관 리 번 호

사 본 번 호

고속도로 제32호선
옥 산 ~ 오 창 고 속 도 로 민 간 투 자 사 업

구 조 계 산 서(보강토옹벽)

(준 공)

2018. 01

국 토 교 통 부
Ministry of Land, Infrastructure and Transport

구 조 부

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type5(H=5.30m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

.....진\type5(H=5.3m).BEN

Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 27.86 N γ= 19.34

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

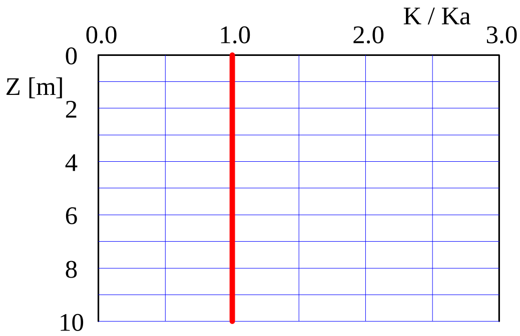
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

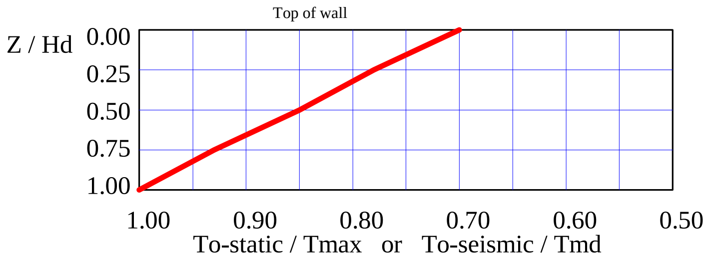
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

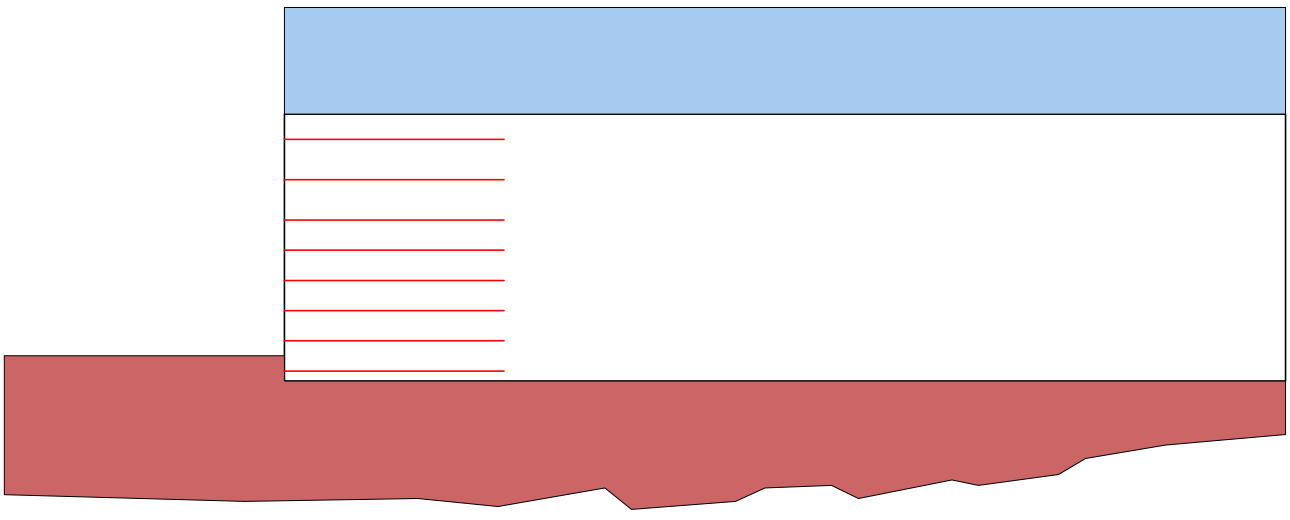
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	5.30	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 4.80 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 43.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.50, Meyerhof stress = 218.10 kPa.

Foundation Interface: Direct sliding, Fs = 1.848, Eccentricity, e/L = 0.1535, Fs-overturning = 3.26

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.36	1	2.16	1.33	1.35	1.332	17.323	1.587	0.1439	60
2	0.80	4.36	1	1.99	1.23	1.24	1.192	13.077	1.747	0.1167	60
3	1.40	4.36	1	2.24	1.39	1.40	1.296	11.810	1.949	0.0919	60
4	2.00	4.36	1	2.56	1.58	1.60	1.421	10.545	2.215	0.0695	60
5	2.60	4.36	1	2.95	1.82	1.84	1.572	9.283	2.584	0.0495	60
6	3.20	4.36	1	2.97	1.84	1.85	1.523	6.943	3.140	0.0323	60
7	4.00	4.36	1	2.01	1.99	2.01	1.567	4.767	4.603	0.0141	60
8	4.80	4.36	2	1.37	3.54	3.58	2.613	3.182	10.442	0.0025	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

