.77
		중앙부	2	1000	420	95.57	219.40	678.82	H16 - 8.0EA	1588.80	2.30
		우측	3	1000	483	143.47	253.61	887.21	H16 - 8.0EA	1588.80	1.77
하부슬래브	1경간	좌측	4	1000	400	130.19	208.60	978.13	H16 - 8.0EA	1588.80	1.60
		중앙부	5	1000	420	85.32	219.40	605.09	H16 - 8.0EA	1588.80	2.57
		우측	6	1000	400	130.19	208.60	978.13	H16 - 8.0EA	1588.80	1.60
좌측벽체	1층	상부	7	1000	483	183.48	408.66	-	H16 - 8.0EA	3177.60	2.23
		중앙부 (외측)	8	1000	400	150.50	322.76	-	H16 - 8.0EA	3177.60	2.15
		중앙부 (내측)	8	1000	420	115.37	395.10	-	H16 - 8.0EA	3177.60	3.42
		하부	9	1000	400	118.98	385.83	-	H16 - 8.0EA	3177.60	3.24
우측벽체	1층	상부	10	1000	483	183.48	408.66	-	H16 - 8.0EA	3177.60	2.23
		중앙부 (외측)	11	1000	400	150.50	322.76	-	H16 - 8.0EA	3177.60	2.15
		중앙부 (내측)	11	1000	420	115.37	395.10	-	H16 - 8.0EA	3177.60	3.42
		하부	12	1000	400	118.98	385.83	-	H16 - 8.0EA	3177.60	3.24

(2) 전단철근 요약

구분	부재 위치			ΦVc	Vu	ΦVn	다리수	req'd As	BAR	s	use'd As	비 고
				kN	kN	kN	EA	mm²		mm	mm²	
상부슬래브	1경간	좌측	1	259.8	284.2	462.53	2.00	30.45	H13	150	253.40	O.K
		우측	3	259.8	284.2	361.17	2.00	60.90	H13	300	253.40	O.K
하부슬래브	1경간	좌측	4	259.8	261.0	462.53	2.00	1.49	H13	150	253.40	O.K
		중앙부	5	272.8	239.3	379.23	2.00	-	H13	300	253.40	O.K
		우측	6	259.8	261.0	361.17	2.00	2.97	H13	300	253.40	O.K
좌측벽체	1층	상부	7	270.2	286.2	472.90	2.00	20.07	H13	150	253.40	O.K
		중앙부	8	269.1	262.4	471.87	2.00	131.25	H13	150	253.40	O.K
		하부	9	270.1	274.9	472.77	2.00	6.03	H13	150	253.40	O.K
우측벽체	1층	상부	10	270.2	286.2	472.90	2.00	20.07	H13	150	253.40	O.K
		중앙부	11	269.1	262.4	471.87	2.00	131.25	H13	150	253.40	O.K
		하부	12	270.1	274.9	472.77	2.00	6.03	H13	150	253.40	O.K

▣ TITLE : 상부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	583.33	483.33	100.00	143.47	284.17

* 강도감소계수(Φ) 산정

T = As x fy = 1588.800 x 400.00 = 635520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 27.692 mm, c = 27.692 / β1 = 27.692 / 0.85 = 32.578 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (483.33 - 32.578) / 32.578 = 0.04151

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 887.208 \text{ mm}^2$$

* 사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm) , [사용률 = 1.791]

1단 : H16 - 8.0 EA (= 1588.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00329

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 27.692 mm

ΦMn = 0.85 x 1588.800 x 400 x (483.33 - a/2) = 253.613 kN.m

≥ Mu (= 143.465 kN.m) ∴ O.K [안전률 1.768]

* 전단에 대한 검토 (d = 400.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 400.00 = 259.808 kN

< Vu (= 284.170 kN) , 전단보강 필요.

Av_req = (284.170-259.808) x 150.00 / (400x400.00xΦ) x 1000 = 30.452 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 400.00 / 150.00 x 1000 = 270.293 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 400.00 / 1000 = 1385.641 kN ≥ 270.293 kN ∴ O.K

ΦVn = 0.75 x (346.410 + 270.293) = 462.528 kN ≥ 284.170 kN ∴ O.K

▣ TITLE : 상부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	500.00	420.00	80.00	95.57	0.00

* 강도감소계수(Φ) 산정

T = As x fy = 1588.800 x 400.00 = 635520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 27.692 mm, c = 27.692 / β1 = 27.692 / 0.85 = 32.578 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (420.00 - 32.578) / 32.578 = 0.03568

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 678.821 \text{ mm}^2$$

* 사용철근량 = 1588.8 mm² (철근도심 : 80.0 mm), [사용률 = 2.341]

1단 : H16 - 8.0 EA (= 1588.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00378

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 27.692 mm

ΦMn = 0.85 x 1588.800 x 400 x (420.00 - a/2) = 219.401 kN.m

≥ Mu (= 95.570 kN.m) ∴ O.K [안전률 2.296]

▣ TITLE : 상부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	583.33	483.33	100.00	143.47	284.17

* 강도감소계수(Φ) 산정

T = As x fy = 1588.800 x 400.00 = 635520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 27.692 mm, c = 27.692 / β1 = 27.692 / 0.85 = 32.578 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (483.33 - 32.578) / 32.578 = 0.04151

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 887.208 \text{ mm}^2$$

* 사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm) , [사용률 = 1.791]

1단 : H16 - 8.0 EA (= 1588.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00329

ρmax ≥ ρuse, As ≥ As(req) x 4/3 → 철근비 만족, ∴ O.K (콘.설 6.3.2)

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 27.692 mm

ΦMn = 0.85 x 1588.800 x 400 x (483.33 - a/2) = 253.613 kN.m

≥ Mu (= 143.465 kN.m) ∴ O.K [안전률 1.768]

* 전단에 대한 검토 (d = 400.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 400.00 = 259.808 kN

< Vu (= 284.170 kN) , 전단보강 필요.

Av_req = (284.170-259.808) x 300.00 / (400x400.00xΦ) x 1000 = 60.905 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 300 mm)

Vs = 253.400 x 400.0 x 400.00 / 300.00 x 1000 = 135.147 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 400.00 / 1000 = 1385.641 kN ≥ 135.147 kN ∴ O.K

ΦVn = 0.75 x (346.410 + 135.147) = 361.168 kN ≥ 284.170 kN ∴ O.K

▣ TITLE : 하부슬래브 1경간(좌측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	500.00	400.00	100.00	130.19	261.00

* 강도감소계수(Φ) 산정

T = As x fy = 1588.800 x 400.00 = 635520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 27.692 mm, c = 27.692 / β1 = 27.692 / 0.85 = 32.578 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (400.00 - 32.578) / 32.578 = 0.03383

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 978.128 \text{ mm}^2$$

* 사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm) , [사용률 = 1.624]

1단 : H16 - 8.0 EA (= 1588.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00397

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 27.692 mm

ΦMn = 0.85 x 1588.800 x 400 x (400.00 - a/2) = 208.597 kN.m

≥ Mu (= 130.191 kN.m) ∴ O.K [안전률 1.602]

* 전단에 대한 검토 (d = 400.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 400.00 = 259.808 kN

< Vu (= 260.997 kN) , 전단보강 필요.

Av_req = (260.997-259.808) x 150.00 / (400x400.00xΦ) x 1000 = 1.487 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 400.00 / 150.00 x 1000 = 270.293 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 400.00 / 1000 = 1385.641 kN ≥ 270.293 kN ∴ O.K

ΦVn = 0.75 x (346.410 + 270.293) = 462.528 kN ≥ 260.997 kN ∴ O.K

▣ TITLE : 하부슬래브 중앙부

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	500.00	420.00	80.00	85.32	239.34

* 강도감소계수(Φ) 산정

T = As x fy = 1588.800 x 400.00 = 635520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 27.692 mm, c = 27.692 / β1 = 27.692 / 0.85 = 32.578 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (420.00 - 32.578) / 32.578 = 0.03568

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 605.088 \text{ mm}^2$$

* 사용철근량 = 1588.8 mm² (철근도심 : 80.0 mm), [사용률 = 2.626]

1단 : H16 - 8.0 EA (= 1588.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00378

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 27.692 mm

ΦMn = 0.85 x 1588.800 x 400 x (420.00 - a/2) = 219.401 kN.m

≥ Mu (= 85.322 kN.m) ∴ O.K [안전률 2.571]

* 전단에 대한 검토 (d = 420.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 420.00 = 272.798 kN

≥ Vu (= 239.342 kN) , 전단보강 불필요.

▣ TITLE : 하부슬래브 1경간(우측)

* 단면제원 및 설계가정

fck = 27 MPa, fy = 400 MPa, k1 = 0.85, Φf = 0.85, Φv = 0.75

B(mm)	H(mm)	d(mm)	피복(mm)	Mu(kN.m)	Vu(kN)
1000.00	500.00	400.00	100.00	130.19	261.00

* 강도감소계수(Φ) 산정

T = As x fy = 1588.800 x 400.00 = 635520.000

C = 0.85 x fck x a x b = 0.85 x 27.00 x a x 1000.000 = 22950.000 x a

T = C 이므로, a = 27.692 mm, c = 27.692 / β1 = 27.692 / 0.85 = 32.578 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt - c) / c = 0.00300 x (400.00 - 32.578) / 32.578 = 0.03383

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

* 필요철근량 산정

Mu / Φ = As x fy x (d - a/2) ---------- ①

a = As x fy / (0.85 x fck x b) ---------- ②

식②를 식①에 대입하여 이차방정식으로 As를 구한다

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0 \text{ , } As = 978.128 \text{ mm}^2$$

* 사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm) , [사용률 = 1.624]

1단 : H16 - 8.0 EA (= 1588.8 mm²)

* 철근비 검토

ρmin : 1.4 / fy = 0.00350

0.25 √fck / fy = 0.00325 , ρmin = 0.00350 적용

ρmax = 0.714 x Pb = 0.714 x k1 x Φx (fck / fy) x {600 / (600 + fy)} = 0.02089

ρuse = As / bd = 0.00397

ρmax ≥ ρuse ≥ρmin → 철근비 만족, ∴ O.K

* 휨에 대한 검토

a = As x fy / (0.85 x fck x b) = 27.692 mm

ΦMn = 0.85 x 1588.800 x 400 x (400.00 - a/2) = 208.597 kN.m

≥ Mu (= 130.191 kN.m) ∴ O.K [안전률 1.602]

* 전단에 대한 검토 (d = 400.00 mm)

ΦVc = 0.75 x 1/6 x √fck x b x d

= 0.75 x 1/6 x √27 x 1000.00 x 400.00 = 259.808 kN

< Vu (= 260.997 kN) , 전단보강 필요.

Av_req = (260.997-259.808) x 300.00 / (400x400.00xΦ) x 1000 = 2.974 mm²

Av_use = 253.400 mm² (H13-2.0 EA, C.T.C 300 mm)

Vs = 253.400 x 400.0 x 400.00 / 300.00 x 1000 = 135.147 kN

Vs_Max = 2√27.0 / 3 x 1000.00 x 400.00 / 1000 = 1385.641 kN ≥ 135.147 kN ∴ O.K

ΦVn = 0.75 x (346.410 + 135.147) = 361.168 kN ≥ 260.997 kN ∴ O.K

▣ TITLE : 좌측벽체 상부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	583	100	483	279.439	183.479	656.6

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

Asf = 1588.800 mm² (압축중심 = 80.00 mm), 1단 : H16- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0064) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 583.3 x 1000.0 = 13387500.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 635520.0 N

Xp = (13387500.0 x 291.67 + 635520.0 x 100.000 + 635520.0 x 503.333) / 14658540.0

= 292.534 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 290.00 mm, ab = k1 x cb = 246.50 mm

Cc = 0.85 x 27.0 x 246500.000 = 5657.175 kN, ∑Csi = 599.057 kN, ∑Tsi = 635.520 kN

Pb = 5657.175 + 599.057 - 635.520 = 5620.712 kN

Mb = Cc x 360.083 + ∑(Csi*di) + ∑(Tsi*di) = 1196.497 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 212.873 mm, e = Mu/Pu = 656.595 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 74.04 mm, a = k1 x c = 62.94 mm 를 사용.

Cc = 0.85 x 27.0 x 62937.965 = 1444.426 kN

∑Csi = 0.000 kN, ∑Tsi = 712.191 kN

Pn = 1444.426 + 0.000 - 712.191 = 732.235 kN

Mn = Cc x 451.864 + ∑(Csi*di) + ∑(Tsi*di) = 480.781 kN.m

- 편심오차 : |e - Mn/Pn(=656.593)| = 0.0017 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 583.33 - 100.00 = 483.333 mm

c = 74.045 mm, a = k1 x c = 62.938 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (483.33-74.04) / 74.04 = 0.01658

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10138.491 kN ≥ Pn = 732.235 kN

ΦPn = 0.85 x 732.235 = 622.400 kN ≥ Pu = 279.439 kN ∴ O.K

ΦMn = ΦPn x 0.657 = 408.665 kN.m ≥ Mu = 183.479 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 400.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 400.00 = 270.179 kN

< Vu (= 286.238 kN) , 전단보강 필요.

Req Av = (286.238 - 270.179) x 150.00 / (400.0 x 400.00 x Φ) = 20.074 mm²

Use Av = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 400.00 / 150.00 = 270.293 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 400.00 = 1385.641 kN ≥ 270.293 kN ∴ O.K

ΦVn = 0.75 x (360.239 + 270.293) = 472.899 kN ≥ 286.238 kN ∴ O.K

▣ TITLE : 좌측벽체 중앙부_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	100	400	251.579	150.501	598.2

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

Asf = 1588.800 mm² (압축중심 = 80.00 mm), 1단 : H16- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0064) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 500.0 x 1000.0 = 11475000.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 635520.0 N

Xp = (11475000.0 x 250.00 + 635520.0 x 100.000 + 635520.0 x 420.000) / 12746040.0

= 250.997 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 240.00 mm, ab = k1 x cb = 204.00 mm

Cc = 0.85 x 27.0 x 204000.000 = 4681.800 kN, ∑Csi = 599.057 kN, ∑Tsi = 635.520 kN

Pb = 4681.800 + 599.057 - 635.520 = 4645.337 kN

Mb = Cc x 298.000 + ∑(Csi*di) + ∑(Tsi*di) = 885.442 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 190.609 mm, e = Mu/Pu = 598.225 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 71.18 mm, a = k1 x c = 60.50 mm 를 사용.

Cc = 0.85 x 27.0 x 60499.239 = 1388.458 kN

∑Csi = 0.000 kN, ∑Tsi = 753.709 kN

Pn = 1388.458 + 0.000 - 753.709 = 634.749 kN

Mn = Cc x 369.750 + ∑(Csi*di) + ∑(Tsi*di) = 379.717 kN.m

- 편심오차 : |e - Mn/Pn(=598.216)| = 0.0087 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 500.00 - 100.00 = 400.000 mm

c = 71.176 mm, a = k1 x c = 60.499 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (400.00-71.18) / 71.18 = 0.01386

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10138.491 kN ≥ Pn = 634.749 kN

ΦPn = 0.85 x 634.749 = 539.537 kN ≥ Pu = 251.579 kN ∴ O.K

ΦMn = ΦPn x 0.598 = 322.764 kN.m ≥ Mu = 150.501 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 400.00 = 269.145 kN

ΦVc/2 < Vu (= 262.386 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 ㎟

Av_use = H13 - 2.0 EA = 253.400 ㎟ ∴ O.K

▣ TITLE : 좌측벽체 중앙부_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	80	420	251.579	115.371	458.6

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 80.00 mm), 1단 : H16- 8.0EA, d1 = 80.00 mm

Asf = 1588.800 mm² (압축중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0064) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 500.0 x 1000.0 = 11475000.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 635520.0 N

Xp = (11475000.0 x 250.00 + 635520.0 x 80.000 + 635520.0 x 400.000) / 12746040.0

= 249.003 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 252.00 mm, ab = k1 x cb = 214.20 mm

Cc = 0.85 x 27.0 x 214200.000 = 4915.890 kN, ∑Csi = 538.531 kN, ∑Tsi = 635.520 kN

Pb = 4915.890 + 538.531 - 635.520 = 4818.901 kN

Mb = Cc x 312.900 + ∑(Csi*di) + ∑(Tsi*di) = 896.104 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 185.956 mm, e = Mu/Pu = 458.587 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 89.98 mm, a = k1 x c = 76.48 mm 를 사용.

Cc = 0.85 x 27.0 x 76483.026 = 1755.285 kN

∑Csi = 0.000 kN, ∑Tsi = 741.675 kN

Pn = 1755.285 + 0.000 - 741.675 = 1013.610 kN

Mn = Cc x 381.758 + ∑(Csi*di) + ∑(Tsi*di) = 464.822 kN.m

- 편심오차 : |e - Mn/Pn(=458.581)| = 0.0060 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 500.00 - 80.00 = 420.000 mm

c = 89.980 mm, a = k1 x c = 76.483 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (420.00-89.98) / 89.98 = 0.01100

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10138.491 kN ≥ Pn = 1013.610 kN

ΦPn = 0.85 x 1013.610 = 861.569 kN ≥ Pu = 251.579 kN ∴ O.K

ΦMn = ΦPn x 0.459 = 395.104 kN.m ≥ Mu = 115.371 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 420.00 = 282.602 kN

ΦVc/2 < Vu (= 262.386 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 ㎟

Av_use = H13 - 2.0 EA = 253.400 ㎟ ∴ O.K

▣ TITLE : 좌측벽체 하부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	100	400	275.96	118.977	431.1

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

Asf = 1588.800 mm² (압축중심 = 80.00 mm), 1단 : H16- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0064) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 500.0 x 1000.0 = 11475000.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 635520.0 N

Xp = (11475000.0 x 250.00 + 635520.0 x 100.000 + 635520.0 x 420.000) / 12746040.0

= 250.997 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 240.00 mm, ab = k1 x cb = 204.00 mm

Cc = 0.85 x 27.0 x 204000.000 = 4681.800 kN, ∑Csi = 599.057 kN, ∑Tsi = 635.520 kN

Pb = 4681.800 + 599.057 - 635.520 = 4645.337 kN

Mb = Cc x 298.000 + ∑(Csi*di) + ∑(Tsi*di) = 885.442 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 190.609 mm, e = Mu/Pu = 431.137 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 84.14 mm, a = k1 x c = 71.52 mm 를 사용.

Cc = 0.85 x 27.0 x 71521.282 = 1641.413 kN

∑Csi = 46.934 kN, ∑Tsi = 635.520 kN

Pn = 1641.413 + 46.934 - 635.520 = 1052.827 kN

Mn = Cc x 364.239 + ∑(Csi*di) + ∑(Tsi*di) = 453.912 kN.m

- 편심오차 : |e - Mn/Pn(=431.136)| = 0.0008 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 500.00 - 100.00 = 400.000 mm

c = 84.143 mm, a = k1 x c = 71.521 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (400.00-84.14) / 84.14 = 0.01126

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10138.491 kN ≥ Pn = 1052.827 kN

ΦPn = 0.85 x 1052.827 = 894.903 kN ≥ Pu = 275.960 kN ∴ O.K

ΦMn = ΦPn x 0.431 = 385.826 kN.m ≥ Mu = 118.977 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 400.00 = 270.050 kN

< Vu (= 274.875 kN) , 전단보강 필요.

Req Av = (274.875 - 270.050) x 150.00 / (400.0 x 400.00 x Φ) = 6.031 ㎟

Use Av = 253.400 ㎟ (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 400.00 / 150.00 = 270.293 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 400.00 = 1385.641 kN ≥ 270.293 kN ∴ O.K

ΦVn = 0.75 x (360.067 + 270.293) = 472.770 kN ≥ 274.875 kN ∴ O.K

▣ TITLE : 우측벽체 상부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	583	100	483	279.439	183.479	656.6

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

Asf = 1588.800 mm² (압축중심 = 80.00 mm), 1단 : H16- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0064) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 583.3 x 1000.0 = 13387500.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 635520.0 N

Xp = (13387500.0 x 291.67 + 635520.0 x 100.000 + 635520.0 x 503.333) / 14658540.0

= 292.534 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 290.00 mm, ab = k1 x cb = 246.50 mm

Cc = 0.85 x 27.0 x 246500.000 = 5657.175 kN, ∑Csi = 599.057 kN, ∑Tsi = 635.520 kN

Pb = 5657.175 + 599.057 - 635.520 = 5620.712 kN

Mb = Cc x 360.083 + ∑(Csi*di) + ∑(Tsi*di) = 1196.497 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 212.873 mm, e = Mu/Pu = 656.595 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 74.04 mm, a = k1 x c = 62.94 mm 를 사용.

Cc = 0.85 x 27.0 x 62937.965 = 1444.426 kN

∑Csi = 0.000 kN, ∑Tsi = 712.191 kN

Pn = 1444.426 + 0.000 - 712.191 = 732.235 kN

Mn = Cc x 451.864 + ∑(Csi*di) + ∑(Tsi*di) = 480.781 kN.m

- 편심오차 : |e - Mn/Pn(=656.593)| = 0.0017 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 583.33 - 100.00 = 483.333 mm

c = 74.045 mm, a = k1 x c = 62.938 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (483.33-74.04) / 74.04 = 0.01658

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10138.491 kN ≥ Pn = 732.235 kN

ΦPn = 0.85 x 732.235 = 622.400 kN ≥ Pu = 279.439 kN ∴ O.K

ΦMn = ΦPn x 0.657 = 408.665 kN.m ≥ Mu = 183.479 kN.m ∴ O.K

㈏ 전단에 대한 검토 (d = 400.00 mm)

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 400.00 = 270.179 kN

< Vu (= 286.238 kN) , 전단보강 필요.

Req Av = (286.238 - 270.179) x 150.00 / (400.0 x 400.00 x Φ) = 20.074 mm²

Use Av = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 400.00 / 150.00 = 270.293 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 400.00 = 1385.641 kN ≥ 270.293 kN ∴ O.K

ΦVn = 0.75 x (360.239 + 270.293) = 472.899 kN ≥ 286.238 kN ∴ O.K

▣ TITLE : 우측벽체 중앙부_외측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	100	400	251.579	150.501	598.2

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

Asf = 1588.800 mm² (압축중심 = 80.00 mm), 1단 : H16- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0064) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 500.0 x 1000.0 = 11475000.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 635520.0 N

Xp = (11475000.0 x 250.00 + 635520.0 x 100.000 + 635520.0 x 420.000) / 12746040.0

= 250.997 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 240.00 mm, ab = k1 x cb = 204.00 mm

Cc = 0.85 x 27.0 x 204000.000 = 4681.800 kN, ∑Csi = 599.057 kN, ∑Tsi = 635.520 kN

Pb = 4681.800 + 599.057 - 635.520 = 4645.337 kN

Mb = Cc x 298.000 + ∑(Csi*di) + ∑(Tsi*di) = 885.442 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 190.609 mm, e = Mu/Pu = 598.225 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 71.18 mm, a = k1 x c = 60.50 mm 를 사용.

Cc = 0.85 x 27.0 x 60499.239 = 1388.458 kN

∑Csi = 0.000 kN, ∑Tsi = 753.709 kN

Pn = 1388.458 + 0.000 - 753.709 = 634.749 kN

Mn = Cc x 369.750 + ∑(Csi*di) + ∑(Tsi*di) = 379.717 kN.m

- 편심오차 : |e - Mn/Pn(=598.216)| = 0.0087 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 500.00 - 100.00 = 400.000 mm

c = 71.176 mm, a = k1 x c = 60.499 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (400.00-71.18) / 71.18 = 0.01386

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10138.491 kN ≥ Pn = 634.749 kN

ΦPn = 0.85 x 634.749 = 539.537 kN ≥ Pu = 251.579 kN ∴ O.K

ΦMn = ΦPn x 0.598 = 322.764 kN.m ≥ Mu = 150.501 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 400.00 = 269.145 kN

ΦVc/2 < Vu (= 262.386 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 ㎟

Av_use = H13 - 2.0 EA = 253.400 ㎟ ∴ O.K

▣ TITLE : 우측벽체 중앙부_내측

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	80	420	251.579	115.371	458.6

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 80.00 mm), 1단 : H16- 8.0EA, d1 = 80.00 mm

Asf = 1588.800 mm² (압축중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0064) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 500.0 x 1000.0 = 11475000.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 635520.0 N

Xp = (11475000.0 x 250.00 + 635520.0 x 80.000 + 635520.0 x 400.000) / 12746040.0

= 249.003 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 252.00 mm, ab = k1 x cb = 214.20 mm

Cc = 0.85 x 27.0 x 214200.000 = 4915.890 kN, ∑Csi = 538.531 kN, ∑Tsi = 635.520 kN

Pb = 4915.890 + 538.531 - 635.520 = 4818.901 kN

Mb = Cc x 312.900 + ∑(Csi*di) + ∑(Tsi*di) = 896.104 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 185.956 mm, e = Mu/Pu = 458.587 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 89.98 mm, a = k1 x c = 76.48 mm 를 사용.

Cc = 0.85 x 27.0 x 76483.026 = 1755.285 kN

∑Csi = 0.000 kN, ∑Tsi = 741.675 kN

Pn = 1755.285 + 0.000 - 741.675 = 1013.610 kN

Mn = Cc x 381.758 + ∑(Csi*di) + ∑(Tsi*di) = 464.822 kN.m

- 편심오차 : |e - Mn/Pn(=458.581)| = 0.0060 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 500.00 - 80.00 = 420.000 mm

c = 89.980 mm, a = k1 x c = 76.483 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (420.00-89.98) / 89.98 = 0.01100

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10138.491 kN ≥ Pn = 1013.610 kN

ΦPn = 0.85 x 1013.610 = 861.569 kN ≥ Pu = 251.579 kN ∴ O.K

ΦMn = ΦPn x 0.459 = 395.104 kN.m ≥ Mu = 115.371 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 420.00 = 282.602 kN

ΦVc/2 < Vu (= 262.386 kN) , 최소 전단철근 보강.

Av_req = 0.35 x 1000.00 x 150.00 / 400 = 131.250 ㎟

Av_use = H13 - 2.0 EA = 253.400 ㎟ ∴ O.K

▣ TITLE : 우측벽체 하부

㉮ 설계조건 및 단면가정

fck=27MPa, fy=400MPa, k1=0.85, Φc=0.65

B(mm)	H(mm)	피복(mm)	d(mm)	Pu(kN)	Mu(kN.m)	e(mm)
1,000	500	100	400	275.96	118.977	431.1

㉯ 철근비 검토

As = 1588.800 mm² (인장중심 = 100.00 mm), 1단 : H16- 8.0EA, d1 = 100.00 mm

Asf = 1588.800 mm² (압축중심 = 80.00 mm), 1단 : H16- 8.0EA, d1 = 80.00 mm

ρmin (= 0.0012) ≤ ρuse (= 0.0064) ≤ ρmax (= 0.0800) ∴ O.K

㉰ 평형하중 산정

- 소성중심 계산

Cc = 0.85 x 27.0 x 500.0 x 1000.0 = 11475000.0 N

Cs = As x fy = 635520.0 N, Cs' = Asf x fy = 635520.0 N

Xp = (11475000.0 x 250.00 + 635520.0 x 100.000 + 635520.0 x 420.000) / 12746040.0

= 250.997 mm

- 평형상태 계산

cb = 600 / (600 + fy) x d = 240.00 mm, ab = k1 x cb = 204.00 mm

Cc = 0.85 x 27.0 x 204000.000 = 4681.800 kN, ∑Csi = 599.057 kN, ∑Tsi = 635.520 kN

Pb = 4681.800 + 599.057 - 635.520 = 4645.337 kN

Mb = Cc x 298.000 + ∑(Csi*di) + ∑(Tsi*di) = 885.442 kN.m

eb < e → 인장 파괴 (eb = Mb/Pb = 190.609 mm, e = Mu/Pu = 431.137 mm)

㉱ 공칭강도 산정

- 반복시산법을 이용하여 c = 84.14 mm, a = k1 x c = 71.52 mm 를 사용.

Cc = 0.85 x 27.0 x 71521.282 = 1641.413 kN

∑Csi = 46.934 kN, ∑Tsi = 635.520 kN

Pn = 1641.413 + 46.934 - 635.520 = 1052.827 kN

Mn = Cc x 364.239 + ∑(Csi*di) + ∑(Tsi*di) = 453.912 kN.m

- 편심오차 : |e - Mn/Pn(=431.136)| = 0.0008 ≤ 0.010 ∴ 허용오차 만족

㉲ 강도감소계수(Φ) 산정

dt = 500.00 - 100.00 = 400.000 mm

c = 84.143 mm, a = k1 x c = 71.521 mm

εy = fy / Es = 400.00 / 200000.00 = 0.0020

εt = 0.00300 x (dt-c) / c = 0.00300 x (400.00-84.14) / 84.14 = 0.01126

εt ≥ 0.00500 이므로 인장지배단면이며, Φ = 0.85 를 적용한다.

㉳ 축방향력 및 휨에 대한 검토

MaxPn = 0.80 x {0.85 fck*(Ag-Ast) + fy*Ast} = 10138.491 kN ≥ Pn = 1052.827 kN

ΦPn = 0.85 x 1052.827 = 894.903 kN ≥ Pu = 275.960 kN ∴ O.K

ΦMn = ΦPn x 0.431 = 385.826 kN.m ≥ Mu = 118.977 kN.m ∴ O.K

㈏ 전단에 대한 검토

ΦVc = 0.75 x 1/6 x (1 + 1/14 Pu/Ag) x √27.0 x 1000.00 x 400.00 = 270.050 kN

< Vu (= 274.875 kN) , 전단보강 필요.

Req Av = (274.875 - 270.050) x 150.00 / (400.0 x 400.00 x Φ) = 6.031 mm²

Use Av = 253.400 mm² (H13-2.0 EA, C.T.C 150 mm)

Vs = 253.400 x 400.0 x 400.00 / 150.00 = 270.293 kN

Vs Max = 2 x √27.0 / 3 x 1000.00 x 400.00 = 1385.641 kN ≥ 270.293 kN ∴ O.K

ΦVn = 0.75 x (360.067 + 270.293) = 472.770 kN ≥ 274.875 kN ∴ O.K

17. 수평철근 검토

1) 상부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 887.208 × 0.20 = 177.44 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 177.442 ∴ O.K

2) 상부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 10EA = 1267.000 ㎟ ≥ 1000.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 678.821 × 0.20 = 135.76 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 135.764 ∴ O.K

3) 상부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 887.208 × 0.20 = 177.44 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 177.442 ∴ O.K

4) 하부슬래브 : 1경간(좌측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 978.128 × 0.20 = 195.63 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 195.626 ∴ O.K

5) 하부슬래브 : 중앙부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 10EA = 1267.000 ㎟ ≥ 1000.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 605.088 × 0.20 = 121.02 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 121.018 ∴ O.K

6) 하부슬래브 : 1경간(우측)

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 5.7.2]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

② Req's As = 필요 철근량 × 20%
= 978.128 × 0.20 = 195.63 ㎟

∴ Used As = H13 - 6.7EA = 845.089 ㎟ ≥ 195.626 ∴ O.K

7) 좌측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

8) 좌측벽체 : 중앙부_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

9) 좌측벽체 : 중앙부_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

10) 좌측벽체 : 하부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

11) 우측벽체 : 상부

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

12) 우측벽체 : 중앙부_외측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]
= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

13) 우측벽체 : 중앙부_내측

① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

14) 우측벽체 : 하부

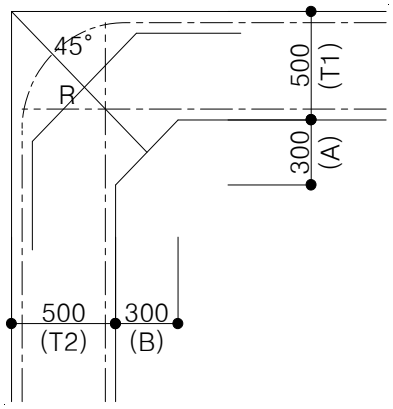
① Req's As = B × H × 0.0020 (≤ 1800 ㎟)[콘.설 11.3(3)]

= 1000 × 500 × 0.0020 = 1000.00 ㎟

∴ Used As = H13 - 13.3EA = 1688.911 ㎟ ≥ 1000.000 ∴ O.K

18. 절점부 검토

1) 좌측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 42.932 kN.m
- 절점부 휨모멘트 : Mo = 42.932 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 919.239 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H16 @250 - 4EA = 794.400 mm²

∴ Total Asb = 794.400 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 42.93 \times 10^6}{919.239^2 \times 1000} = 0.254 \text{ MPa} < 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요없음 !!!

② 내측인장 휨모멘트 보강검토

- 수평부재 내측에 배근된 주철근량 : 1588.8 ㎟

  $k = -np + \sqrt{(2 \times np + (np)^2)}$ [∵ n = 7]

  $= -7 \times 0.0037829 + \sqrt{(2 \times 0.0265 + (0.0265)^2)} = 0.205$

  $j = 1 - k / 3 = 1 - 0.205 / 3 = 0.932$

  $fs = Mo / (As \times d \times j) = 19370053.000 / (1588.800 \times 420.000 \times 0.932)$

  $= 31.159$ MPa

  인장력 $Th1 = fs \times As = 31.159 \times 1588.800 = 49504.787$ N

- 연직부재 내측에 배근된 주철근량 : 1588.8 ㎟

  $k = -np + \sqrt{(2 \times np + (np)^2)}$ [∵ n = 7]

  $= -7 \times 0.0037829 + \sqrt{(2 \times 0.0265 + (0.0265)^2)} = 0.205$

  $j = 1 - k / 3 = 1 - 0.205 / 3 = 0.932$

  $fs = Mo / (As \times d \times j) = 19370053.000 / (1588.800 \times 420.000 \times 0.932)$

  $= 31.159$ MPa

  인장력 $Th2 = fs \times As = 31.159 \times 1588.800 = 49504.787$ N

- 보강철근량 산정

  $T = \sqrt{(Th1^2 + Th2^2)} = fsa \times As$ T : 대각선 방향의 인장력

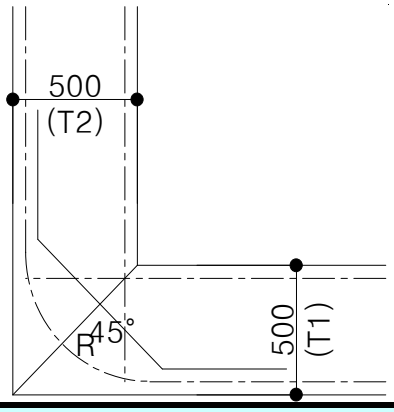
  Th : 수평부재 또는 연직부재에 작용하는 인장력

  $As = \sqrt{(Th1^2 + Th2^2)} / fsa = \sqrt{(49504.787^2 + 49504.787^2)} / 180.0$

  $As = 388.946$ ㎟

  사용철근량 : H13 @ 500, 2EA = 506.800 ㎟ ∴ O.K

2) 좌측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 74.082 kN.m
- 절점부 휨모멘트 : Mo = 74.082 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 707.107$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H16 @250 - 4EA = 794.400 mm²

∴ Total Asb = 794.400 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 74.08 \times 10^6}{707.107^2 \times 1000} = 0.741 \text{ MPa} > 0.13\sqrt{fck}\ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 74.08 \times 10^6}{707.107 \times 180} = 1164.085 \text{ mm}^2$$

Asb = 794.400 mm²

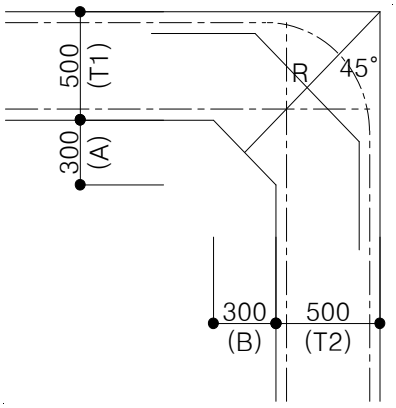
Req'd As = As - Asb
= 1164.085 mm² - 794.400 mm²
= 369.685 mm²

- 사용보강철근

Use'd As = H13 - 8EA

∴ Total As = 1013.600 mm² > Req'd As (= 369.685 mm²) ----------> O.K !!!

3) 우측상단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 42.932 kN.m
- 절점부 휨모멘트 : Mo = 42.932 kN.m

$$R = \frac{(T1 \times B + T2 \times A + A \times B)}{(A + B)} \sqrt{2}$$

$$= 919.239 \text{ mm}$$

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H16 @250 - 4EA = 794.400 mm²

∴ Total Asb = 794.400 mm²

① 외측인장 휨모멘트 보강검토

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 42.93 \times 10^6}{919.239^2 \times 1000} = 0.254 \text{ MPa} < 0.13\sqrt{fck} \ (=0.675)$$

∴ 절점부 보강철근 필요없음 !!!

② 내측인장 휨모멘트 보강검토

- 수평부재 내측에 배근된 주철근량 : 1588.8 ㎟

  $k = -np + \sqrt{(2 \times np + (np)^2)}$ [∵ n = 7]

  $= -7 \times 0.0037829 + \sqrt{(2 \times 0.0265 + (0.0265)^2)} = 0.205$

  $j = 1 - k / 3 = 1 - 0.205 / 3 = 0.932$

  $fs = Mo / (As \times d \times j) = 19370053.000 / (1588.800 \times 420.000 \times 0.932)$

  $= 31.159$ MPa

  인장력 $Th1 = fs \times As = 31.159 \times 1588.800 = 49504.787$ N

- 연직부재 내측에 배근된 주철근량 : 1588.8 ㎟

  $k = -np + \sqrt{(2 \times np + (np)^2)}$ [∵ n = 7]

  $= -7 \times 0.0037829 + \sqrt{(2 \times 0.0265 + (0.0265)^2)} = 0.205$

  $j = 1 - k / 3 = 1 - 0.205 / 3 = 0.932$

  $fs = Mo / (As \times d \times j) = 19370053.000 / (1588.800 \times 420.000 \times 0.932)$

  $= 31.159$ MPa

  인장력 $Th2 = fs \times As = 31.159 \times 1588.800 = 49504.787$ N

- 보강철근량 산정

  $T = \sqrt{(Th1^2 + Th2^2)} = fsa \times As$ T : 대각선 방향의 인장력

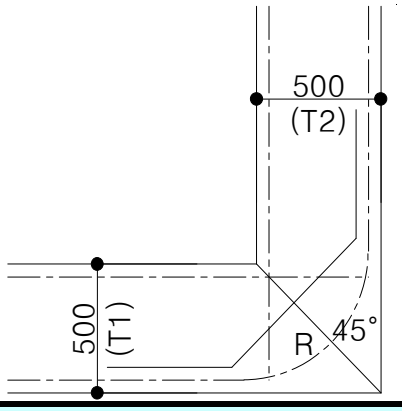
  Th : 수평부재 또는 연직부재에 작용하는 인장력

  $As = \sqrt{(Th1^2 + Th2^2)} / fsa = \sqrt{(49504.787^2 + 49504.787^2)} / 180.0$

  $As = 388.946$ ㎟

  사용철근량 : H13 @ 500, 2EA = 506.800 ㎟ ∴ O.K

4) 우측하단



- CON'C 설계기준강도: fck = 27 MPa
- 철근 항복강도 : fy = 400 MPa
- 사용 모멘트 : Mu = 74.082 kN.m
- 절점부 휨모멘트 : Mo = 74.082 kN.m

$R = \sqrt{(T1^2 + T2^2)} = 707.107$ mm

▣ 절점부 보강철근으로 볼 수 있는 주 철근량

H16 @250 - 4EA = 794.400 mm²

∴ Total Asb = 794.400 mm²

- 절점부 보강철근량 필요여부 판정

$$Ftmax = \frac{5 \times Mo}{R^2 \times W} = \frac{5 \times 74.08 \times 10^6}{707.107^2 \times 1000} = 0.741 \text{ MPa} > 0.13\sqrt{fck}\ (=0.675)$$

∴ 절점부 보강철근 필요 !!!

- 소요철근량

외측 인장에 대한 보강철근량(As)

$$As = \frac{2 \times Mo}{R \times fsa} = \frac{2 \times 74.08 \times 10^6}{707.107 \times 180} = 1164.085 \text{ mm}^2$$

Asb = 794.400 mm²

Req'd As = As - Asb
= 1164.085 mm² - 794.400 mm²
= 369.685 mm²

- 사용보강철근

Use'd As = H13 - 8EA

∴ Total As = 1013.600 mm² > Req'd As (= 369.685 mm²) ----------> O.K !!!

19. 사용성 검토

(1) 균열 검토 (콘크리트 구조설계기준・해설 6.3.3(4))

(C.T.C. 125 mm)

구분	부재 위치			유효높이 (mm)	인장사용철근량	철근 간격(mm)	최대 간격 (mm)	검토 결과	S.F
상부슬래브	1경간	좌측	1	483	H16 - 8.0EA	125	1273.107	O.K	10.185
		중앙부	2	420	H16 - 8.0EA	125	488.368	O.K	3.907
		우측	3	483	H16 - 8.0EA	125	1273.107	O.K	10.185
하부슬래브	1경간	좌측	4	400	H16 - 8.0EA	125	552.722	O.K	4.422
		중앙부	5	420	H16 - 8.0EA	125	611.957	O.K	4.896
		우측	6	400	H16 - 8.0EA	125	552.722	O.K	4.422
좌측벽체	1층	상부	7	483	H16 - 8.0EA	125	1054.463	O.K	8.436
		중앙부	8	400	H16 - 8.0EA	125	1175.974	O.K	9.408
		중앙부	8	420	H16 - 8.0EA	125	41535.943	O.K	332.288
		하부	9	400	H16 - 8.0EA	125	622.084	O.K	4.977
우측벽체	1층	상부	10	483	H16 - 8.0EA	125	1054.463	O.K	8.436
		중앙부	11	400	H16 - 8.0EA	125	1175.974	O.K	9.408
		중앙부	11	420	H16 - 8.0EA	125	41535.943	O.K	332.288
		하부	12	400	H16 - 8.0EA	125	622.084	O.K	4.977

1) 상부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 35.559 x 1000000 / [1588.800 x (483.333 - 93.160/3)]
= 49.485 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x483.3/(7x1588.800)]
= 93.160 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 49.49) - 2.5 x 92.00 = 1361.38 mm
300 x (Kcr / fs) = 300 x (210 / 49.49) = 1273.11 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1273.11 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1273.11 mm) ∴ O.K

2) 상부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 73.247 x 1000000 / [1588.800 x (420.000 - 86.171/3)]
= 117.824 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x420.0/(7x1588.800)]
= 86.171 mm

사용철근량 = 1588.8 mm² (철근도심 : 80.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 16/2 = 72.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 117.82) - 2.5 x 72.00 = 488.37 mm
300 x (Kcr / fs) = 300 x (210 / 117.82) = 534.69 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 488.37 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 488.37 mm) ∴ O.K

3) 상부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 35.559 x 1000000 / [1588.800 x (483.333 - 93.160/3)]
= 49.485 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x483.3/(7x1588.800)]
= 93.160 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 49.49) - 2.5 x 92.00 = 1361.38 mm
300 x (Kcr / fs) = 300 x (210 / 49.49) = 1273.11 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1273.11 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1273.11 mm) ∴ O.K

4) 하부슬래브 1경간(좌측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 59.472 x 1000000 / [1588.800 x (400.000 - 83.857/3)]
= 100.610 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x400.0/(7x1588.800)]
= 83.857 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 100.61) - 2.5 x 92.00 = 552.72 mm
300 x (Kcr / fs) = 300 x (210 / 100.61) = 626.18 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 552.72 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 552.72 mm) ∴ O.K

5) 하부슬래브 중앙부

① 응력 산정

fs = M / [As x (d - χ/3)] = 61.816 x 1000000 / [1588.800 x (420.000 - 86.171/3)]
= 99.437 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x420.0/(7x1588.800)]
= 86.171 mm

사용철근량 = 1588.8 mm² (철근도심 : 80.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 16/2 = 72.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 99.44) - 2.5 x 72.00 = 611.96 mm
300 x (Kcr / fs) = 300 x (210 / 99.44) = 633.57 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 611.96 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 611.96 mm) ∴ O.K

6) 하부슬래브 1경간(우측)

① 응력 산정

fs = M / [As x (d - χ/3)] = 59.472 x 1000000 / [1588.800 x (400.000 - 83.857/3)]
= 100.610 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x400.0/(7x1588.800)]
= 83.857 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 100.61) - 2.5 x 92.00 = 552.72 mm
300 x (Kcr / fs) = 300 x (210 / 100.61) = 626.18 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 552.72 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 552.72 mm) ∴ O.K

7) 좌측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 42.932 x 1000000 / [1588.800 x (483.333 - 93.160/3)]
= 59.746 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x483.3/(7x1588.800)]
= 93.160 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 59.75) - 2.5 x 92.00 = 1088.08 mm
300 x (Kcr / fs) = 300 x (210 / 59.75) = 1054.46 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1054.46 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1054.46 mm) ∴ O.K

8) 좌측벽체 중앙부_외측

① 응력 산정

fs = M / [As x (d - χ/3)] = 31.667 x 1000000 / [1588.800 x (400.000 - 83.857/3)]
= 53.573 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x400.0/(7x1588.800)]
= 83.857 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 53.57) - 2.5 x 92.00 = 1239.97 mm
300 x (Kcr / fs) = 300 x (210 / 53.57) = 1175.97 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1175.97 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1175.97 mm) ∴ O.K

9) 좌측벽체 중앙부_내측

① 응력 산정

fs = M / [As x (d - χ/3)] = 0.943 x 1000000 / [1588.800 x (420.000 - 86.171/3)]
= 1.517 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x420.0/(7x1588.800)]
= 86.171 mm

사용철근량 = 1588.8 mm² (철근도심 : 80.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 16/2 = 72.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 1.52) - 2.5 x 72.00 = 51739.93 mm
300 x (Kcr / fs) = 300 x (210 / 1.52) = 41535.94 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 41535.94 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 41535.94 mm) ∴ O.K

10) 좌측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 54.631 x 1000000 / [1588.800 x (400.000 - 83.857/3)]
= 92.420 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x400.0/(7x1588.800)]
= 83.857 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 92.42) - 2.5 x 92.00 = 622.08 mm
300 x (Kcr / fs) = 300 x (210 / 92.42) = 681.67 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 622.08 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 622.08 mm) ∴ O.K

11) 우측벽체 상부

① 응력 산정

fs = M / [As x (d - χ/3)] = 42.932 x 1000000 / [1588.800 x (483.333 - 93.160/3)]
= 59.746 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x483.3/(7x1588.800)]
= 93.160 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 59.75) - 2.5 x 92.00 = 1088.08 mm
300 x (Kcr / fs) = 300 x (210 / 59.75) = 1054.46 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1054.46 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1054.46 mm) ∴ O.K

12) 우측벽체 중앙부_외측

① 응력 산정

fs = M / [As x (d - χ/3)] = 31.667 x 1000000 / [1588.800 x (400.000 - 83.857/3)]
= 53.573 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x400.0/(7x1588.800)]
= 83.857 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 53.57) - 2.5 x 92.00 = 1239.97 mm
300 x (Kcr / fs) = 300 x (210 / 53.57) = 1175.97 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 1175.97 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 1175.97 mm) ∴ O.K

13) 우측벽체 중앙부_내측

① 응력 산정

fs = M / [As x (d - χ/3)] = 0.943 x 1000000 / [1588.800 x (420.000 - 86.171/3)]
= 1.517 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x420.0/(7x1588.800)]
= 86.171 mm

사용철근량 = 1588.8 mm² (철근도심 : 80.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 80.00 - 16/2 = 72.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 1.52) - 2.5 x 72.00 = 51739.93 mm
300 x (Kcr / fs) = 300 x (210 / 1.52) = 41535.94 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 41535.94 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 41535.94 mm) ∴ O.K

14) 우측벽체 하부

① 응력 산정

fs = M / [As x (d - χ/3)] = 54.631 x 1000000 / [1588.800 x (400.000 - 83.857/3)]
= 92.420 MPa

χ = -nAs/b + nAs/b√[1 + 2bd/(nAs)]
= -7x1588.800/1000.0 + 7x1588.800/1000.0 x √[(1 + 2x1000.0x400.0/(7x1588.800)]
= 83.857 mm

사용철근량 = 1588.8 mm² (철근도심 : 100.0 mm)
1단 : H16 - 8.0 EA (= 1588.8 mm²)

② 철근의 최대 중심간격

Cc = 100.00 - 16/2 = 92.00 mm
여기서 Cc ; 인장철근이나 긴장재의 표면과 콘크리트 표면사이의 두께(mm)
Smin : 375 x (Kcr / fs) - 2.5 x Cc = 375 x (210 / 92.42) - 2.5 x 92.00 = 622.08 mm
300 x (Kcr / fs) = 300 x (210 / 92.42) = 681.67 mm
습윤환경이므로 Kcr = 210 적용

Sa는 작은 값인 622.08 mm 를 적용
S = 1000.00 / 8.0 EA = 125.00 ≤ Sa (= 622.08 mm) ∴ O.K

(2) 처짐검토

▣ 철근콘크리트 부재의 처짐은 시방서에서 규정한 부재의 최소두께를 고려하여 간접적으로 제한한다.

- 경계조건 : 1방향 슬래브, 양단연속
- 지 간 : L = 2.500 m
- fy = 400 MPa
- 부재두께(T) = 0.50 m

▣ 처짐계산을 하지 않는 경우의 휨 부재의 최소두께 (fy = 400 MPa 인 경우)

부재	최소두께 또는 높이 (mm)			
	단 순 지 지	일 단 연 속	양 단 연 속	캔 틸 레 버
1방향 슬래브	l / 20	l / 24	l / 28	l / 10
1보	l / 16	l / 18.5	l / 21	l / 8

Tmin = L / 28

T = 2.500 / 28

T = 0.089 m < 0.500 m ----------> O.K

20. 기초 지지력 검토

(1) 하중산정

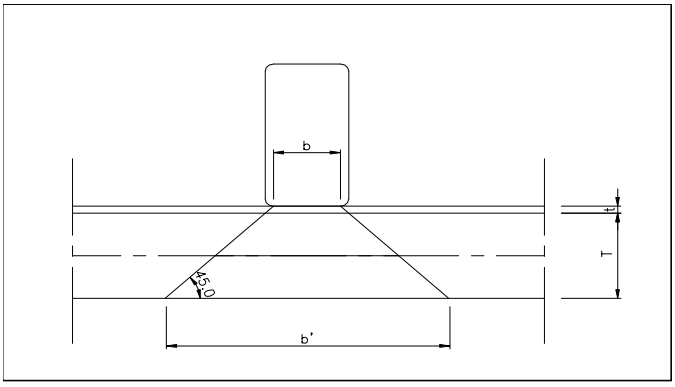
1) 고정하중

- 구체자중 = 127.250 / 3.000 = 42.417 kN/m²
- 상부연직하중 = 102.700 kN/m² (지하수위 미 고려시)
- 암거아스콘포장 = 0.08 × 23.00 = 1.840 kN/m²

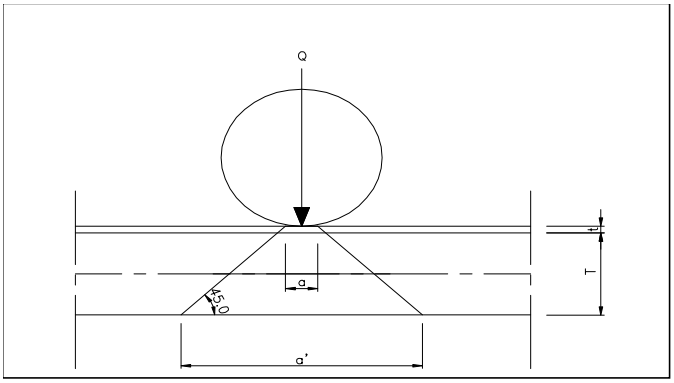
2) 활하중

- 도로 노면 활하중 = 10.000 kN/m²
- 상재활하중 = 0.000 kN/m²

- 암거 내부 활하중



t = 80 mm (암거내부 포장두께)
T = 500 mm (하부 슬래브 두께)
b' = 0.500 + 2 × (0.500 + 0.080) × cot 45°
= 1.660 m



a' = 0.200 + 2 × (0.500 + 0.080) × cot 45°
= 1.360 m

Qz = 96.0 / (1.660 × 1.360)= 42.523 kN/m²

(2) 허용 지지력 검토

1) 최대 지반 반력

Qmax = 42.42 + 102.70 + 10.00 + 1.84 + 42.52

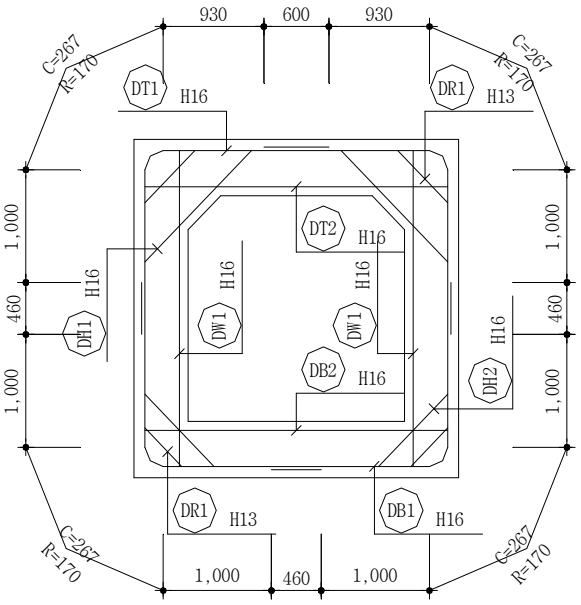
= 199.480 kN/m²

Qa' = 400.000 kN/m² > Qmax = 199.480 kN/m² ..... O.K !!!

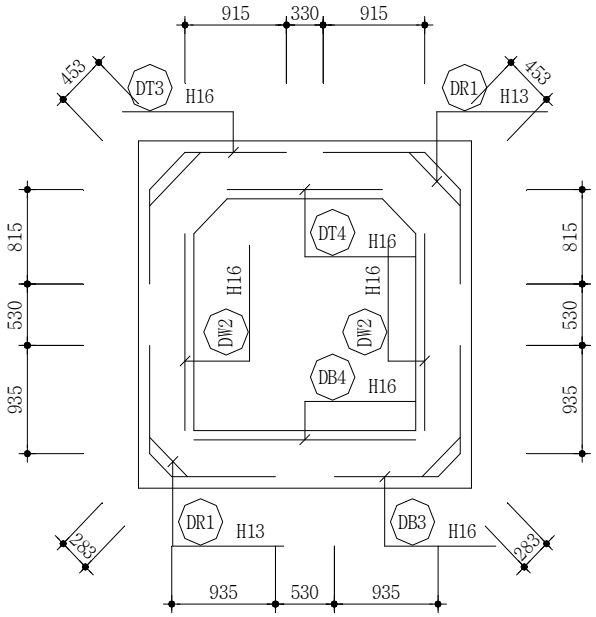
(지반조사 보고서 참조)

21. 주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



2.5 점검통로 단면 E-E

목 차

1. 설계개요 및 조건

2. 단면가정

3. 구조해석모델링

4. 하중산정

5. 하중조합

6. 구조해석결과

7. 단면설계

8. 단면설계 요약

9. 우각부보강설계

10. 사용성검토

11. 주철근조립도

12. 배력철근 검토

1. 설계개요 및 조건

1.1 개요

• Plane Strain의 단위길이당 평면 뼈대요소로 해석

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 단위중량

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	24.5	아스팔트 포장	23.0
흙(지하수위 이상)	20.0	흙(지하수위 이하)	11.0
물	10.0	모르타르	21.5
기계실하중	25.0	무근콘크리트	23.0

(3) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,700 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(4) 토사 내부마찰각 : Φ = 30°

(5) 토압 : K_o = 0.500

1.4 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

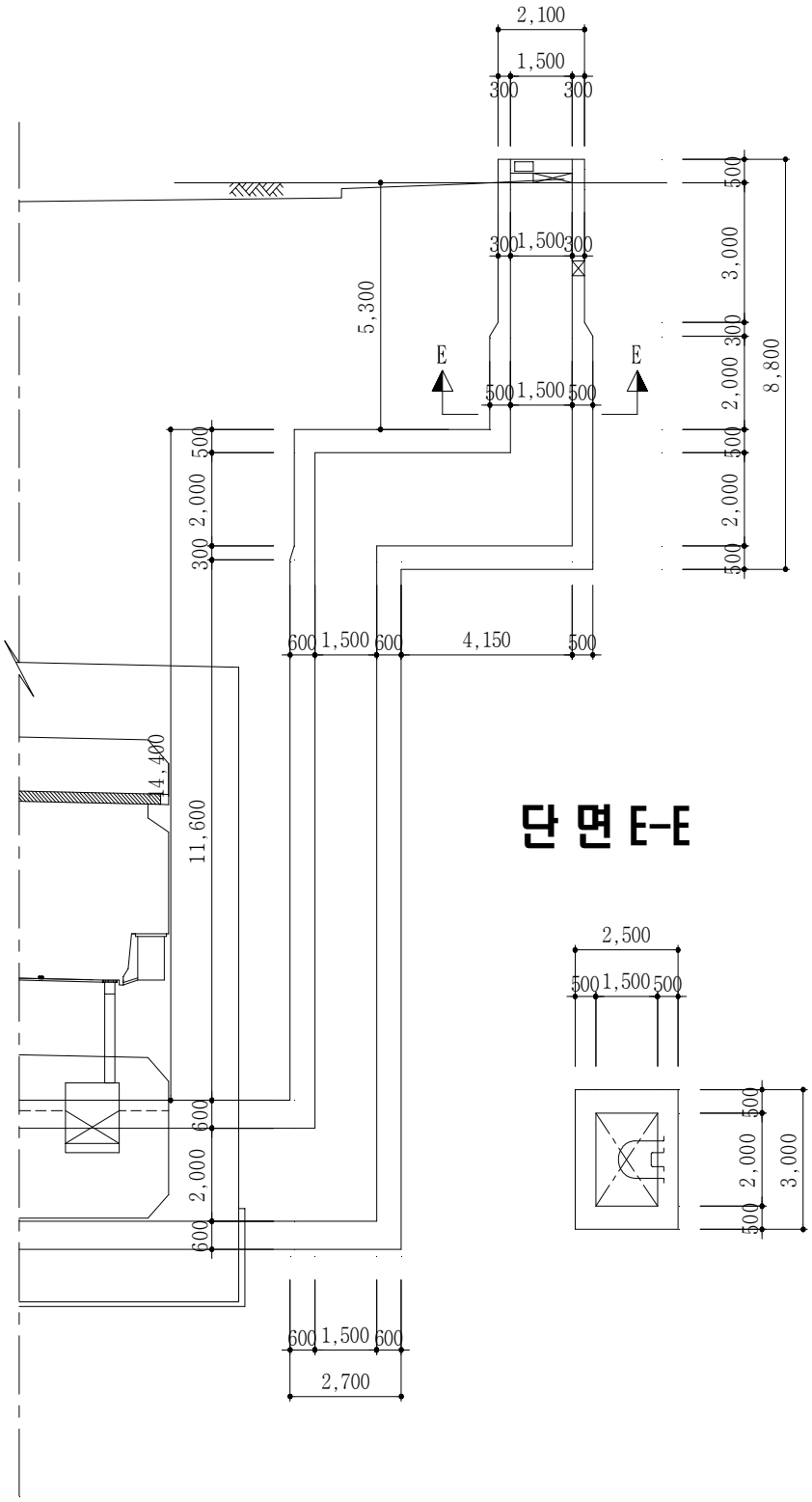
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면가정

설계적용 토피 = 5.300 m



2.1 강역 설정

1) 강역설정기준(콘크리트구조기준 2012)

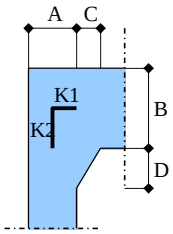
CASE 1 : 부재단부가 다른 부재와 접합할 때는 부재단에서 부재두께의 1/4 안쪽점에서 절점까지

CASE 2 : 부재가 그 축선에 대해 25° 이상 60° 미만인 경사진 헌치를 갖는 경우에는 부재두께가 1.5배가 되는 점에서 부터 절점까지

CASE 3 : 헌치의 경사가 60° 이상의 경우는 헌치의 시점에서 부재두께의 1/4 안쪽 점에서부터 절점까지

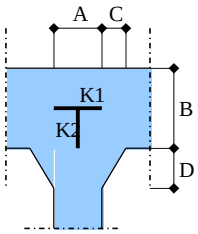
2) 강역설정

① 단부



A	=	0.50	m
B	=	0.50	m
C	=	0.00	m
D	=	0.00	m
K1	=	0.13	m
K2	=	0.13	m

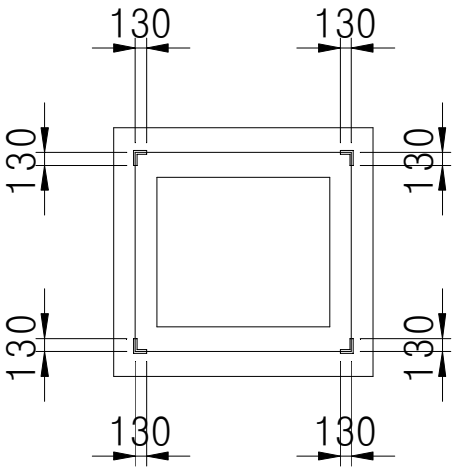
② 내부 지점부

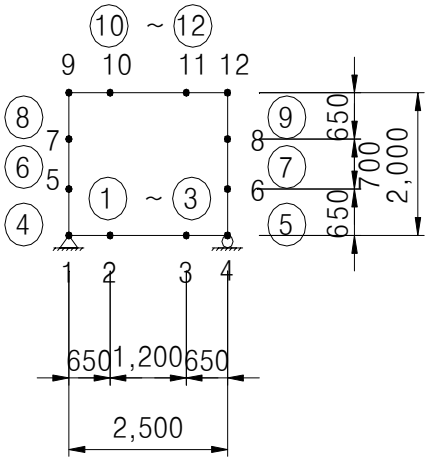


A	=	0.00	m
B	=	0.00	m
C	=	0.00	m
D	=	0.00	m
K1	=	0.00	m
K2	=	0.00	m

3. 구조해석 모델링

3.1 해석모형





3.2 단면제원

번 호	폭(m)	높이(m)	단면적(m²)	단면2차모멘트(m⁴)	비 고
1	1.00	0.50	0.500	0.010417	장 지 간
2	1.00	0.50	0.500	0.010417	단 지 간

4. 하중산정

4.1 활하중에 의한 측압 (만재하시) ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	$Pvl \times D$, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, $Pvl \times D$의 상위값을 적용 *D/B_0 중노면활하중(Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 5.300 / 3.000 = 1.767

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

Lh1 = 0.500 × 10.000 = 5.000 kN/m²

4.2 활하중에 의한 측압 (편재하시) ---------- LC 2, 3

Lh1 = 0.500 × 10.000 = 5.000 kN/m²

4.4 수평토압(지하수 無) ---------- LC 4

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + (4.800 + 0.000 / 2) × 20.000)

= 53.750 kN/m²

4.5 수평 토압(지하수 有) ---------- LC 5

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 +

(4.300 + 0.000 / 2) × 11.000) = 34.400 kN/m²

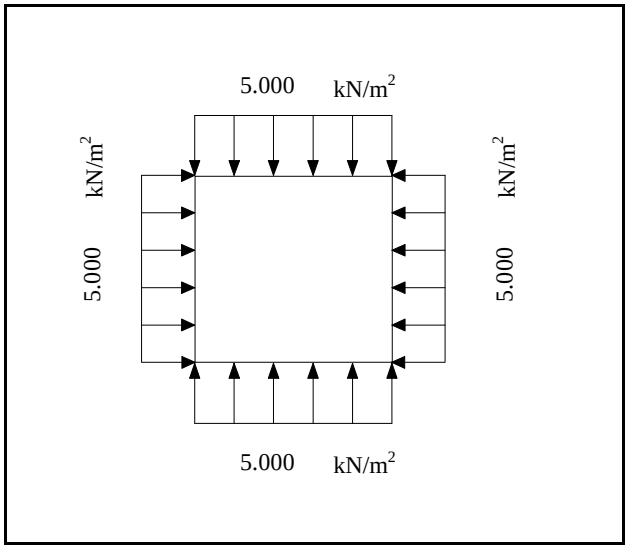
4.6 수평 수압(지하수 有) ---------- LC 6

1) 벽체

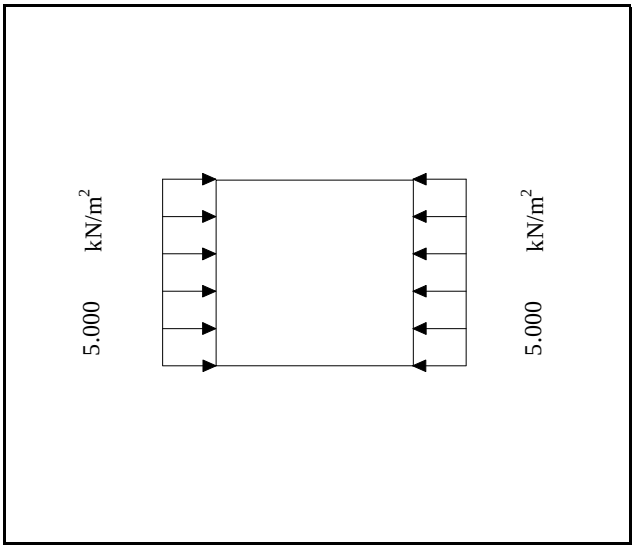
q_{W1} = 10.000 × (4.300 + 0.000 / 2) = 43.000 kN/m²

4.7 하중재하도

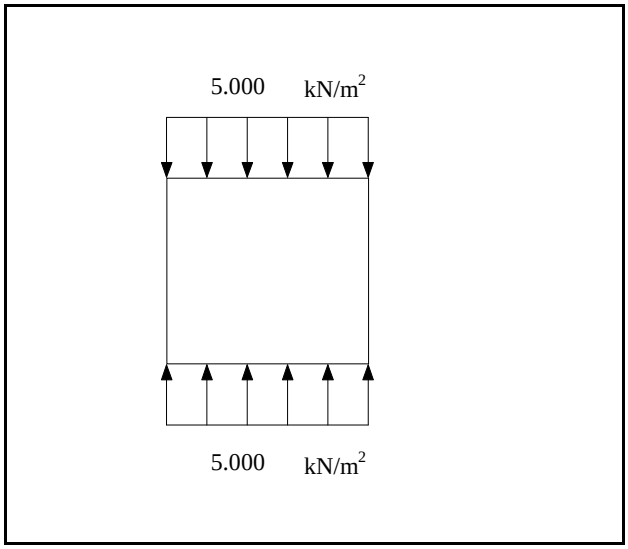
1) 활하중에 의한 측압(만재하시) ------- LC 1



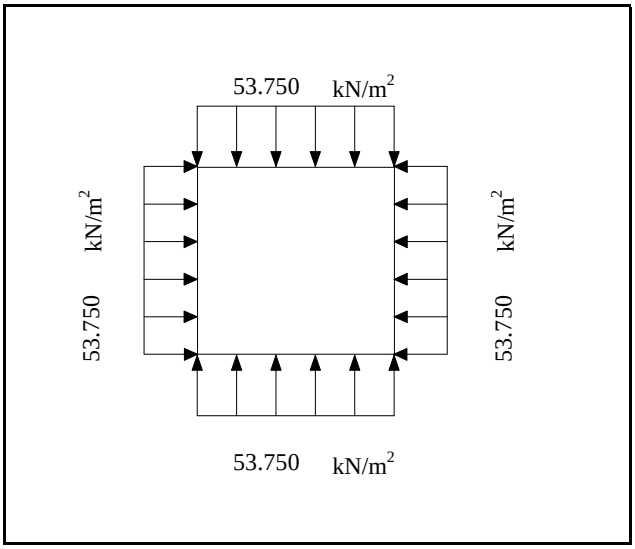
2) 활하중에 의한 측압(편재하시-1) ------- LC 2



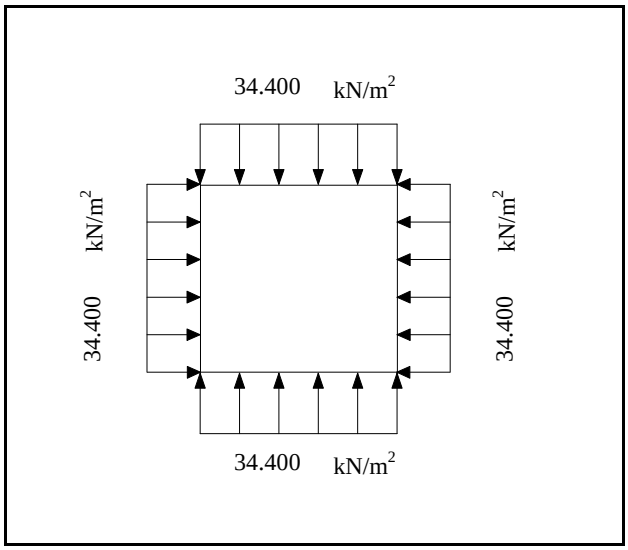
3) 활하중에 의한 측압(편재하시-2) ------- LC 3



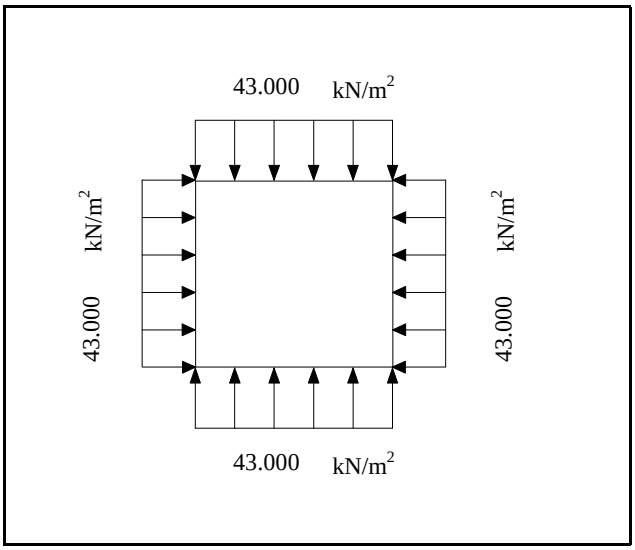
4) 수평 토압(지하수 무) ------- LC 4



5) 수평 토압(지하수 유) ------- LC 5



6) 수평 수압(지하수 유) ------- LC 6



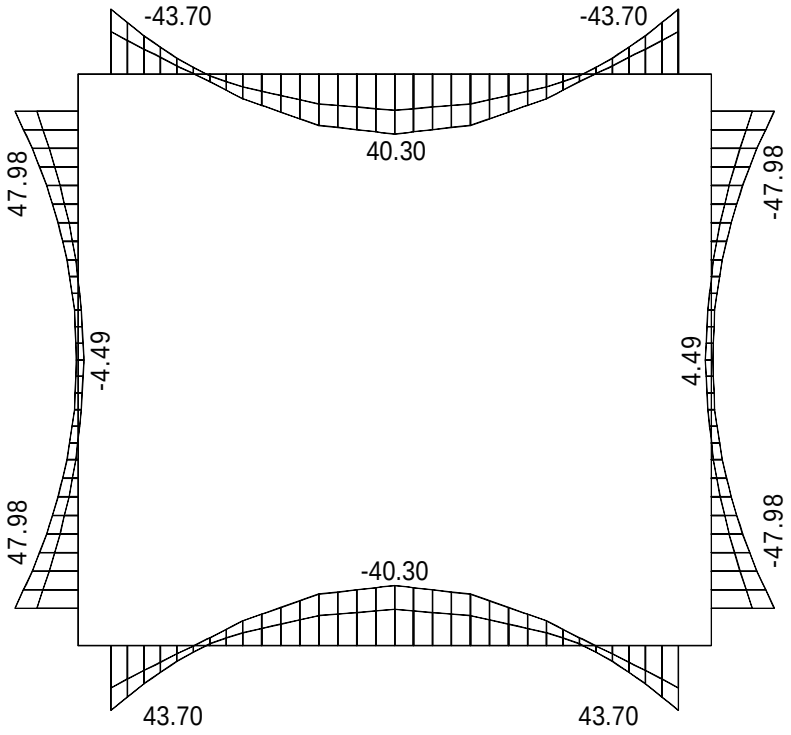
5. 하중조합

하중 조합	활하중			지하수 없을때	지하수 있을때		비고
	만재하	편재하					
	수평	수평		수평 토압	수평 토압	수평 수압	
		상하	좌우				
	LC01	LC02	LC03	LC04	LC05	LC06	
CB01	1.60			1.60			극한하중조합
CB02		1.60		1.60			
CB03			1.60	1.60			
CB04				1.60			
CB05	1.60				1.60	1.60	
CB6		1.60			1.60	1.60	
CB7			1.60		1.60	1.60	
CB8					1.60	1.60	
CB9	1.00			1.00			사용하중조합
CB10		1.00		1.00			
CB11			1.00	1.00			
CB12				1.00			
CB13	1.00				1.00	1.00	
CB14		1.00			1.00	1.00	
CB15			1.00		1.00	1.00	
CB16					1.00	1.00	

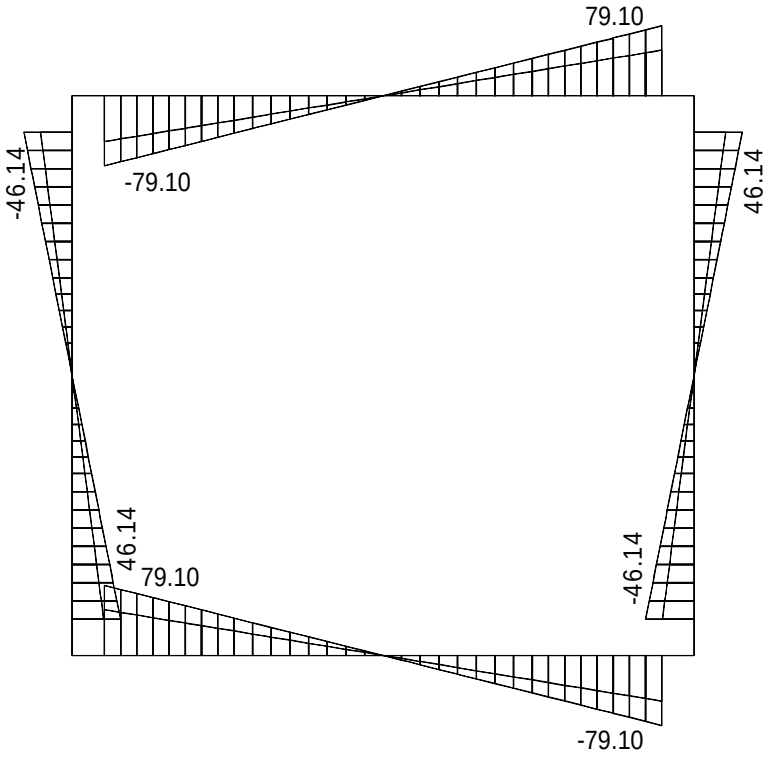
6. 구조해석 결과

6.1 부재력도

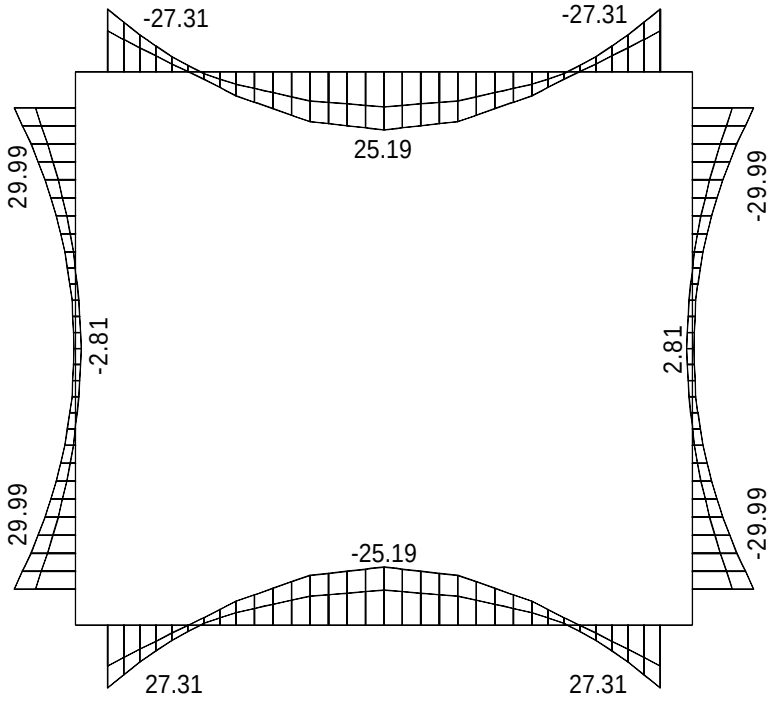
B.M.D (계수하중) [kN·m]



S.F.D (계수하중) [kN]



B.M.D (사용하중) [kN·m]



6.2 부재력 집계

구분		계수하중			사용하중	
		Mu(kN·m)	Pu(kN)	Vu(kN)	Mo(kN·m)	Po(kN)
슬래브 장지간	단 부	43.700		79.100	27.310	
	중앙부	40.300			25.190	
슬래브 단지간	단 부	47.980		46.140	29.990	
	중앙부	4.490			2.810	

7. 단면검토

1) 슬래브 장지간 단부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 431.473 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	27.3
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	400.0	100.0	43.700	79.100

전단설계시 단면의 유효높이 ds = 400.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 8ea = 1588.800 ㎟

∴ P = As / (B × D) = 0.00397

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 27.692 mm

최외단 인장철근 변형률 εt = 0.03383 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 208597302 N·mm

= 208.597 kN·m > 43.700 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 323.605 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 259.808 kN

∴ 전단철근이 필요없음.

2) 슬래브 장지간 중앙부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 378.513 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	25.2
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	420.0	80.0	40.300	0.000

전단설계시 단면의 유효높이 ds = 420.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 8ea = 1588.800 ㎟

∴ P = As / (B × D) = 0.00378

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 27.692 mm

최외단 인장철근 변형률 εt = 0.03568 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 219401142 N·mm

= 219.401 kN·m > 40.300 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 283.885 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 272.798 kN

∴ 전단철근이 필요없음.

3) 슬래브 단지간 단부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 474.064 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	30.0
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	400.0	100.0	47.980	46.140

전단설계시 단면의 유효높이 ds = 400.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 8ea = 1588.800 ㎟

∴ P = As / (B × D) = 0.00397

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 27.692 mm

최외단 인장철근 변형률 εt = 0.03383 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 208597302 N·mm

= 208.597 kN·m > 47.980 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 355.548 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 259.808 kN

∴ 전단철근이 필요없음.

4) 슬래브 단지간 중앙부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 41.951 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	2.8
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	420.0	80.0	4.490	0.000

전단설계시 단면의 유효높이 ds = 420.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 8ea = 1588.800 ㎟

∴ P = As / (B × D) = 0.00378

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 27.692 mm

최외단 인장철근 변형률 εt = 0.03568 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 219401142 N·mm

= 219.401 kN·m > 4.490 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

$Mu / \Phi = As \times fy \times (d - a / 2)$ ---------- (1)

$a = As \times fy / (0.85 \times fck \times b)$ ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2 \times 0.85 \times fck \times b} \times As^2 - fy \times d \times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 31.463 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 272.798 kN

∴ 전단철근이 필요없음.

8. 단면설계요약

1) 휨설계 요약

구분		Mu (kN·m)	Pu (kN)	사용철근				ΦMn (kN·m)	ΦPn (kN)	안전율	비고
				1단		2단					
슬래브 장지간	단 부	43.700		H16	125	H0	0	208.597		4.77	O.K
	중앙부	40.300		H16	125	H0	0	219.401		5.44	O.K
슬래브 단지간	단 부	47.980		H16	125	H0	0	208.597		4.35	O.K
	중앙부	4.490		H16	125	H0	0	219.401		48.86	O.K

2) 전단설계 요약

구분		Vu (kN·m)	사용철근			ΦVn (kN·m)	안전율	비고
			직경	개수	간격			
슬래브 장지간	단 부	79.100	H13	2.0EA	150	전단철근 불필요		
	중앙부	0.000	H13	2.0EA	300	전단철근 불필요		
슬래브 단지간	단 부	46.140	H13	2.0EA	150	전단철근 불필요		
	중앙부	0.000	H13	2.0EA	300	전단철근 불필요		

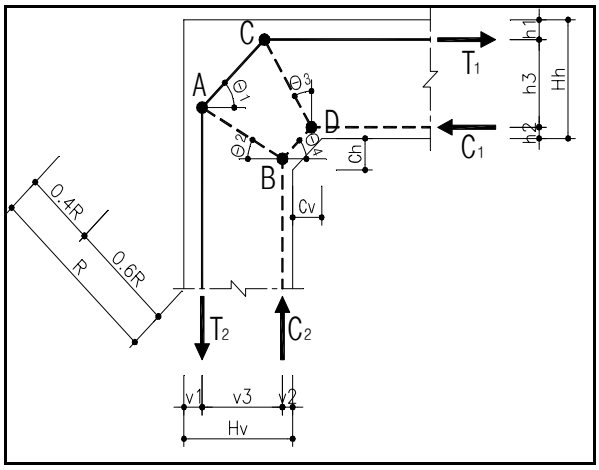
9. 라멘 우각부 보강 설계 (스트럿-타이 모델 해석에 의한 라멘접합부 보강)

9.1 슬래브

(1) 계산조건

슬래브두께	H_h	=	500.00 mm	벽체 높이	H_v	=	500.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	320.00 mm	벽체측 우력 거리	v_3	=	320.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	47.980 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 707.11 mm

② 사잇각

θ_1 = 45.00°

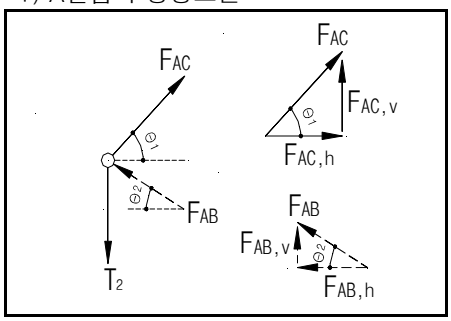
θ_2 = 29.36°

θ_3 = 29.36°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

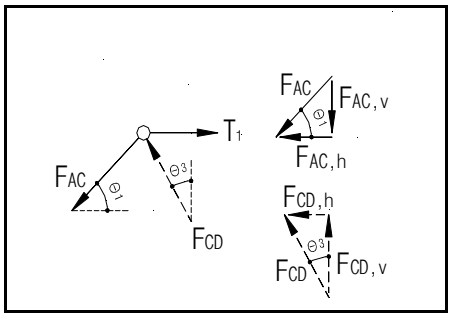
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$

$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \Theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \Theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \Theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \Theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{47.980}{0.320} =$ 149.938 kN

$T_2 = \frac{M_u}{v_3} = \frac{47.980}{0.320} =$ 149.938 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 135.708 kN

식 ⑥ 으로부터

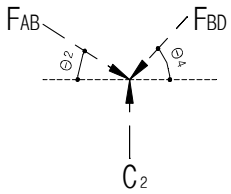
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 135.708 kN

따라서 F_{AC} = **135.708** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 110.099 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 135.708 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 110.099 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	**135.708**	타이
AB	**-110.099**	스트럿
BD	**-135.708**	스트럿
CD	**-110.099**	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 135.708 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{135,707.933}{0.85 \times 400} = 399.14 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	250	=	0.00	mm^2	(1 cycle)
	= H	16	@	250	=	794.40	mm^2	(2 cycle)
우각부철근 As	= H	0	@	250	=	0.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**794.40**	mm^2	

$A_{s,used}$ = 794.40 mm^2 > 399.14 mm^2 ……O.K

5) 스트럿과 절점영역의 강도검토

- 스트럿의 유효강도와 절점의 유효강도 중 작은 값을 스트럿의 유효강도로 설정함.
  스트럿의 유효강도를 이용해 필요 유효폭을 계산하고 구조물의 기하학적 형상을 벗어나는지 검토함.
  이 때 추가적인 절점영역의 강도 검토과정은 수행할 필요가 없음.

- 스트럿의 필요 유효폭

$$w_{req} = \frac{Fu}{\Phi_c f_{max}\, b}$$

여기서, Fu = 스트럿의 단면력 (N)

f_{max} = 0.85 β_s f_{ck} ; 계산된 스트럿의 유효강도값(MPa)

b = 부재 폭(1000mm)

Φ_c = 0.75

- 스트럿과 절점영역 강도검토 결과

스트럿 요소	요소종류	β_s	$\Phi_c f_{max}$		Fu (kN)	w_{req}(mm)	안전여부
AB	스트럿 AB	0.60	0.75 x 0.85 β_s f_{ck}	10.33	110.099	10.661	O.K
	절점A- CTT	0.60		10.33			
	절점B- CCC	1.00		17.21			
BD	스트럿 BD	0.60	0.75 x 0.85 β_s f_{ck}	10.33	135.708	13.140	O.K
	절점B- CCC	1.00		17.21			
	절점D- CCC	1.00		17.21			
CD	스트럿 CD	0.60	0.75 x 0.85 β_s f_{ck}	10.33	110.099	10.661	O.K
	절점C- CTT	0.60		10.33			
	절점D- CCC	1.00		17.21			

▶ 필요유효폭 안전여부

$$\frac{w_{req_BD}}{2} = 6.570 \text{ mm} < 0.1R = 70.711 \text{ mm} \quad \cdots\cdots \text{ O.K}$$

10. 사용성 검토

10.1 처짐 검토

1) 장지간 슬래브 : 최소부재두께 적용

철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	2.000	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.083	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.083m	<	H	=	0.500m	(처짐검토 생략)

2) 단지간 슬래브 : 최소부재두께 적용

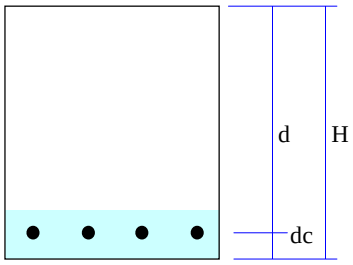
철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	1.500	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.063	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.063m	<	H	=	0.500m	(처짐검토 생략)

10.2 균열 검토

1) 슬래브 장지간 단부 (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	500.00	mm,	B =	1000.00	mm ,
d =	400.00	mm,	dc =	100.00	mm ,
Mo =	27.310	kN· m,	As =	1588.800	mm^2
N =	8		n =	7	

- 응력산정

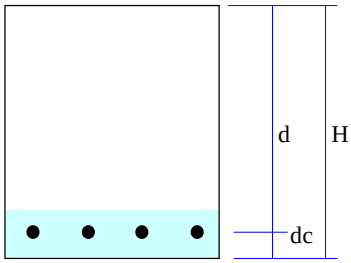
x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	83.857	mm
f s = M / (As (d - x / 3))	=	46.201	mm
f st = fs (H -Dc_min - x) / (D - x)	=	46.201	mm

- 철근의 최대 중심간격

Cc = 100 - 16 / 2	=	92.000	mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]	=	1363.599	mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 1363.599 mm **O.K!!**

2) 슬래브 장지간 중앙부 (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	500.00	mm,	B =	1000.00	mm ,
d =	420.00	mm,	dc =	80.00	mm ,
Mo =	25.190	kN· m,	As =	1588.800	mm^2
N =	8		n =	7	

- 응력산정

$x = -(n \cdot As / b) + (n \cdot As / b \cdot \sqrt{(1 + (2 \cdot b \cdot d / n \cdot As))}$ = 86.171 mm

$f_s = M / (As (d - x / 3))$ = 40.521 mm

$f_{st} = fs (H - Dc_min - x) / (D - x)$ = 40.521 mm

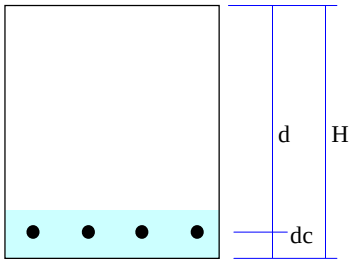
- 철근의 최대 중심간격

Cc = 80 - 16 / 2 = 72.000 mm

S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)] = 2073.022 mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 2073.022 mm **O.K!!**

3) 슬래브 단지간 단부 (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	500.00	mm,	B =	1000.00	mm ,
d =	400.00	mm,	dc =	100.00	mm ,
Mo =	29.990	kN· m,	As =	1588.800	mm^2
N =	8		n =	7	

- 응력산정

$x = -(n \cdot As / b) + (n \cdot As / b \cdot \sqrt{(1 + (2 \cdot b \cdot d / n \cdot As))}$ = 83.857 mm

$f_s = M / (As (d - x / 3))$ = 50.735 mm

$f_{st} = fs (H - Dc_min - x) / (D - x)$ = 50.735 mm

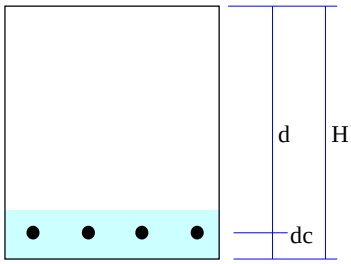
- 철근의 최대 중심간격

Cc = 100 - 16 / 2 = 92.000 mm

S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)] = 1241.743 mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 1241.743 mm **O.K!!**

4) 슬래브 단지간 중앙부 (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	500.00	mm,	B =	1000.00	mm ,
d =	420.00	mm,	dc =	80.00	mm ,
Mo =	2.810	kN· m,	As =	1588.800	mm^2
N =	8		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	86.171	mm
f s = M / (As (d - x / 3))	=	4.520	mm
f st = fs (H -Dc_min - x) / (D - x)	=	4.520	mm

- 철근의 최대 중심간격

Cc = 80 - 16 / 2	=	72.000	mm
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]	=	18583.427	mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 18583.427 mm **O.K!!**

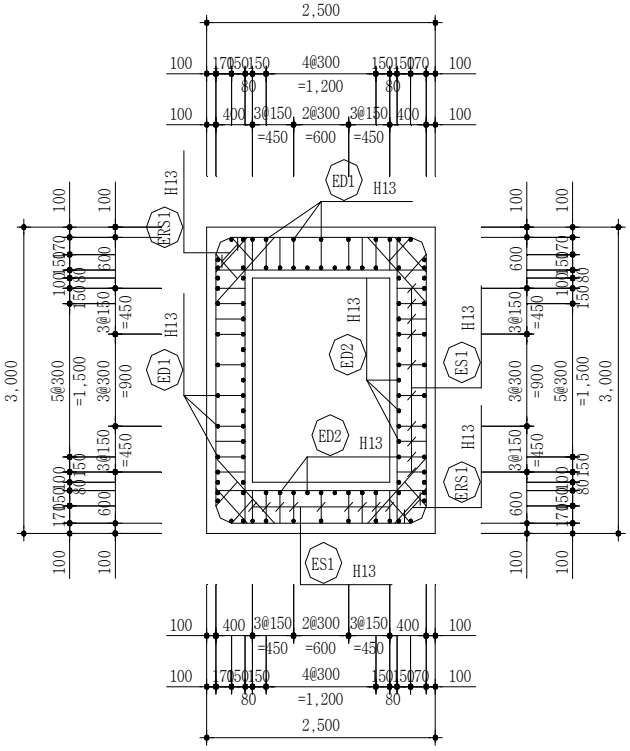
10.3 사용성검토 요약

1) 균열검토 요약

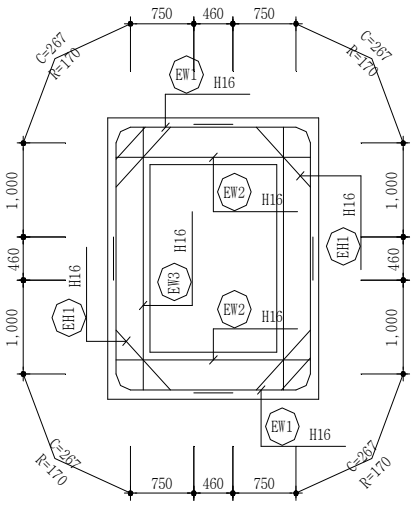
구분		Mo (kN·m)	주철근 (mm)	fs (Mpa)	Cc (mm)	S (mm)	Smin (mm)	비고
슬래브 장지간	단부	27.310	H16	46	92.0	125	1364	**O.K**
	중앙부	25.190	H16	41	72.0	125	2073	**O.K**
슬래브 단지간	단부	29.990	H16	51	92.0	125	1242	**O.K**
	중앙부	2.810	H16	5	72.0	125	18583	**O.K**

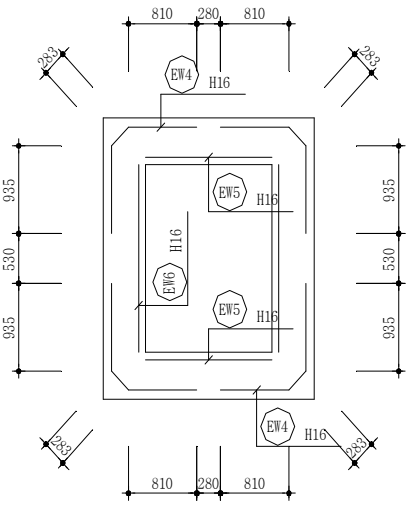
11. 주철근 조립도

표준단면도



주철근 조립도





12. 배력철근 검토

(1) 온도, 수축철근

-벽　체 : ρmin = 0.0020

-슬 래 브 : ρmin = 0.0020

- 주철근량 미만

(2) 배력철근

- 주철근의 20%이상

(3) 부재별 온도 / 배력철근

12.1 슬래브 장지간

구 분	사용주철근 (mm^2)	필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)	검토
단부	H 16@ 125 = 1588.800 0@ 0 0.000	317.760	1000.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**
중앙부	H 16@ 125 = 1588.800 0@ 0 0.000	317.760	1000.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**

12.2 슬래브 단지간

구 분	사용주철근 (mm^2)	필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)	검토
단부	H 16@ 125 = 1588.800 0@ 0 0.000	317.760	1000.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**
중앙부	H 16@ 125 = 1588.800 0@ 0 0.000	317.760	1000.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**

2.6 점검통로 단면 F-F

목 차

1. 설계개요 및 조건

2. 단면가정

3. 구조해석모델링

4. 하중산정

5. 하중조합

6. 구조해석결과

7. 단면설계

8. 단면설계 요약

9. 우각부보강설계

10. 사용성검토

11. 주철근조립도

12. 배력철근 검토

1. 설계개요 및 조건

1.1 개요

• Plane Strain의 단위길이당 평면 뼈대요소로 해석

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 단위중량

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	24.5	아스팔트 포장	23.0
흙(지하수위 이상)	20.0	흙(지하수위 이하)	11.0
물	10.0	모르타르	21.5
기계실하중	25.0	무근콘크리트	23.0

(3) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,700 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(4) 토사 내부마찰각 : Φ = 30°

(5) 토압 : K_o = 0.500

1.4 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

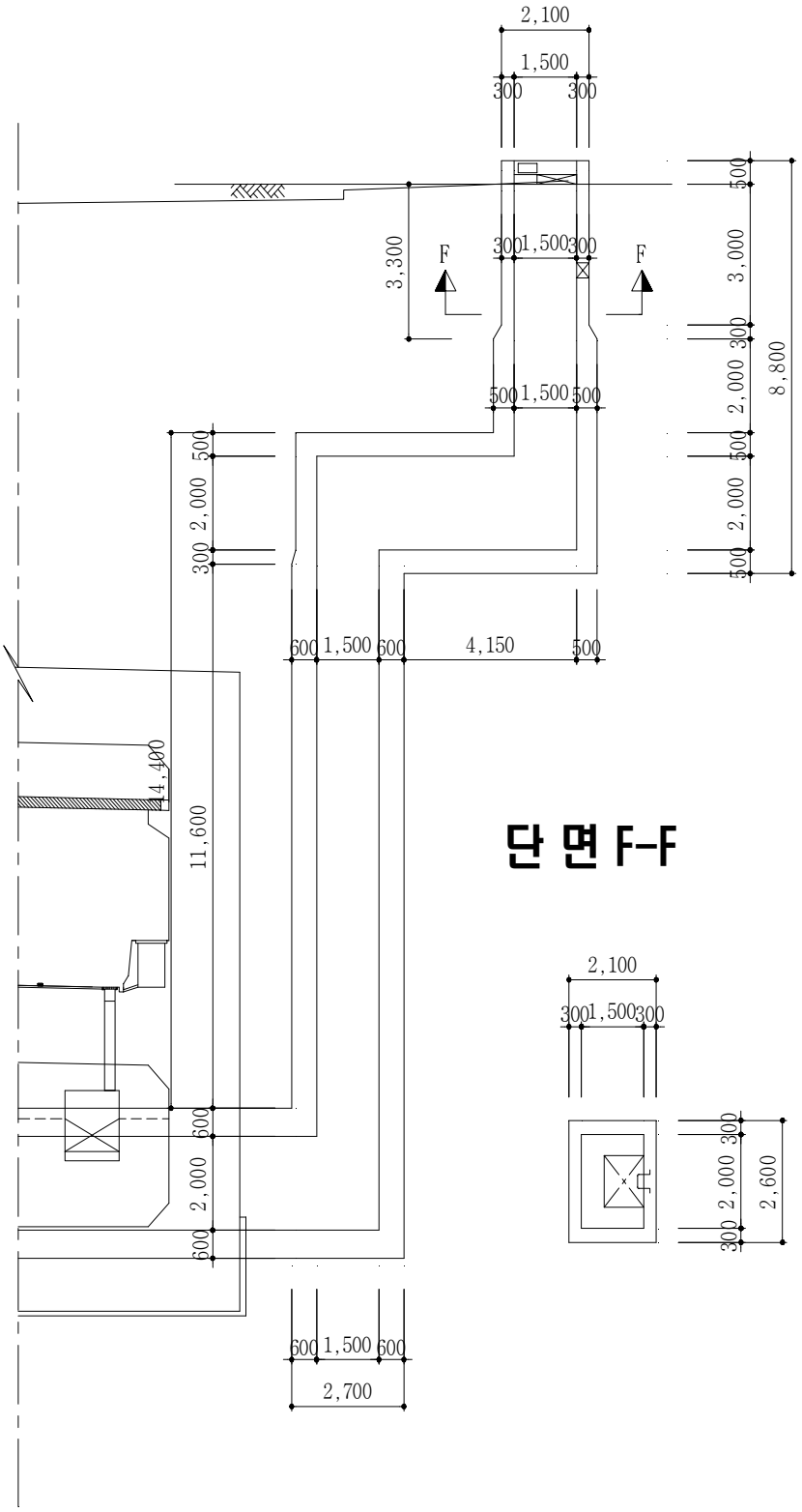
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면가정

설계적용 토피 = 3.300 m



2.1 강역 설정

1) 강역설정기준(콘크리트구조기준 2012)

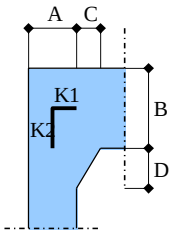
CASE 1 : 부재단부가 다른 부재와 접합할 때는 부재단에서 부재두께의 1/4 안쪽점에서 절점까지

CASE 2 : 부재가 그 축선에 대해 25° 이상 60° 미만인 경사진 헌치를 갖는 경우에는 부재두께가 1.5배가 되는 점에서 부터 절점까지

CASE 3 : 헌치의 경사가 60° 이상의 경우는 헌치의 시점에서 부재두께의 1/4 안쪽 점에서부터 절점까지

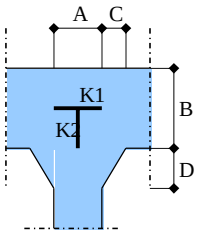
2) 강역설정

① 단부



A	=	0.30	m
B	=	0.30	m
C	=	0.00	m
D	=	0.00	m
K1	=	0.08	m
K2	=	0.08	m

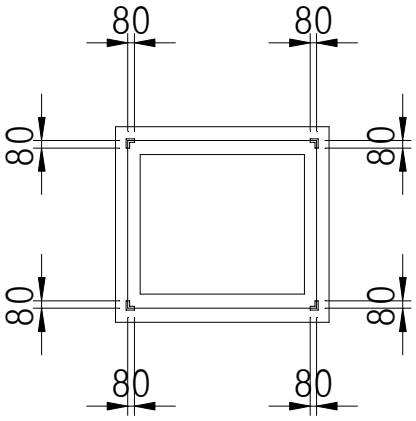
② 내부 지점부

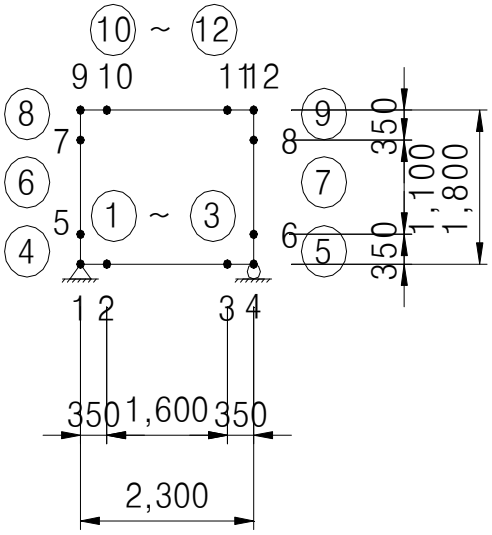


A	=	0.00	m
B	=	0.00	m
C	=	0.00	m
D	=	0.00	m
K1	=	0.00	m
K2	=	0.00	m

3. 구조해석 모델링

3.1 해석모형





3.2 단면제원

번 호	폭(m)	높이(m)	단면적(m²)	단면2차모멘트(m⁴)	비 고
1	1.00	0.30	0.300	0.002250	장 지 간
2	1.00	0.30	0.300	0.002250	단 지 간

4. 하중산정

4.1 활하중에 의한 측압 (만재하시) ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중(Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 3.300 / 2.600 = 1.269

- 노면 활하중 (DB-24) Lv = 11.000 kN/m²

Lh1 = 0.500 × 11.000 = 5.500 kN/m²

4.2 활하중에 의한 측압 (편재하시) ---------- LC 2, 3

Lh1 = 0.500 × 11.000 = 5.500 kN/m²

4.4 수평토압(지하수 無) ---------- LC 4

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + (2.800 + 0.000 / 2) × 20.000)

= 33.750 kN/m²

4.5 수평 토압(지하수 有) ---------- LC 5

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 +

(2.300 + 0.000 / 2) × 11.000) = 23.400 kN/m²

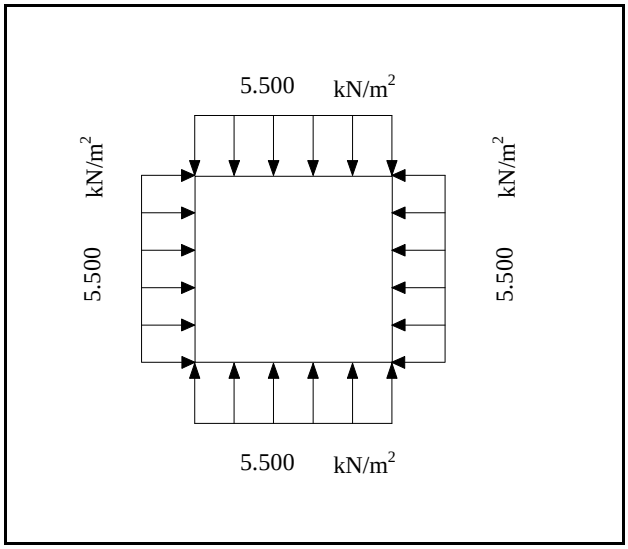
4.6 수평 수압(지하수 有) ---------- LC 6

1) 벽체

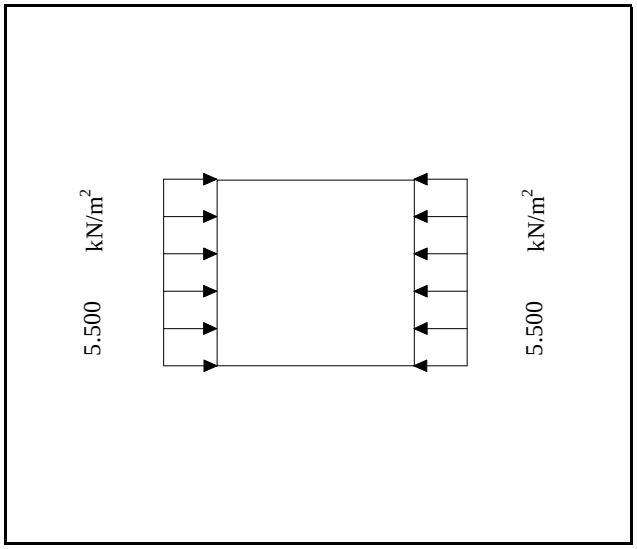
q_{W1} = 10.000 × (2.300 + 0.000 / 2) = 23.000 kN/m²

4.7 하중재하도

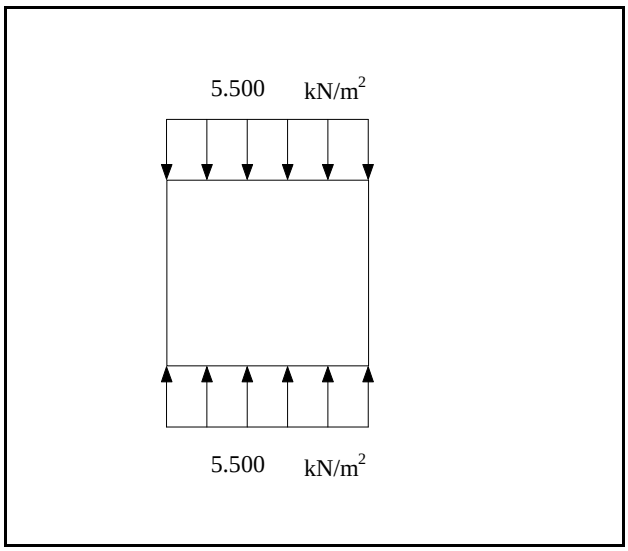
1) 활하중에 의한 측압(만재하시) ------- LC 1



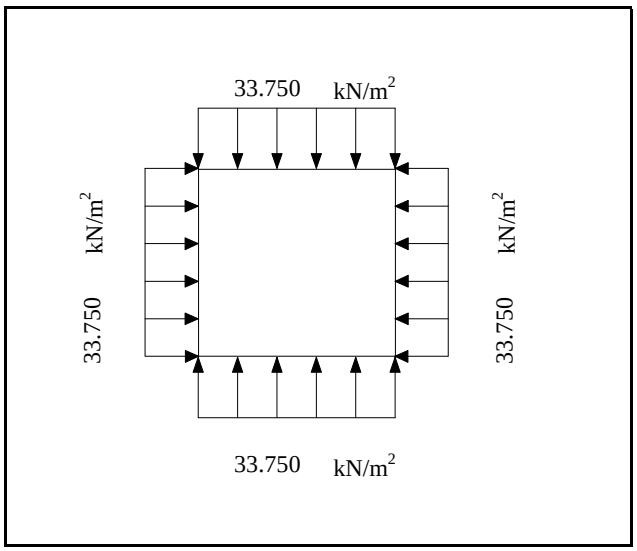
2) 활하중에 의한 측압(편재하시-1) ------- LC 2



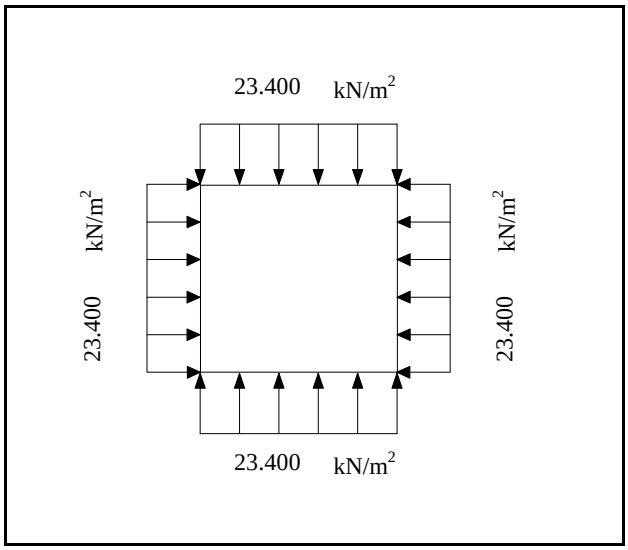
3) 활하중에 의한 측압(편재하시-2) ------- LC 3



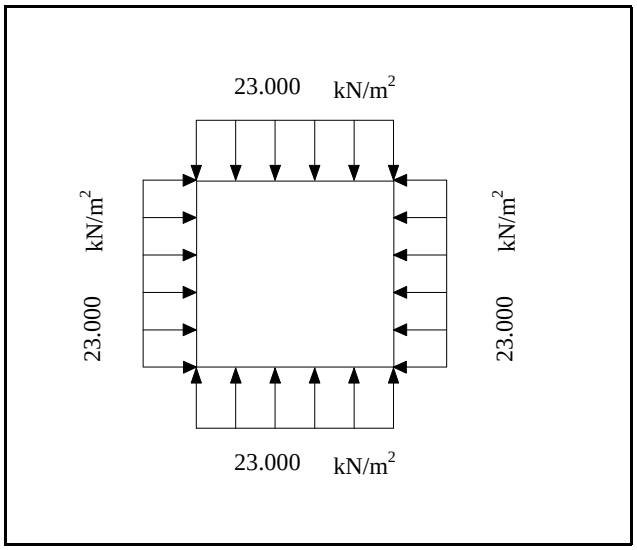
4) 수평 토압(지하수 무) ------- LC 4



5) 수평 토압(지하수 유) ------- LC 5



6) 수평 수압(지하수 유) ------- LC 6



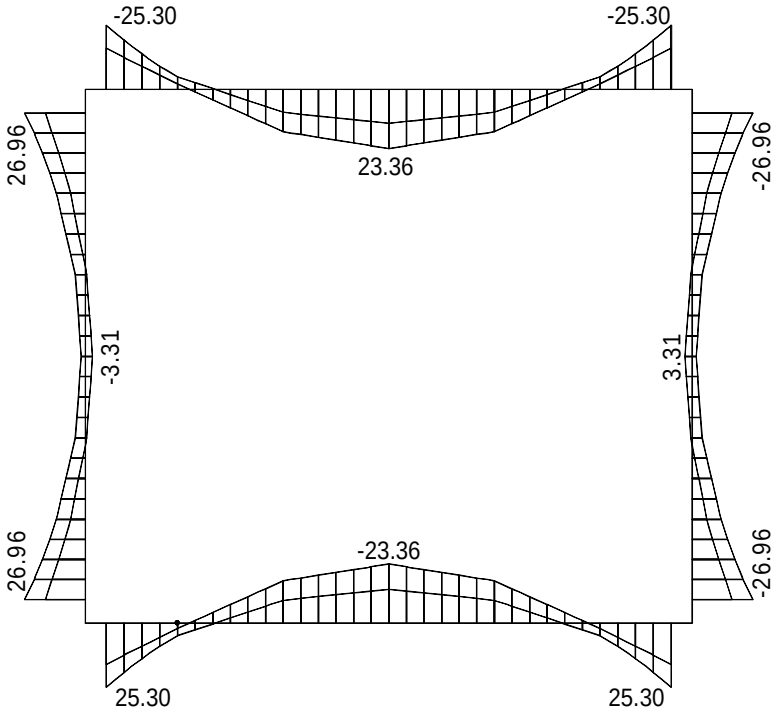
5. 하중조합

하중 조합	활하중			지하수 없을때	지하수 있을때		비고
	만재하	편재하					
	수평	수평		수평 토압	수평 토압	수평 수압	
		상하	좌우				
	LC01	LC02	LC03	LC04	LC05	LC06	
CB01	1.60			1.60			극한하중조합
CB02		1.60		1.60			
CB03			1.60	1.60			
CB04				1.60			
CB05	1.60				1.60	1.60	
CB6		1.60			1.60	1.60	
CB7			1.60		1.60	1.60	
CB8					1.60	1.60	
CB9	1.00			1.00			사용하중조합
CB10		1.00		1.00			
CB11			1.00	1.00			
CB12				1.00			
CB13	1.00				1.00	1.00	
CB14		1.00			1.00	1.00	
CB15			1.00		1.00	1.00	
CB16					1.00	1.00	

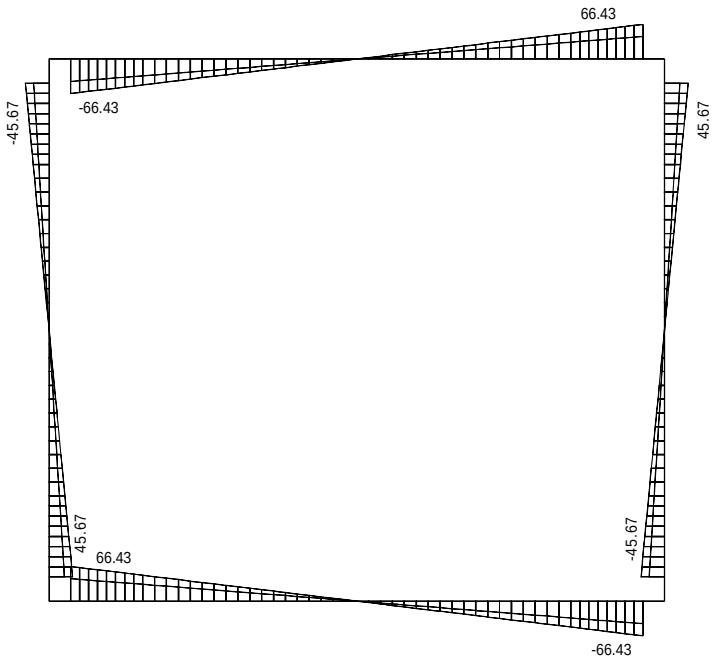
6. 구조해석 결과

6.1 부재력도

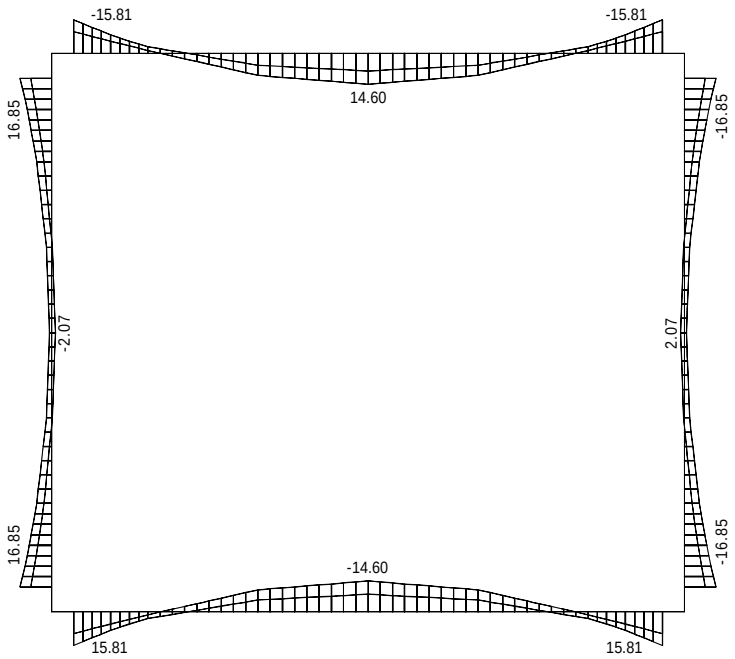
B.M.D (계수하중) [kN·m]



S.F.D (계수하중) [kN]



B.M.D (사용하중) [kN·m]



6.2 부재력 집계

구분		계수하중			사용하중	
		Mu(kN·m)	Pu(kN)	Vu(kN)	Mo(kN·m)	Po(kN)
슬래브 장지간	단 부	25.300		66.430	15.810	
	중앙부	23.360			14.600	
슬래브 단지간	단 부	26.960		45.670	16.850	
	중앙부	3.310			2.070	

7. 단면검토

1) 슬래브 장지간 단부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 504.393 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	15.8
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	300.0	200.0	100.0	25.300	66.430

전단설계시 단면의 유효높이 ds = 200.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H13 × 8ea = 1013.600 ㎟

∴ P = As / (B × D) = 0.00507

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 17.666 mm

최외단 인장철근 변형률 εt = 0.02587 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 65880736 N·mm

= 65.881 kN·m > 25.300 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 378.294 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 129.904 kN

1/2 x Φv x Vc = 64.952 kN ≤ Vu ≤Φv x Vc ∴ 최소전단 철근을 배근하는것이 좋다.

Req Av = 0.35×bw×s / fy = 0.35×1,000.0×150.0 / 400.0

= 131.250 ㎟

Use Av = 253.400 ㎟ (H13×2 EA, 간격 s = 150.0 mm) ≥ req.Av ----- ∴ O.K.

2) 슬래브 장지간 중앙부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 421.682 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	14.6
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	300.0	220.0	80.0	23.360	0.000

전단설계시 단면의 유효높이 ds = 220.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H13 × 8ea = 1013.600 ㎟

∴ P = As / (B × D) = 0.00461

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 17.666 mm

최외단 인장철근 변형률 εt = 0.02876 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 72773216 N·mm

= 72.773 kN·m > 23.360 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 316.261 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 142.894 kN

∴ 전단철근이 필요없음.

3) 슬래브 단지간 단부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 538.090 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	16.9
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	300.0	200.0	100.0	26.960	45.670

전단설계시 단면의 유효높이 ds = 200.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H13 × 8ea = 1013.600 ㎟

∴ P = As / (B × D) = 0.00507

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 17.666 mm

최외단 인장철근 변형률 εt = 0.02587 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 65880736 N·mm

= 65.881 kN·m > 26.960 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 403.567 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 129.904 kN

∴ 전단철근이 필요없음.

4) 슬래브 단지간 중앙부

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 59.106 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	2.1
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	300.0	220.0	80.0	3.310	0.000

전단설계시 단면의 유효높이 ds = 220.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H13 × 8ea = 1013.600 ㎟

∴ P = As / (B × D) = 0.00461

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 17.666 mm

최외단 인장철근 변형률 εt = 0.02876 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 72773216 N·mm

= 72.773 kN·m > 3.310 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 44.329 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 142.894 kN

∴ 전단철근이 필요없음.

8. 단면설계요약

1) 휨설계 요약

구분		Mu (kN·m)	Pu (kN)	사용철근				ΦMn (kN·m)	ΦPn (kN)	안전율	비고
				1단		2단					
슬래브 장지간	단 부	25.300		H13	125	H0	0	65.881		2.60	O.K
	중앙부	23.360		H13	125	H0	0	72.773		3.12	O.K
슬래브 단지간	단 부	26.960		H13	125	H0	0	65.881		2.44	O.K
	중앙부	3.310		H13	125	H0	0	72.773		21.99	O.K

2) 전단설계 요약

구분		Vu (kN·m)	사용철근			ΦVn (kN·m)	안전율	비고
			직경	개수	간격			
슬래브 장지간	단 부	66.430	H13	2.0EA	150	231.264		
	중앙부	0.000	H13	2.0EA	300	전단철근 불필요		
슬래브 단지간	단 부	45.670	H13	2.0EA	150	전단철근 불필요		
	중앙부	0.000	H13	2.0EA	300	전단철근 불필요		

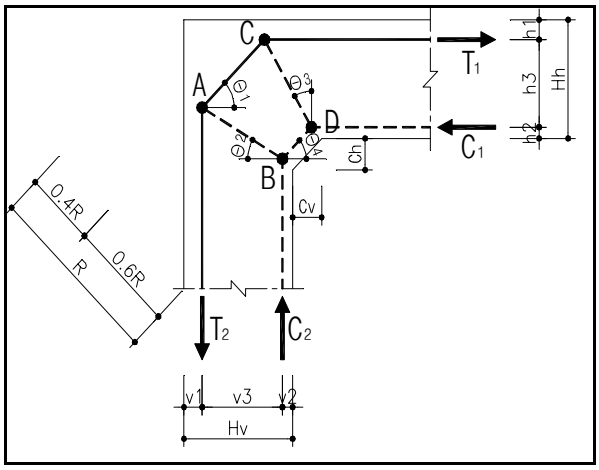
9. 라멘 우각부 보강 설계 (스트럿-타이 모델 해석에 의한 라멘접합부 보강)

9.1 슬래브

(1) 계산조건

슬래브두께	H_h	=	300.00 mm	벽체 높이	H_v	=	300.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	120.00 mm	벽체측 우력 거리	v_3	=	120.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	26.960 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 424.26 mm

② 사잇각

θ_1 = 45.00°

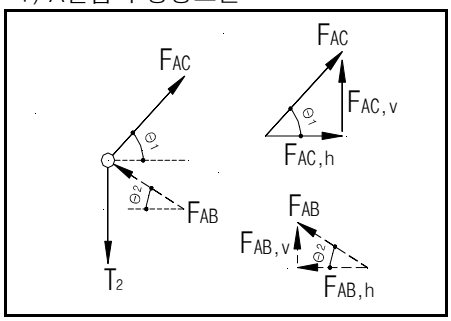
θ_2 = 56.31°

θ_3 = 56.31°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

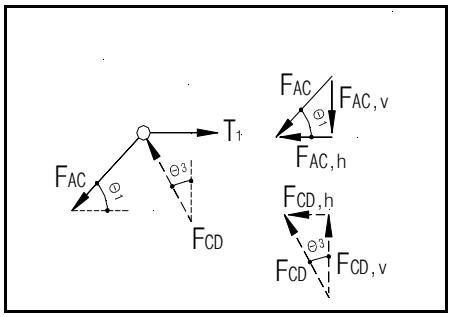
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$

$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\epsilon = F_{CD} \cdot \cos\theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\theta_1 + F_{AC} \times \dfrac{\sin\theta_1}{\cos\theta_3} \times \sin\theta_3$

$= F_{AC}(\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \dfrac{M_u}{h_3} = \dfrac{26.960}{0.120} =$ 224.667 kN

$T_2 = \dfrac{M_u}{v_3} = \dfrac{26.960}{0.120} =$ 224.667 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \dfrac{T_2}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2} =$ 127.091 kN

식 ⑥ 으로부터

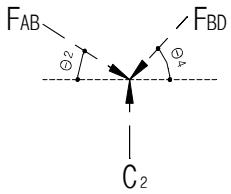
$F_{AC} = \dfrac{T_1}{\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3} =$ 127.091 kN

따라서 F_{AC} = **127.091** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 162.009 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 127.091 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 162.009 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	**127.091**	타이
AB	**-162.009**	스트럿
BD	**-127.091**	스트럿
CD	**-162.009**	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 127.091 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{127,090.659}{0.85 \times 400} = 373.80 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	250	=	0.00	mm^2	(1 cycle)
	= H	13	@	250	=	506.80	mm^2	(2 cycle)
우각부철근 As	= H	0	@	250	=	0.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**506.80**	mm^2	

$A_{s,used}$ = 506.80 mm^2 > 373.80 mm^2 ……O.K

5) 스트럿과 절점영역의 강도검토

- 스트럿의 유효강도와 절점의 유효강도 중 작은 값을 스트럿의 유효강도로 설정함.
  스트럿의 유효강도를 이용해 필요 유효폭을 계산하고 구조물의 기하학적 형상을 벗어나는지 검토함.
  이 때 추가적인 절점영역의 강도 검토과정은 수행할 필요가 없음.

- 스트럿의 필요 유효폭

$$w_{req} = \frac{Fu}{\Phi_c f_{max}\, b}$$

여기서, Fu = 스트럿의 단면력 (N)

f_{max} = 0.85 β_s f_{ck} ; 계산된 스트럿의 유효강도값(MPa)

b = 부재 폭(1000mm)

Φ_c = 0.75

- 스트럿과 절점영역 강도검토 결과

스트럿 요소	요소종류	β_s	$\Phi_c f_{max}$		Fu (kN)	w_{req}(mm)	안전여부
AB	스트럿 AB	0.60	0.75 x 0.85 β_s f_{ck}	10.33	162.009	15.687	O.K
	절점A- CTT	0.60		10.33			
	절점B- CCC	1.00		17.21			
BD	스트럿 BD	0.60	0.75 x 0.85 β_s f_{ck}	10.33	127.091	12.306	O.K
	절점B- CCC	1.00		17.21			
	절점D- CCC	1.00		17.21			
CD	스트럿 CD	0.60	0.75 x 0.85 β_s f_{ck}	10.33	162.009	15.687	O.K
	절점C- CTT	0.60		10.33			
	절점D- CCC	1.00		17.21			

▶ 필요유효폭 안전여부

$$\frac{w_{req_BD}}{2} = 6.153 \text{ mm} < 0.1R = 42.426 \text{ mm} \quad \cdots\cdots \text{ O.K}$$

10. 사용성 검토

10.1 처짐 검토

1) 장지간 슬래브 : 최소부재두께 적용

철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	2.000	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.083	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.083m	<	H	=	0.300m	(처짐검토 생략)

2) 단지간 슬래브 : 최소부재두께 적용

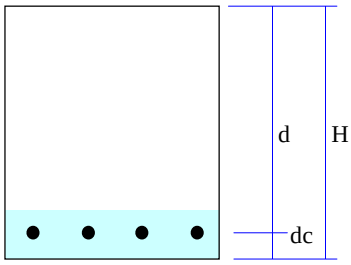
철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	1.500	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.063	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.063m	<	H	=	0.300m	(처짐검토 생략)

10.2 균열 검토

1) 슬래브 장지간 단부 (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	300.00	mm,	B =	1000.00	mm ,
d =	200.00	mm,	dc =	100.00	mm ,
Mo =	15.810	kN· m,	As =	1013.600	mm^2
N =	8		n =	7	

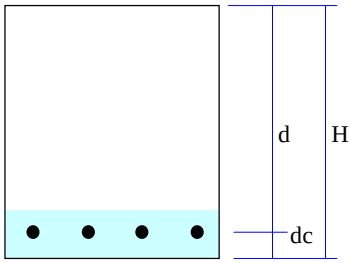
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	46.649	mm
f s = M / (As (d - x / 3))	=	84.564	mm
f st = fs (H -Dc_min - x) / (D - x)	=	84.564	mm

- 철근의 최대 중심간격

Cc =	100	-	13	/	2	=	93.500	mm	
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]	=	697.497	mm	
최외단철근 평균배근간격;	1000	/	8	=	125	mm	<	697.497	mm	O.K!!

2) 슬래브 장지간 중앙부 (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	300.00	mm,	B =	1000.00	mm ,
d =	220.00	mm,	dc =	80.00	mm ,
Mo =	14.600	kN· m,	As =	1013.600	mm^2
N =	8		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 49.227 mm

f s = M / (As (d - x / 3)) = 70.750 mm

f st = fs (H -Dc_min - x) / (D - x) = 70.750 mm

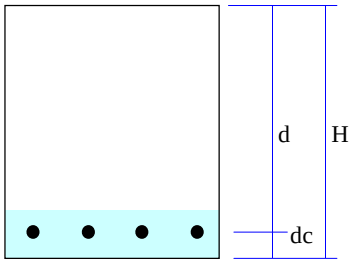
- 철근의 최대 중심간격

Cc = 80 - 13 / 2 = 73.500 mm

S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)] = 1187.275 mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 1187.275 mm **O.K!!**

3) 슬래브 단지간 단부 (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	300.00	mm,	B =	1000.00	mm ,
d =	200.00	mm,	dc =	100.00	mm ,
Mo =	16.850	kN· m,	As =	1013.600	mm^2
N =	8		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 46.649 mm

f s = M / (As (d - x / 3)) = 90.127 mm

f st = fs (H -Dc_min - x) / (D - x) = 90.127 mm

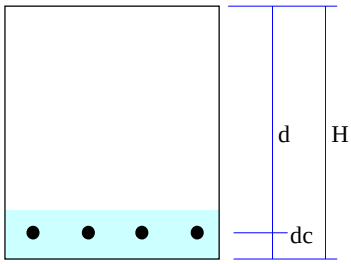
- 철근의 최대 중심간격

Cc = 100 - 13 / 2 = 93.500 mm

S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)] = 640.019 mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 640.019 mm **O.K!!**

4) 슬래브 단지간 중앙부 (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	300.00	mm,	B =	1000.00	mm ,
d =	220.00	mm,	dc =	80.00	mm ,
Mo =	2.070	kN· m,	As =	1013.600	mm^2
N =	8		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	49.227	mm
f s = M / (As (d - x / 3))	=	10.031	mm
f st = fs (H -Dc_min - x) / (D - x)	=	10.031	mm

- 철근의 최대 중심간격

Cc = 80 - 13 / 2	=	73.500	mm
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]	=	8374.018	mm

최외단철근 평균배근간격; 1000 / 8 = 125 mm < 8374.018 mm **O.K!!**

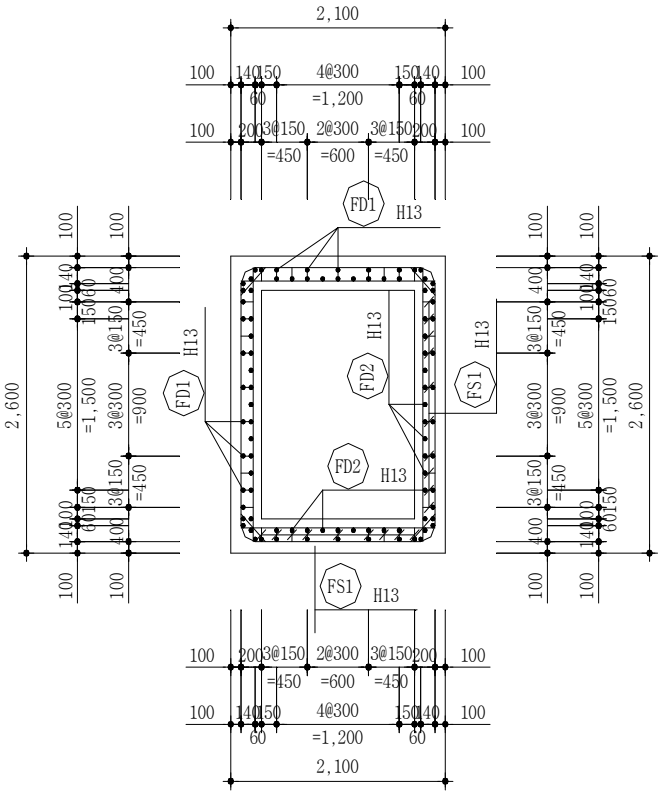
10.3 사용성검토 요약

1) 균열검토 요약

구분		Mo (kN·m)	주철근 (mm)	fs (Mpa)	Cc (mm)	S (mm)	Smin (mm)	비고
슬래브 장지간	단부	15.810	H13	85	93.5	125	697	**O.K**
	중앙부	14.600	H13	71	73.5	125	1187	**O.K**
슬래브 단지간	단부	16.850	H13	90	93.5	125	640	**O.K**
	중앙부	2.070	H13	10	73.5	125	8374	**O.K**

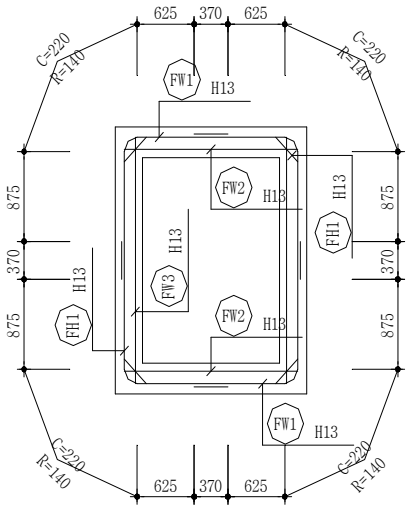
11. 주철근 조립도

표준단면도

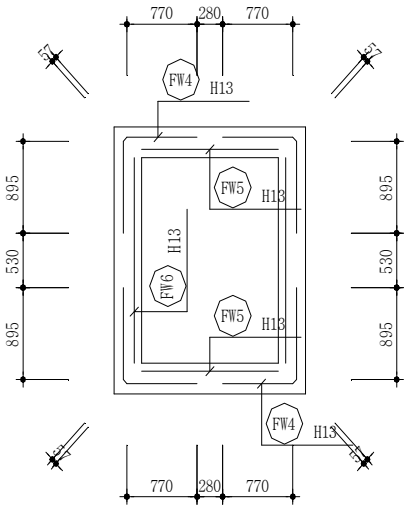


주철근 조립도

CYCLE-1 (@250)



CYCLE-2 (@250)



12. 배력철근 검토

(1) 온도, 수축철근

-벽　체 : ρmin = 0.0020

-슬 래 브 : ρmin = 0.0020

- 주철근량 미만

(2) 배력철근

- 주철근의 20%이상

(3) 부재별 온도 / 배력철근

12.1 슬래브 장지간

구 분	사용주철근 (mm^2)	필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)	검토
단부	H 13@ 125 = 1013.600 0@ 0 0.000	202.720	600.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**
중앙부	H 13@ 125 = 1013.600 0@ 0 0.000	202.720	600.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**

12.2 슬래브 단지간

구 분	사용주철근 (mm^2)	필요배력철근 (mm^2)	온도철근 (mm^2)	사용배력철근 (mm^2)	검토
단부	H 13@ 125 = 1013.600 0@ 0 0.000	202.720	600.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**
중앙부	H 13@ 125 = 1013.600 0@ 0 0.000	202.720	600.000	인장 H 13@ 150 = 844.667 0@ 0.000 압축 H 13@ 300 = 422.333	**O.K**

2.7 보강거더 #1,#2

목 차

1. 설계개요 및 조건

1.1 설계개요

1.2 설계방법

1.3 일반사항

1.4 설계하중

1.5 참고문헌

2. 단면가정

3. 하중산정

4. 하중조합

5. 보강거더 및 기둥설계

5.1 보강거더 설계

1. 설계개요 및 조건

1.1 설계개요

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,702 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(3) 토사 내부마찰각 : Φ = 30°

(4) 토압 : K_o = 0.500

1.4 설계하중

(1) 고정하중

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	25.0	아스팔트 포장	23.0
흙(지하수위 이상)	20.0	흙(지하수위 이하)	11.0
지하수	10.0	기계실하중	25.0

(2) 활하중 (DB-24 기준)

토 피	활하중(kN/m^2)	토 피	활하중(kN/m^2)
1.0	51.0	3.0 ~ 7.0	15.0
1.5	39.0	8.0	12.0
2.0	21.0	9.0	11.0
2.5	17.0	10.0 이상	10.0

주) 활하중 적용 토피는 고정하중 적용 토피보다 1단계 큰값을 적용한다.

1.5 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

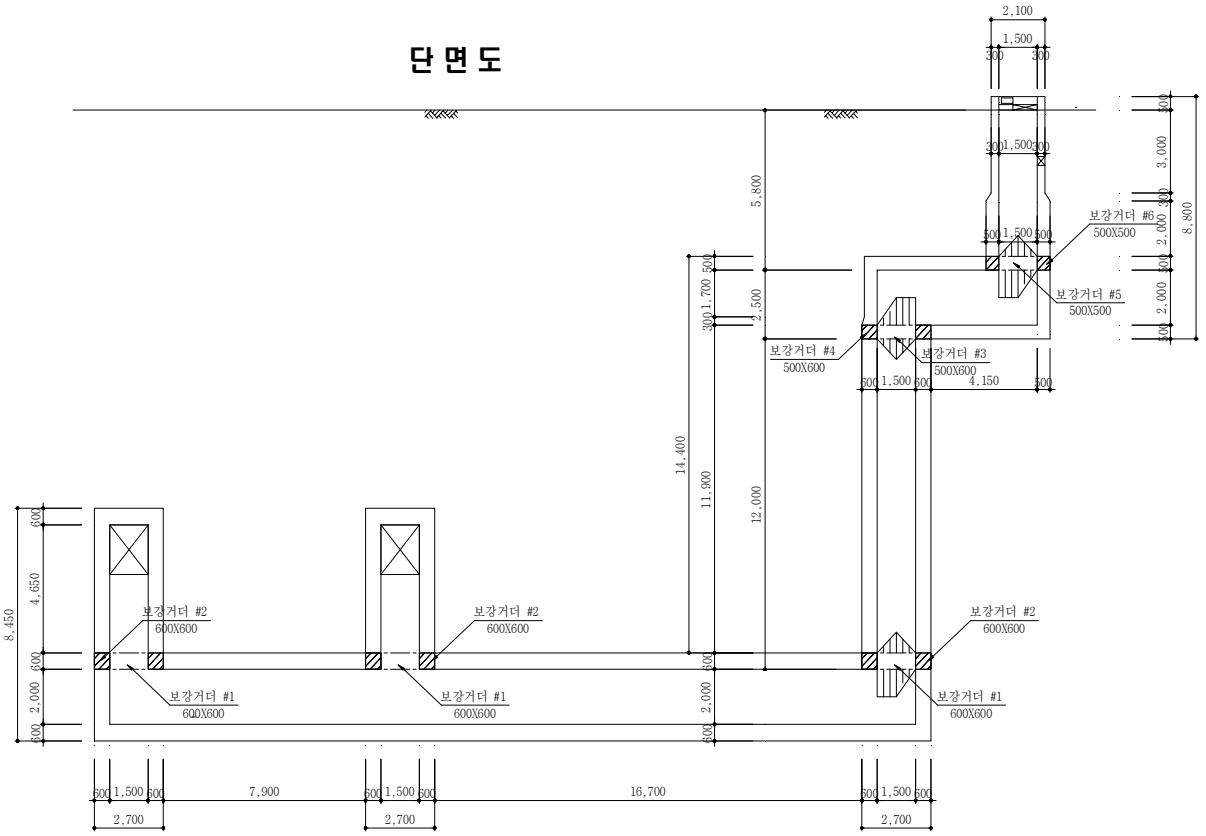
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면 가정

• 설계적용 토피 : 20.60 m



3. 하중산정

3.1 거더 #1 하중산정 : 수평하중 작용시

(1) 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준) :

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 20.600 / 3.200 = 6.438

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

L_h = 0.500 × 10.000 = 5.000 kN/m^2

(2) 토압

① 지하수가 있을때 ---------- LC 2

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 + 19.600 × 11.000) = 118.550 kN/m^2

② 지하수가 없을때 ---------- LC 3

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + 20.100 × 20.000) = 206.750 kN/m^2

(3) 측벽 수압 ---------- LC 4

w_1 = 10.000 × 19.600 = 196.000 kN/m^2

4.2 거더 #2 하중산정 : 수평하중 작용시

(1) 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준) :

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 20.600 / 3.200 = 6.438

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

L_h = 0.500 × 10.000 = 5.000 kN/m^2

(2) 토압

① 지하수가 있을때 ---------- LC 2

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 + 19.600 × 11.000) = 118.550 kN/m^2

② 지하수가 없을때 ---------- LC 3

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + 20.100 × 20.000) = 206.750 kN/m^2

(3) 측벽 수압 ---------- LC 4

w_1 = 10.000 × 19.600 = 196.000 kN/m^2

4. 하중조합

4.1 계수하중

구분	횡토압(H_h)			수압(W)	비 고
	LC1	LC2	LC3	LC4	
CB1	1.60	1.40		1.40	
CB2	1.60		1.40		

4.2 사용하중

구분	횡토압(H_h)			수압(W)	비 고
	LC1	LC2	LC3	LC4	
CB3	1.00	1.00		1.00	
CB4	1.00		1.00		

LC1 : 활하중에의한 측압, LC2 : 횡토압(지하수고려), LC3 : 횡토압(지하수미고려), LC4 : 측벽수압 또는 양수압

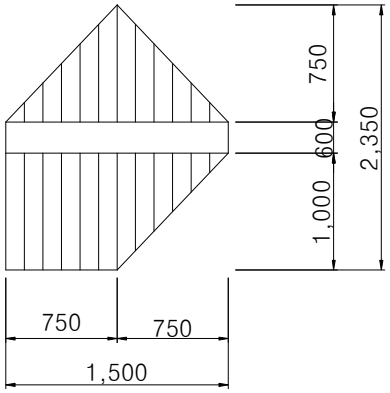
- 보강거더 #1 : 수평하중 작용시

CB1 = 1.60 × 5.000 + 1.40 × 118.550 + 1.40 × 196.000 = 448.37 kN/m^2

CB2 = 1.60 × 5.000 + 1.40 × 206.750 = 297.45 kN/m^2

CB3 = 1.00 × 5.000 + 1.00 × 118.550 + 1.00 × 196.000 = 319.55 kN/m^2

CB4 = 1.00 × 5.000 + 1.00 × 206.750 = 211.75 kN/m^2



- 단면적 : 1.500 × 0.600 + 1.500 × 0.750 / 2
  + (1.500 + 0.750) × 1.000 / 2 = 2.588 m^2
- 계수하중 : (448.370 × 2.588) / 1.500 = 773.588 kN/m^2
- 사용하중 : (319.550 × 2.588) / 1.500 = 551.330 kN/m^2

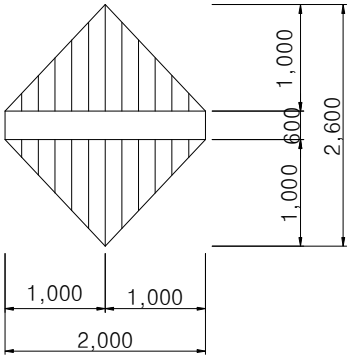
- 보강거더 #2 : 수평하중 작용시

CB1 = 1.60 × 5.000 + 1.40 × 118.550 + 1.40 × 196.000 = 448.37 kN/m^2

CB2 = 1.60 × 5.000 + 1.40 × 206.750 = 297.45 kN/m^2

CB3 = 1.00 × 5.000 + 1.00 × 118.550 + 1.00 × 196.000 = 319.550 kN/m^2

CB4 = 1.00 × 5.000 + 1.00 × 206.750 = 211.75 kN/m^2



- 단면적 : 2.000 × 0.600 + 2.000 × 1.000 / 2 × 2

= 3.200 m^2

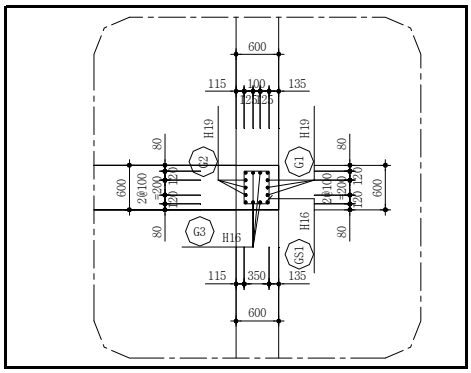
- 계수하중 : (448.370 × 3.200) / 2.000 = 717.392 kN/m^2

- 사용하중 : (319.550 × 3.200) / 2.000 = 511.280 kN/m^2

5. 보강거더 및 기둥설계

5.1 보강거더 설계 : GIRDER #1

(1) 거더



B = 600 mm, H1 = 600 mm (정모멘트부)

H2 = 600 mm (부모멘트부)

d = 485 mm (정모멘트부) d = 465 mm (부모멘트부)

d'= 115 mm (정모멘트부) d'= 135 mm (부모멘트부)

Ln= 1,500 mm (연속경간) d = 465 mm (전단)

• Ln / d = 3.23 ≤ 4 ☞ 깊은보로 설계

• 계수하중 : Wu1 = 773.588 kN/m

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = 773.588 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	부모멘트부	W × Ln^2 ÷ 12	**145.048**	
	정모멘트부	W × Ln^2 ÷ 14	**124.327**	
전단력 Vu (kN)		W x (Ln-2x0.15Ln)/2	**406.134**	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 부모멘트부 : 6,123 ㎟ O.K

• 정모멘트부 : 6,386 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟) 1.4bd/(f_y)	$A_{s.min}$ (㎟) 4A_s/3	$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
부모멘트	945	977	1,260	977	H 19	5 EA	1,433	1,433	**216.345**
					H 0	0 EA	-		
					H	EA	-		O.K
정모멘트	772	1,019	1,029	1,019	H 19	5 EA	1,433	1,433	**226.086**
					H 0	0 EA	-		
									O.K

4) 전단력 검토

• $\phi Vc = \phi v \cdot 1/6 \cdot \sqrt{fck} \cdot bw \cdot d$ = 181.216 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : **H 16 , N = 2 EA , s1 = 150 mm** < d/5또는300mm O.K

Av = 397.2 ㎟ > Av.min=0.0025·b·s = 225 ㎟ O.K

• 수평전단철근 : **H 16 , N = 2 EA , s2 = 150 mm** < d/5또는300mm O.K

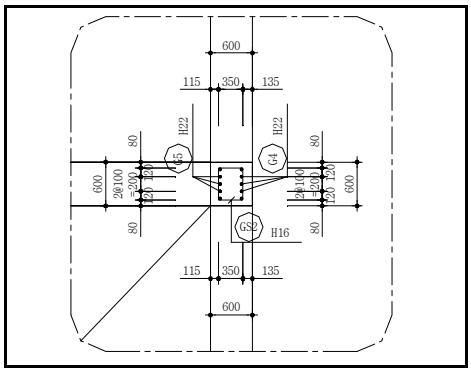
Ah = 397.2 ㎟ > Ah.min=0.0015·b·s = 135 ㎟ O.K

Vu = **406.134 kN** < MIN $\phi Vn=\phi(Vc+Vs)$ = **550.612** kN, $\phi Vnmax=\Phi 1/18(10+ln/d)\sqrt{fck}\cdot bo\cdot d$ = **798.908** kN O.K

여기서, Vs : 일반보의 경우 : $Vs = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $Vs = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right)+\frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$

5.2 보강거더 설계 : GIRDER #2 (수평하중 작용시)

(1) 거더



B = 600 mm, H1 = 600 mm (정모멘트부)
H2 = 600 mm (부모멘트부)

d = 485 mm (정모멘트부) d = 465 mm (부모멘트부)

d'= 115 mm (정모멘트부) d'= 135 mm (부모멘트부)

Ln= 2,000 mm (연속경간) d = 465 mm (전단)

• Ln / d = 4.30 > 4 ☞ 일반보로 설계

• 계수하중 : Wu1 = 717.392 kN/m

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = 717.392 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	부모멘트부	W × Ln^2 ÷ 12	239.131	
	정모멘트부	W × Ln^2 ÷ 14	204.969	
전단력 Vu (kN)		W x (Ln − 2 d)/2	383.805	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 부모멘트부 : 6,123 ㎟ O.K

• 정모멘트부 : 6,386 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟) 1.4bd/(f_y)	$A_{s.min}$ (㎟) 4A_s/3	$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
부모멘트	1,592	977	2,122	1,592	H 22	5 EA	1,936	1,936	287.503
					H 0	0 EA	-		
					H	EA	-		O.K
정모멘트	1,293	1,019	1,724	1,293	H 22	5 EA	1,936	1,936	300.664
					H 0	0 EA	-		
									O.K

4) 전단력 검토

• $\phi Vc = \phi v \cdot 1/6 \cdot \sqrt{fck} \cdot bw \cdot d$ = 181.216 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : H 16 , N = 2 EA , s1 = 150 mm < d/2또는600mm O.K

Av = 397.2 ㎟

Vu = 383.805 kN < MIN { ΦVn=Φ(Vc+Vs) = 550.612 kN ; ΦVn=Φ(Vc+Vs(max))= 906.079 kN } O.K

{ 여기서, Vs : 일반보의 경우 : $V_s = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $V_s = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right) + \frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$ }

2.8 보강거더 #3,#4

목 차

1. 설계개요 및 조건

1.1 설계개요

1.2 설계방법

1.3 일반사항

1.4 설계하중

1.5 참고문헌

2. 단면가정

3. 하중산정

4. 하중조합

5. 보강거더 및 기둥설계

5.1 보강거더 설계

1. 설계개요 및 조건

1.1 설계개요

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,702 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(3) 토사 내부마찰각 : Φ = 30°

(4) 토압 : K_o = 0.500

1.4 설계하중

(1) 고정하중

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	25.0	아스팔트 포장	23.0
흙(지하수위 이상)	20.0	흙(지하수위 이하)	11.0
지하수	10.0	기계실하중	25.0

(2) 활하중 (DB-24 기준)

토 피	활하중(kN/m^2)	토 피	활하중(kN/m^2)
1.0	51.0	3.0 ~ 7.0	15.0
1.5	39.0	8.0	12.0
2.0	21.0	9.0	11.0
2.5	17.0	10.0 이상	10.0

주) 활하중 적용 토피는 고정하중 적용 토피보다 1단계 큰값을 적용한다.

1.5 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

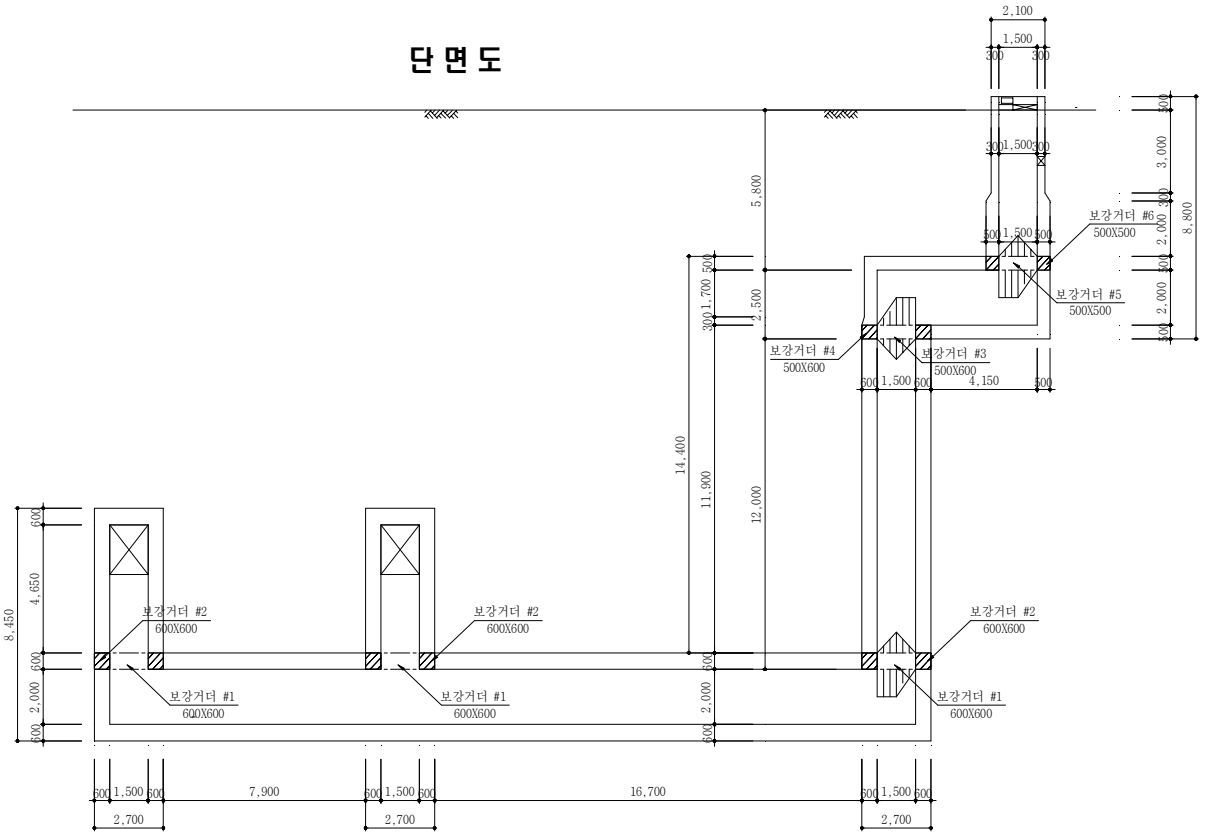
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면 가정

• 설계적용 토피 : 8.55 m



3. 하중산정

3.1 거더 #3 하중산정 : 수평하중 작용시

(1) 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준) :

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 8.550 / 3.200 = 2.672

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

L_h = 0.500 × 10.000 = 5.000 kN/m^2

(2) 토압

① 지하수가 있을때 ---------- LC 2

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 + 7.550 × 11.000) = 52.275 kN/m^2

② 지하수가 없을때 ---------- LC 3

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + 8.050 × 20.000) = 86.250 kN/m^2

(3) 측벽 수압 ---------- LC 4

w_1 = 10.000 × 7.550 = 75.500 kN/m^2

4.2 거더 #4 하중산정 : 수평하중 작용시

(1) 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준) :

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 8.550 / 3.200 = 2.672

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

L_h = 0.500 × 10.000 = 5.000 kN/m^2

(2) 토압

① 지하수가 있을때 ---------- LC 2

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 + 7.550 × 11.000) = 52.275 kN/m^2

② 지하수가 없을때 ---------- LC 3

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + 8.050 × 20.000) = 86.250 kN/m^2

(3) 측벽 수압 ---------- LC 4

w_1 = 10.000 × 7.550 = 75.500 kN/m^2

4. 하중조합

4.1 계수하중

구분	횡토압(H_h)			수압(W)	비 고
	LC1	LC2	LC3	LC4	
CB1	1.60	1.40		1.40	
CB2	1.60		1.40		

4.2 사용하중

구분	횡토압(H_h)			수압(W)	비 고
	LC1	LC2	LC3	LC4	
CB3	1.00	1.00		1.00	
CB4	1.00		1.00		

LC1 : 활하중에의한 측압, LC2 : 횡토압(지하수고려), LC3 : 횡토압(지하수미고려), LC4 : 측벽수압 또는 양수압

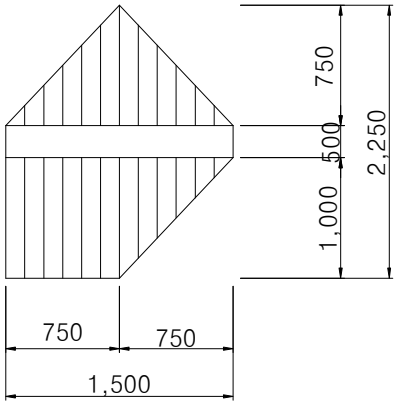
- 보강거더 #3 : 수평하중 작용시

CB1 = 1.60 × 5.000 + 1.40 × 52.275 + 1.40 × 75.500 = 186.885 kN/m^2

CB2 = 1.60 × 5.000 + 1.40 × 86.250 = 128.75 kN/m^2

CB3 = 1.00 × 5.000 + 1.00 × 52.275 + 1.00 × 75.500 = 132.775 kN/m^2

CB4 = 1.00 × 5.000 + 1.00 × 86.250 = 91.25 kN/m^2



- 단면적 : 1.500 × 0.500 + 1.500 × 0.750 / 2
  + (1.500 + 0.750) × 1.000 / 2 = 2.438 m^2
- 계수하중 : (186.885 × 2.438) / 1.500 = 303.750 kN/m^2
- 사용하중 : (132.775 × 2.438) / 1.500 = 215.804 kN/m^2

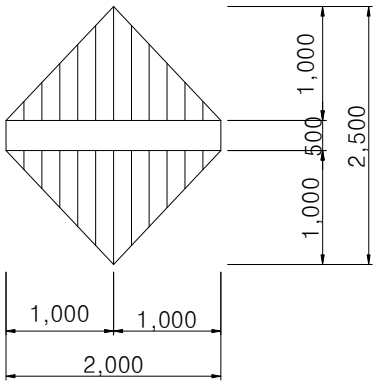
- 보강거더 #4 : 수평하중 작용시

CB1 = 1.60 × 5.000 + 1.40 × 52.275 + 1.40 × 75.500 = 186.885 kN/m^2

CB2 = 1.60 × 5.000 + 1.40 × 86.250 = 128.75 kN/m^2

CB3 = 1.00 × 5.000 + 1.00 × 52.275 + 1.00 × 75.500 = 132.775 kN/m^2

CB4 = 1.00 × 5.000 + 1.00 × 86.250 = 91.25 kN/m^2



- 단면적 : 2.000 × 0.500 + 2.000 × 1.000 / 2 × 2

= 3.000 m^2

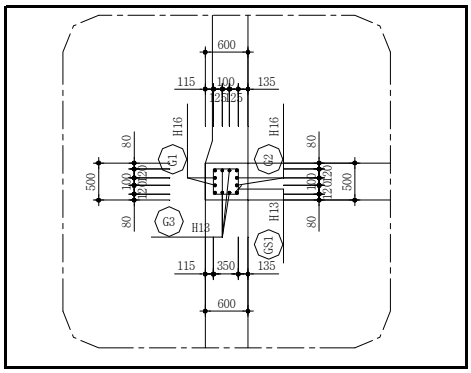
- 계수하중 : (186.885 × 3.000) / 2.000 = 280.328 kN/m^2

- 사용하중 : (132.775 × 3.000) / 2.000 = 199.163 kN/m^2

5. 보강거더 및 기둥설계

5.1 보강거더 설계 : GIRDER #3

(1) 거더



B = 500 mm, H1 = 600 mm (정모멘트부)

H2 = 600 mm (부모멘트부)

d = 485 mm (정모멘트부) d = 465 mm (부모멘트부)

d'= 115 mm (정모멘트부) d'= 135 mm (부모멘트부)

Ln= 1,500 mm (연속경간) d = 465 mm (전단)

• Ln / d = 3.23 ≤ 4 ☞ 깊은보로 설계

• 계수하중 : Wu1 = 303.750 kN/m

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = 303.750 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	부모멘트부	W × Ln^2 ÷ 12	56.953	
	정모멘트부	W × Ln^2 ÷ 14	48.817	
전단력 Vu (kN)		W x (Ln-2x0.15Ln)/2	159.469	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 부모멘트부 : 5,102 ㎟ O.K

• 정모멘트부 : 5,322 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟) 1.4bd/(f_y)	$A_{s.min}$ (㎟) 4A_s/3	$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
부모멘트	365	814	487	487	H 16	4 EA	794	794	121.855
					H 0	0 EA	-		
					H	EA	-		O.K
정모멘트	299	849	399	399	H 16	4 EA	794	794	127.257
					H 0	0 EA	-		
									O.K

4) 전단력 검토

• ϕVc = ϕv·1/6·√fck·bw·d= 151.013 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : H 13 , N = 2 EA , s1 = 150 mm < d/5또는300mm O.K

Av = 253.4 ㎟ > Av.min=0.0025·b·s = 188 ㎟ O.K

• 수평전단철근 : H 13 , N = 2 EA , s2 = 150 mm < d/5또는300mm O.K

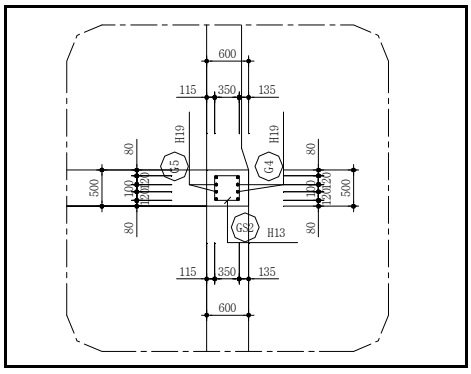
Ah = 253.4 ㎟ > Ah.min=0.0015·b·s = 113 ㎟ O.K

Vu = 159.469 kN < MIN ΦVn=Φ(Vc+Vs) = 386.675 kN, ΦVnmax=Φ1/18(10+ln/d)√fck·bo·d= 665.757 kN } O.K

{ 여기서, Vs : 일반보의 경우 : $V_s = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $V_s = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right)+\frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$ }

5.2 보강거더 설계 : GIRDER #4

(1) 거더



B = 500 mm, H1 = 600 mm (정모멘트부)
H2 = 600 mm (부모멘트부)
d = 485 mm (정모멘트부) d = 465 mm (부모멘트부)
d'= 115 mm (정모멘트부) d'= 135 mm (부모멘트부)
Ln= 2,000 mm (연속경간) d = 465 mm (전단)
• Ln / d = 4.30 > 4 ☞ 일반보로 설계
• 계수하중 : Wu1 = 280.328 kN/m
• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = 280.328 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	부모멘트부	W × Ln^2 ÷ 12	93.443	
	정모멘트부	W × Ln^2 ÷ 14	80.094	
전단력 Vu (kN)		W x (Ln - 2 d)/2	149.975	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 부모멘트부 : 5,102 ㎟ O.K
• 정모멘트부 : 5,322 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟) 1.4bd/(f_y)	$A_{s.min}$ (㎟) 4A_s/3	$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
부모멘트	605	814	806	806	H 19	4 EA	1,146	1,146	173.400
					H 0	0 EA	-		
					H	EA	-		O.K
정모멘트	494	849	659	659	H 19	4 EA	1,146	1,146	181.193
					H 0	0 EA	-		
									O.K

4) 전단력 검토

• $\phi Vc = \phi v \cdot 1/6 \cdot \sqrt{fck} \cdot bw \cdot d$ = 151.013 kN, V_u > 1/2ϕVc ∴ 최소전단철근필요!!
• 수직전단철근 : H 13 , N = 2 EA , s1 = 150 mm < d/2또는600mm O.K
Av = 253.4 ㎟

Vu = 149.975 kN < MIN { ΦVn=Φ(Vc+Vs) = 386.675 kN, ΦVn=Φ(Vc+Vs(max))= 755.066 kN } O.K

{ 여기서, Vs : 일반보의 경우 : $V_s = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $V_s = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right) + \frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$ }

2.9 보강거더 #5,#6

목 차

1. 설계개요 및 조건

1.1 설계개요

1.2 설계방법

1.3 일반사항

1.4 설계하중

1.5 참고문헌

2. 단면가정

3. 하중산정

4. 하중조합

5. 보강거더 및 기둥설계

5.1 보강거더 설계

1. 설계개요 및 조건

1.1 설계개요

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,702 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(3) 토사 내부마찰각 : Φ = 30°

(4) 토압 : K_o = 0.500

1.4 설계하중

(1) 고정하중

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	25.0	아스팔트 포장	23.0
흙(지하수위 이상)	20.0	흙(지하수위 이하)	11.0
지하수	10.0	기계실하중	25.0

(2) 활하중 (DB-24 기준)

토 피	활하중(kN/m^2)	토 피	활하중(kN/m^2)
1.0	51.0	3.0 ~ 7.0	15.0
1.5	39.0	8.0	12.0
2.0	21.0	9.0	11.0
2.5	17.0	10.0 이상	10.0

주) 활하중 적용 토피는 고정하중 적용 토피보다 1단계 큰값을 적용한다.

1.5 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

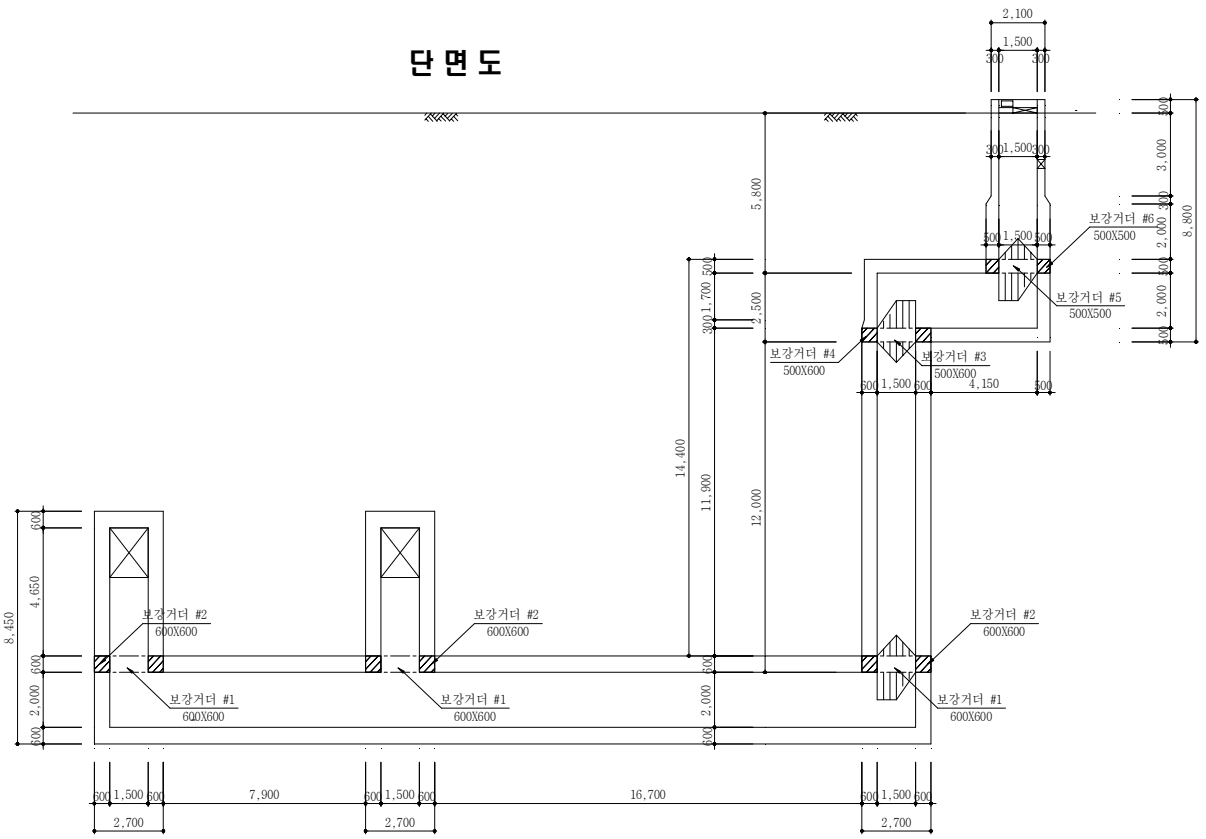
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면 가정

• 설계적용 토피 : 6.05 m



3. 하중산정

3.1 거더 #5 하중산정 : 수평하중 작용시

(1) 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준) :

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 6.050 / 3.000 = 2.017

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

L_h = 0.500 × 10.000 = 5.000 kN/m^2

(2) 토압

① 지하수가 있을때 ---------- LC 2

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 + 5.050 × 11.000) = 38.525 kN/m^2

② 지하수가 없을때 ---------- LC 3

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + 5.550 × 20.000) = 61.250 kN/m^2

(3) 측벽 수압 ---------- LC 4

w_1 = 10.000 × 5.050 = 50.500 kN/m^2

4.2 거더 #6 하중산정 : 수평하중 작용시

(1) 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준) :

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 6.050 / 3.000 = 2.017

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

L_h = 0.500 × 10.000 = 5.000 kN/m^2

(2) 토압

① 지하수가 있을때 ---------- LC 2

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 20.000 + 5.050 × 11.000) = 38.525 kN/m^2

② 지하수가 없을때 ---------- LC 3

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + 5.550 × 20.000) = 61.250 kN/m^2

(3) 측벽 수압 ---------- LC 4

w_1 = 10.000 × 5.050 = 50.500 kN/m^2

4. 하중조합

4.1 계수하중

구분	횡토압(H_h)			수압(W)	비 고
	LC1	LC2	LC3	LC4	
CB1	1.60	1.44		1.44	
CB2	1.60		1.44		

4.2 사용하중

구분	횡토압(H_h)			수압(W)	비 고
	LC1	LC2	LC3	LC4	
CB3	1.00	1.00		1.00	
CB4	1.00		1.00		

LC1 : 활하중에의한 측압, LC2 : 횡토압(지하수고려), LC3 : 횡토압(지하수미고려), LC4 : 측벽수압 또는 양수압

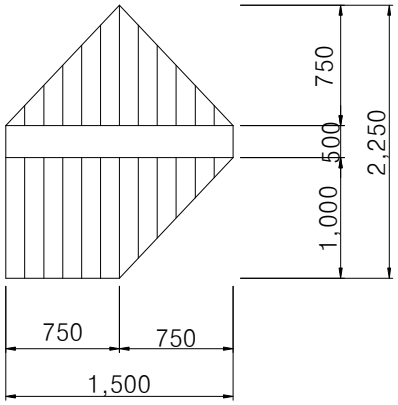
- 보강거더 #5 : 수평하중 작용시

CB1 = 1.60 × 5.000 + 1.44 × 38.525 + 1.44 × 50.500 = 136.018 kN/m^2

CB2 = 1.60 × 5.000 + 1.44 × 61.250 = 96.078 kN/m^2

CB3 = 1.00 × 5.000 + 1.00 × 38.525 + 1.00 × 50.500 = 94.025 kN/m^2

CB4 = 1.00 × 5.000 + 1.00 × 61.250 = 66.25 kN/m^2



- 단면적 : 1.500 × 0.500 + 1.500 × 0.750 / 2
  + (1.500 + 0.750) × 1.000 / 2 = 2.438 m^2
- 계수하중 : (136.018 × 2.438) / 1.500 = 221.075 kN/m^2
- 사용하중 : (94.025 × 2.438) / 1.500 = 152.822 kN/m^2

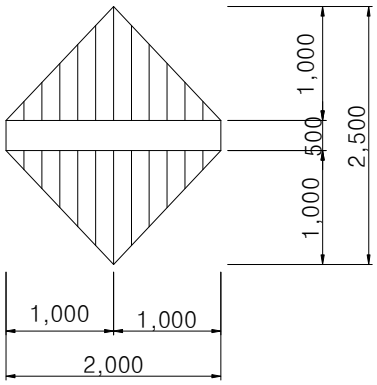
- 보강거더 #6 : 수평하중 작용시

CB1 = 1.60 × 5.000 + 1.44 × 38.525 + 1.44 × 50.500 = 136.018 kN/m^2

CB2 = 1.60 × 5.000 + 1.44 × 61.250 = 96.078 kN/m^2

CB3 = 1.00 × 5.000 + 1.00 × 38.525 + 1.00 × 50.500 = 94.025 kN/m^2

CB4 = 1.00 × 5.000 + 1.00 × 61.250 = 66.25 kN/m^2



- 단면적 : 2.000 × 0.500 + 2.000 × 1.000 / 2 × 2

= 3.000 m^2

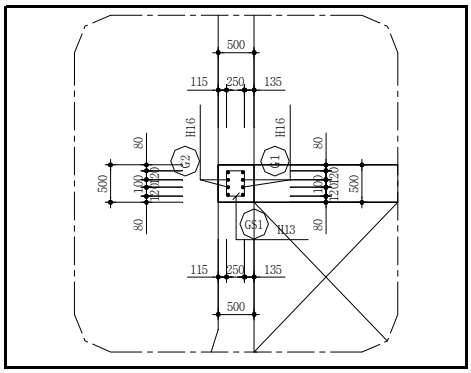
- 계수하중 : (136.018 × 3.000) / 2.000 = 204.027 kN/m^2

- 사용하중 : (94.025 × 3.000) / 2.000 = 141.038 kN/m^2

5. 보강거더 및 기둥설계

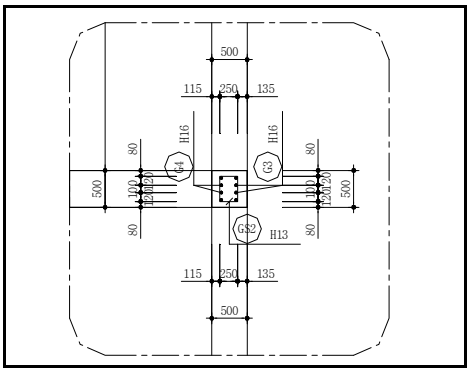
5.1 보강거더 설계 : GIRDER #5

(1) 거더



5.2 보강거더 설계 : GIRDER #6

(1) 거더



B = 500 mm, H1 = 500 mm (정모멘트부)

H2 = 500 mm (부모멘트부)

d = 385 mm (정모멘트부) d = 365 mm (부모멘트부)

d'= 115 mm (정모멘트부) d'= 135 mm (부모멘트부)

Ln= 2,000 mm (연속경간) d = 365 mm (전단)

• Ln / d = 5.48 > 4 ☞ 일반보로 설계

• 계수하중 : Wu1 = 204.027 kN/m

• 거더 추가자중 : Wd = - kN/m (헌치 등)

1) 작용하중

• 계수하중 Wu = 204.027 kN/m

2) 단면력 산정

구 분		산 정 식	계 수 하 중	비 고
Mu(kN·m)	부모멘트부	W × Ln^2 ÷ 12	68.009	
	정모멘트부	W × Ln^2 ÷ 14	58.293	
전단력 Vu (kN)		W x (Ln − 2 d)/2	129.557	

3) 휨철근량 검토

$$A_{smax} = 0.75 \cdot 0.85\beta_1 \cdot \frac{f_{ck}}{f_y} \cdot \frac{600}{600+f_y} \cdot b \cdot d$$

• 부모멘트부 : 4,005 ㎟ O.K

• 정모멘트부 : 4,225 ㎟ O.K

구 분	$A_{s.req}$ (㎟)	$A_{s.min}$ (㎟) 1.4bd/(f_y)	$A_{s.min}$ (㎟) 4A_s/3	$A_{s.req}$ (㎟)	DIA	N (EA)	$A_{s.use}$ (㎟)	$\sum A_{s.use}$ (㎟)	ϕM_n (kN·m)
부모멘트	563	639	751	639	H 16	4 EA	794	794	94.845
					H 0	0 EA	-		
					H	EA	-		O.K
정모멘트	455	674	606	606	H 16	4 EA	794	794	100.247
					H 0	0 EA	-		
									O.K

4) 전단력 검토

• ϕVc = ϕv·1/6·√fck·bw·d= 118.537 kN, V_u > ϕVc ∴ 전단보강철근 필요!!

• 수직전단철근 : H 13 , N = 2 EA , s1 = 150 mm < d/2또는600mm O.K

Av = 253.4 ㎟

Vu = 129.557 kN < MIN ΦVn=Φ(Vc+Vs) = 303.519 kN, ΦVn=Φ(Vc+Vs(max))= 592.686 kN O.K

여기서, Vs : 일반보의 경우 : $V_s = \frac{A_v f_y d}{s}$, 깊은보의 경우 : $V_s = \left[\frac{A_v}{s_1}\left(\frac{1+\frac{L_n}{d}}{12}\right)+\frac{A_h}{s_2}\left(\frac{11-\frac{L_n}{d}}{12}\right)\right] f_y d$

2.10 집수정 마감벽

목 차

1. 설계개요 및 조건

2. 단면가정

3. 구조해석모델링

4. 하중산정

5. 하중조합

6. 구조해석결과

7. 단면설계

8. 단면설계 요약

9. 우각부보강설계

10. 사용성검토

11. 주철근조립도

1. 설계개요 및 조건

1.1 개요

• Plane Strain의 평면 판요소로 해석

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 단위중량

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	24.5	아스팔트 포장	23.0
흙(지하수위 이상)	19.0	흙(지하수위 이하)	10.0
물	10.0	모르타르	21.5
기계실하중	25.0	무근콘크리트	23.0

(3) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,700 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(4) 토사 내부마찰각 : Φ = 30°

(5) 토압 : K_o = 0.500

1.4 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

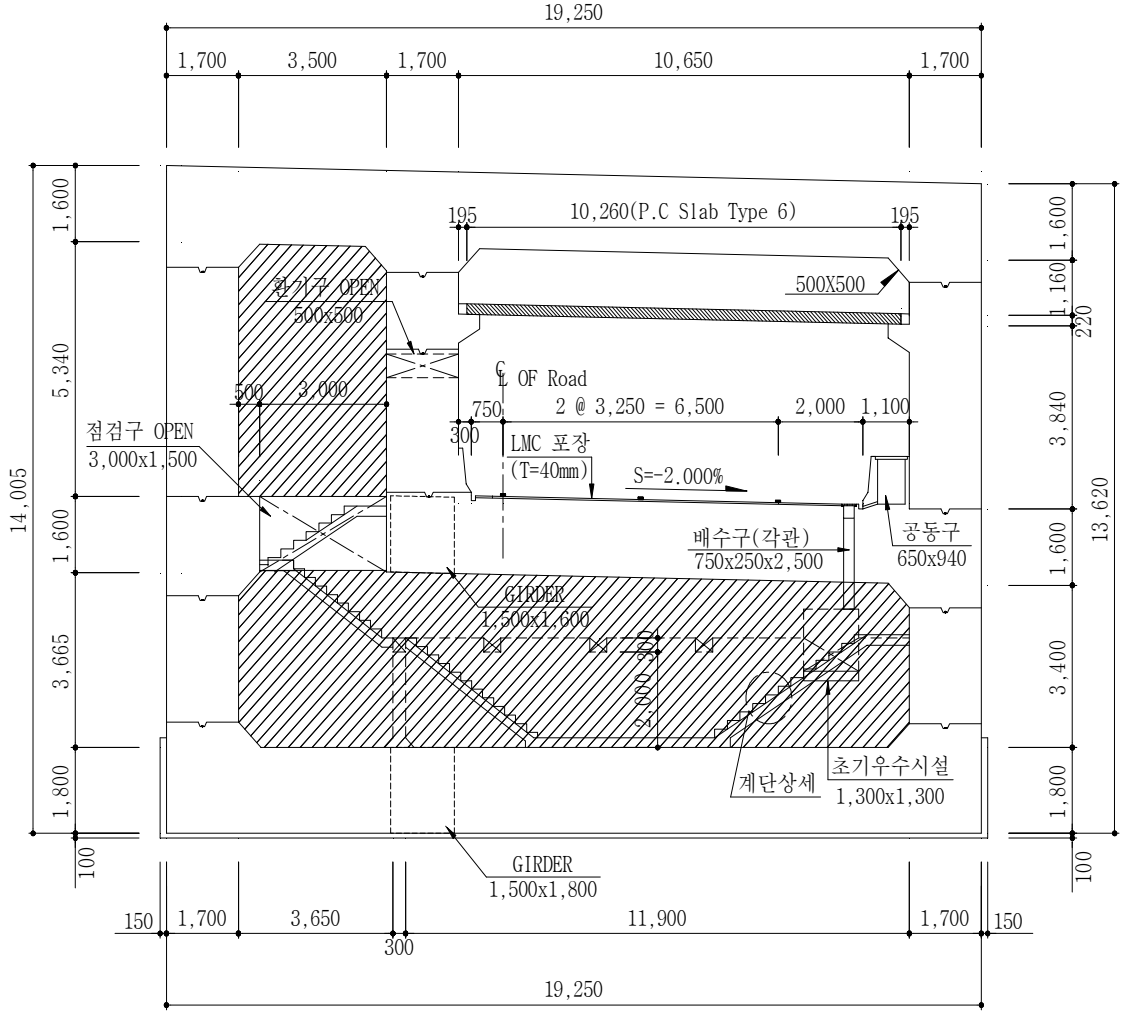
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면가정

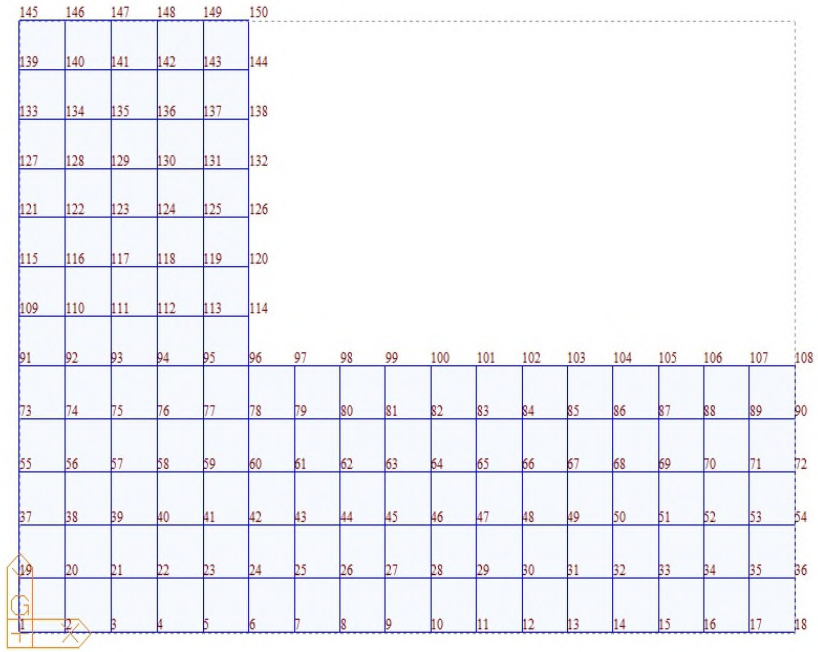
설계적용 토피 = 10.600 m



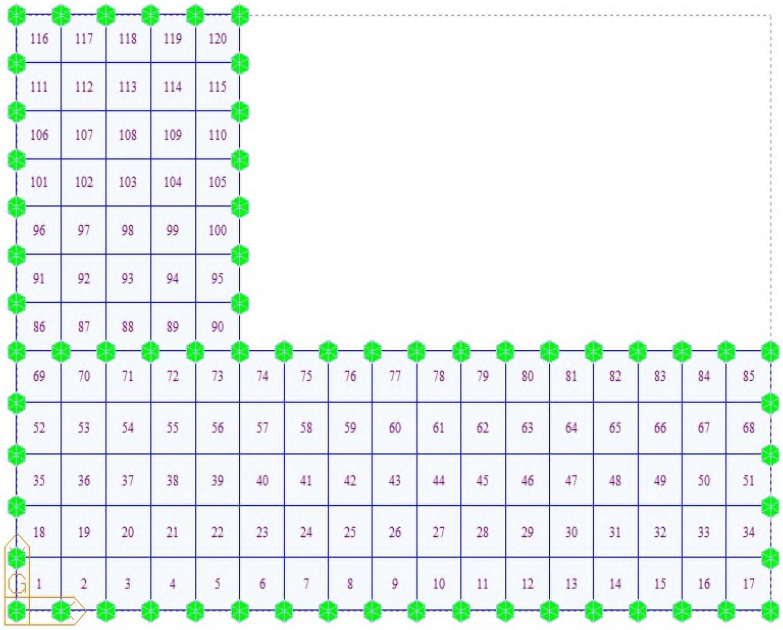
3. 구조해석 모델링

3.1 해석모형

절점



부재 및 경계조건



3.2 단면제원

번 호	폭(m)	높이(m)	단면적(m^2)	단면2차모멘트(m^4)	비 고
1	1.00	1.10	1.100	0.110917	마감벽

4. 하중산정

4.1 고정하중

- 구조물자중 (프로그램에서 자동재하)

4.2 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중(Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 10.600 / 19.250 = 0.551

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

Lh1 = 0.500 × 10.000 = 5.000 kN/m²

4.3 수평토압(지하수 無) ---------- LC 2

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + (10.100 + 1.600 / 2) × 19.000)

= 109.300 kN/m²

$q_{N2'}$ = 109.300 + 6.940 × 19.000 × 0.500 = 175.230 kN/m²

$q_{N3'}$ = 175.230 + 5.365 × 19.000 × 0.500 = 226.198 kN/m²

4.4 수평 토압(지하수 有) ---------- LC 3

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 19.000 +

(9.600 + 1.600 / 2) × 10.000) = 62.500 kN/m²

q_{N2} = 62.500 + 6.940 × 10.000 × 0.500 = 97.200 kN/m²

q_{N3} = 97.200 + 5.365 × 10.000 × 0.500 = 124.025 kN/m²

4.5 수평 수압(지하수 有) ---------- LC 4

1) 벽체

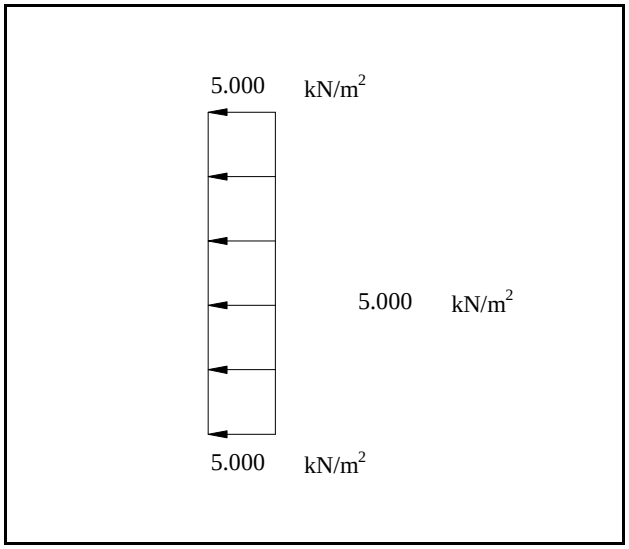
q_{W1} = 10.000 × (9.600 + 1.600 / 2) = 104.000 kN/m²

q_{W2} = 104.000 + 6.940 × 10.000 = 173.400 kN/m²

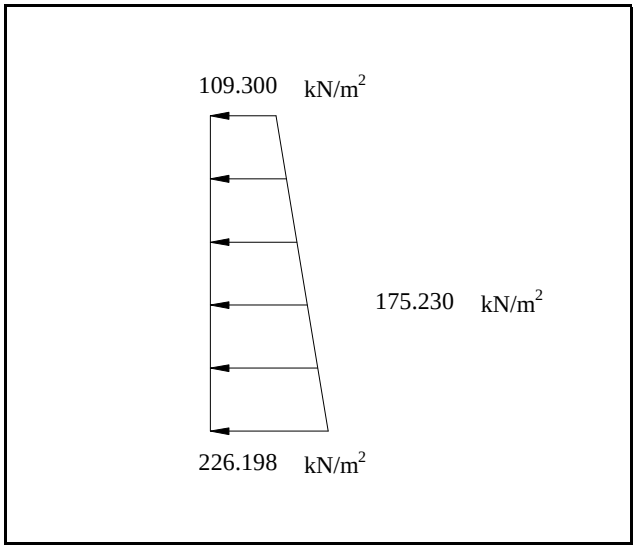
q_{W3} = 173.400 + 5.365 × 10.000 = 227.050 kN/m²

4.6 하중재하도

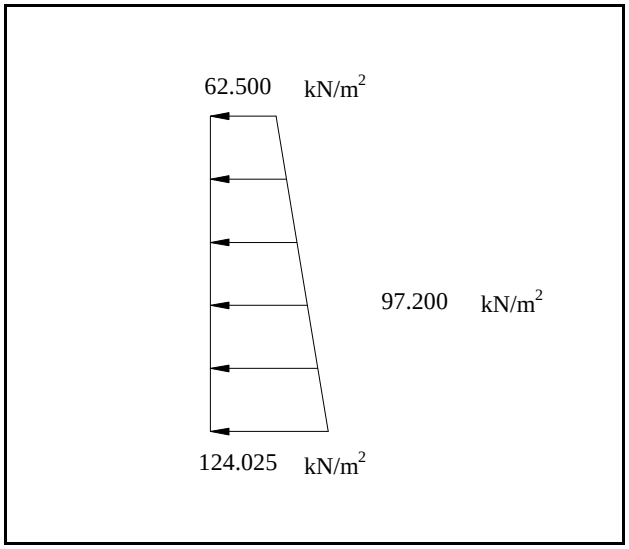
1) 활하중에 의한 측압 ------- LC 1



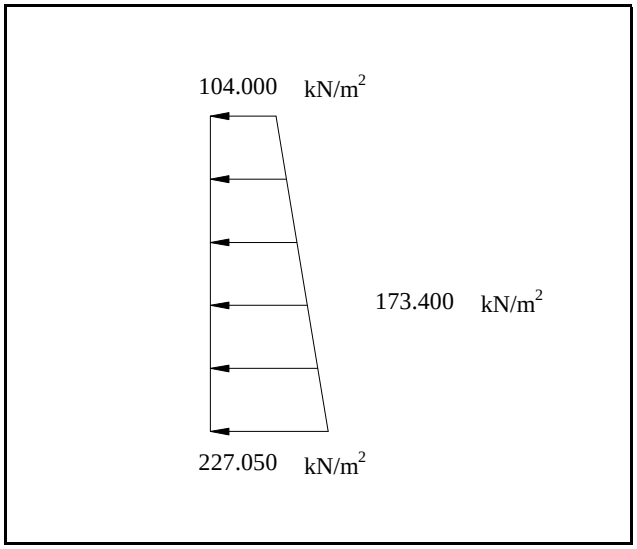
2) 수평 토압(지하수 무) ------- LC 2



3) 수평 토압(지하수 유) ------- LC 3



4) 수평 수압(지하수 유) ------- LC 4



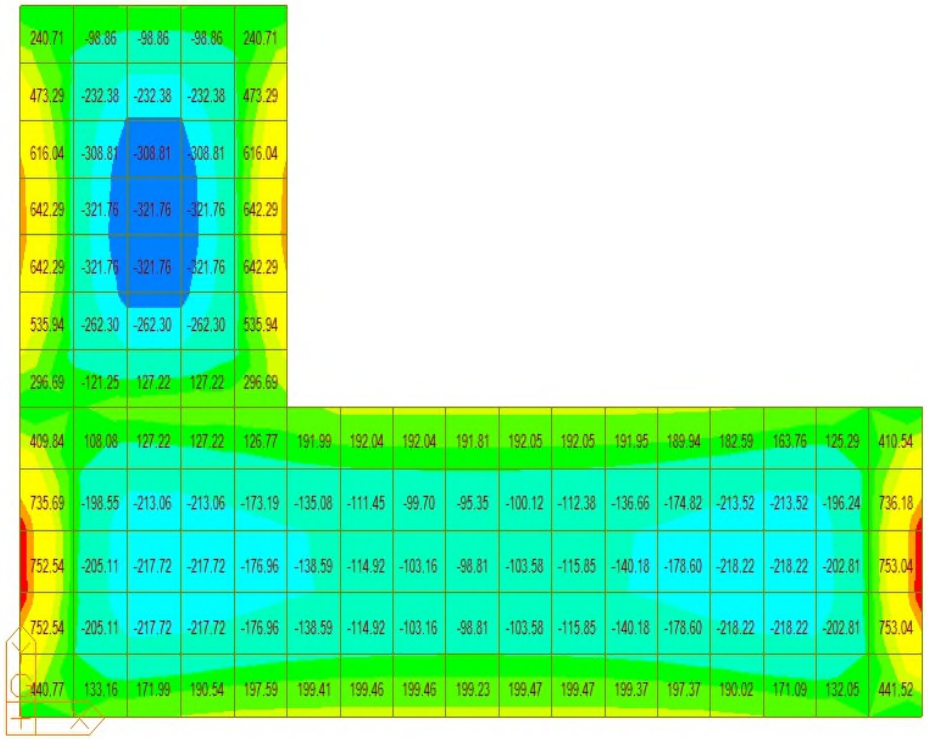
5. 하중조합

하중 조합	활하중	지하수 없을때	지하수 있을때		비고
	수평	수평 토압	수평 토압	수평 수압	
	LC01	LC02	LC03	LC04	
CB01	1.60	1.60			극한하중 조합
CB02		1.60			
CB03	1.60		1.60	1.60	
CB4			1.60	1.60	
CB5	1.00	1.00			사용하중 조합
CB6		1.00			
CB7	1.00		1.00	1.00	
CB8			1.00	1.00	

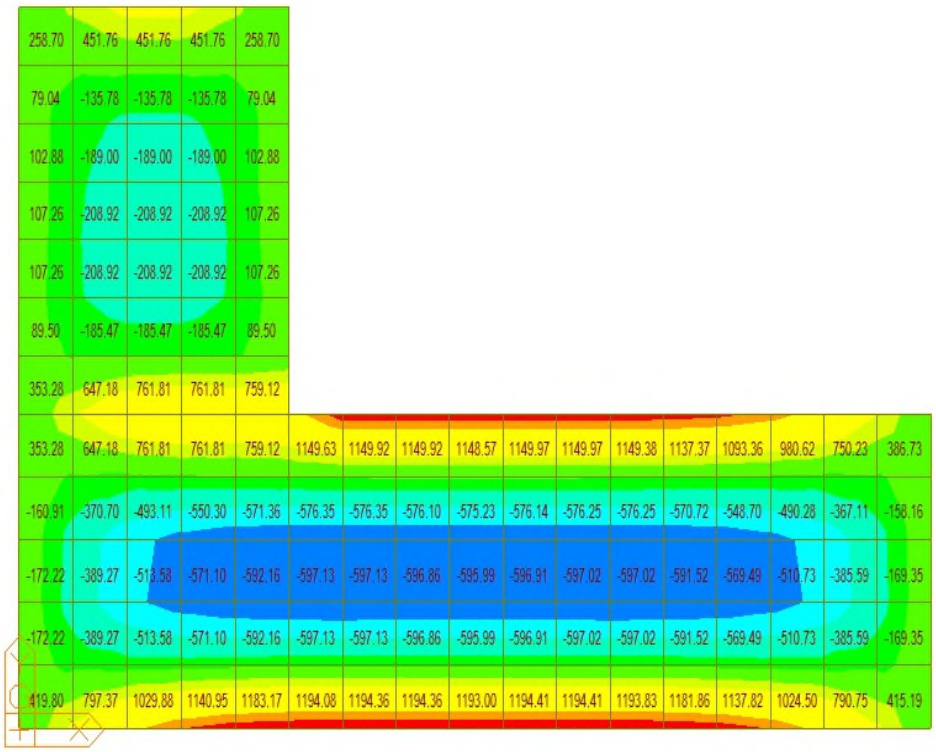
6. 구조해석 결과

6.1 부재력도

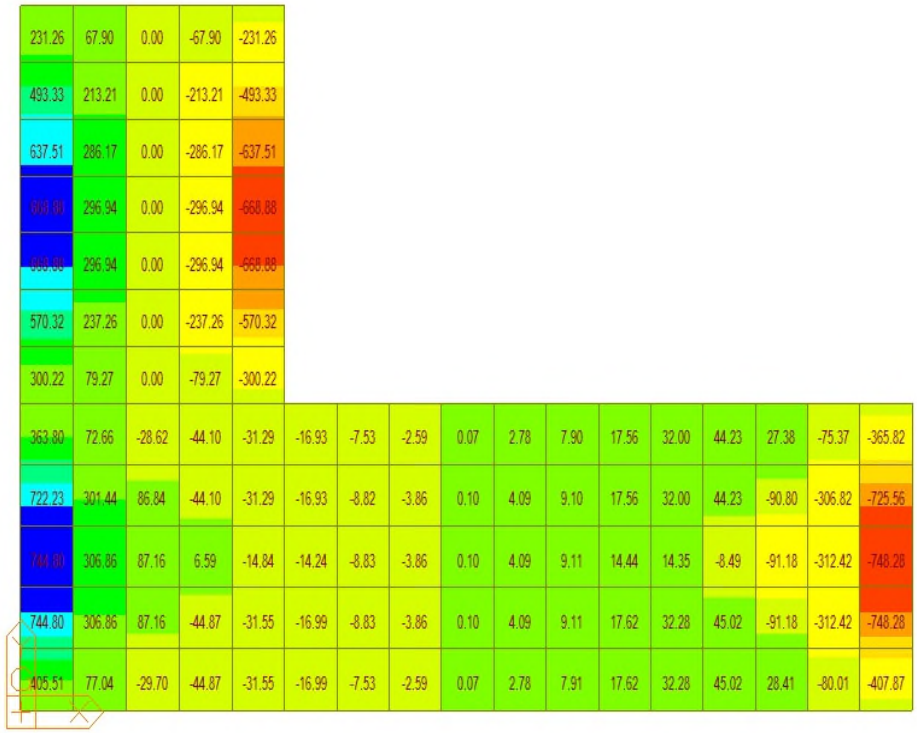
B.M.D (계수하중) [kN·m] : Mxx



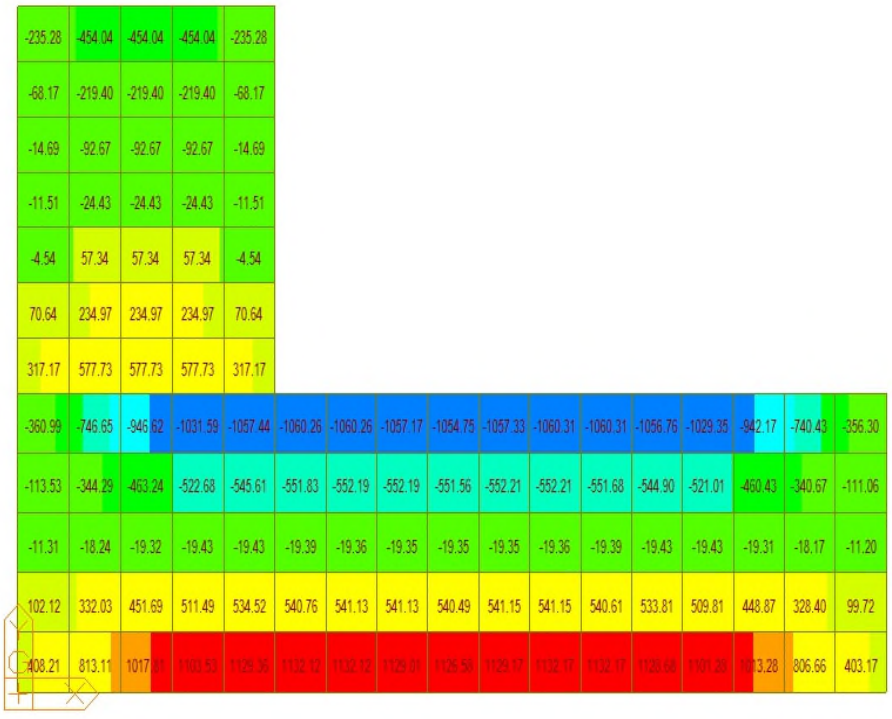
B.M.D (계수하중) [kN·m] : Myy



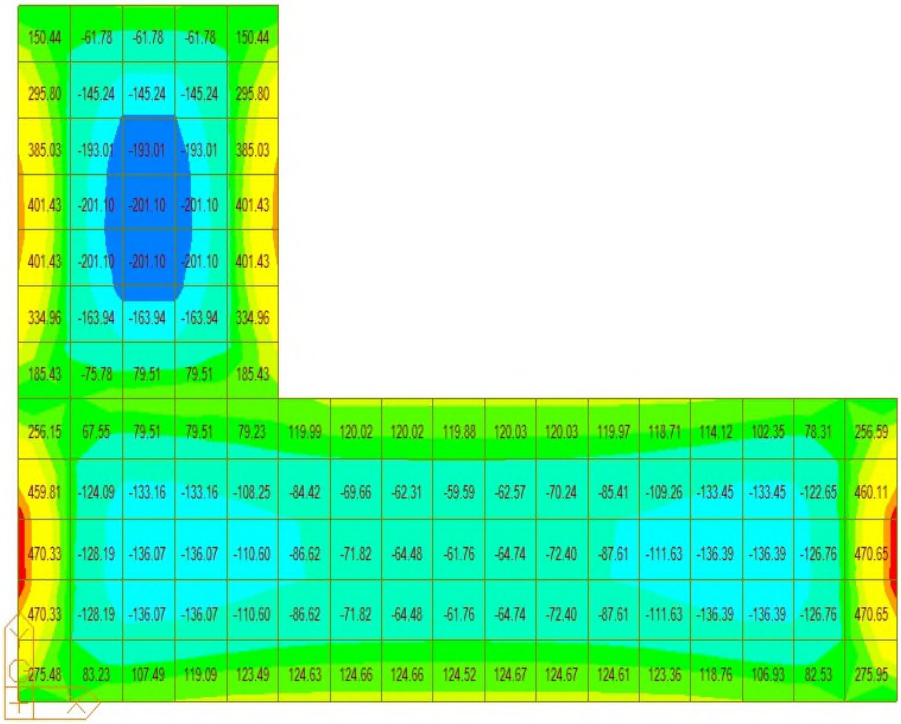
S.F.D (계수하중) [kN] : Vxx



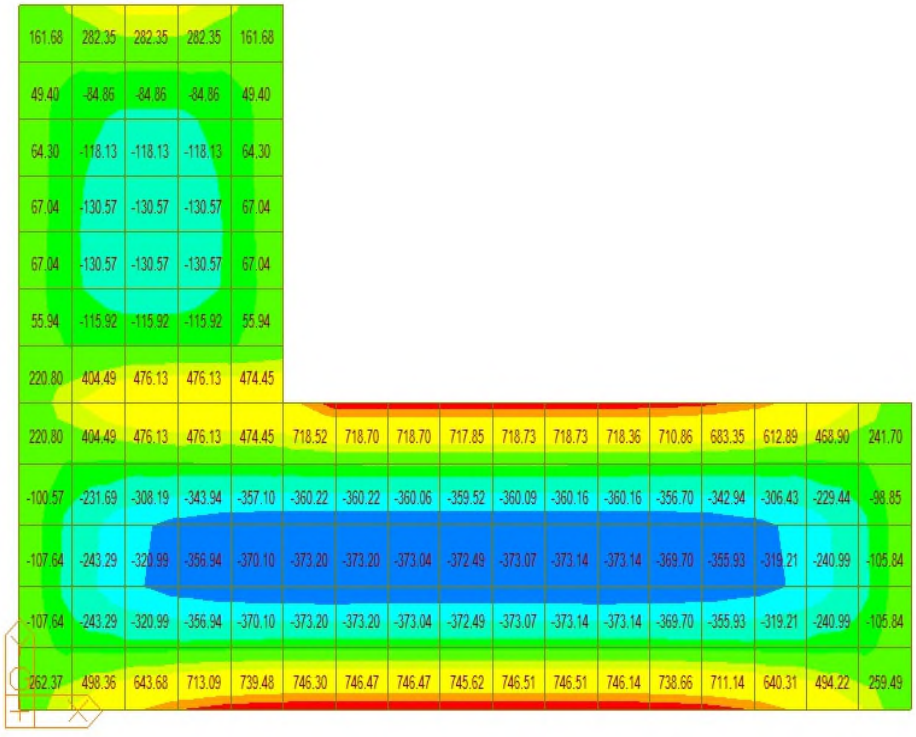
S.F.D (계수하중) [kN] : Vyy



B.M.D (사용하중) [kN·m] : Mxx



B.M.D (사용하중) [kN·m] : Myy



6.2 부재력 집계

구분		계수하중			사용하중	
		Mu(kN·m)	Pu(kN)	Vu(kN)	Mo(kN·m)	Po(kN)
2층벽체 Mxx	단 부	642.290		668.880	401.430	
	중앙부	321.760			201.100	
1층벽체 Mxx	단 부	753.040		748.280	470.650	
	중앙부	218.220			136.390	
2층벽체 Myy	상 부	451.760		454.040	282.350	
	중앙부	208.920			130.570	
	하 부	761.810		1057.440	476.130	
1층벽체 Myy	상 부	1149.970		1060.310	718.850	
	중앙부	597.130			373.200	
	하 부	1194.410		1132.170	746.510	

7. 단면검토

1) 2층 벽체 단부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 2561.674 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	401.4
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1000.0	100.0	642.290	668.880

전단설계시 단면의 유효높이 ds = 1000.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H22 × 6.67ea = 2580.667 ㎟

∴ P = As / (B × D) = 0.00258

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 44.979 mm

최외단 인장철근 변형률 εt = 0.05369 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 857693780 N·mm

= 857.694 kN·m > 642.290 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 1921.256 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 649.519 kN

Vu > Φv x Vc ∴ 전단철근보강이 필요하다.

Req Av = (668.9 - 649.519)×10³×150.0 / (400.0×1,000.0×0.75)

= 9.680 ㎟

Use Av = 331.066 ㎟ (H16×1.67 EA, 간격 s = 150.0 mm)

Øv·Vs = Øv·Av·fy·D / (s × B) = 662.132 kN

s = 150.0 mm < Min (600, 0.5D) = mm ----- ∴ O.K.

Øv·Vn = Øv·Vc + Øv·Vs = 1311.651 kN < Vu ----- ∴ O.K.

2) 2층 벽체 중앙부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 1247.027 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	201.1
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1020.0	80.0	321.760	0.000

전단설계시 단면의 유효높이 ds = 1020.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00130

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.10971 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 453969254 N·mm

= 453.969 kN·m > 321.760 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 935.270 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 662.509 kN

∴ 전단철근이 필요없음.

3) 1층 벽체 단부 (Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 3012.409 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	470.7
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1000.0	100.0	753.040	748.280

전단설계시 단면의 유효높이 ds = 1000.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H25 × 6.67ea = 3378.000 ㎟

∴ P = As / (B × D) = 0.00338

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 58.876 mm

최외단 인장철근 변형률 εt = 0.04031 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 1114709868 N·mm

= 1114.710 kN·m > 753.040 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 2259.307 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 649.519 kN

Vu > Φv x Vc ∴ 전단철근보강이 필요하다.

Req Av = (748.3 - 649.519)×10^3×150.0 / (400.0×1,000.0×0.75)

= 49.380 ㎟

Use Av = 331.066 ㎟ (H16×1.67 EA, 간격 s = 150.0 mm)

Øv·Vs = Øv·Av·fy·D / (s × B) = 662.132 kN

s = 150.0 mm < Min (600, 0.5D) = 500.0 mm ----- ∴ O.K.

Øv·Vn = Øv·Vc + Øv·Vs = 1311.651 kN < Vu ----- ∴ O.K.

4) 1층 벽체 중앙부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 843.545 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	136.4
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1020.0	80.0	218.220	0.000

전단설계시 단면의 유효높이 ds = 1020.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00130

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.10971 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 453969254 N·mm

= 453.969 kN·m > 218.220 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 632.658 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 662.509 kN

∴ 전단철근이 필요없음.

5) 2층벽체 상부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 1792.611 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	282.4
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1000.0	100.0	451.760	454.040

전단설계시 단면의 유효높이 ds = 1000.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H19 × 6.67ea = 1910.000 ㎟

∴ P = As / (B × D) = 0.00191

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 33.290 mm

최외단 인장철근 변형률 εt = 0.07360 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 638590737 N·mm

= 638.591 kN·m > 451.760 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 1344.458 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 649.519 kN

1/2 x Φv x Vc = 324.760 kN ≤ Vu ≤Φv x Vc ∴ 최소전단 철근을 배근하는것이 좋다.

Req Av = 0.35×bw×s / fy = 0.35×1,000.0×150.0 / 400.0

= 131.250 ㎟

Use Av = 331.066 ㎟ (H16×1.667 EA, 간격 s = 150.0 mm) ≥ req.Av ----- ∴ O.K.

s = 150.0 mm < Min (600, 0.5D) = 500.0 mm ----- ∴ O.K.

6) 2층벽체 중앙부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 807.407 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	130.6
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1020.0	80.0	208.920	0.000

전단설계시 단면의 유효높이 ds = 1020.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00130

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.10971 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 453969254 N·mm

= 453.969 kN·m > 208.920 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 605.555 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 662.509 kN

∴ 전단철근이 필요없음.

7) 2층벽체 하부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 3048.220 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	476.1
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1000.0	100.0	761.810	1057.440

전단설계시 단면의 유효높이 ds = 1000.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H29 × 6.67ea = 4282.667 ㎟

∴ P = As / (B × D) = 0.00428

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 74.643 mm

최외단 인장철근 변형률 εt = 0.03116 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 1401762582 N·mm

= 1401.763 kN·m > 761.810 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 2286.165 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 649.519 kN

Vu > Φv x Vc ∴ 전단철근보강이 필요하다.

Req Av = (1,057.4 - 649.519)×10^3×150.0 / (400.0×1,000.0×0.75)

= 203.960 ㎟

Use Av = 331.066 ㎟ (H16×1.67 EA, 간격 s = 150.0 mm)

Øv·Vs = Øv·Av·fy·D / (s × B) = 662.132 kN

s = 150.0 mm < Min (600, 0.5D) = 500.0 mm ----- ∴ O.K.

Øv·Vn = Øv·Vc + Øv·Vs = 1311.651 kN < Vu ----- ∴ O.K.

8) 1층벽체 상부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 4651.075 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	718.9
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1000.0	100.0	1149.970	1060.310

전단설계시 단면의 유효높이 ds = 1000.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H29 × 6.67ea = 4282.667 ㎟

∴ P = As / (B × D) = 0.00428

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 74.643 mm

최외단 인장철근 변형률 εt = 0.03116 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 1401762582 N·mm

= 1401.763 kN·m > 1149.970 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 3488.306 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 649.519 kN

Vu > Φv x Vc ∴ 전단철근보강이 필요하다.

Req Av = (1,060.3 - 649.519)×10³×150.0 / (400.0×1,000.0×0.75)

= 205.395 ㎟

Use Av = 331.066 ㎟ (H16×1.67 EA, 간격 s = 150.0 mm)

Øv·Vs = Øv·Av·fy·D / (s × B) = 662.132 kN

s = 150.0 mm < Min (600, 0.5D) = 500.0 mm ----- ∴ O.K.

Øv·Vn = Øv·Vc + Øv·Vs = 1311.651 kN < Vu ----- ∴ O.K.

9) 1층벽체 중앙부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 2330.575 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	373.2
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1020.0	80.0	597.130	0.000

전단설계시 단면의 유효높이 ds = 1020.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H22 × 6.67ea = 2580.667 ㎟

∴ P = As / (B × D) = 0.00253

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 44.979 mm

최외단 인장철근 변형률 εt = 0.05483 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 875242313 N·mm

= 875.242 kN·m > 597.130 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 1747.931 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 662.509 kN

∴ 전단철근이 필요없음.

10) 1층벽체 하부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 4836.871 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	746.5
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	1100.0	1000.0	100.0	1194.410	1132.170

전단설계시 단면의 유효높이 ds = 1000.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H29 × 6.67ea = 4282.667 ㎟

∴ P = As / (B × D) = 0.00428

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 74.643 mm

최외단 인장철근 변형률 εt = 0.03116 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 1401762582 N·mm

= 1401.763 kN·m > 1194.410 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 3627.654 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 649.519 kN

Vu > Φv x Vc ∴ 전단철근보강이 필요하다.

Req Av = (1,132.2 - 649.519)×10^3×150.0 / (400.0×1,000.0×0.75)

= 241.325 ㎟

Use Av = 331.066 ㎟ (H16×1.67 EA, 간격 s = 150.0 mm)

Øv·Vs = Øv·Av·fy·D / (s × B) = 662.132 kN

s = 150.0 mm < Min (600, 0.5D) = 500.0 mm ----- ∴ O.K.

Øv·Vn = Øv·Vc + Øv·Vs = 1311.651 kN < Vu ----- ∴ O.K.

8. 단면설계요약

1) 휨설계 요약

구분		Mu (kN·m)	Pu (kN)	사용철근				ΦMn (kN·m)	ΦPn (kN)	안전율	비고
				1단		2단					
2층벽체 Mxx	단 부	642.290		H22	150	H0	0	857.694		1.34	O.K
	중앙부	321.760		H16	150	H0	0	453.969		1.41	O.K
1층벽체 Mxx	단 부	753.040		H25	150	H0	0	1114.710		1.48	O.K
	중앙부	218.220		H16	150	H0	0	453.969		2.08	O.K
2층벽체 Myy	상 부	451.760		H19	150	H0	0	638.591		1.41	O.K
	중앙부	208.920		H16	150	H0	0	453.969		2.17	O.K
	하 부	761.810		H29	150	H0	0	1401.763		1.84	O.K
1층 벽체 Myy	상 부	1149.970		H29	150	H0	0	1401.763		1.22	O.K
	중앙부	597.130		H22	150	H0	0	875.242		1.47	O.K
	하 부	1194.410		H29	150	H0	0	1401.763		1.17	O.K

2) 전단설계 요약

구분		Vu (kN·m)	사용철근			ΦVn (kN·m)	안전율	비고
			직경	개수	간격			
2층 벽체 Mxx	단 부	668.880	H16	1.7EA	150	1311.651	1.96	O.K
	중앙부	0.000	H16	1.7EA	300	전단철근 필요없음		
1층 벽체 Mxx	단 부	748.280	H16	1.7EA	150	1311.651	1.75	O.K
	중앙부	0.000	H16	1.7EA	300	전단철근 필요없음		
2층 벽체 Myy	상 부	454.040	H16	1.7EA	150	1311.651	2.89	O.K
	중앙부	0.000	H16	1.7EA	300	전단철근 필요없음		
	하 부	1057.440	H16	1.7EA	150	1311.651	1.24	O.K
1층 벽체 Myy	상 부	1060.310	H16	1.7EA	150	1311.651	1.24	O.K
	중앙부	0.000	H16	1.7EA	300	전단철근 필요없음		
	하 부	1132.170	H16	1.7EA	150	1311.651	1.16	O.K

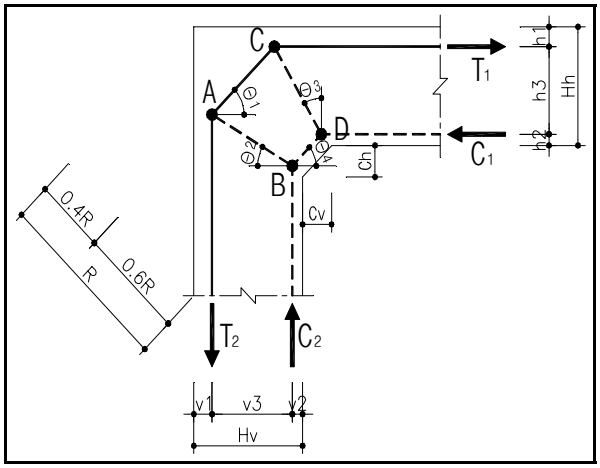
9. 우각부 보강 설계 (스트럿-타이 모델 해석에 의한 라멘접합부 보강)

9.1 벽체 Mxx (단부)

(1) 계산조건

슬래브두께	H_h	=	1700.00 mm	벽체 높이	H_v	=	1100.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	1520.00 mm	벽체측 우력 거리	v_3	=	920.00 mm
수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	753.040 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 2024.85 mm

② 사잇각

θ_1 = 45.00°

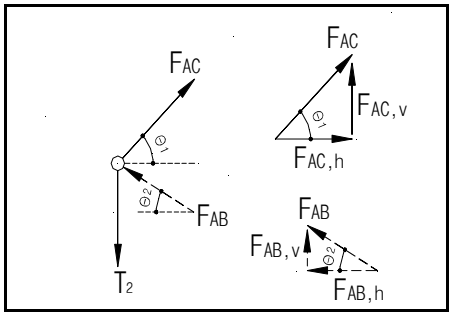
θ_2 = 27.71°

θ_3 = -4.40°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

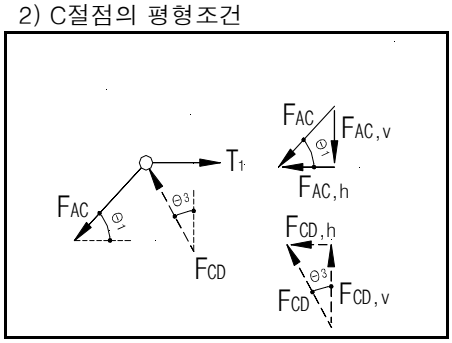
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$

$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \Theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \Theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \Theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \Theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{753.040}{1.520} =$ 495.421 kN

$T_2 = \frac{M_u}{v_3} = \frac{753.040}{0.920} =$ 818.522 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 758.979 kN

식 ⑥ 으로부터

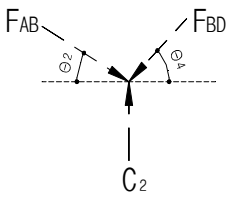
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 758.979 kN

따라서 $F_{AC} =$ **758.979** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 606.185 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 758.979 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 538.263 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	758.979	타이
AB	-606.185	스트럿
BD	-758.979	스트럿
CD	-538.263	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 758.979 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{758{,}979.485}{0.85 \times 400} = 2{,}232.29 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	22	@	300	=	1,290.33	mm^2	(2 cycle)
우각부철근 As	= H	22	@	300	=	1,290.33	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**2,580.67**	mm^2	

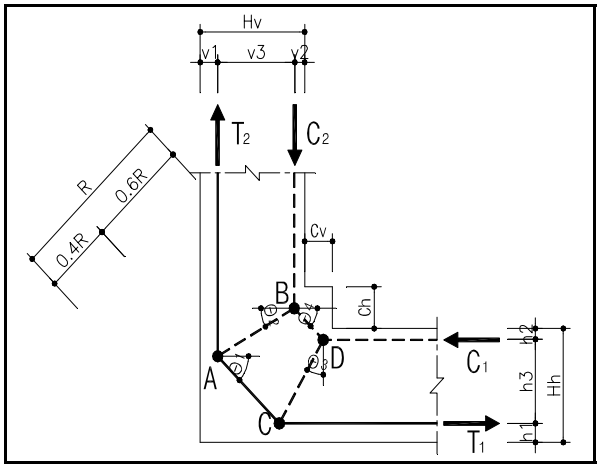
$A_{s,used}$ = 2,580.67 mm^2 > 2,232.29 mm^2 ……O.K

9.2 벽체 Myy (2층 상부)

(1) 계산조건

슬래브두께	H_h	=	1600.00 mm	벽체 높이	H_v	=	1100.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	1420.00 mm	벽체측 우력 거리	v_3	=	920.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	451.760 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1941.65 mm

② 사잇각

Θ_1 = 45.00°

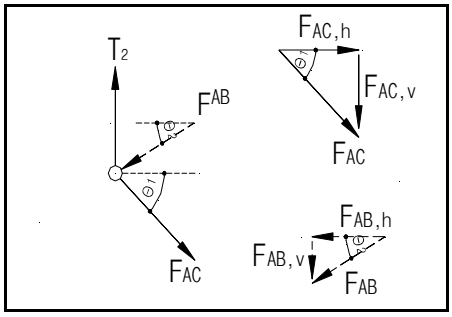
Θ_2 = 26.21°

Θ_3 = -1.90°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

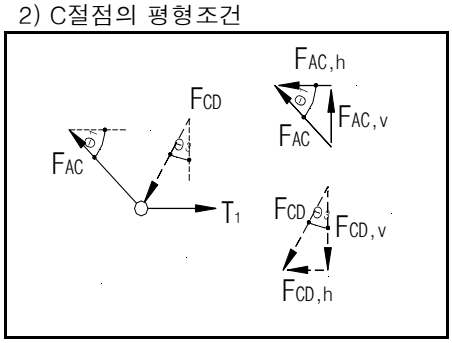
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\Theta$ => $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{451.760}{1.420} =$ 318.141 kN

$T_2 = \frac{M_u}{v_3} = \frac{451.760}{0.920} =$ 491.043 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 465.336 kN

식 ⑥ 으로부터

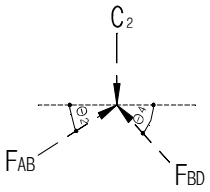
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 465.336 kN

따라서 $F_{AC} =$ **465.336** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 366.761 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 465.336 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 329.223 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	465.336	타이
AB	-366.761	스트럿
BD	-465.336	스트럿
CD	-329.223	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 465.336 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{465,336.475}{0.85 \times 400} = 1,368.64 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	19	@	300	=	955.00	mm^2	(2 cycle)
우각부철근 As	= H	19	@	300	=	955.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**1,910.00**	mm^2	

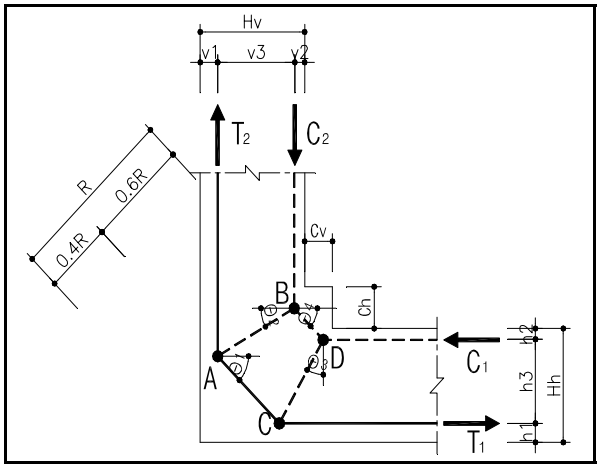
$A_{s,used}$ = 1,910.00 mm^2 > 1,368.64 mm^2 ……O.K

9.3 벽체 Myy (1층 상부)

(1) 계산조건

슬래브두께	H_h	=	1600.00 mm	벽체 높이	H_v	=	1100.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	1420.00 mm	벽체측 우력 거리	v_3	=	920.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	1149.970 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 1941.65 mm

② 사잇각

Θ_1 = 45.00°

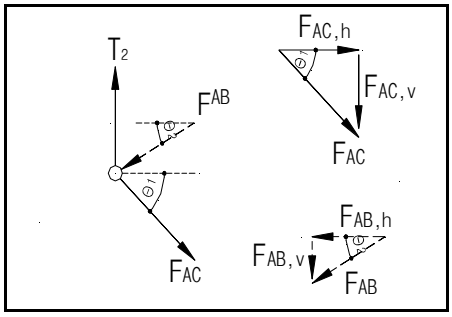
Θ_2 = 26.21°

Θ_3 = -1.90°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

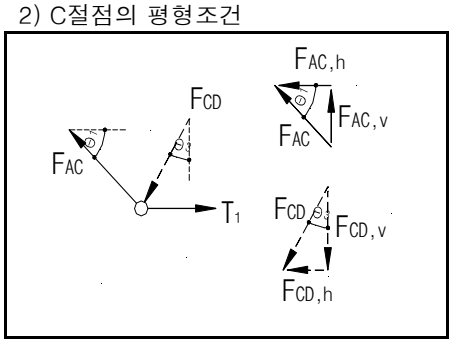
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\Theta$ => $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{1,149.970}{1.420} =$ 809.838 kN

$T_2 = \frac{M_u}{v_3} = \frac{1,149.970}{0.920} =$ 1,249.967 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 1,184.529 kN

식 ⑥ 으로부터

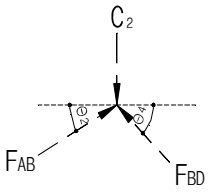
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 1,184.529 kN

따라서 $F_{AC} =$ **1,184.529** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 933.601 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 1,184.529 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 838.048 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	1,184.529	타이
AB	-933.601	스트럿
BD	-1,184.529	스트럿
CD	-838.048	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 1,184.529 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{1,184,529.364}{0.85 \times 400} = 3,483.91 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00 mm²	(1 cycle)
	= H	29	@	300	=	2,141.33 mm²	(2 cycle)
우각부철근 As	= H	29	@	300	=	2,141.33 mm²	(1 단)
	= H	0	@	0	=	0.00 mm²	(2 단)
				합계	=	**4,282.67** mm²	

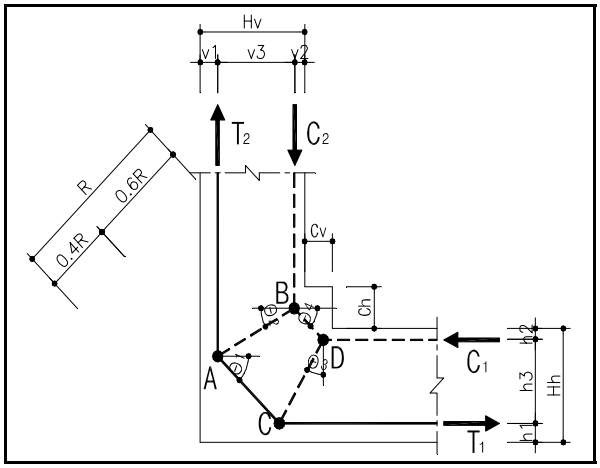
$A_{s,used}$ = 4,282.67 mm^2 > 3,483.91 mm^2 ……O.K

9.4 벽체 Myy (하부)

(1) 계산조건

슬래브두께	H_h	=	1800.00 mm	벽체 높이	H_v	=	1100.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	1620.00 mm	벽체측 우력 거리	v_3	=	920.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	1194.410 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 2109.50 mm

② 사잇각

θ_1 = 45.00°

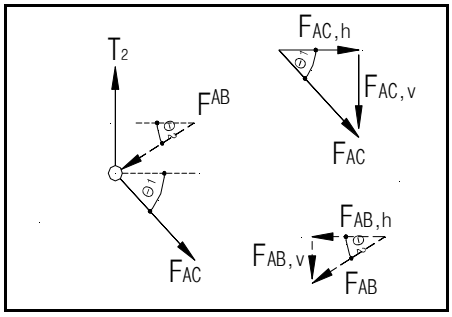
θ_2 = 31.85°

θ_3 = -4.53°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

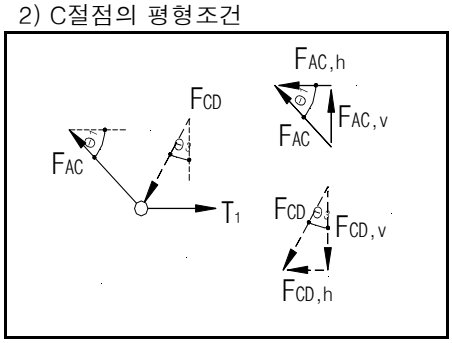
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$

$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{1{,}194.410}{1.620} =$ 737.290 kN

$T_2 = \frac{M_u}{v_3} = \frac{1{,}194.410}{0.920} =$ 1,298.272 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 1,132.409 kN

식 ⑥ 으로부터

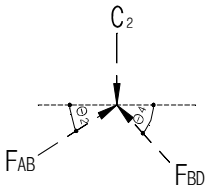
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 1,132.409 kN

따라서 F_{AC} = **1,132.409** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 942.719 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 1,132.409 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 803.244 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	1,132.409	타이
AB	-942.719	스트럿
BD	-1,132.409	스트럿
CD	-803.244	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 1,132.409 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{1,132,409.283}{0.85 \times 400} = 3,330.62 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	29	@	300	=	2,141.33	mm^2	(2 cycle)
우각부철근 As	= H	25	@	300	=	1,689.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**3,830.33**	mm^2	

$A_{s,used}$ = 3,830.33 mm^2 > 3,330.62 mm^2 ……O.K

10. 사용성 검토

10.1 처짐 검토

1) Mxx 벽체 : 최소부재두께 적용

철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	15.850	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.660	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.660m	<	H	=	1.100m	(처짐검토 생략)

2) Myy 벽체 : 최소부재두께 적용

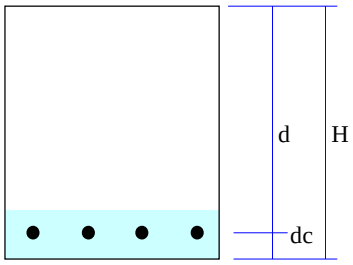
철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	5.340	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.223	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.223m	<	H	=	1.100m	(처짐검토 생략)

10.2 균열 검토

1) 2층 벽체 단부(Mxx) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1000.00	mm,	dc =	100.00	mm ,
Mo =	401.430	kN· m,	As =	2580.667	mm^2
N =	6.67		n =	7	

- 응력산정

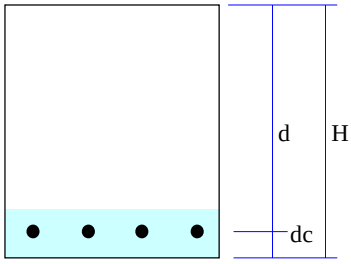
x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	172.869	mm
f s = M / (As (d - x / 3))	=	165.064	mm
f st = fs (H -Dc_min - x) / (D - x)	=	165.064	mm

- 철근의 최대 중심간격

Cc = 100 - 22 / 2	=	89.000	mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]	=	254.587	mm

최외단철근 평균배근간격; 1000 / 6.7 = 150 mm < 254.587 mm **O.K!!**

2) 2층 벽체 중앙부(Mxx) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1020.00	mm,	dc =	80.00	mm ,
Mo =	201.100	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

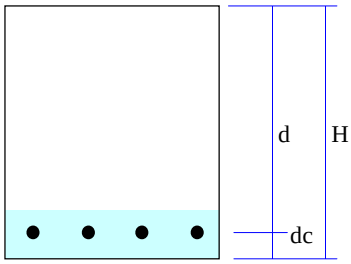
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	128.546	mm
f s = M / (As (d - x / 3))	=	155.440	mm
f st = fs (H -Dc_min - x) / (D - x)	=	155.440	mm

- 철근의 최대 중심간격

Cc =	80	-	16	/	2	=	72.000 mm
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]						=	495.503 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	495.503 mm **O.K!!**

3) 1층 벽체 단부(Mxx) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1000.00	mm,	dc =	100.00	mm ,
Mo =	470.650	kN· m,	As =	3378.000	mm^2
N =	6.666667		n =	7	

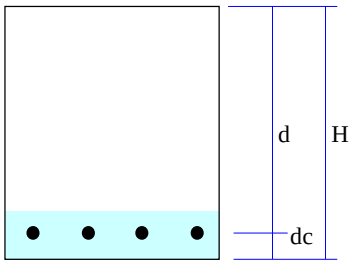
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	195.103	mm
f s = M / (As (d - x / 3))	=	149.019	mm
f st = fs (H -Dc_min - x) / (D - x)	=	149.019	mm

- 철근의 최대 중심간격

Cc =	100	-	25	/	2	=	87.500 mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]						=	309.705 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	309.705 mm **O.K!!**

4) 1층 벽체 중앙부(Mxx) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1020.00	mm,	dc =	80.00	mm ,
Mo =	136.390	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 128.546 mm

f s = M / (As (d - x / 3)) = 105.422 mm

f st = fs (H -Dc_min - x) / (D - x) = 105.422 mm

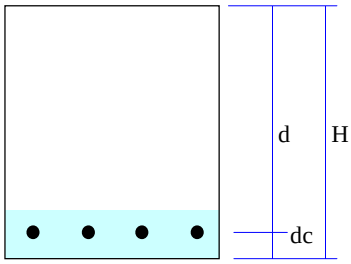
- 철근의 최대 중심간격

Cc = 80 - 16 / 2 = 72.000 mm

S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)] = 796.795 mm

최외단철근 평균배근간격; 1000 / 6.7 = 150 mm < 796.795 mm **O.K!!**

5) 2층 벽체 상부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1000.00	mm,	dc =	100.00	mm ,
Mo =	282.350	kN· m,	As =	1910.000	mm^2
N =	6.67		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 150.699 mm

f s = M / (As (d - x / 3)) = 155.646 mm

f st = fs (H -Dc_min - x) / (D - x) = 155.646 mm

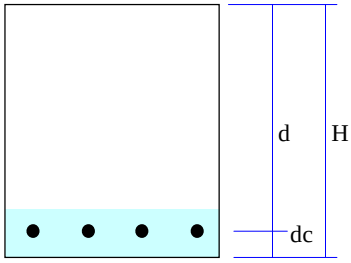
- 철근의 최대 중심간격

Cc = 100 - 19 / 2 = 90.500 mm

S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)] = 279.706 mm

최외단철근 평균배근간격; 1000 / 6.7 = 150 mm < 279.706 mm **O.K!!**

6) 2층 벽체 중앙부(Myy) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1020.00	mm,	dc =	80.00	mm ,
Mo =	130.570	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

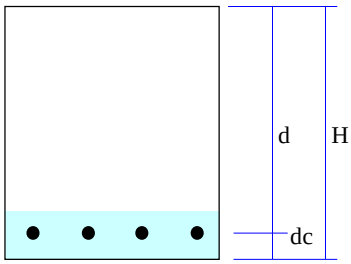
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	128.546	mm
f s = M / (As (d - x / 3))	=	100.924	mm
f st = fs (H -Dc_min - x) / (D - x)	=	100.924	mm

- 철근의 최대 중심간격

Cc =	80 - 16 / 2	=	72.000	mm	
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]		=	832.311	mm	
최외단철근 평균배근간격;	1000 / 6.7 = 150 mm	<	832.311	mm	**O.K!!**

7) 2층 벽체 하부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1000.00	mm,	dc =	100.00	mm ,
Mo =	476.130	kN· m,	As =	4282.667	mm^2
N =	6.67		n =	7	

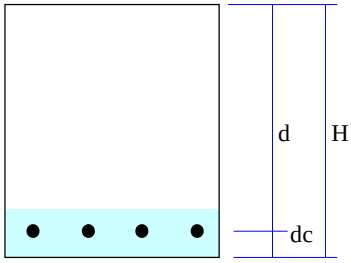
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	216.712	mm
f s = M / (As (d - x / 3))	=	119.832	mm
f st = fs (H -Dc_min - x) / (D - x)	=	119.832	mm

- 철근의 최대 중심간격

Cc =	100 - 29 / 2	=	85.500	mm	
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]		=	443.418	mm	
최외단철근 평균배근간격;	1000 / 6.7 = 150 mm	<	443.418	mm	**O.K!!**

8) 1층 벽체 상부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1000.00	mm,	dc =	100.00	mm ,
Mo =	718.850	kN· m,	As =	4282.667	mm^2
N =	6.67		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 216.712 mm

f s = M / (As (d - x / 3)) = 180.920 mm

f st = fs (H -Dc_min - x) / (D - x) = 180.920 mm

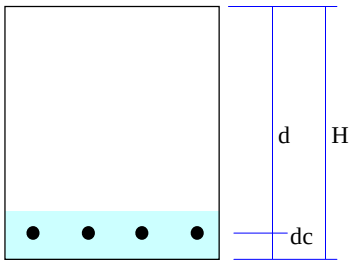
- 철근의 최대 중심간격

Cc = 100 - 29 / 2 = 85.500 mm

S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)] = 221.525 mm

최외단철근 평균배근간격; 1000 / 6.7 = 150 mm < 221.525 mm **O.K!!**

9) 1층 벽체 중앙부(Myy) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1020.00	mm,	dc =	80.00	mm ,
Mo =	373.200	kN· m,	As =	2580.667	mm^2
N =	6.67		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 174.752 mm

f s = M / (As (d - x / 3)) = 150.365 mm

f st = fs (H -Dc_min - x) / (D - x) = 150.365 mm

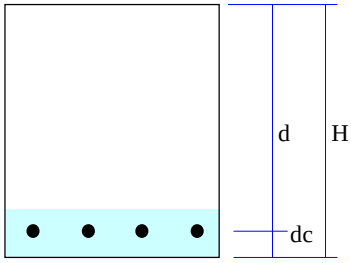
- 철근의 최대 중심간격

Cc = 80 - 22 / 2 = 69.000 mm

S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)] = 525.799 mm

최외단철근 평균배근간격; 1000 / 6.7 = 150 mm < 525.799 mm **O.K!!**

10) 1층 벽체 하부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	1100.00	mm,	B =	1000.00	mm ,
d =	1000.00	mm,	dc =	100.00	mm ,
Mo =	746.510	kN· m,	As =	4282.667	mm^2
N =	6.67		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	216.712	mm
f s = M / (As (d - x / 3))	=	187.882	mm
f st = fs (H -Dc_min - x) / (D - x)	=	187.882	mm

- 철근의 최대 중심간격

Cc = 100 - 29 / 2	=	85.500	mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]	=	205.397	mm

최외단철근 평균배근간격; 1000 / 6.7 = 150 mm < 205.397 mm **O.K!!**

10.3 사용성검토 요약

1) 균열검토 요약

구분		Mo (kN·m)	주철근 (mm)	fs (Mpa)	Cc (mm)	S (mm)	Smin (mm)	비고
2층 벽체 Mxx	단 부	401.430	H22	165	89.0	150	255	O.K
	중앙부	201.100	H16	155	72.0	150	496	O.K
1층 벽체 Mxx	단 부	470.650	H25	149	87.5	150	310	O.K
	중앙부	136.390	H16	105	72.0	150	797	O.K
2층 벽체 Myy	상 부	282.350	H19	156	90.5	150	280	O.K
	중앙부	130.570	H16	101	72.0	150	832	O.K
	하 부	476.130	H29	120	85.5	150	443	O.K
1층 벽체 Myy	상 부	718.850	H29	181	85.5	150	222	O.K
	중앙부	373.200	H22	150	69.0	150	526	O.K
	하 부	746.510	H29	188	85.5	150	205	O.K

2.11 집수정 점검통로 마감벽 #1

목 차

1. 설계개요 및 조건

2. 단면가정

3. 구조해석모델링

4. 하중산정

5. 하중조합

6. 구조해석결과

7. 단면설계

8. 단면설계 요약

9. 우각부보강설계

10. 사용성검토

11. 주철근조립도

1. 설계개요 및 조건

1.1 개요

• Plane Strain의 평면 판요소로 해석

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 단위중량

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	24.5	아스팔트 포장	23.0
흙(지하수위 이상)	19.0	흙(지하수위 이하)	10.0
물	10.0	모르타르	21.5
기계실하중	25.0	무근콘크리트	23.0

(3) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,700 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(4) 토사 내부마찰각 : Φ = 30°

(5) 토압 : K_o = 0.500

1.4 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

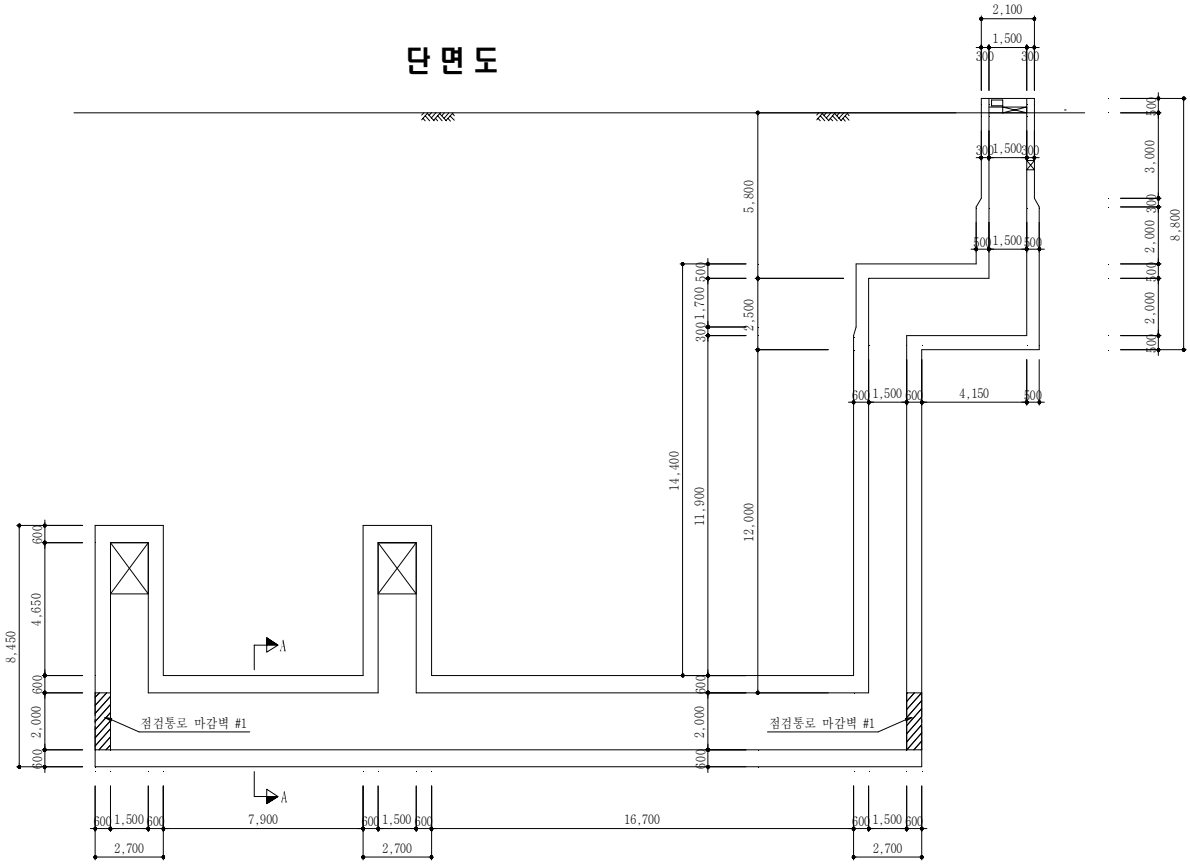
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

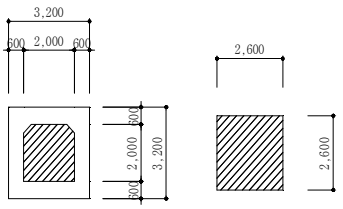
(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면가정

설계적용 토피 = 20.300 m

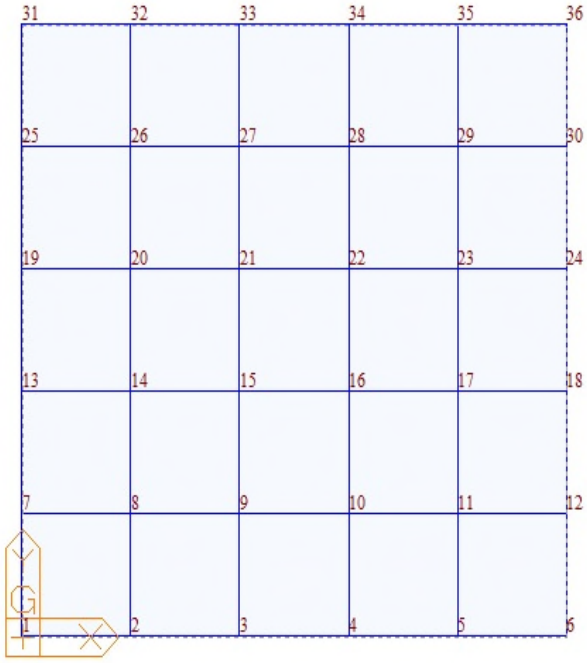




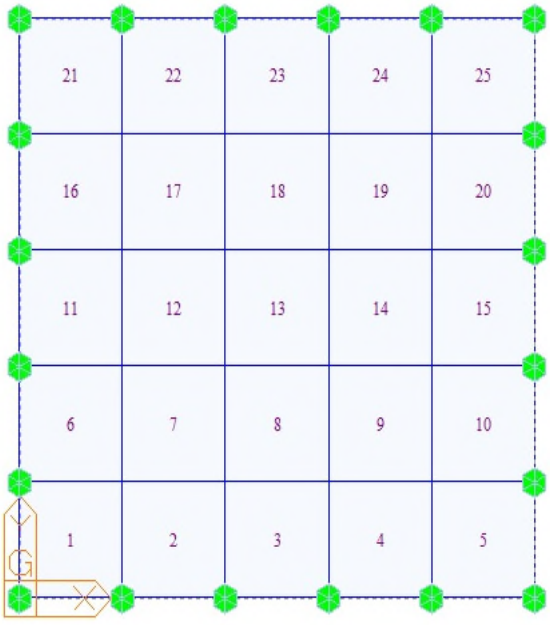
3. 구조해석 모델링

3.1 해석모형

절점



부재 및 경계조건



3.2 단면제원

번 호	폭(m)	높이(m)	단면적(m^2)	단면2차모멘트(m^4)	비 고
1	1.00	0.60	0.600	0.018000	마감벽

4. 하중산정

4.1 고정하중

- 구조물자중 (프로그램에서 자동재하)

4.2 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 20.300 / 3.200 = 6.344

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

Lh1 = 0.500 × 10.000 = 5.000 kN/m²

4.3 수평토압(지하수 無) ---------- LC 2

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + (19.800 + 1.600 / 2) × 19.000)

= 201.450 kN/m²

$q_{N2'}$ = 201.450 + 2.600 × 19.000 × 0.500 = 226.150 kN/m²

4.4 수평 토압(지하수 有) ---------- LC 3

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 19.000 +

(19.300 + 1.600 / 2) × 10.000) = 111.000 kN/m²

q_{N2} = 111.000 + 2.600 × 10.000 × 0.500 = 124.000 kN/m²

4.5 수평 수압(지하수 有) ---------- LC 4

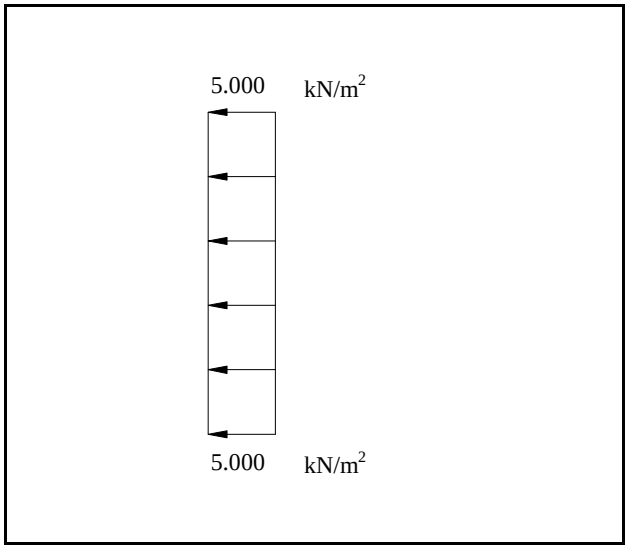
1) 벽체

q_{W1} = 10.000 × (19.300 + 1.600 / 2) = 201.000 kN/m²

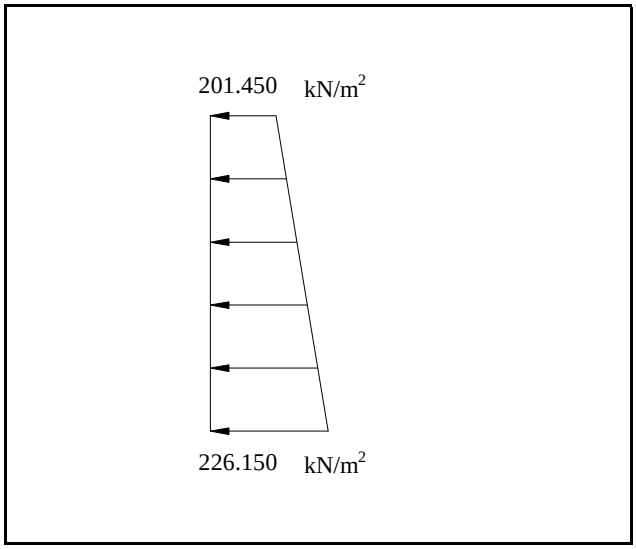
q_{W2} = 201.000 + 2.600 × 10.000 = 227.000 kN/m²

4.6 하중재하도

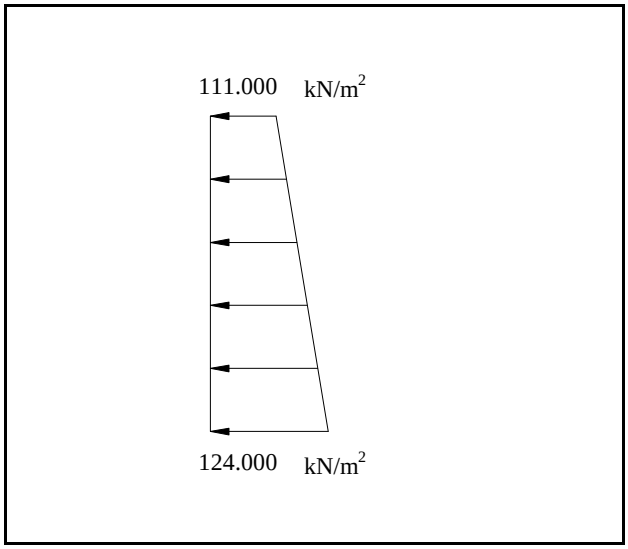
1) 활하중에 의한 측압 ------- LC 1



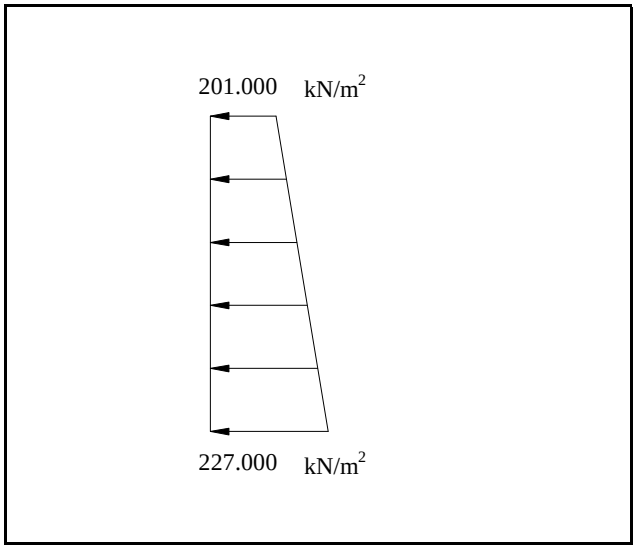
2) 수평 토압(지하수 무) ------- LC 2



3) 수평 토압(지하수 유) ------- LC 3



4) 수평 수압(지하수 유) ------- LC 4



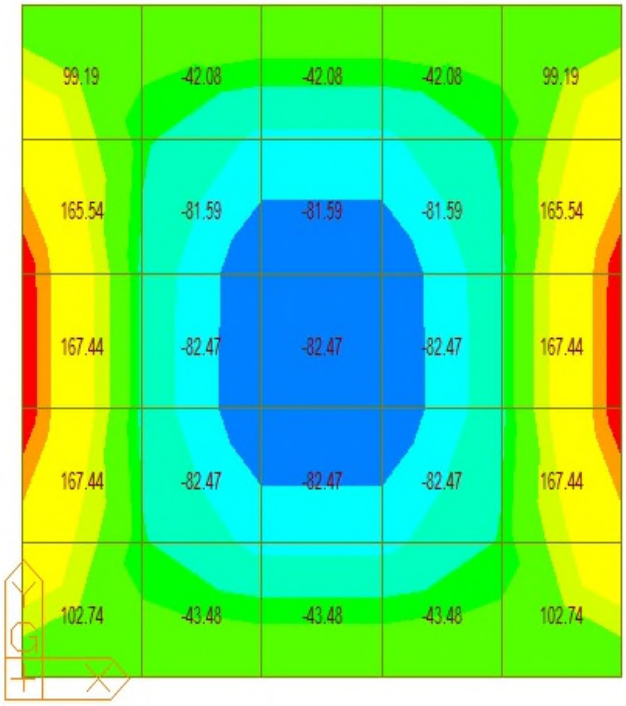
5. 하중조합

하중 조합	활하중	지하수 없을때	지하수 있을때		비고
	수평	수평 토압	수평 토압	수평 수압	
	LC01	LC02	LC03	LC04	
CB01	1.60	1.60			극한하중 조합
CB02		1.60			
CB03	1.60		1.60	1.60	
CB4			1.60	1.60	
CB5	1.00	1.00			사용하중 조합
CB6		1.00			
CB7	1.00		1.00	1.00	
CB8			1.00	1.00	

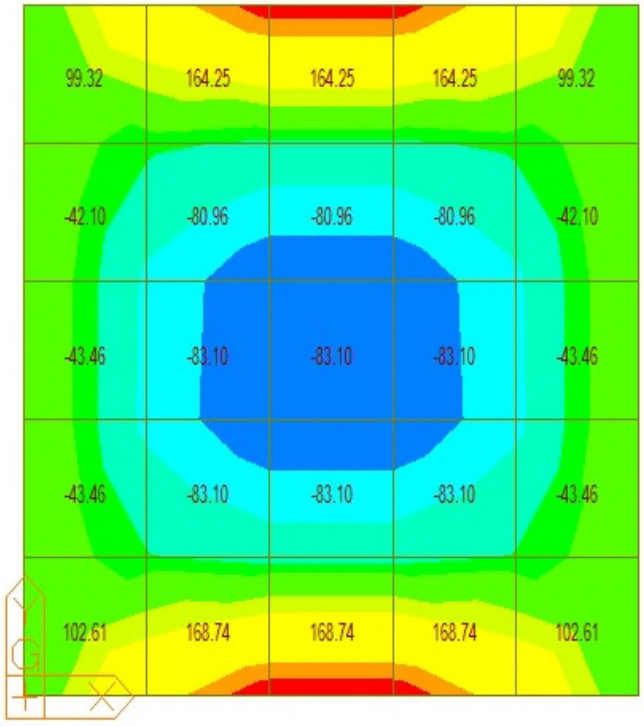
6. 구조해석 결과

6.1 부재력도

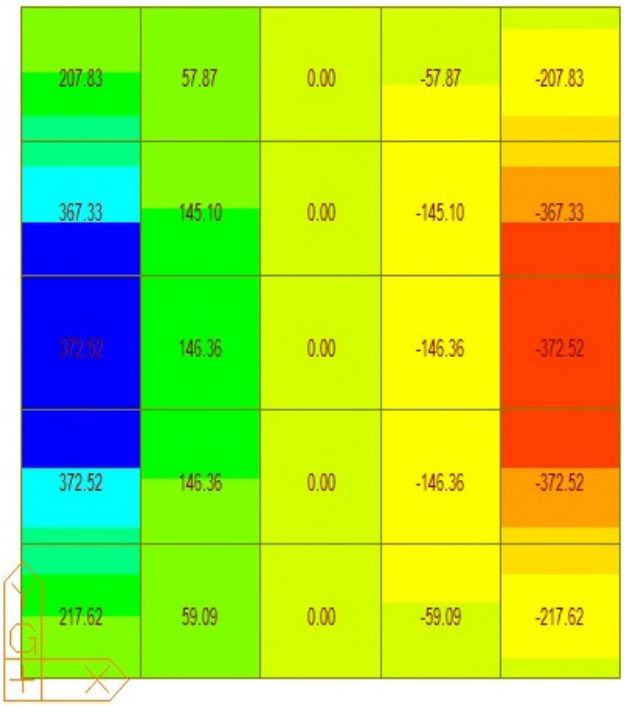
B.M.D (계수하중) [kN·m] : Mxx



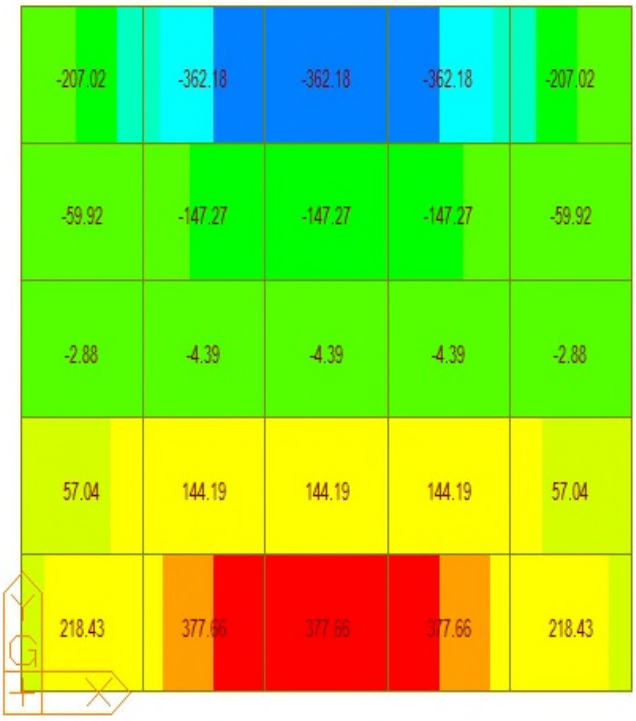
B.M.D (계수하중) [kN·m] : Myy



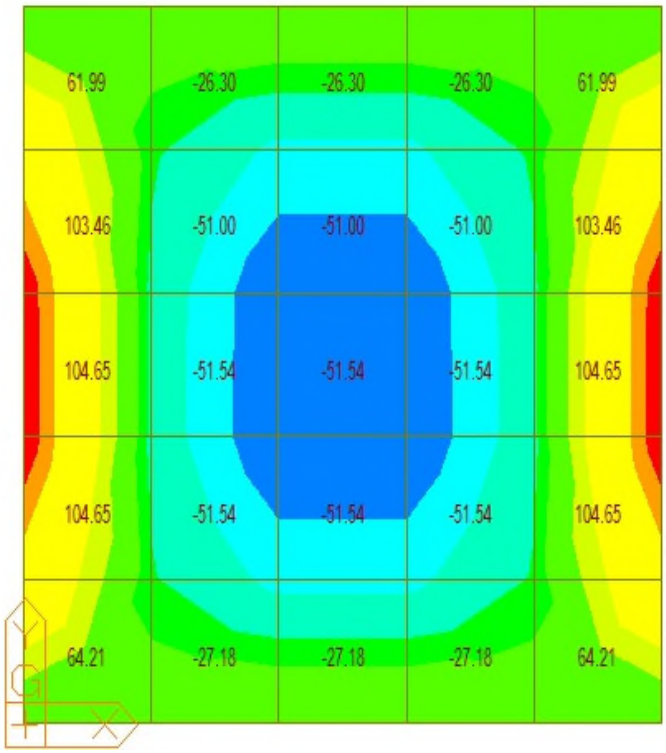
S.F.D (계수하중) [kN] : Vxx



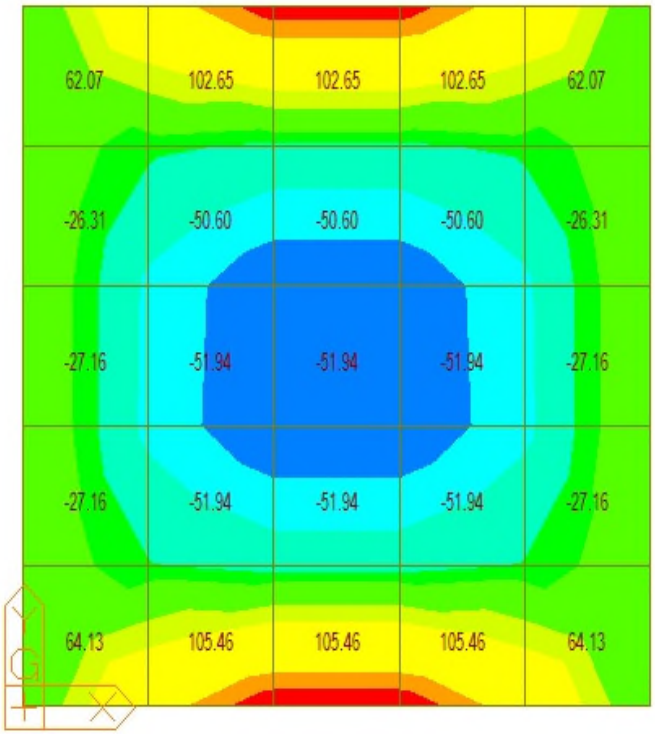
S.F.D (계수하중) [kN] : Vyy



B.M.D (사용하중) [kN·m] : Mxx



B.M.D (사용하중) [kN·m] : Myy



6.2 부재력 집계

구분		계수하중			사용하중	
		Mu(kN·m)	Pu(kN)	Vu(kN)	Mo(kN·m)	Po(kN)
벽체 Mxx	단 부	167.440		372.520	104.650	
	중앙부	82.470			51.540	
벽체 Myy	상 부	164.250		362.180	102.650	
	중앙부	83.100			51.940	
	하 부	168.740		377.660	105.460	

7. 단면검토

1) 벽체 단부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 1336.608 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	104.7
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	500.0	100.0	167.440	372.520

전단설계시 단면의 유효높이 ds = 500.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H19 × 6.67ea = 1910.000 ㎟

∴ P = As / (B × D) = 0.00382

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 33.290 mm

최외단 인장철근 변형률 εt = 0.03530 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 313890737 N·mm

= 313.891 kN·m > 167.440 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a / 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 1002.456 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 324.760 kN

Vu > Φv x Vc ∴ 전단철근보강이 필요하다.

Req Av = (372.5 - 324.760)×10³×150.0 / (400.0×500.0×0.75)

= 47.760 ㎟

Use Av = 211.209 ㎟ (H13×1.67 EA, 간격 s = 150.0 mm)

Øv·Vs = Øv·Av·fy·D / (s × B) = 211.209 kN

s = 150.0 mm < Min (600, 0.5D) = mm ----- ∴ O.K.

Øv·Vn = Øv·Vc + Øv·Vs = 535.969 kN < Vu ----- ∴ O.K.

2) 벽체 중앙부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 626.885 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	51.5
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	520.0	80.0	82.470	0.000

전단설계시 단면의 유효높이 ds = 520.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00255

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.05446 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 228889254 N·mm

= 228.889 kN·m > 82.470 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ／ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 470.164 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 337.750 kN

∴ 전단철근이 필요없음.

3) 벽체 상부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 1310.692 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	102.7
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	500.0	100.0	164.250	362.180

전단설계시 단면의 유효높이 ds = 500.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H19 × 6.67ea = 1910.000 ㎟

∴ P = As / (B × D) = 0.00382

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 33.290 mm

최외단 인장철근 변형률 εt = 0.03530 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 313890737 N·mm

= 313.891 kN·m > 164.250 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 983.019 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 324.760 kN

Vu > Φv x Vc ∴ 전단철근보강이 필요하다.

Req Av = (362.2 - 324.760)×10³×150.0 / (400.0×500.0×0.75)

= 37.420 ㎟

Use Av = 211.209 ㎟ (H13×1.667 EA, 간격 s = 150.0 mm)

Øv·Vs = Øv·Av·fy·D / (s × B) = 211.209 kN

s = 150.0 mm < Min (600, 0.5D) = 250.0 mm ----- ∴ O.K.

Øv·Vn = Øv·Vc + Øv·Vs = 535.969 kN < Vu ----- ∴ O.K.

4) 벽체 중앙부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 631.713 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	51.9
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	520.0	80.0	83.100	0.000

전단설계시 단면의 유효높이 ds = 520.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00255

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.05446 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 228889254 N·mm

= 228.889 kN·m > 83.100 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 473.785 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 337.750 kN

∴ 전단철근이 필요없음.

5) 벽체 하부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 1347.175 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	105.5
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	500.0	100.0	168.740	377.660

전단설계시 단면의 유효높이 ds = 500.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H19 × 6.67ea = 1910.000 ㎟

∴ P = As / (B × D) = 0.00382

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 33.290 mm

최외단 인장철근 변형률 εt = 0.03530 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 313890737 N·mm

= 313.891 kN·m > 168.740 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 1010.381 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : Pmin < P ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 324.760 kN

Vu > Φv x Vc ∴ 전단철근보강이 필요하다.

Req Av = (377.7 - 324.760)×10^3×150.0 / (400.0×500.0×0.75)

= 52.900 ㎟

Use Av = 211.209 ㎟ (H13×1.67 EA, 간격 s = 150.0 mm)

Øv·Vs = Øv·Av·fy·D / (s × B) = 211.209 kN

s = 150.0 mm < Min (600, 0.5D) = 250.0 mm ----- ∴ O.K.

Øv·Vn = Øv·Vc + Øv·Vs = 535.969 kN < Vu ----- ∴ O.K.

8. 단면설계요약

1) 휨설계 요약

구분		Mu (kN·m)	Pu (kN)	사용철근				ΦMn (kN·m)	ΦPn (kN)	안전율	비고
				1단		2단					
벽체 Mxx	단 부	167.440		H19	150	H0	0	313.891		1.87	O.K
	중앙부	82.470		H16	150	H0	0	228.889		2.78	O.K
벽체 Myy	상 부	164.250		H19	150	H0	0	313.891		1.91	O.K
	중앙부	83.100		H16	150	H0	0	228.889		2.75	O.K
	하 부	168.740		H19	150	H0	0	313.891		1.86	O.K

2) 전단설계 요약

구분		Vu (kN·m)	사용철근			ΦVn (kN·m)	안전율	비고
			직경	개수	간격			
벽체 Mxx	단 부	372.520	H13	1.7EA	150	535.969	1.44	O.K
	중앙부	0.000	H13	1.7EA	300	전단철근 필요없음		
벽체 Myy	상 부	362.180	H13	1.7EA	150	535.969	1.48	O.K
	중앙부	0.000	H13	1.7EA	300	전단철근 필요없음		
	하 부	377.660	H13	1.7EA	150	535.969	1.42	O.K

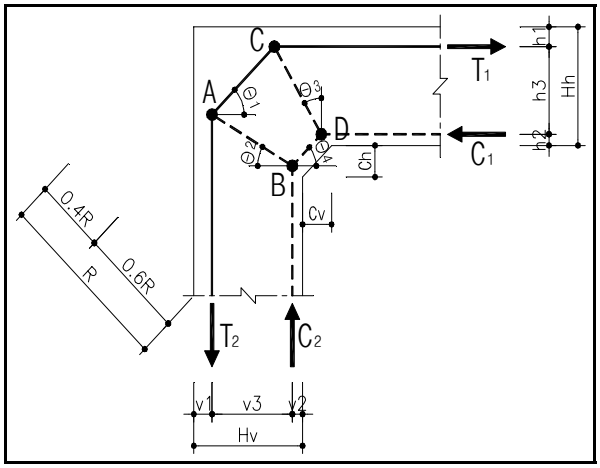
9. 우각부 보강 설계 (스트럿-타이 모델 해석에 의한 라멘접합부 보강)

9.1 벽체 Mxx (단부)

(1) 계산조건

슬래브두께	H_h	=	600.00 mm	벽체 높이	H_v	=	600.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	420.00 mm	벽체측 우력 거리	v_3	=	420.00 mm
수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	167.440 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 848.53 mm

② 사잇각

θ_1 = 45.00°

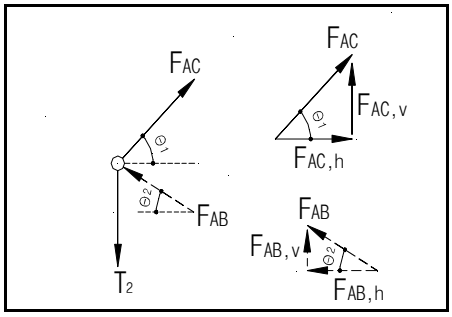
θ_2 = 21.80°

θ_3 = 21.80°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

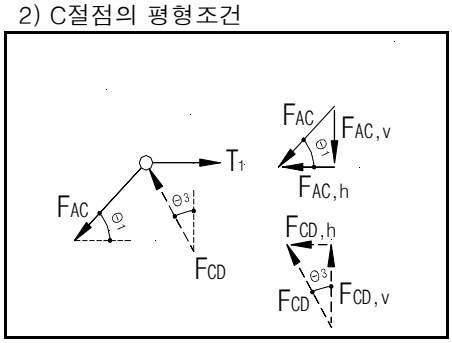
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$

$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \Theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \Theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \Theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \Theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{167.440}{0.420} =$ 398.667 kN

$T_2 = \frac{M_u}{v_3} = \frac{167.440}{0.420} =$ 398.667 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 402.714 kN

식 ⑥ 으로부터

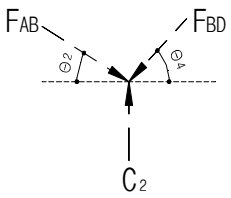
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 402.714 kN

따라서 $F_{AC} =$ **402.714** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 306.698 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 402.714 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 306.698 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	402.714	타이
AB	-306.698	스트럿
BD	-402.714	스트럿
CD	-306.698	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 402.714 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{402,714.148}{0.85 \times 400} = 1,184.45 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	19	@	300	=	955.00	mm^2	(2 cycle)
우각부철근 As	= H	19	@	300	=	955.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**1,910.00**	mm^2	

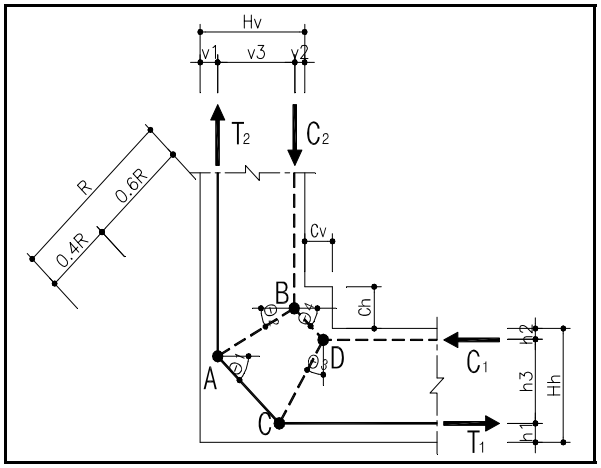
$A_{s,used}$ = 1,910.00 mm^2 > 1,184.45 mm^2 ……O.K

9.2 벽체 Myy (상부)

(1) 계산조건

슬래브두께	H_h	=	600.00 mm	벽체 높이	H_v	=	600.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	420.00 mm	벽체측 우력 거리	v_3	=	420.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	164.250 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 848.53 mm

② 사잇각

θ_1 = 45.00°

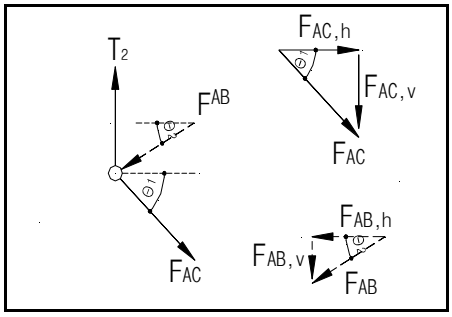
θ_2 = 23.20°

θ_3 = 23.20°

θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\theta_1 + F_{AB} \cdot \sin\theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

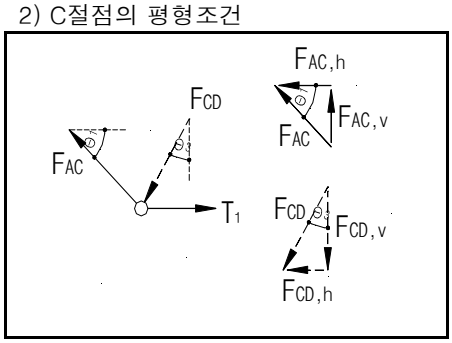
$F_{AC} \cdot \cos\theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\theta_1 + F_{AC} \times \dfrac{\cos\theta_1}{\cos\theta_2} \times \sin\theta_2$

$= F_{AC}(\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{164.250}{0.420} =$ 391.071 kN

$T_2 = \frac{M_u}{v_3} = \frac{164.250}{0.420} =$ 391.071 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 387.141 kN

식 ⑥ 으로부터

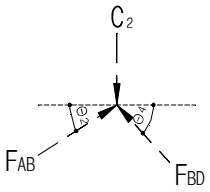
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 387.141 kN

따라서 F_{AC} = **387.141** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 297.831 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 387.141 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 297.831 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	387.141	타이
AB	-297.831	스트럿
BD	-387.141	스트럿
CD	-297.831	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 387.141 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{387,140.963}{0.85 \times 400} = 1,138.65 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	19	@	300	=	955.00	mm^2	(2 cycle)
우각부철근 As	= H	19	@	300	=	955.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**1,910.00**	mm^2	

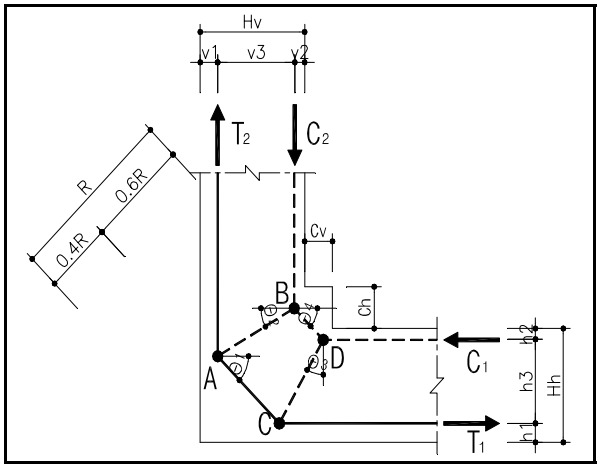
$A_{s,used}$ = 1,910.00 mm^2 > 1,138.65 mm^2 ……O.K

9.3 벽체 Myy (하부)

(1) 계산조건

슬래브두께	H_h	=	600.00 mm	벽체 높이	H_v	=	600.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	420.00 mm	벽체측 우력 거리	v_3	=	420.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	168.740 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 848.53 mm

② 사잇각

Θ_1 = 45.00°

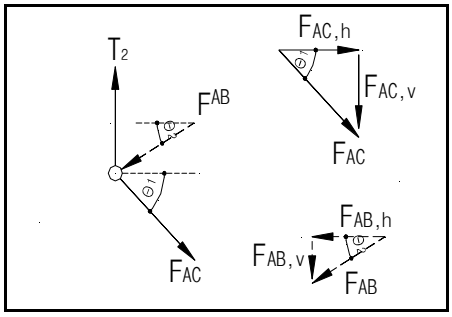
Θ_2 = 23.20°

Θ_3 = 23.20°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

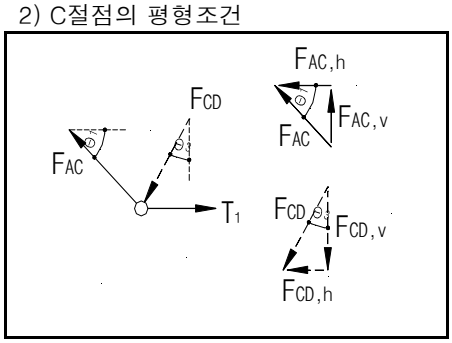
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\Theta$ => $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{168.740}{0.420} =$ 401.762 kN

$T_2 = \frac{M_u}{v_3} = \frac{168.740}{0.420} =$ 401.762 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 397.724 kN

식 ⑥ 으로부터

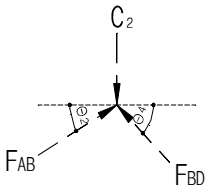
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 397.724 kN

따라서 F_{AC} = **397.724** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 305.973 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 397.724 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 305.973 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	397.724	타이
AB	-305.973	스트럿
BD	-397.724	스트럿
CD	-305.973	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 397.724 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{397,723.994}{0.85 \times 400} = 1,169.78 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	19	@	300	=	955.00	mm^2	(2 cycle)
우각부철근 As	= H	19	@	300	=	955.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**1,910.00**	mm^2	

$A_{s,used}$ = 1,910.00 mm^2 > 1,169.78 mm^2 ……O.K

10. 사용성 검토

10.1 처짐 검토

1) Mxx 벽체 : 최소부재두께 적용

철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	2.000	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.083	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.083m	<	H	=	0.600m	(처짐검토 생략)

2) Myy 벽체 : 최소부재두께 적용

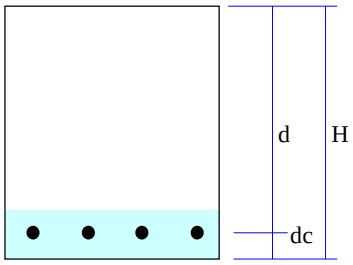
철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	2.000	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.083	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.083m	<	H	=	0.600m	(처짐검토 생략)

10.2 균열 검토

1) 벽체 단부(Mxx) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	500.00	mm,	dc =	100.00	mm ,
Mo =	104.650	kN· m,	As =	1910.000	mm^2
N =	6.67		n =	7	

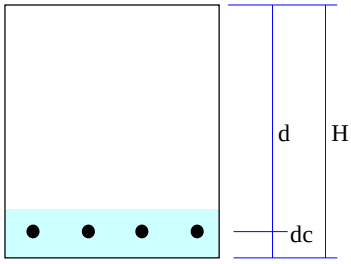
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	103.029	mm
f s = M / (As (d - x / 3))	=	117.663	mm
f st = fs (H -Dc_min - x) / (D - x)	=	117.663	mm

- 철근의 최대 중심간격

Cc =	100	-	19	/	2	=	90.500	mm	
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]	=	443.035	mm	
최외단철근 평균배근간격;	1000	/	6.7	=	150	mm	<	443.035	mm	O.K!!

2) 벽체 중앙부(Mxx) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	520.00	mm,	dc =	80.00	mm ,
Mo =	51.540	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

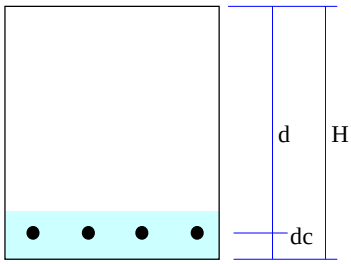
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	89.345	mm
f s = M / (As (d - x / 3))	=	79.409	mm
f st = fs (H -Dc_min - x) / (D - x)	=	79.409	mm

- 철근의 최대 중심간격

Cc =	80	-	16	/	2	=	72.000 mm
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]						=	1057.821 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	1057.821 mm **O.K!!**

3) 벽체 상부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	500.00	mm,	dc =	100.00	mm ,
Mo =	102.650	kN· m,	As =	1910.000	mm^2
N =	6.67		n =	7	

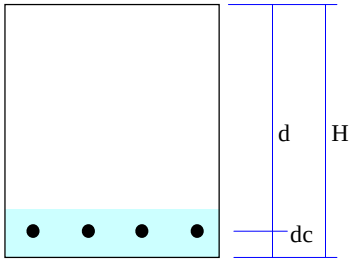
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	103.029	mm
f s = M / (As (d - x / 3))	=	115.414	mm
f st = fs (H -Dc_min - x) / (D - x)	=	115.414	mm

- 철근의 최대 중심간격

Cc =	100	-	19	/	2	=	90.500 mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]						=	456.075 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	456.075 mm **O.K!!**

4) 벽체 중앙부(Myy) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	520.00	mm,	dc =	80.00	mm ,
Mo =	51.940	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

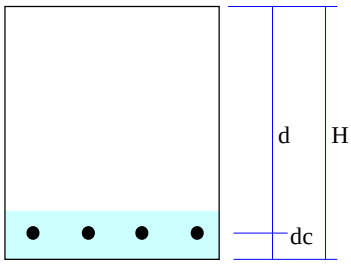
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	89.345	mm
f s = M / (As (d - x / 3))	=	80.025	mm
f st = fs (H -Dc_min - x) / (D - x)	=	80.025	mm

- 철근의 최대 중심간격

Cc =	80	-	16	/	2	=	72.000 mm
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]						=	1049.675 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	1049.675 mm **O.K!!**

5) 벽체 하부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	500.00	mm,	dc =	100.00	mm ,
Mo =	105.460	kN· m,	As =	1910.000	mm^2
N =	6.67		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	103.029	mm
f s = M / (As (d - x / 3))	=	118.574	mm
f st = fs (H -Dc_min - x) / (D - x)	=	118.574	mm

- 철근의 최대 중심간격

Cc =	100	-	19	/	2	=	90.500 mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]						=	437.894 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	437.894 mm **O.K!!**

10.3 사용성검토 요약

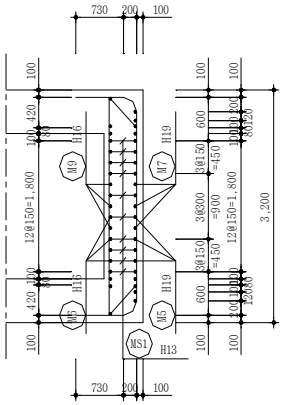
1) 균열검토 요약

구분		Mo (kN·m)	주철근 (mm)	fs (Mpa)	Cc (mm)	S (mm)	Smin (mm)	비고
벽체 Mxx	단 부	104.650	H19	118	90.5	150	443	**O.K**
	중앙부	51.540	H16	79	72.0	150	1058	**O.K**
벽체 Myy	상 부	102.650	H19	115	90.5	150	456	**O.K**
	중앙부	51.940	H16	80	72.0	150	1050	**O.K**
	하 부	105.460	H19	119	90.5	150	438	**O.K**

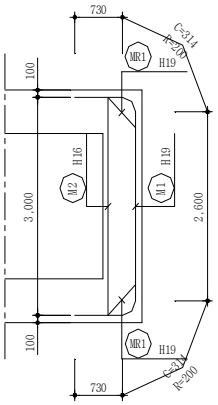
11. 주철근 조립도

Mxx 방향 표준단면도 및 주철근 조립도

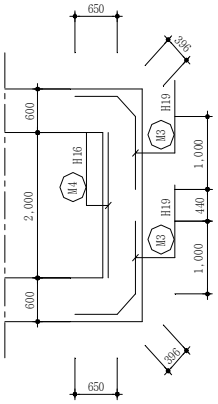
표 준 단 면 도



CYCLE-1 (@300)

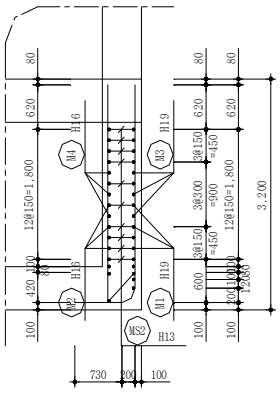


CYCLE-2 (@300)

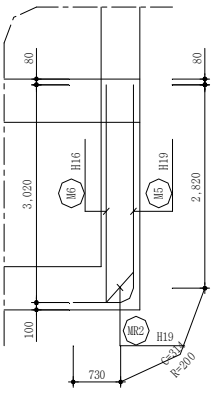


Myy 방향 표준단면도 및 주철근 조립도

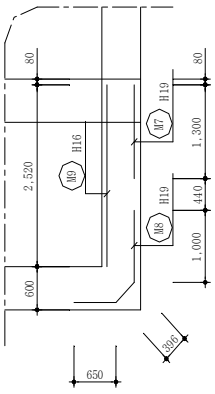
표 준 단 면 도



CYCLE-1 (@300)



CYCLE-2 (@300)



2.12 집수정 점검통로 마감벽 #2

목 차

1. 설계개요 및 조건

2. 단면가정

3. 구조해석모델링

4. 하중산정

5. 하중조합

6. 구조해석결과

7. 단면설계

8. 단면설계 요약

9. 우각부보강설계

10. 사용성검토

11. 주철근조립도

1. 설계개요 및 조건

1.1 개요

• Plane Strain의 평면 판요소로 해석

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 단위중량

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	24.5	아스팔트 포장	23.0
흙(지하수위 이상)	19.0	흙(지하수위 이하)	10.0
물	10.0	모르타르	21.5
기계실하중	25.0	무근콘크리트	23.0

(3) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,700 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(4) 토사 내부마찰각 : Φ = 30°

(5) 토압 : K_o = 0.500

1.4 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

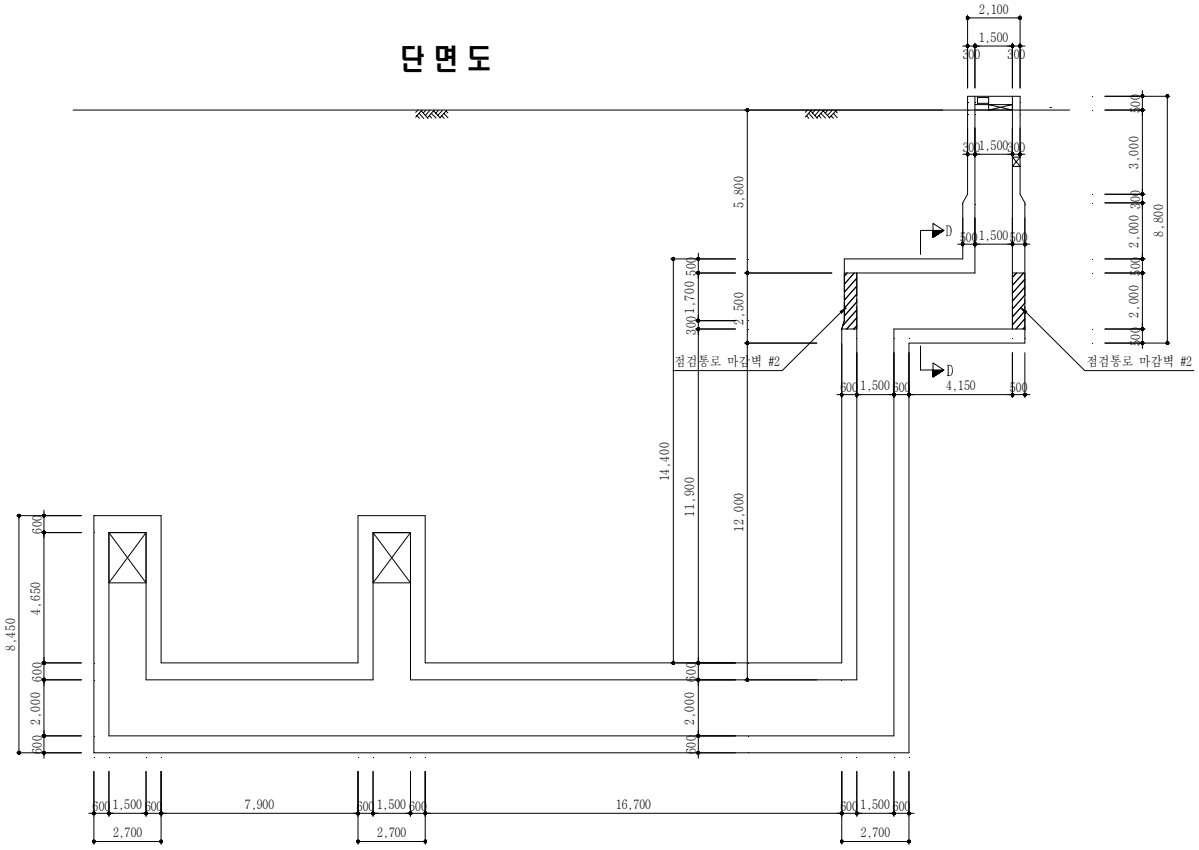
(3) KR-Code (철도시설공단, 2012)

(4) 도시철도 내진설계기준 (국토교통부, 2013)

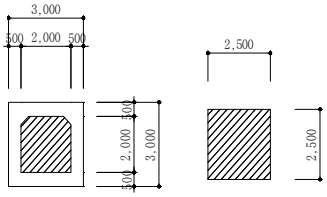
2. 단면가정

설계적용 토피 = 5.800 m

단 면 도



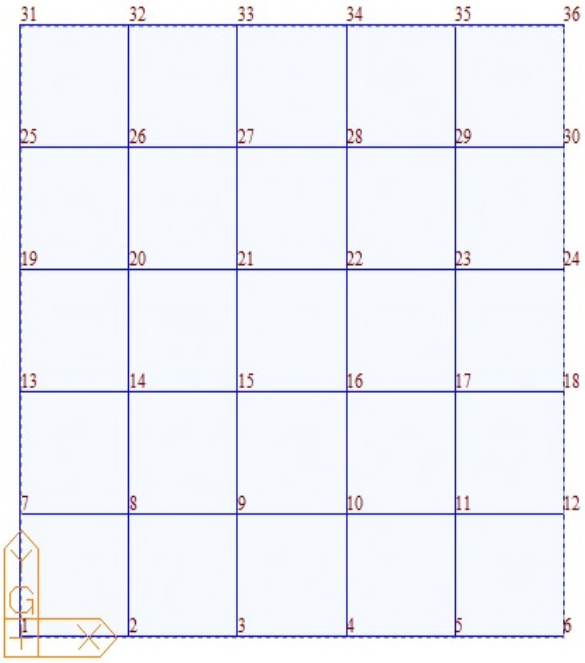
단 면 D-D



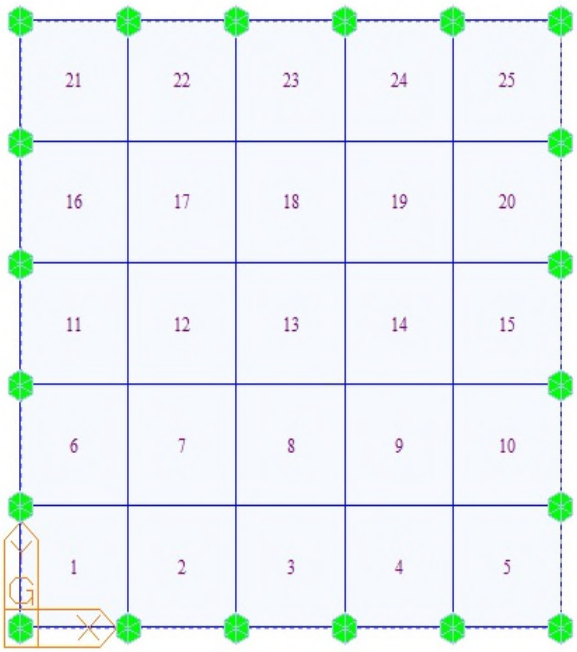
3. 구조해석 모델링

3.1 해석모형

절점



부재 및 경계조건



3.2 단면제원

번 호	폭(m)	높이(m)	단면적(m²)	단면2차모멘트(m⁴)	비 고
1	1.00	0.50	0.500	0.010417	마감벽

4. 하중산정

4.1 고정하중

- 구조물자중 (프로그램에서 자동재하)

4.2 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중 (Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 5.800 / 3.000 = 1.933

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

Lh1 = 0.500 × 10.000 = 5.000 kN/m²

4.3 수평토압(지하수 無) ---------- LC 2

$q_{N1'}$ = 0.500 × (0.500 × 23.000 + (5.300 + 1.600 / 2) × 19.000)

= 63.700 kN/m²

$q_{N2'}$ = 63.700 + 2.500 × 19.000 × 0.500 = 87.450 kN/m²

4.4 수평 토압(지하수 有) ---------- LC 3

q_{N1} = 0.500 × (0.500 × 23.000 + 0.500 × 19.000 +

(4.800 + 1.600 / 2) × 10.000) = 38.500 kN/m²

q_{N2} = 38.500 + 2.500 × 10.000 × 0.500 = 51.000 kN/m²

4.5 수평 수압(지하수 有) ---------- LC 4

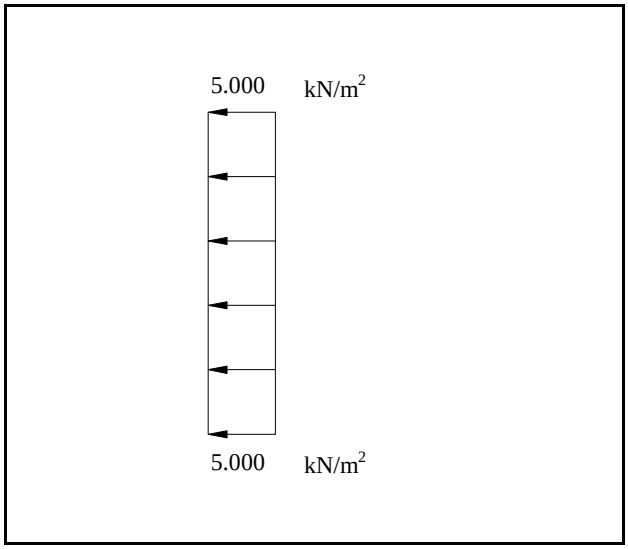
1) 벽체

q_{W1} = 10.000 × (4.800 + 1.600 / 2) = 56.000 kN/m²

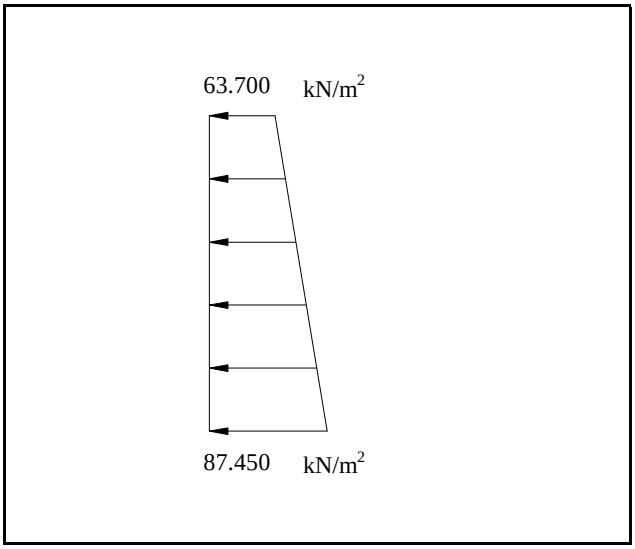
q_{W2} = 56.000 + 2.500 × 10.000 = 81.000 kN/m²

4.6 하중재하도

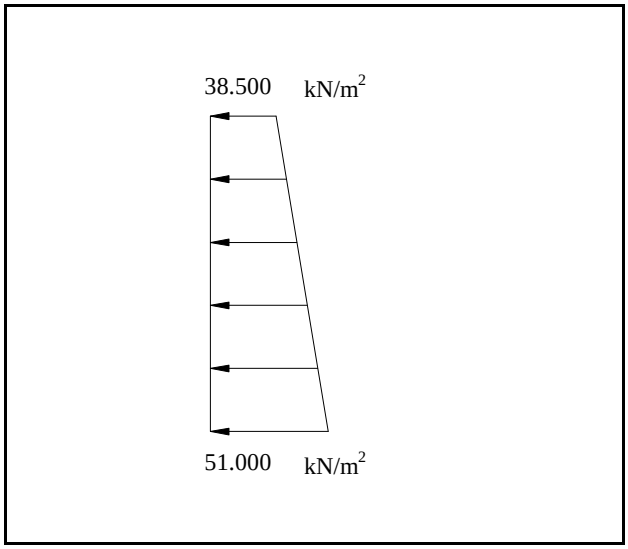
1) 활하중에 의한 측압 ------- LC 1



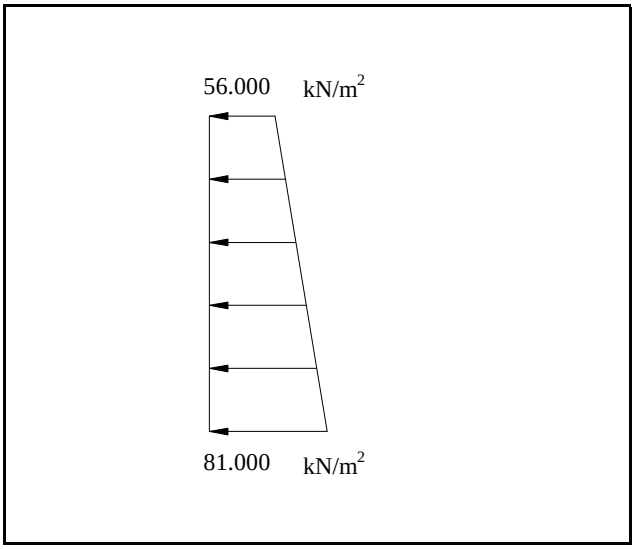
2) 수평 토압(지하수 무) ------- LC 2



3) 수평 토압(지하수 유) ------- LC 3



4) 수평 수압(지하수 유) ------- LC 4



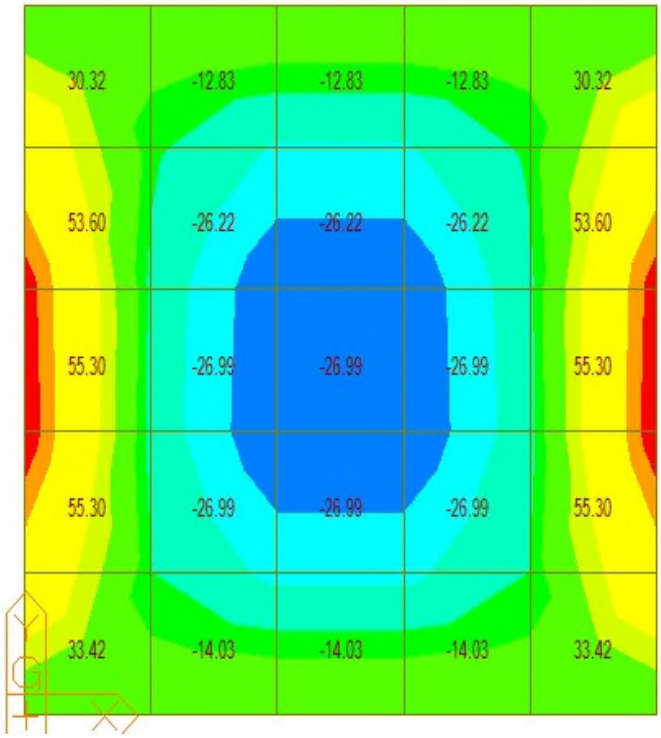
5. 하중조합

하중 조합	활하중	지하수 없을때	지하수 있을때		비고
	수평	수평 토압	수평 토압	수평 수압	
	LC01	LC02	LC03	LC04	
CB01	1.60	1.60			극한하중 조합
CB02		1.60			
CB03	1.60		1.60	1.60	
CB4			1.60	1.60	
CB5	1.00	1.00			사용하중 조합
CB6		1.00			
CB7	1.00		1.00	1.00	
CB8			1.00	1.00	

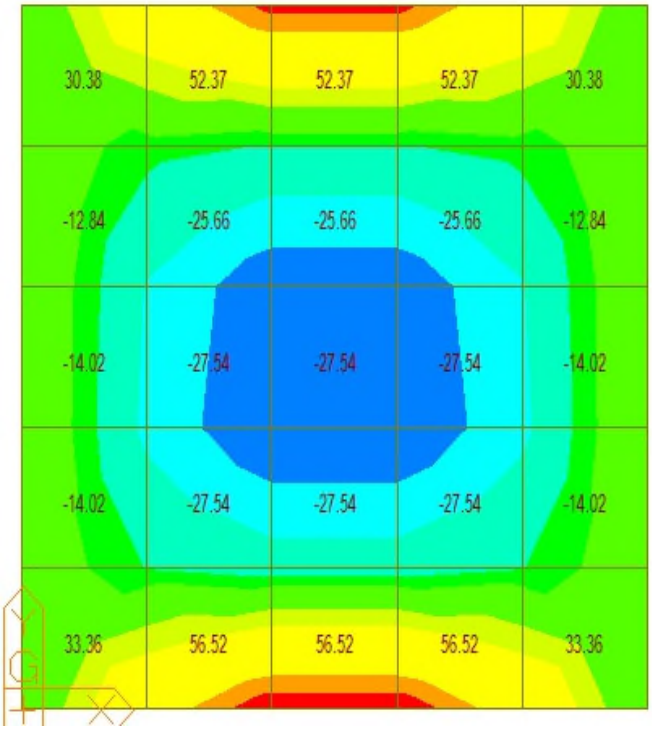
6. 구조해석 결과

6.1 부재력도

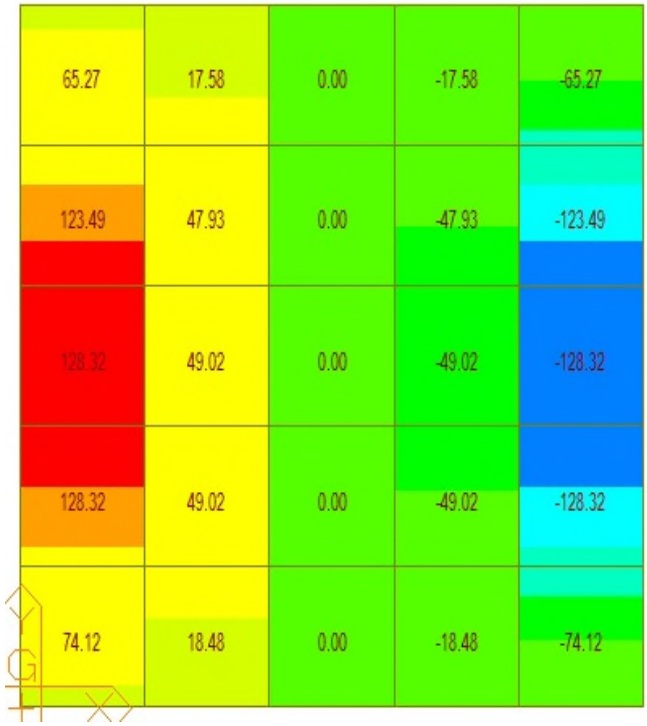
B.M.D (계수하중) [kN·m] : Mxx



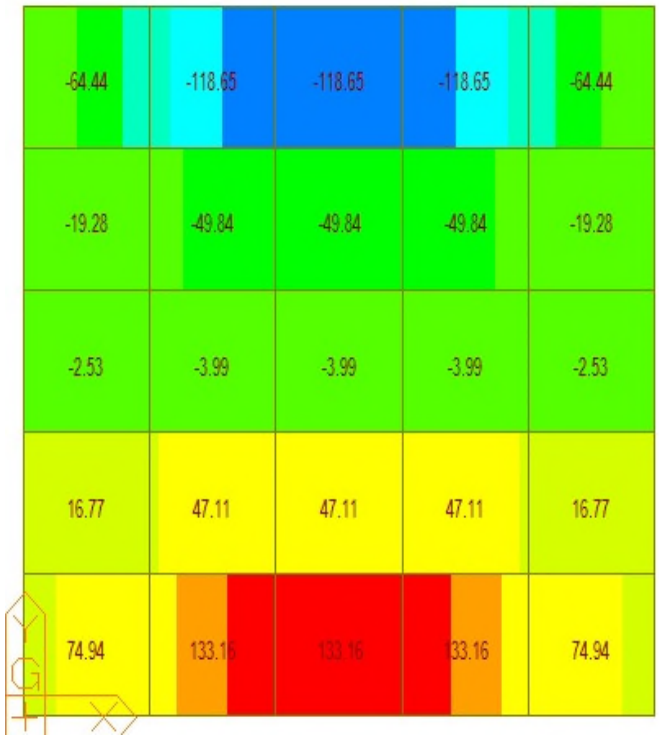
B.M.D (계수하중) [kN·m] : Myy



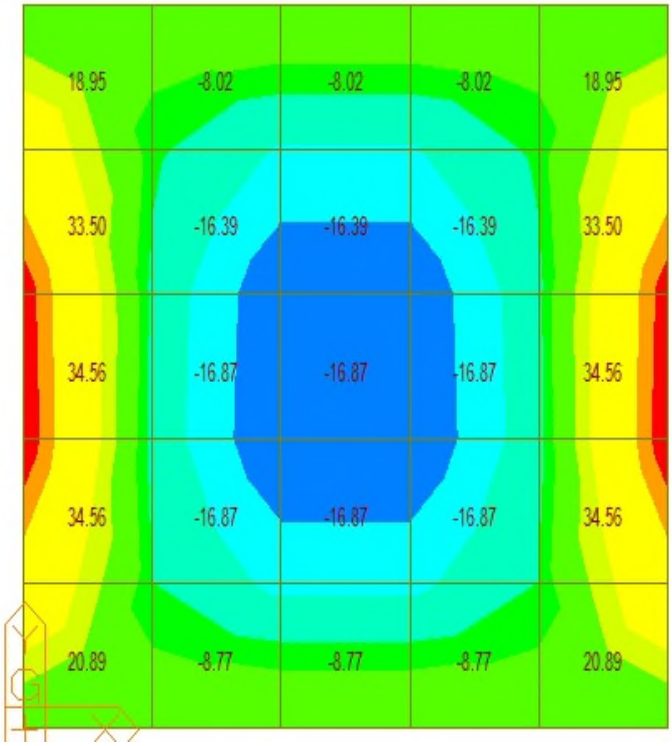
S.F.D (계수하중) [kN] : Vxx



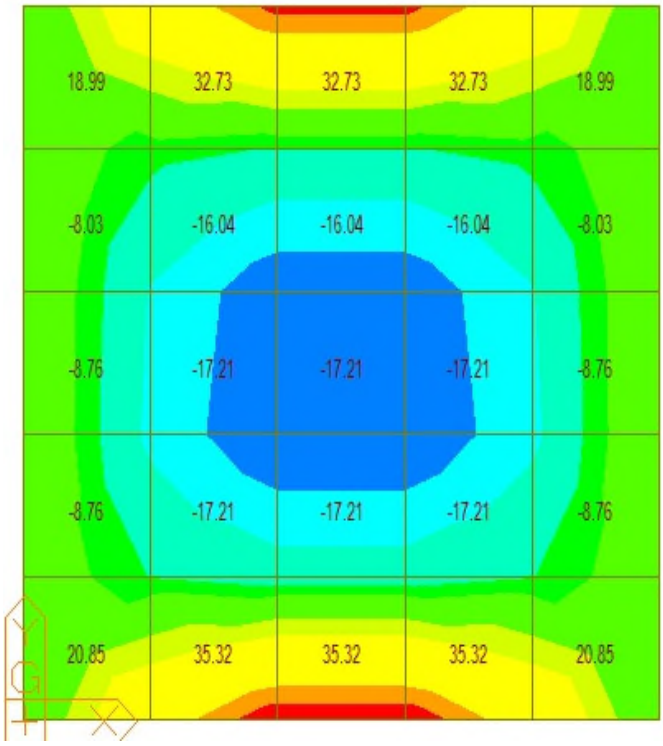
S.F.D (계수하중) [kN] : Vyy



B.M.D (사용하중) [kN·m] : Mxx



B.M.D (사용하중) [kN·m] : Myy



6.2 부재력 집계

구분		계수하중			사용하중	
		Mu(kN·m)	Pu(kN)	Vu(kN)	Mo(kN·m)	Po(kN)
벽체 Mxx	단 부	55.300		128.320	34.560	
	중앙부	26.990			16.870	
벽체 Myy	상 부	52.370		118.650	32.730	
	중앙부	27.540			17.210	
	하 부	56.520		133.160	35.320	

7. 단면검토

1) 벽체 단부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 547.047 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	34.6
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	400.0	100.0	55.300	128.320

전단설계시 단면의 유효높이 ds = 400.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00331

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.04120 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 174870054 N·mm

= 174.870 kN·m > 55.300 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 410.285 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 259.808 kN

∴ 전단철근이 필요없음.

2) 벽체 중앙부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 253.004 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	16.9
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	420.0	80.0	26.990	0.000

전단설계시 단면의 유효높이 ds = 420.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00315

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.04341 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 183873254 N·mm

= 183.873 kN·m > 26.990 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 189.753 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 272.798 kN

∴ 전단철근이 필요없음.

3) 벽체 상부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 517.813 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	32.7
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	400.0	100.0	52.370	118.650

전단설계시 단면의 유효높이 ds = 400.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00331

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.04120 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 174870054 N·mm

= 174.870 kN·m > 52.370 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 388.359 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 259.808 kN

∴ 전단철근이 필요없음.

4) 벽체 중앙부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 258.180 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	17.2
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	420.0	80.0	27.540	0.000

전단설계시 단면의 유효높이 ds = 420.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00315

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.04341 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 183873254 N·mm

= 183.873 kN·m > 27.540 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 193.635 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 272.798 kN

∴ 전단철근이 필요없음.

5) 벽체 하부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 559.228 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	35.3
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	500.0	400.0	100.0	56.520	133.160

전단설계시 단면의 유효높이 ds = 400.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00331

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.04120 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 174870054 N·mm

= 174.870 kN·m > 56.520 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 419.421 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 259.808 kN

1/2 x Φv x Vc = 129.904 kN ≤ Vu ≤Φv x Vc ∴ 최소전단 철근을 배근하는것이 좋다.

Req Av = 0.35×bw×s / fy = 0.35×1,000.0×150.0 / 400.0

= 131.250 ㎟

Use Av = 211.209 ㎟ (H13×1.67 EA, 간격 s = 150.0 mm) ≥ req.Av ----- ∴ O.K.

s = 150.0 mm < Min (600, 0.5D) = 200.0 mm ----- ∴ O.K.

8. 단면설계요약

1) 휨설계 요약

구분		Mu (kN·m)	Pu (kN)	사용철근				ΦMn (kN·m)	ΦPn (kN)	안전율	비고
				1단		2단					
벽체 Mxx	단 부	55.300		H16	150	H0	0	174.870		3.16	O.K
	중앙부	26.990		H16	150	H0	0	183.873		6.81	O.K
벽체 Myy	상 부	52.370		H16	150	H0	0	174.870		3.34	O.K
	중앙부	27.540		H16	150	H0	0	183.873		6.68	O.K
	하 부	56.520		H16	150	H0	0	174.870		3.09	O.K

2) 전단설계 요약

구분		Vu (kN·m)	사용철근			ΦVn (kN·m)	안전율	비고
			직경	개수	간격			
벽체 Mxx	단 부	128.320	H13	1.7EA	150	전단철근 필요없음		
	중앙부	0.000	H13	1.7EA	300	전단철근 필요없음		
벽체 Myy	상 부	118.650	H13	1.7EA	150	전단철근 필요없음		
	중앙부	0.000	H13	1.7EA	300	전단철근 필요없음		
	하 부	133.160	H13	1.7EA	150	428.775	3.22	O.K

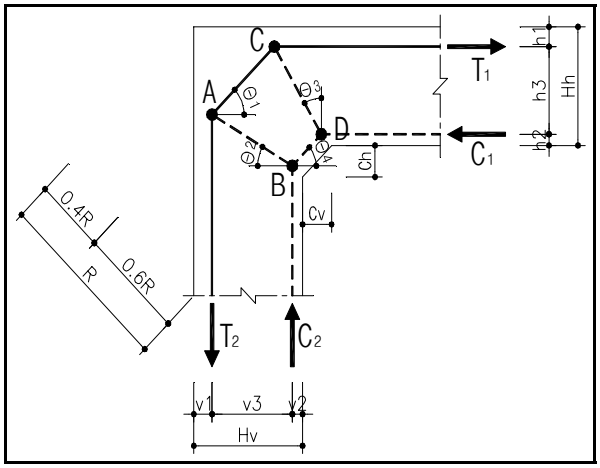
9. 우각부 보강 설계 (스트럿-타이 모델 해석에 의한 라멘접합부 보강)

9.1 벽체 Mxx (단부)

(1) 계산조건

슬래브두께	H_h	=	500.00 mm	벽체 높이	H_v	=	500.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	320.00 mm	벽체측 우력 거리	v_3	=	320.00 mm
수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	55.300 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 707.11 mm

② 사잇각

Θ_1 = 45.00°

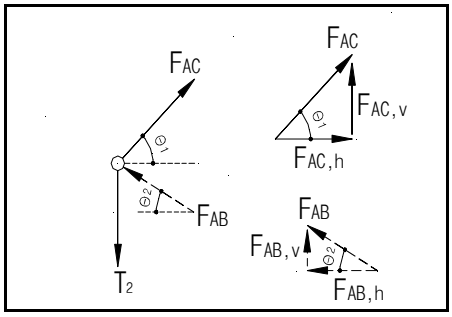
Θ_2 = 27.98°

Θ_3 = 27.98°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

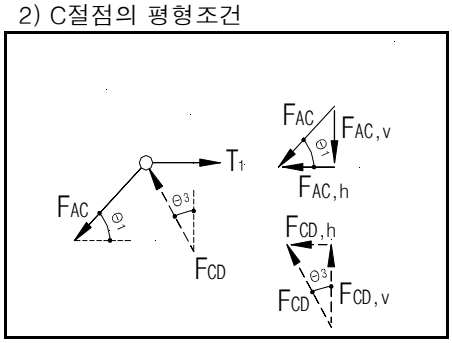
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\Theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\Theta_3$

$\Sigma V = 0$:

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\epsilon = F_{CD} \cdot \cos\Theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \dfrac{\sin\Theta_1}{\cos\Theta_3}$

$\Sigma H = 0$:

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \dfrac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \dfrac{M_u}{h_3} = \dfrac{55.300}{0.320} =$ 172.813 kN

$T_2 = \dfrac{M_u}{v_3} = \dfrac{55.300}{0.320} =$ 172.813 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \dfrac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 159.604 kN

식 ⑥ 으로부터

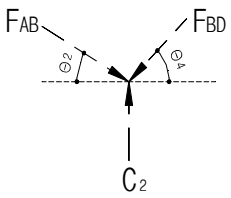
$F_{AC} = \dfrac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 159.604 kN

따라서 $F_{AC} =$ **159.604** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 127.794 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 159.604 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 127.794 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	159.604	타이
AB	-127.794	스트럿
BD	-159.604	스트럿
CD	-127.794	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 159.604 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{159,604.102}{0.85 \times 400} = 469.42 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	16	@	300	=	662.00	mm^2	(2 cycle)
우각부철근 As	= H	0	@	0	=	0.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**662.00**	mm^2	

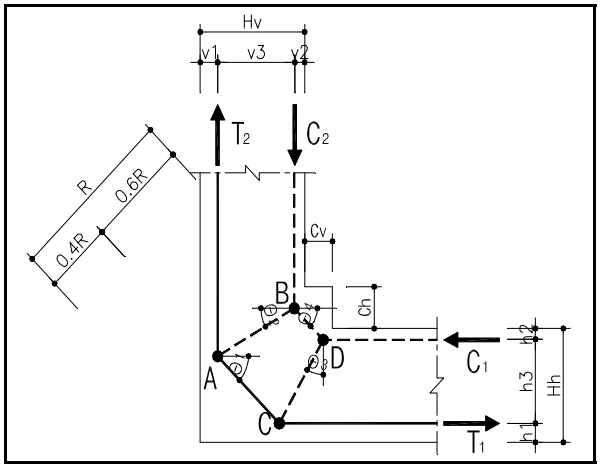
$A_{s,used}$ = 662.00 mm^2 > 469.42 mm^2 ……O.K

9.2 벽체 Myy (상부)

(1) 계산조건

슬래브두께	H_h	=	500.00 mm	벽체 높이	H_v	=	500.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	320.00 mm	벽체측 우력 거리	v_3	=	320.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	52.370 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 707.11 mm

② 사잇각

Θ_1 = 45.00°

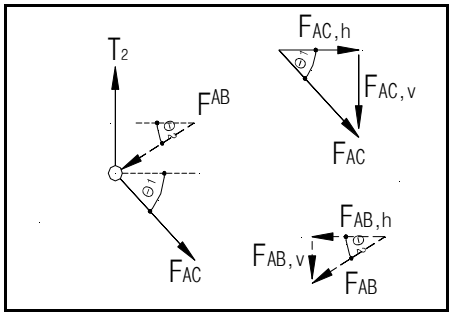
Θ_2 = 29.36°

Θ_3 = 29.36°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

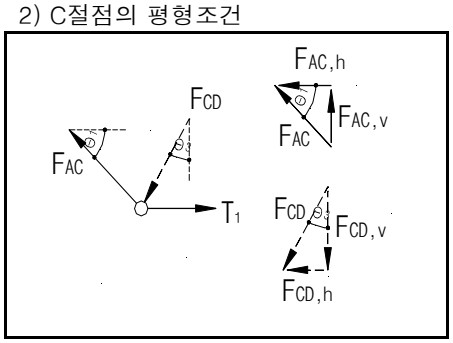
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\Theta$ => $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{52.370}{0.320} =$ 163.656 kN

$T_2 = \frac{M_u}{v_3} = \frac{52.370}{0.320} =$ 163.656 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 148.125 kN

식 ⑥ 으로부터

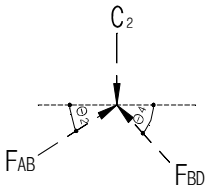
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 148.125 kN

따라서 F_{AC} = **148.125** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 120.173 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 148.125 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 120.173 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	148.125	타이
AB	-120.173	스트럿
BD	-148.125	스트럿
CD	-120.173	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 148.125 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{148,124.729}{0.85 \times 400} = 435.66 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	16	@	300	=	662.00	mm^2	(2 cycle)
우각부철근 As	= H	0	@	0	=	0.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**662.00**	mm^2	

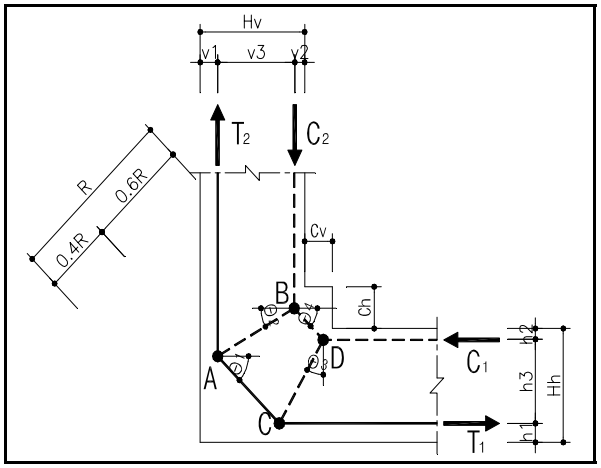
$A_{s,used}$ = 662.00 mm^2 > 435.66 mm^2 ……O.K

9.3 벽체 Myy (하부)

(1) 계산조건

슬래브두께	H_h	=	500.00 mm	벽체 높이	H_v	=	500.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	320.00 mm	벽체측 우력 거리	v_3	=	320.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	56.520 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 707.11 mm

② 사잇각

Θ_1 = 45.00°

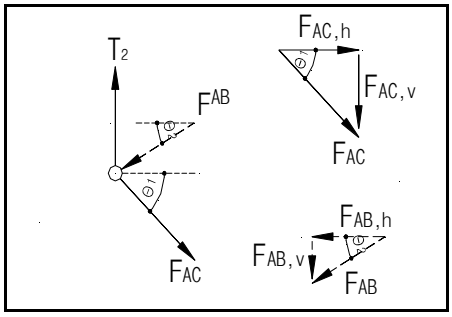
Θ_2 = 29.36°

Θ_3 = 29.36°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

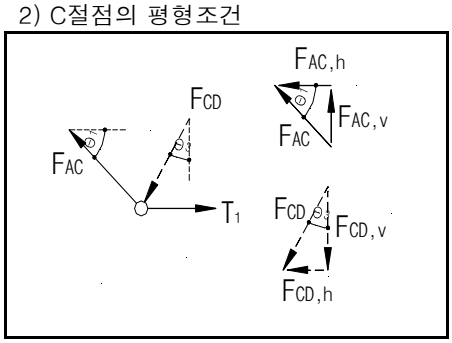
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\epsilon = F_{CD} \cdot \cos\theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\theta_1}{\cos\theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\theta_1 + F_{AC} \times \frac{\sin\theta_1}{\cos\theta_3} \times \sin\theta_3$

$= F_{AC}(\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{56.520}{0.320} =$ 176.625 kN

$T_2 = \frac{M_u}{v_3} = \frac{56.520}{0.320} =$ 176.625 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\theta_1 + \cos\theta_1 \cdot \tan\theta_2} =$ 159.863 kN

식 ⑥ 으로부터

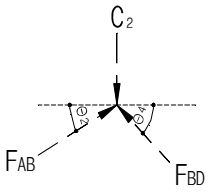
$F_{AC} = \frac{T_1}{\cos\theta_1 + \sin\theta_1 \cdot \tan\theta_3} =$ 159.863 kN

따라서 F_{AC} = **159.863** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 129.696 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 159.863 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 129.696 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	159.863	타이
AB	-129.696	스트럿
BD	-159.863	스트럿
CD	-129.696	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 159.863 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{159,862.701}{0.85 \times 400} = 470.18 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	16	@	300	=	662.00	mm^2	(2 cycle)
우각부철근 As	= H	0	@	0	=	0.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**662.00**	mm^2	

$A_{s,used}$ = 662.00 mm^2 > 470.18 mm^2 ……O.K

10. 사용성 검토

10.1 처짐 검토

1) Mxx 벽체 : 최소부재두께 적용

철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	2.000	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.083	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.083m	<	H	=	0.500m	(처짐검토 생략)

2) Myy 벽체 : 최소부재두께 적용

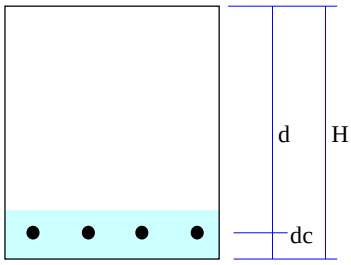
철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	2.000	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.083	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.083m	<	H	=	0.500m	(처짐검토 생략)

10.2 균열 검토

1) 벽체 단부(Mxx) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	500.00	mm,	B =	1000.00	mm ,
d =	400.00	mm,	dc =	100.00	mm ,
Mo =	34.560	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

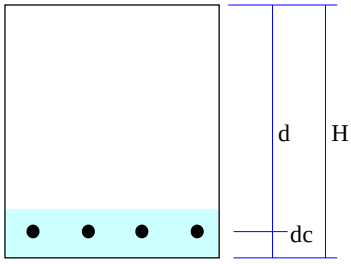
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	77.336	mm
f s = M / (As (d - x / 3))	=	69.752	mm
f st = fs (H -Dc_min - x) / (D - x)	=	69.752	mm

- 철근의 최대 중심간격

Cc =	100	-	16	/	2	=	92.000	mm	
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]						=	898.998	mm	
최외단철근 평균배근간격;	1000	/	6.7	=	150	mm	<	898.998	mm	**O.K!!**

2) 벽체 중앙부(Mxx) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	500.00	mm,	B =	1000.00	mm ,
d =	420.00	mm,	dc =	80.00	mm ,
Mo =	16.870	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

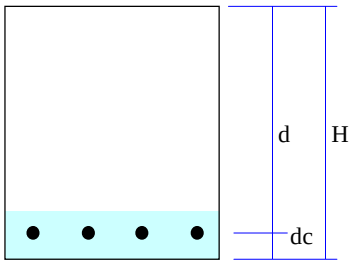
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	79.451	mm
f s = M / (As (d - x / 3))	=	32.379	mm
f st = fs (H -Dc_min - x) / (D - x)	=	32.379	mm

- 철근의 최대 중심간격

Cc =	80 - 16 / 2	=	72.000	mm	
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]		=	2594.269	mm	
최외단철근 평균배근간격;	1000 / 6.7 = 150 mm	<	2594.269	mm	O.K!!

3) 벽체 상부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	500.00	mm,	B =	1000.00	mm ,
d =	400.00	mm,	dc =	100.00	mm ,
Mo =	32.730	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

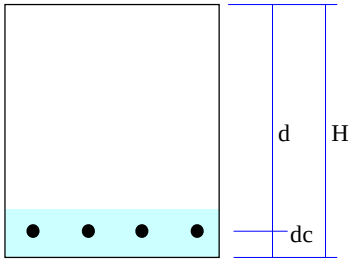
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	77.336	mm
f s = M / (As (d - x / 3))	=	66.059	mm
f st = fs (H -Dc_min - x) / (D - x)	=	66.059	mm

- 철근의 최대 중심간격

Cc =	100 - 16 / 2	=	92.000	mm	
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]		=	953.698	mm	
최외단철근 평균배근간격;	1000 / 6.7 = 150 mm	<	953.698	mm	O.K!!

4) 벽체 중앙부(Myy) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,	
H =	500.00	mm,	B =	1000.00	mm ,	
d =	420.00	mm,	dc =	80.00	mm ,	
Mo =	17.210	kN· m,	As =	1324.000	mm^2	
N =	6.67		n =	7		

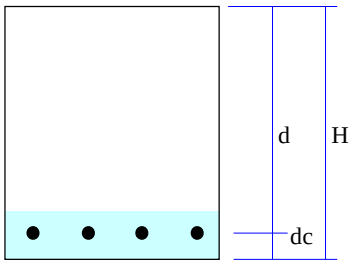
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	79.451	mm
f s = M / (As (d - x / 3))	=	33.032	mm
f st = fs (H -Dc_min - x) / (D - x)	=	33.032	mm

- 철근의 최대 중심간격

Cc =	80	-	16	/	2	=	72.000 mm
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]						=	2543.017 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	2543.017 mm **O.K!!**

5) 벽체 하부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,	
H =	500.00	mm,	B =	1000.00	mm ,	
d =	400.00	mm,	dc =	100.00	mm ,	
Mo =	35.320	kN· m,	As =	1324.000	mm^2	
N =	6.67		n =	7		

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	77.336	mm
f s = M / (As (d - x / 3))	=	71.286	mm
f st = fs (H -Dc_min - x) / (D - x)	=	71.286	mm

- 철근의 최대 중심간격

Cc =	100	-	16	/	2	=	92.000 mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]						=	874.705 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	874.705 mm **O.K!!**

10.3 사용성검토 요약

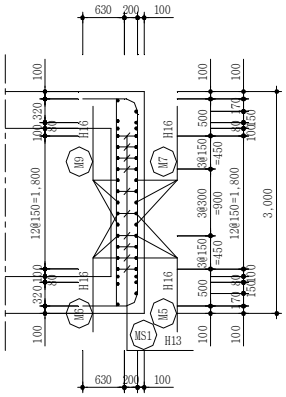
1) 균열검토 요약

구분		Mo (kN·m)	주철근 (mm)	fs (Mpa)	Cc (mm)	S (mm)	Smin (mm)	비고
벽체 Mxx	단 부	34.560	H16	70	92.0	150	899	O.K
	중앙부	16.870	H16	32	72.0	150	2594	O.K
벽체 Myy	상 부	32.730	H16	66	92.0	150	954	O.K
	중앙부	17.210	H16	33	72.0	150	2543	O.K
	하 부	35.320	H16	71	92.0	150	875	O.K

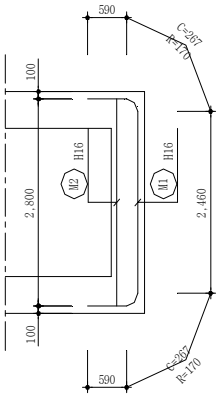
11. 주철근 조립도

Mxx 방향 표준단면도 및 주철근 조립도

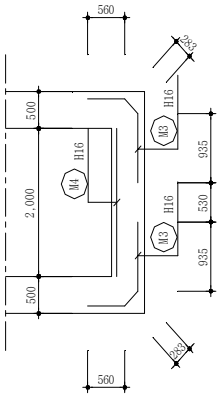
표 준 단 면 도



CYCLE-1 (@300)



CYCLE-2 (@300)

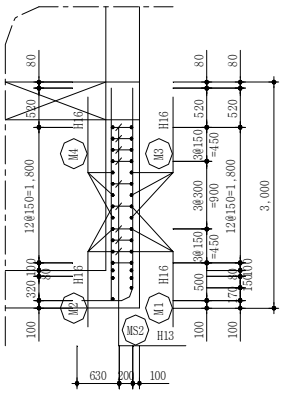


Myy 방향 표준단면도 및 주철근 조립도

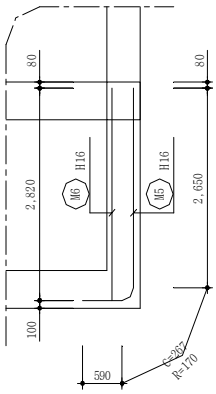
단면 B-B

주 철 근 조 립 도

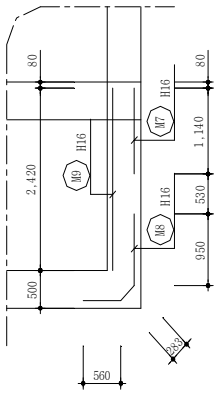
표 준 단 면 도



CYCLE-1 (@300)



CYCLE-2 (@300)



2.13 집수정 점검통로 마감벽 #3

목 차

1. 설계개요 및 조건

2. 단면가정

3. 구조해석모델링

4. 하중산정

5. 하중조합

6. 구조해석결과

7. 단면설계

8. 단면설계 요약

9. 우각부보강설계

10. 사용성검토

11. 주철근조립도

1. 설계개요 및 조건

1.1 개요

• Plane Strain의 평면 판요소로 해석

• 구조해석 프로그램 : MIDAS CIVIL

1.2 설계방법

(1) 부재의 단면검토 : 강도설계법

(2) 사용성 검토 : 허용응력설계법

1.3 일반사항

(1) 사용재료의 강도

① 콘크리트의 압축강도 : f_{ck} = 27 MPa

② 철근의 항복강도 : f_y = 400 MPa

(2) 사용재료의 단위중량

재 료	단위중량(kN/m^3)	재 료	단위중량(kN/m^3)
철근콘크리트	24.5	아스팔트 포장	23.0
흙(지하수위 이상)	19.0	흙(지하수위 이하)	10.0
물	10.0	모르타르	21.5
기계실하중	25.0	무근콘크리트	23.0

(3) 사용재료의 탄성계수

① 콘크리트의 탄성계수 : E_c = 26,700 MPa

② 철근의 탄성계수 : E_s = 200,000 MPa

(4) 토사 내부마찰각 : Φ = 30°

(5) 토압 : K_o = 0.500

1.4 참고문헌

(1) 철도설계기준 (노반편) (철도시설공단, 2013)

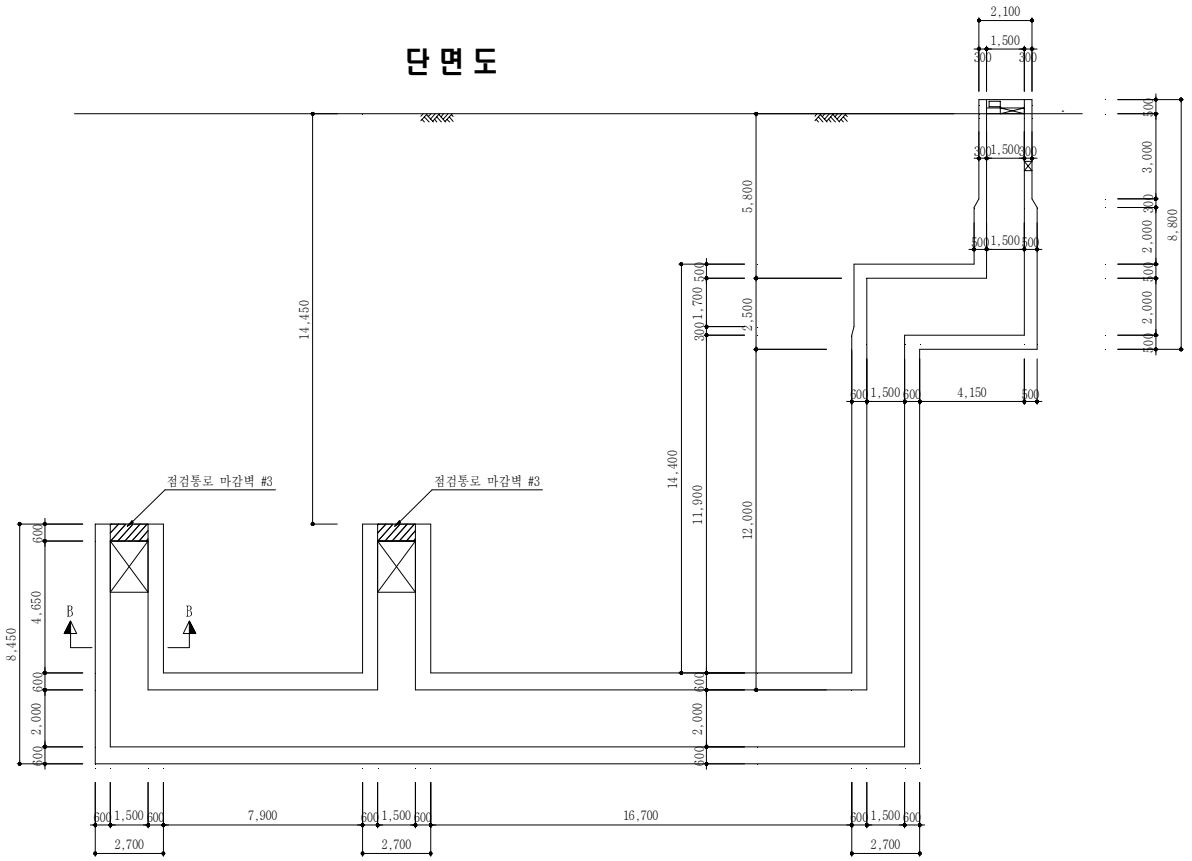
(2) 콘크리트 구조기준 (한국콘크리트학회, 2012)

(3) KR-Code (철도시설공단, 2012)

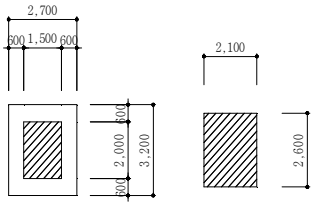
(4) 도시철도 내진설계기준 (국토교통부, 2013)

2. 단면가정

설계적용 토피 = 14.500 m



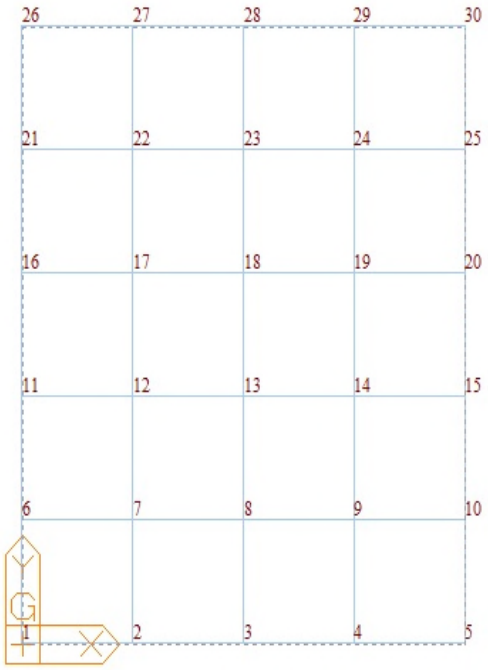
단 면 B-B



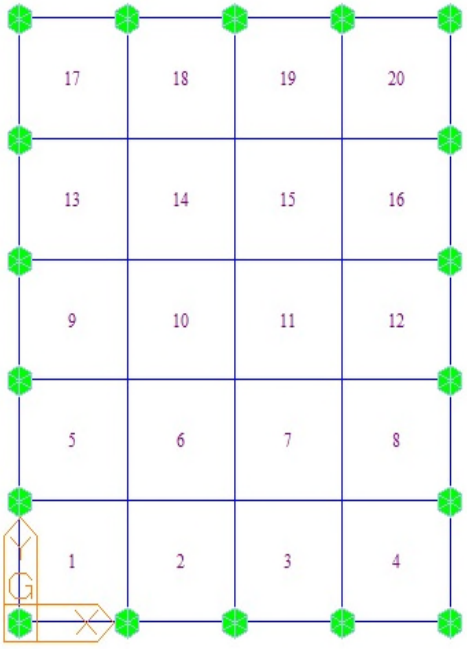
3. 구조해석 모델링

3.1 해석모형

절점



부재 및 경계조건



3.2 단면제원

번 호	폭(m)	높이(m)	단면적(m²)	단면2차모멘트(m^4)	비 고
1	1.00	0.60	0.600	0.018000	마감벽

4. 하중산정

4.1 고정하중

- 구조물자중 (프로그램에서 자동재하)

4.2 활하중에 의한 측압 ---------- LC 1

도로면 활하중의 등가 등분포하중(DB24 기준)

$D/B_0 \geqq 0.5$		
토피고(D, m)	노면활하중(Pvl, kN/m^2)	비 고
1.0	39.000	* 토피의 중간 값은 노면 활하중 상위의 값을 적용.
1.5	25.000	
2.0	18.000	
2.5	14.000	
3.0	11.000	
3.5이상	10.000	

$D/B_0 < 0.5$		
D/B_0	Pvl × D, kN/m^2	비 고
0.1	17.000	* D/B_0의 중간 값은, Pvl × D의 상위값을 적용 *D/B_0 중노면활하중(Pvl)은 표의 값을 D로 나누어 구한다.
0.2	27.000	
0.3	33.000	
0.4이상	36.000	

- D/B_0 = 14.500 / 3.200 = 4.531

- 노면 활하중 (DB-24) Lv = 10.000 kN/m²

Lh1 = 0.500 × 10.000 = 5.000 kN/m²

4.3 연직 토압(지하수 無) ---------- LC 2

아스팔트	$wd_{1'}$	=	0.500	×	23.000	=	11.500 kN/m²
모르타르	$wd_{2'}$	=	0.000	×	21.500	=	0.000 kN/m²
토사	$wd_{3'}$	=	14.000	×	19.000	=	266.000 kN/m²
	Σwd'					=	277.500 kN/m²

4.4 연직 토압(지하수 有) ---------- LC 3

아스팔트	wd_1	=	0.500	×	23.000	=	11.500 kN/m²
모르타르	wd_2	=	0.000	×	21.500	=	0.000 kN/m²
토사(지하수 위)	wd_3	=	0.500	×	19.000	=	9.500 kN/m²
토사(지하수 아래)	wd_4	=	13.500	×	10.000	=	135.000 kN/m²
	Σwd					=	156.000 kN/m²

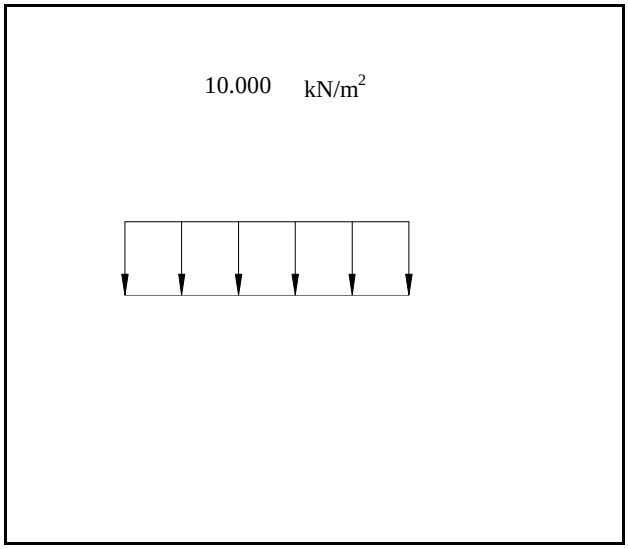
4.5 연직 수압(지하수 有) ---------- LC 4

① 상부 슬래브 (연직수압)

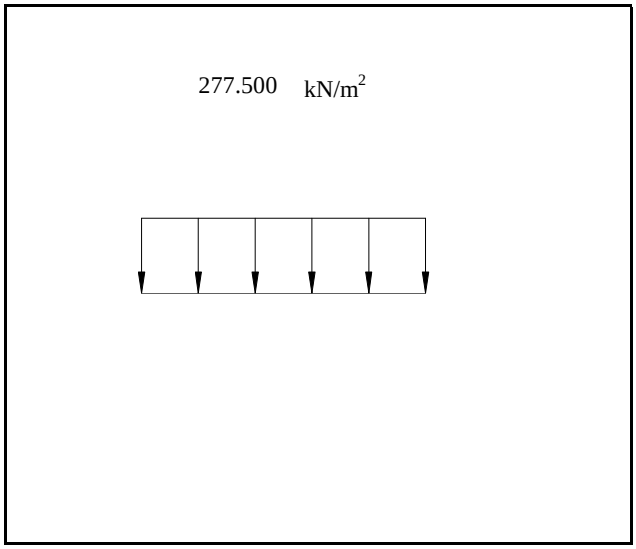
w_1 = 10.000 × 13.500 = 135.000 kN/m²

4.6 하중재하도

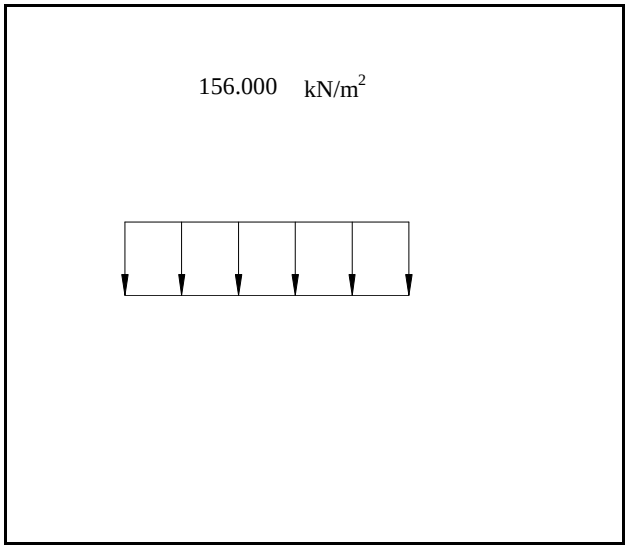
1) 활하중에 의한 측압 ------- LC 1



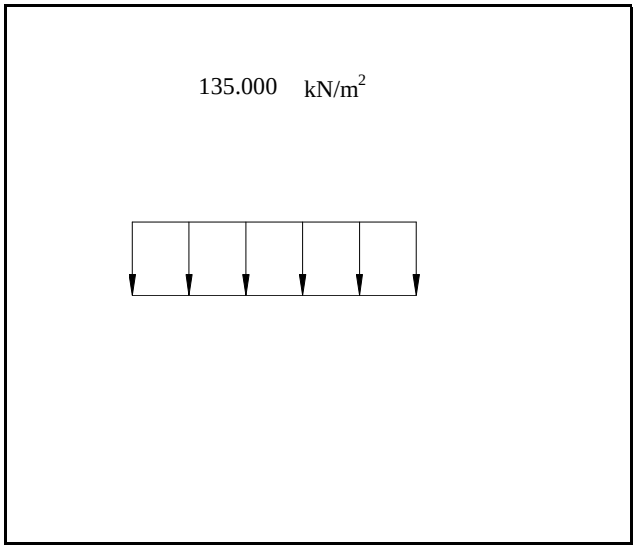
2) 수평 토압(지하수 무) ------- LC 2



3) 수평 토압(지하수 유) ------- LC 3



4) 수평 수압(지하수 유) ------- LC 4



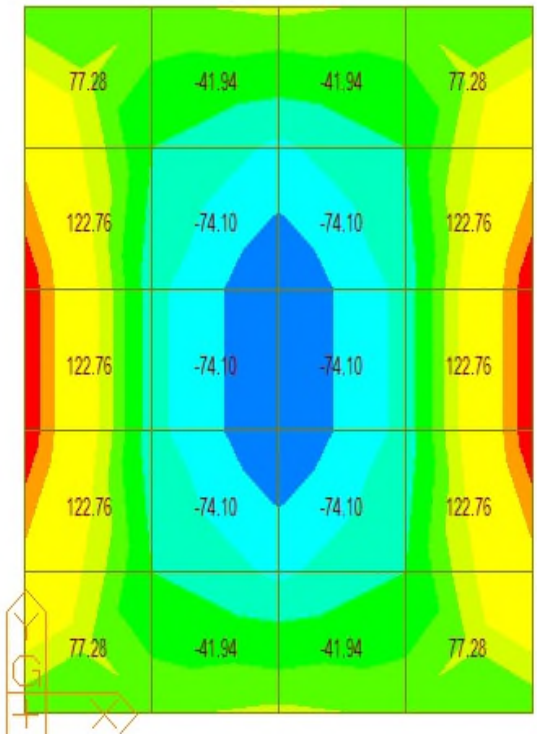
5. 하중조합

하중 조합	활하중	지하수 없을때	지하수 있을때		비고
	연직	연직 토압	연직 토압	연직 수압	
	LC01	LC02	LC03	LC04	
CB01	1.60	1.60			극한하중 조합
CB02		1.60			
CB03	1.60		1.60	1.60	
CB4			1.60	1.60	
CB5	1.00	1.00			사용하중 조합
CB6		1.00			
CB7	1.00		1.00	1.00	
CB8			1.00	1.00	

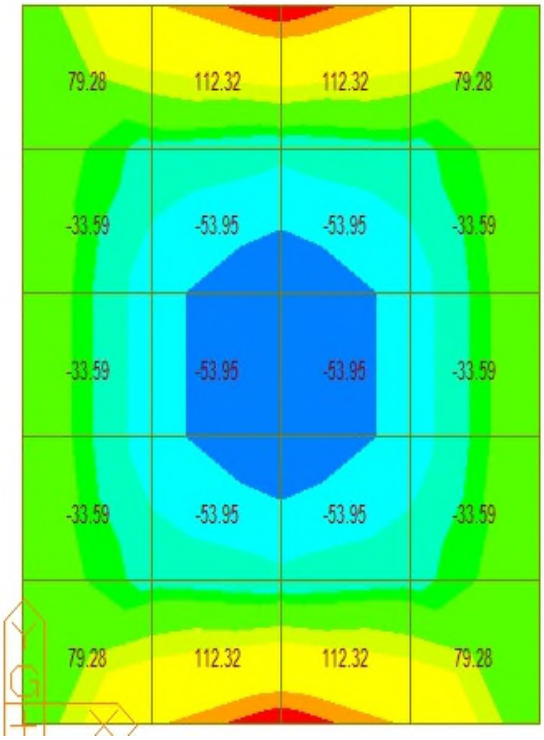
6. 구조해석 결과

6.1 부재력도

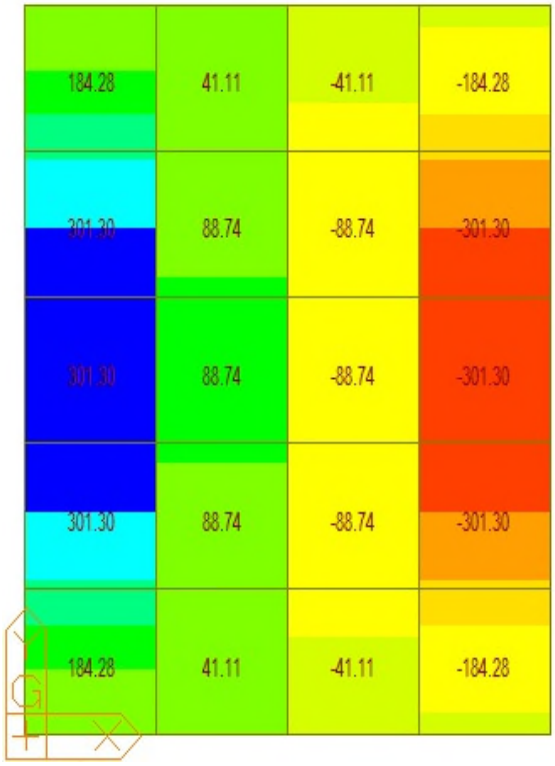
B.M.D (계수하중) [kN·m] : Mxx



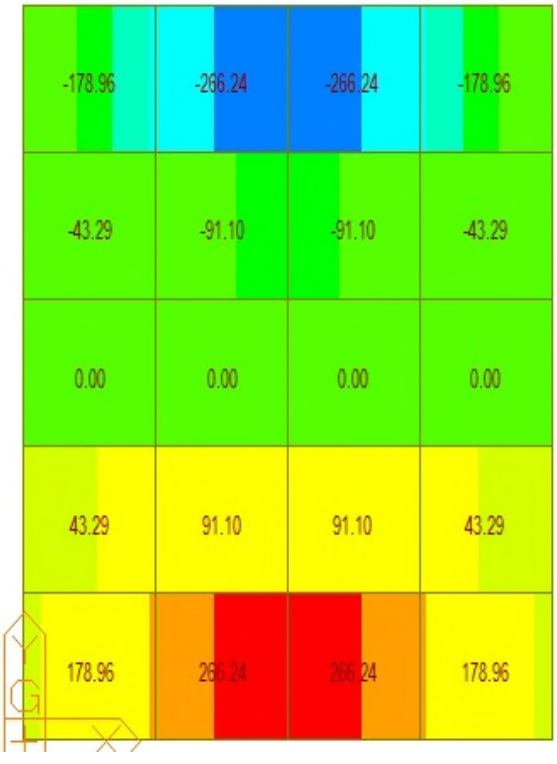
B.M.D (계수하중) [kN·m] : Myy



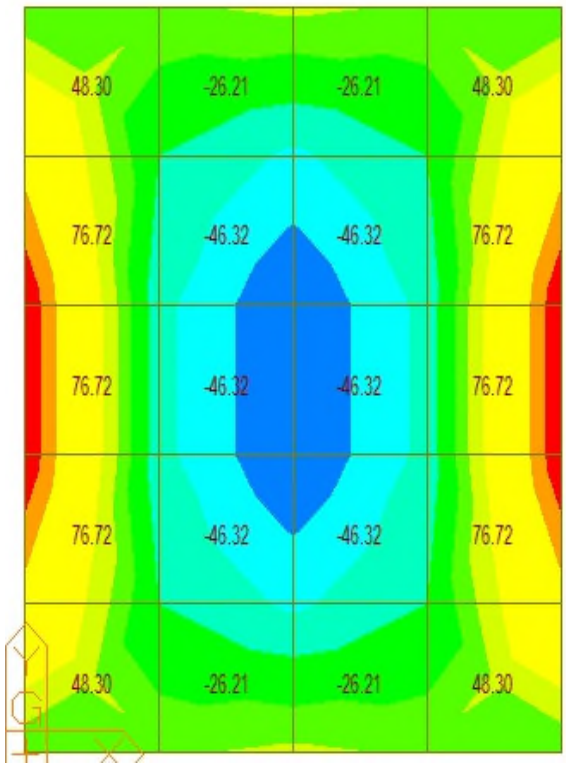
S.F.D (계수하중) [kN] : Vxx



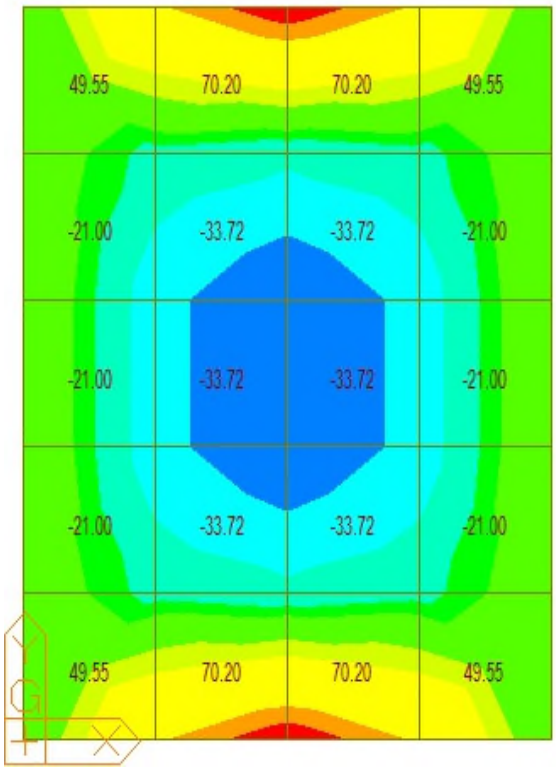
S.F.D (계수하중) [kN] : Vyy



B.M.D (사용하중) [kN·m] : Mxx



B.M.D (사용하중) [kN·m] : Myy



6.2 부재력 집계

구분		계수하중			사용하중	
		Mu(kN·m)	Pu(kN)	Vu(kN)	Mo(kN·m)	Po(kN)
슬래브 Mxx	단 부	122.760		301.300	76.720	
	중앙부	74.100			46.320	
슬래브 Myy	단 부	112.320		266.240	70.200	
	중앙부	53.950			33.720	

7. 단면검토

1) 슬래브 단부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 975.257 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	76.7
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	500.0	100.0	122.760	301.300

전단설계시 단면의 유효높이 ds = 500.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00265

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.05225 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 219886054 N·mm

= 219.886 kN·m > 122.760 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 731.442 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 324.760 kN

1/2 x Φv x Vc = 162.380 kN ≤ Vu ≤Φv x Vc ∴ 최소전단 철근을 배근하는것이 좋다.

Req Av = 0.35×bw×s / fy = 0.35×1,000.0×150.0 / 400.0

= 131.250 ㎟

Use Av = 211.209 ㎟ (H13×1.67 EA, 간격 s = 150.0 mm) ≥ req.Av ----- ∴ O.K.

s = 150.0 mm < Min (600, 0.5D) = mm ----- ∴ O.K.

2) 슬래브 중앙부(Mxx)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 562.805 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	46.3
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	520.0	80.0	74.100	0.000

전단설계시 단면의 유효높이 ds = 520.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00255

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.05446 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 228889254 N·mm

= 228.889 kN·m > 74.100 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 422.104 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 337.750 kN

∴ 전단철근이 필요없음.

3) 슬래브 단부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 891.326 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	70.2
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	500.0	100.0	112.320	266.240

전단설계시 단면의 유효높이 ds = 500.0 d1' = 100 d2' = 200

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00265

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.05225 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 219886054 N·mm

= 219.886 kN·m > 112.320 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 668.495 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 324.760 kN

1/2 x Φv x Vc = 162.380 kN ≤ Vu ≤Φv x Vc ∴ 최소전단 철근을 배근하는것이 좋다.

Req Av = 0.35×bw×s / fy = 0.35×1,000.0×150.0 / 400.0

= 131.250 ㎟

Use Av = 211.209 ㎟ (H13×1.667 EA, 간격 s = 150.0 mm) ≥ req.Av ----- ∴ O.K.

s = 150.0 mm < Min (600, 0.5D) = 250.0 mm ----- ∴ O.K.

4) 슬래브 중앙부(Myy)

＊ 검토 조건

pmin = max(0.25√ fck / fy, 1.4/fy) = 0.00350 4/3 Req.As = 408.965 mm^2

fck (Mpa)	fy (Mpa)	β1	Φf	Φv	Mo (kN.m)
27.0	400.0	0.850	0.850	0.750	33.7
B (mm)	**H (mm)**	**d (mm)**	**피복 (mm)**	**Mu (kN.m)**	**Su (kN)**
1000.0	600.0	520.0	80.0	53.950	0.000

전단설계시 단면의 유효높이 ds = 520.0 d1' = 80 d2' = 180

＊ 휨모멘트 검토

ⓐ 휨강도 검토

사용철근량 = H16 × 6.67ea = 1324.000 ㎟

∴ P = As / (B × D) = 0.00255

공칭강도시 등가응력깊이 a = (As×fy) / (0.85×fck×B) = 23.076 mm

최외단 인장철근 변형률 εt = 0.05446 ≥ 0.004 ----- ∴ O.K.

여기서 εt = 0.003×(H - a/β1 - Dc_min) / (a/β1)

0.005 ≤ εt 이므로 인장지배단면, Φf = 0.850 를 적용한다.

ØMn = Øf·fy·As·(D - a/2) = 228889254 N·mm

= 228.889 kN·m > 53.950 kN·m ----- ∴ O.K.

ⓑ 필요철근량 및 철근비 검토

Mu / Φ = As × fy x (d - a ⁄ 2) ---------- (1)

a = As×fy / (0.85×fck×b) ---------- (2)

式(2)를 式(1)에 대입하여 2차방정식으로 As를 구한다.

$$\frac{fy^2}{2\times 0.85\times fck\times b}\times As^2 - fy\times d\times As + \frac{Mu}{\Phi} = 0$$

필요 철근량 req.As = 306.724 mm^2 < 사용철근량 ----- ∴ O.K.

철근비검토 : P < Pmin ∴ As=[MIN(Pmin,4/3 Req.As)] 이상배근 ----- ∴ O.K.

＊ 전단력 검토

Øv·Vc = Øv·1/6·√ fck·B·d / 1000 = 337.750 kN

∴ 전단철근이 필요없음.

8. 단면설계요약

1) 휨설계 요약

구분		Mu (kN·m)	Pu (kN)	사용철근				ΦMn (kN·m)	ΦPn (kN)	안전율	비고
				1단		2단					
슬래브 Mxx	단 부	122.760		H16	150	H0	0	219.886		1.79	O.K
	중앙부	74.100		H16	150	H0	0	228.889		3.09	O.K
슬래브 Myy	단 부	112.320		H16	150	H0	0	219.886		1.96	O.K
	중앙부	53.950		H16	150	H0	0	228.889		4.24	O.K

2) 전단설계 요약

구분		Vu (kN·m)	사용철근			ΦVn (kN·m)	안전율	비고
			직경	개수	간격			
슬래브 Mxx	단 부	301.300	H13	1.7EA	150	535.969	1.78	O.K
	중앙부	0.000	H13	1.7EA	300	전단철근 필요없음		
슬래브 Myy	상 부	266.240	H13	1.7EA	150	535.969	2.01	O.K
	중앙부	0.000	H13	1.7EA	300	전단철근 필요없음		

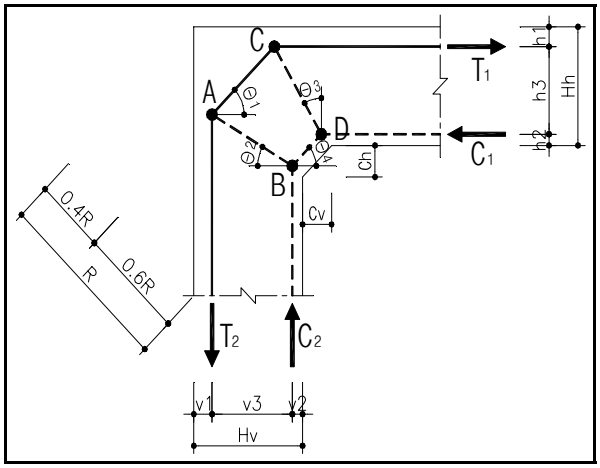
9. 우각부 보강 설계 (스트럿-타이 모델 해석에 의한 라멘접합부 보강)

9.1 슬래브 Mxx (단부)

(1) 계산조건

슬래브두께	H_h	=	600.00 mm	벽체 높이	H_v	=	600.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	420.00 mm	벽체측 우력 거리	v_3	=	420.00 mm
수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	122.760 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 848.53 mm

② 사잇각

Θ_1 = 45.00°

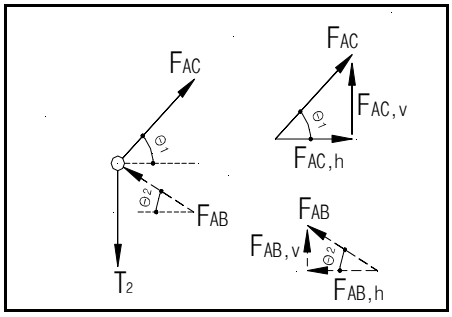
Θ_2 = 21.80°

Θ_3 = 21.80°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

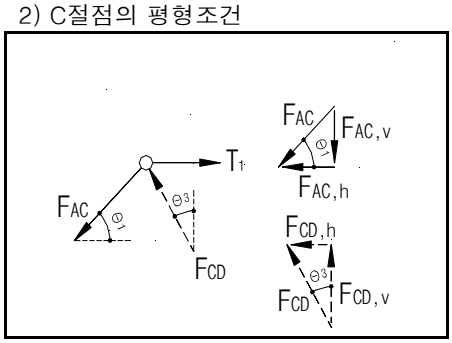
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\epsilon \Rightarrow$ $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{CD,V} = F_{CD} \cdot \cos\Theta_3$

$F_{CD,H} = F_{CD} \cdot \sin\Theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin\epsilon = F_{CD} \cdot \cos\Theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\Theta_1 + F_{CD} \cdot \sin\Theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{122.760}{0.420} =$ 292.286 kN

$T_2 = \frac{M_u}{v_3} = \frac{122.760}{0.420} =$ 292.286 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 295.253 kN

식 ⑥ 으로부터

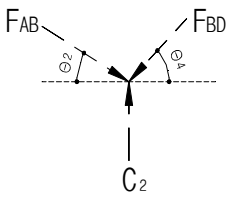
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 295.253 kN

따라서 F_{AC} = **295.253** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 224.858 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 295.253 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 224.858 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	295.253	타이
AB	-224.858	스트럿
BD	-295.253	스트럿
CD	-224.858	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 295.253 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{295,253.158}{0.85 \times 400} = 868.39 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	16	@	300	=	662.00	mm^2	(2 cycle)
우각부철근 As	= H	16	@	300	=	662.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**1,324.00**	mm^2	

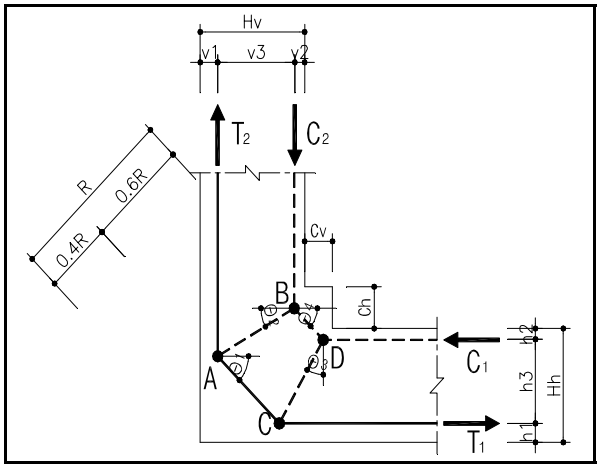
$A_{s,used}$ = 1,324.00 mm^2 > 868.39 mm^2 ……O.K

9.2 슬래브 Myy (단부)

(1) 계산조건

슬래브두께	H_h	=	600.00 mm	벽체 높이	H_v	=	600.00 mm
슬래브 바깥쪽 피복두께	h_1	=	100.00 mm	벽체 바깥쪽 피복두께	v_1	=	100.00 mm
슬래브 안쪽 피복두께	h_2	=	80.00 mm	벽체 안쪽 피복두께	v_2	=	80.00 mm
슬래브측 우력 거리	h_3	=	420.00 mm	벽체측 우력 거리	v_3	=	420.00 mm
헌치부 수직 거리	C_h	=	0.00 mm	콘크리트설계기준 강도	f_{ck}	=	27 MPa
헌치부 수평 거리	C_v	=	0.00 mm	철근 항복 강도	f_y	=	400 MPa
				닫힘 모멘트	M_u	=	112.320 kN.m

(2) 스트럿-타이 모델 구성



① 우각부 대각선 길이 (R)

R = 848.53 mm

② 사잇각

Θ_1 = 45.00°

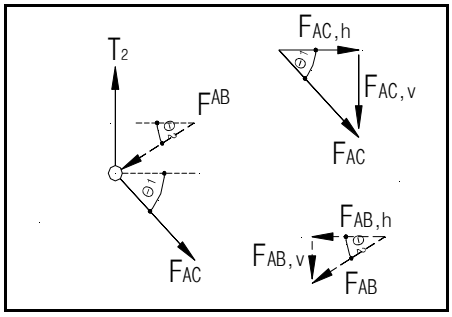
Θ_2 = 23.20°

Θ_3 = 23.20°

Θ_4 = 45.00°

(3) 스트럿-타이 단면력 산정

1) A절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin\Theta_1$

$F_{AC,H} = F_{AC} \cdot \cos\Theta_1$

$F_{AB,V} = F_{AB} \cdot \sin\Theta_2$

$F_{AB,H} = F_{AB} \cdot \cos\Theta_2$

$\Sigma V = 0$:

$T_2 = F_{AC,v} + F_{AB,v} = F_{AC} \cdot \sin\Theta_1 + F_{AB} \cdot \sin\Theta_2$ ····· ①

$\Sigma H = 0$:

$F_{AC,h} = F_{AB,h}$

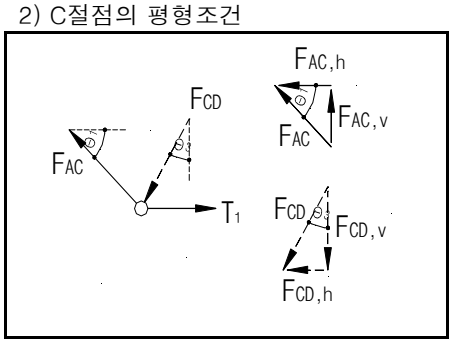
$F_{AC} \cdot \cos\Theta_1 = F_{AB} \cdot \cos\Theta$ => $F_{AB} = F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2}$ ····· ②

식 ②를 식 ①에 대입

$T_2 = F_{AC} \times \sin\Theta_1 + F_{AC} \times \dfrac{\cos\Theta_1}{\cos\Theta_2} \times \sin\Theta_2$

$= F_{AC}(\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2)$ ····· ③

2) C절점의 평형조건



$F_{AC,V} = F_{AC} \cdot \sin \theta_1$

$F_{AC,H} = F_{AC} \cdot \cos \theta_1$

$F_{CD,V} = F_{CD} \cdot \cos \theta_3$

$F_{CD,H} = F_{CD} \cdot \sin \theta_3$

ΣV = 0 :

$F_{AC,V} = F_{CD,V}$ ····· ④

$F_{AC} \cdot \sin \epsilon = F_{CD} \cdot \cos \theta_3 \Rightarrow \quad F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3}$

ΣH = 0 :

$T_1 = F_{AC,h} + F_{CD,h} = F_{AC} \cdot \cos\theta_1 + F_{CD} \cdot \sin\theta_3$ ····· ⑤

식 ④를 식 ⑤에 대입

$T_1 = F_{AC} \times \cos\Theta_1 + F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} \times \sin\Theta_3$

$= F_{AC}(\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3)$ ····· ⑥

3) 단면력 산정

- 우력 T = C의 결정

$T_1 = \frac{M_u}{h_3} = \frac{112.320}{0.420} =$ 267.429 kN

$T_2 = \frac{M_u}{v_3} = \frac{112.320}{0.420} =$ 267.429 kN

- 타이(AC)의 단면력 산정

식 ③ 으로부터

$F_{AC} = \frac{T_2}{\sin\Theta_1 + \cos\Theta_1 \cdot \tan\Theta_2} =$ 264.741 kN

식 ⑥ 으로부터

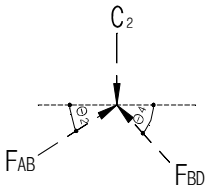
$F_{AC} = \frac{T_1}{\cos\Theta_1 + \sin\Theta_1 \cdot \tan\Theta_3} =$ 264.741 kN

따라서 F_{AC} = **264.741** kN 을 설계 단면력으로 적용

- 스트럿(AB)의 단면력 산정

식 ② 로부터

$$F_{AB} = F_{AC} \times \frac{\cos\Theta_1}{\cos\Theta_2} = 203.668 \quad kN$$



- 스트럿(BD)의 단면력 산정

ΣV = 0 :

$$C_2 = F_{AB} \cdot \sin\Theta_2 + F_{BD} \cdot \sin\Theta_4$$

$$F_{BD} = \frac{C_2 - F_{AB} \cdot \sin\Theta_2}{\sin\Theta_4} = 264.741 \quad kN$$

- 스트럿(CD)의 단면력 산정

식 ④ 로부터

$$F_{CD} = F_{AC} \times \frac{\sin\Theta_1}{\cos\Theta_3} = 203.668 \quad kN$$

- 단면력 결과

요 소	단면력(kN)	요소종류
AC	264.741	타이
AB	-203.668	스트럿
BD	-264.741	스트럿
CD	-203.668	스트럿

4) 타이의 철근량 검토

설계인장력 (T) = 264.741 kN

필요철근량

$$A_{s,req} = \frac{T}{\Phi_s f_u} = \frac{264{,}740.779}{0.85 \times 400} = 778.65 \quad mm^2$$

사용철근량

1단 주철근 As	= H	0	@	0	=	0.00	mm^2	(1 cycle)
	= H	16	@	300	=	662.00	mm^2	(2 cycle)
우각부철근 As	= H	16	@	300	=	662.00	mm^2	(1 단)
	= H	0	@	0	=	0.00	mm^2	(2 단)
				합계	=	**1,324.00**	mm^2	

$A_{s,used}$ = 1,324.00 mm^2 > 778.65 mm^2 ……O.K

10. 사용성 검토

10.1 처짐 검토

1) Mxx 슬래브 : 최소부재두께 적용

철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	1.500	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.063	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.063m	<	H	=	0.600m	(처짐검토 생략)

2) Myy 슬래브 : 최소부재두께 적용

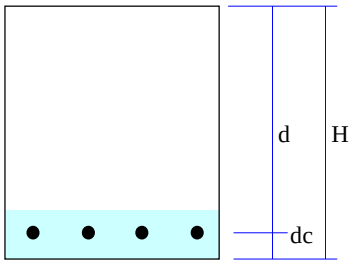
철근의 항복응력	fy	=	400	MPa				
부재의 지간길이	L	=	2.000	m				
일방향 슬래브 양단 연속의 경우	T	=	L	/	24	=	0.083	m

(보정계수) FACTOR = 1

처짐계산을 하지않는 경우의 최소두께	T	=	0.083m	<	H	=	0.600m	(처짐검토 생략)

10.2 균열 검토

1) 슬래브 단부(Mxx) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	500.00	mm,	dc =	100.00	mm ,
Mo =	76.720	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

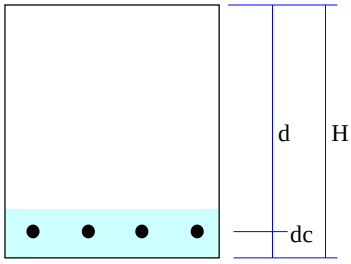
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	87.448	mm
f s = M / (As (d - x / 3))	=	123.066	mm
f st = fs (H -Dc_min - x) / (D - x)	=	123.066	mm

- 철근의 최대 중심간격

Cc =	100	-	16	/	2	=	92.000	mm	
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]						=	409.902	mm	
최외단철근 평균배근간격;	1000	/	6.7	=	150	mm	<	409.902	mm	O.K!!

2) 슬래브 중앙부(Mxx) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	520.00	mm,	dc =	80.00	mm ,
Mo =	46.320	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

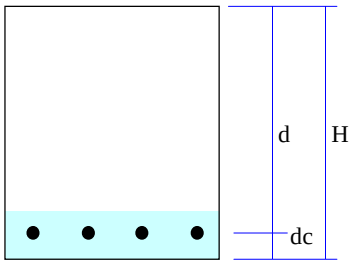
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	89.345	mm
f s = M / (As (d - x / 3))	=	71.366	mm
f st = fs (H -Dc_min - x) / (D - x)	=	71.366	mm

- 철근의 최대 중심간격

Cc =	80	-	16	/	2	=	72.000 mm
S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)]						=	1177.032 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	1177.032 mm **O.K!!**

3) 슬래브 단부(Myy) (부식 조건 : 습윤)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	500.00	mm,	dc =	100.00	mm ,
Mo =	70.200	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

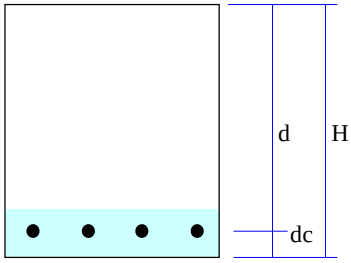
- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As))	=	87.448	mm
f s = M / (As (d - x / 3))	=	112.607	mm
f st = fs (H -Dc_min - x) / (D - x)	=	112.607	mm

- 철근의 최대 중심간격

Cc =	100	-	16	/	2	=	92.000 mm
S = min [375 · (210 / fst) - 2.5 Cc , 300 · (210 / fst)]						=	469.334 mm
최외단철근 평균배근간격;	1000	/	6.7	=	150 mm	<	469.334 mm **O.K!!**

4) 슬래브 중앙부(Myy) (부식 조건 : 건조)



fck =	27	MPa,	fy =	400	MPa,
H =	600.00	mm,	B =	1000.00	mm ,
d =	520.00	mm,	dc =	80.00	mm ,
Mo =	33.720	kN· m,	As =	1324.000	mm^2
N =	6.67		n =	7	

- 응력산정

x = - (n · As / b) + (n · As / b · √ (1 + (2 · b · d/n · As)) = 89.345 mm

f s = M / (As (d - x / 3)) = 51.953 mm

f st = fs (H -Dc_min - x) / (D - x) = 51.953 mm

- 철근의 최대 중심간격

Cc = 80 - 16 / 2 = 72.000 mm

S = min [375 · (280 / fst) - 2.5 Cc , 300 · (280 / fst)] = 1616.848 mm

최외단철근 평균배근간격; 1000 / 6.7 = 150 mm < 1616.848 mm **O.K!!**

10.3 사용성검토 요약

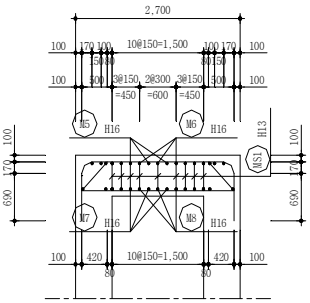
1) 균열검토 요약

구분		Mo (kN·m)	주철근 (mm)	fs (Mpa)	Cc (mm)	S (mm)	Smin (mm)	비고
슬래브 Mxx	단 부	76.720	H16	123	92.0	150	410	**O.K**
	중앙부	46.320	H16	71	72.0	150	1177	**O.K**
슬래브 Myy	단 부	70.200	H16	113	92.0	150	469	**O.K**
	중앙부	33.720	H16	52	72.0	150	1617	**O.K**

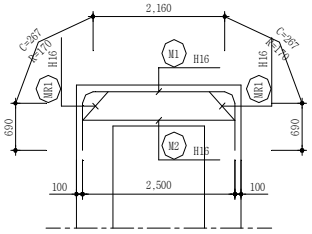
11. 주철근 조립도

Mxx 방향 표준단면도 및 주철근 조립도

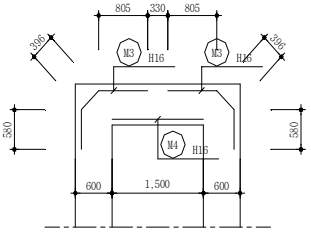
표 준 단 면 도



CYCLE-1 (@300)

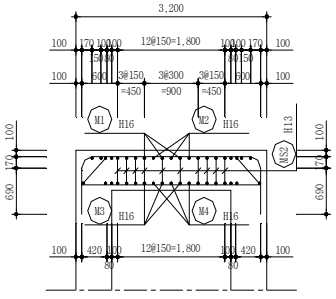


CYCLE-2 (@300)

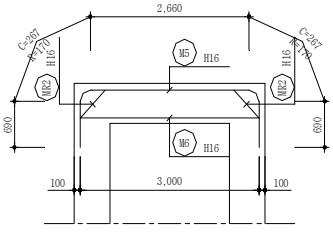


Myy 방향 표준단면도 및 주철근 조립도

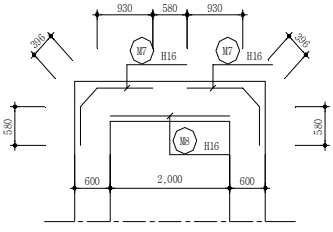
표 준 단 면 도



CYCLE-1 (@300)



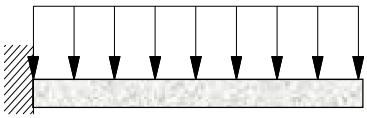
CYCLE-2 (@300)



2.14 내부계단 및 월류벽

내부계단

1. 단면가정 및 설계조건



2. 하중산정

1) 고정하중에 의한 단면력

① 등분포 고정하중

DW = 0.220 × 1.00 × 25.00 = 5.500 kN·m : 자중

DW = 0.096 × 0.75 × 25.00 = 1.800 kN·m : 계단마감자중

DF = 5.000 kN·m : 마감하중

2) 활하중에 의한 단면력

① 활하중(군집하중)

LM = 5.000 kN·m

3) 하중 조합

계수하중

1.2D + 1.6L

1.20 × 7.30 + 1.60 × 5.00 = 16.760 kN·m

M = 16.760 × 0.750 ² / 2 = 4.714 kN·m

V = 16.760 × 0.750 = 12.570 kN·m

사용하중

1.0D + 1.0L

1.00 × 7.30 + 1.00 × 5.00 = 12.300 kN·m

M = 12.300 × 0.750 ² / 2 = 3.459 kN·m

V = 12.300 × 0.750 = 9.225 kN·m

(2) 단면검토

설계기준강도	f_{ck} =	27	MPa	부재폭	b_w =	1000	mm
인장철근항복강도	f_y =	400	MPa	부재의 총두께	h =	220	mm
전단철근항복강도	f_{ys} =	400	MPa	유효높이	d =	160	mm
계수 모멘트	M_u =	4.714	kN·m	휨강도 감소계수	ϕ_f =	0.85	
계수 전단력	V_u =	12.570	kN	전단강도 감소계수	ϕ_s =	0.75	
콘크리트 피복	d' =	60	mm	유효길이계수	β_1 =	0.85	

T = As · = 662.000 × 400 = 264800
C = 0.85 · fck = 0.85 × 27 × a × 1000 = 22950 × a
T = C 이므로, a = 11.538 mm , c = a / β = 11.538 ÷ 0.85 = 13.574 mm

εy = fy / E = 400 ÷ 200000 = 0.002
εt = 0.003 · (dt − = 0.003 × (160 − 13.574) / 13.574 = 0.0324

εt ≥ 0.005 이므로 인장지배단면이며, Φ = 0.85 를 적용한다. ☞ O.K

a = f_y / (0.85 · f_{ck} · … ①
M_u = · A_s · f_y (d − a / … ② ①을 ②에 대입하면
f_y^2 / (1.7 · f_{ck} · b) A_s^2 − d · f →· A_s^2 + B · A_s + C =… ③
③을 근의공식에 대입하여 A_s를 구한다.
여기서,
A = f_y^2 / (1.7 · f_c = 3.485839
B = − d · fy = −64000
C = M_u / ϕ = 5545588 $A_{s,req}$ = 87.063 ㎟

① 최소 철근량

균형철근비 (ρ_b) = 0.85 · β_1 · f_{ck} / f_y · 600 / (6(= 0.029261
최대철근비 (ρ_{max} = 0.714 · ρ_b = 0.020893
최소철근비 (ρ_{min} = MAX [(0.25 · √ f_{ck} / f_y) , (1. = 0.0035
최소 철근 A_{smin1} = (1.4/fy) b · d = 560 ㎟
온도 철근 A_{smin2} = 0.002 · b · d = 320 ㎟
∴ 최소철근 A_{smin} = = 560.00 ㎟
4/3 · A_s = 116.08 ㎟

② 사용 철근량

사용 철근량 $A_{s,use}$ 1단 = H 16 @ 300 = 662 ㎟ ∴ 총 사용 철근량 = 662 ㎟

사용철근비 (ρ) = A_s / b · d = 0.004138

사용된 철근량이 계산에 의한 요구량의 4/3배 이상이므로 최소철근량 규정을 사용하지 않이☞ O.K

③ 공칭모멘트 검토

a = f_y / (0.85 · f_{ck} · = 11.538 mm
ϕ · M_n = · A_s · f_y (d − a / = 3.471E+07 N·㎜ = 34.714 kN·m
ϕ · M_n = 34.714 kN·r > M_u = 4.7138 kN·m ☞ O.K

④ 전단에 대한 검토

ΦVc = 0.8 · 1/6 · √ fck · b = 110.85 kN

ΦVc = 110.85 kN > V_u = 12.57 kN ∴ ϕVc > Vu 이므로 전단보강 불필요

(3) 사용성 검토

설계기준강도	f_{ck}	=	27	MPa	부재폭	b_w =	1000 mm
철근탄성계수	Es	=	200000	MPa	부재의 총두께	h =	220 mm
콘크리트탄성계수	Ec	=	27783	MPa	유효높이	d =	160 mm
탄성계수비	n	=	7.20	kN · m	사용철근량	As =	662 mm^2
콘크리트 피복	d'	=	60	mm	사용하중모멘트	M_o =	3.46 kN · m

· 주철근응력의 제한에 의한 검토

Mo = 3.46 kN · r = 3.459E+06 N · mm
ρ = ; / (b · d = 0.004138
k = ρ + √ { 2n · ρ + (n · = 0.2161 , j = 1 - k / 3 = 0.928

∴ f_s = (ρ · j · b · c = 35.20 MPa < 0.6 f_y = 240 MPa ☞ O.K

· 철근 중심간격에 의한 균열검토

Cc = 피복두께 - 사용철근지름 = 52
s = 75 · (210 / fs) - 2.5 · (= 2107.5
s = 300 · (210 / fs) = 1790 → MIN → 1790

∴ s = 1790.01 mm > 300 mm ☞ O.K

· 사용하중에 의한 균열폭 계산

A = · d' · b / = 36000 mm^2 , y_1 = ㄱ - k · d - d = 125.425 mm
R = y_2 / y_1 = 1.4784 , y_2 = ㅣ - k · d = 185.425 mm
w = · R · f_s · ³ √ (d' · A) · = 0.07264 mm
w_a = 0.006 t_c = 0.006 × 52 = 0.31 mm → MAX → 0.40
w_a = 0.40 mm

∴ w = 0.07 mm < w_a = 0.40 mm ☞ O.K

(4) 철근 배치

- 배력철근
  사용철근량 : H 13 @ 200 = 633.5 mm^2
  H 0 @ 0 = 0 mm^2

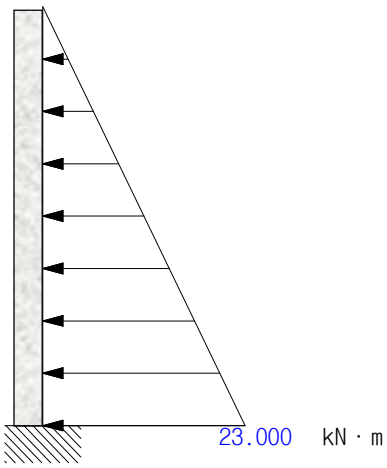
∴ 총 사용 철근량 = 633.5 mm^2 ≥ 인장주철근/4 (= 166 mm^2) ☞ O.K

- 압축철근측의 배력철근
  사용철근량 : H 13 @ 200 = 633.5 mm^2
  H 0 @ 0 = 0 mm^2

∴ 총 사용 철근량 = 633.5 mm^2 ≥ 인장측 배력철근/2 (= 317 mm^2) ☞ O.K

월류벽

1. 단면가정 및 설계조건



2. 하중산정

2) 수압에 의한 단면력

① 수압

Wh = 23.000 kN · m

3) 하중 조합

계수하중

1.6Wh

1.60 × 23.00 = 36.800 kN · m

M = 36.800 × 2.500 ² / 2 = 115.000 kN · m
V = 36.800 × 2.500 / 2 = 46.000 kN · m
0.00

사용하중 0.00

1.0Wh

1.00 × 23.00 = 23.000 kN · m

M = 23.000 × 2.500 ² / 2 = 71.875 kN · m
V = 23.000 × 2.500 / 2 = 28.750 kN · m

(2) 단면검토

설계기준강도	f_{ck}	=	27	MPa	부재폭	b_w =	1000 mm
인장철근항복강도	f_y	=	400	MPa	부재의 총두께	h =	300 mm
전단철근항복강도	f_{ys}	=	400	MPa	유효높이	d =	220 mm
계수 모멘트	M_u	=	115.000	kN·m	휨강도 감소계수	ϕ_f =	0.85
계수 전단력	V_u	=	46.000	kN	전단강도 감소계수	ϕ_s =	0.75
콘크리트 피복	d'	=	80	mm	유효길이계수	β_1 =	0.85

T = As · = 1910.000 × 400 = 764000
C = 0.85 · fck = 0.85 × 27 × a × 1000 = 22950 × a
T = C 이므로, a = 33.290 mm , c = a / β = 33.290 ÷ 0.85 = 39.164 mm

εy = fy / E = 400 ÷ 200000 = 0.002
εt = 0.003 · (dt − = 0.003 × (220 − 39.164) / 39.164 = 0.0139

εt ≥ 0.005 이므로 인장지배단면이며, Φ = 0.85 를 적용한다. ☞ O.K

a = f_y / (0.85 · f_{ck} · … ①
M_u = · A_s · f_y (d − a / … ② ①을 ②에 대입하면
f_y^2 / (1.7 · f_{ck} · b) A_s^2 − d · f_y → · A_s^2 + B · A_s + C = … ③
③을 근의공식에 대입하여 A_s를 구한다.
여기서,
A = f_y^2 / (1.7 · f_c = 3.485839
B = − d · fy = −88000
C = M_u / ϕ = 1.35E+08 $A_{s,req}$ = 1644.567 ㎟

① 최소 철근량

균형철근비 (ρ_b) = 0.85 · β_1 · f_{ck} / f_y · 600 / (6(= 0.029261
최대철근비 (ρ_{max} = 0.714 · ρ_b = 0.020893
최소철근비 (ρ_{min} = MAX [(0.25 · √ f_{ck} / f_y) , (1.· = 0.0035
최소 철근 A_{smin1} = (1.4/fy) b · d = 770 ㎟
온도 철근 A_{smin2} = 0.002 · b · d = 440 ㎟
∴ 최소철근 A_{smin} = = 1644.57 ㎟
4/3 · A_s = 2192.76 ㎟

② 사용 철근량

사용 철근량 $A_{s,use}$ 1단 = H 19 @ 150 = 1910 ㎟ ∴ 총 사용 철근량 = 1910 ㎟
2단 = H 0 @ 125 = 0 ㎟

사용철근비 (ρ) = A_s / b · d = 0.008682

ρmin ≤ ρuse ≤ ρmax ☞ O.K

③ 공칭모멘트 검토

a = f_y / (0.85 · f_{ck} · = 33.29 mm
ϕ · M_n = · A_s · f_y (d − a / = 1.321E+08 N·㎜ = 132.1 kN·m
ϕ · M_n = 132.1 kN·m > M_u = 115 kN·m ☞ O.K

④ 전단에 대한 검토

ΦVc = 0.8 · 1/6 · √fck · b = 152.42 kN

ΦVc = 152.42 kN > V_u = 46.00 kN ∴ ϕVc > Vu 이므로 전단보강 불필요

(3) 사용성 검토

설계기준강도	f_{ck}	=	27	MPa	부재폭	b_w =	1000 mm
철근탄성계수	Es	=	200000	MPa	부재의 총두께	h =	300 mm
콘크리트탄성계수	Ec	=	27783	MPa	유효높이	d =	220 mm
탄성계수비	n	=	7.20	kN · m	사용철근량	As =	1910 mm^2
콘크리트 피복	d'	=	80	mm	사용하중모멘트	M_o =	71.88 kN · m

· 주철근응력의 제한에 의한 검토

Mo = 71.88 kN · r = 7.188E+07 N · mm
ρ = ; / (b · d = 0.008682
k = ρ + √ { 2n · ρ + (n · = 0.2965 , j = 1 − k / 3 = 0.9012

∴ f_s = (ρ · j · b · d = 189.81 MPa < 0.6 f_y = 240 MPa ☞ O.K

· 철근 중심간격에 의한 균열검토

Cc = 피복두께 − 사용철근지름 = 70.5
s = 75 · (210 / fs) − 2.5 · (= 238.64
s = 300 · (210 / fs) = 331.91
MIN → 238.64

∴ s = 238.64 mm > 150 mm ☞ O.K

· 사용하중에 의한 균열폭 계산

A = ! · d' · b / = 24000 mm^2 , y_1 = ı − k · d − d' = 154.7634 mm
R = y_2 / y_1 = 1.5169 , y_2 = ı − k · d = 234.7634 mm
w = · R · f_s · ³ √ (d' · A) · = 0.38649 mm
w_a = 0.006 t_c = 0.006 × 70.5 = 0.42 mm
w_a = 0.40 mm
MAX → 0.42

∴ w = 0.39 mm < w_a = 0.42 mm ☞ O.K

(4) 철근 배치

- 압축측 주철근
  사용철근량 : H 16 @ 300 = 662 mm^2
  H 0 @ 0 = 0 mm^2

∴ 총 사용 철근량 = 662 mm^2 ≥ 인장주철근/3 (= 637 mm^2) ☞ O.K

- 배력철근
  사용철근량 : H 16 @ 300 = 662 mm^2
  H 0 @ 0 = 0 mm^2

∴ 총 사용 철근량 = 662 mm^2 ≥ 인장주철근/4 (= 478 mm^2) ☞ O.K

- 압축철근측의 배력철근
  사용철근량 : H 16 @ 300 = 662 mm^2
  H 0 @ 0 = 0 mm^2

∴ 총 사용 철근량 = 662 mm^2 ≥ 인장측 배력철근/2 (= 331 mm^2) ☞ O.K