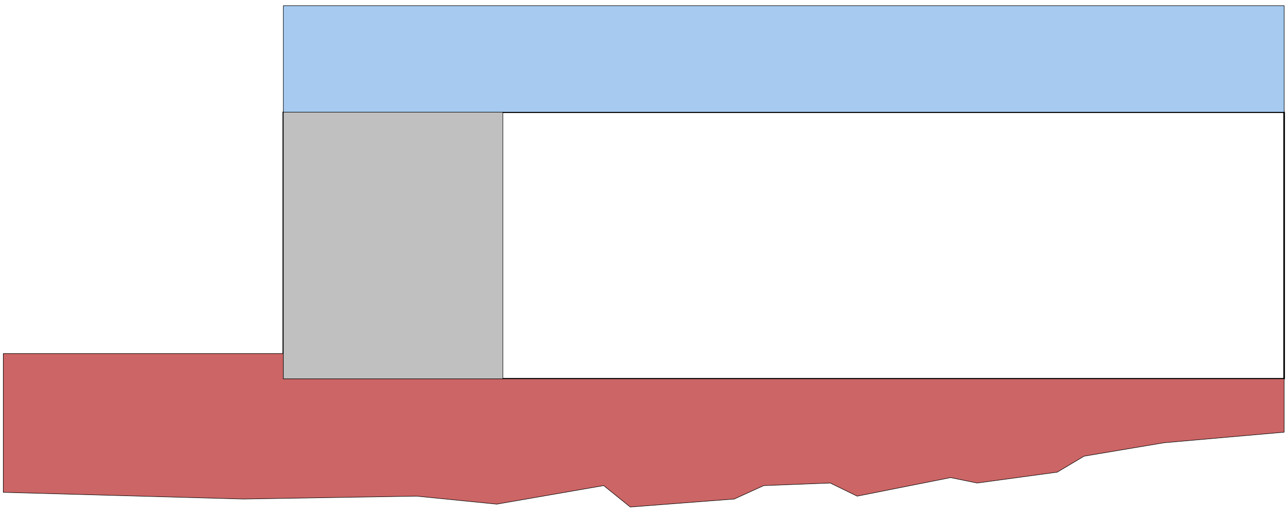
Bearing capacity, Fs = 2.07, Meyerhof stress = 239.74 kPa.

Foundation Interface: Direct sliding, Fs = 1.560, Eccentricity, e/L = 0.1889, Fs-overturning = 2.65

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.36	1	1.42	1.16	1.17	1.162	11.401	1.343	0.1763	60
2	0.80	4.36	1	1.35	1.10	1.11	1.064	8.887	1.494	0.1409	60
3	1.40	4.36	1	1.53	1.24	1.25	1.158	8.037	1.687	0.1092	60
4	2.00	4.36	1	1.74	1.41	1.43	1.271	7.188	1.943	0.0811	60
5	2.60	4.36	1	2.01	1.63	1.65	1.408	6.340	2.302	0.0567	60
6	3.20	4.36	1	2.07	1.67	1.69	1.385	4.848	2.848	0.0361	60
7	4.00	4.36	1	1.43	1.84	1.86	1.447	3.397	4.299	0.0152	60
8	4.80	4.36	2	1.00	3.31	3.34	2.438	2.303	10.132	0.0026	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	545.2	496.0	[kPa]
Meyerhof stress, σ_V	218.10	239.7	[kPa]
Eccentricity, e	0.61	0.76	[m]
Eccentricity, e/L	0.141	0.173	
Fs calculated	2.50	2.07	
Base length	4.36	4.36	[m]



DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.848 and Fs-seismic = 1.560

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.36	1.587	1.343	1	60
2	0.80	4.36	1.747	1.494	1	60
3	1.40	4.36	1.949	1.687	1	60
4	2.00	4.36	2.215	1.943	1	60
5	2.60	4.36	2.584	2.302	1	60
6	3.20	4.36	3.140	2.848	1	60
7	4.00	4.36	4.603	4.299	1	60
8	4.80	4.36	10.442	10.132	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1535, e/L seismic = 0.1889; Overturning: Fs-static = 3.26, Fs-seismic = 2.65

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.36	0.1439	0.1763	1	60
2	0.80	4.36	0.1167	0.1409	1	60
3	1.40	4.36	0.0919	0.1092	1	60
4	2.00	4.36	0.0695	0.0811	1	60
5	2.60	4.36	0.0495	0.0567	1	60
6	3.20	4.36	0.0323	0.0361	1	60
7	4.00	4.36	0.0141	0.0152	1	60
8	4.80	4.36	0.0025	0.0026	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	25.33	5.46	N/A	1.332	N/A	1.162	60
2	0.80	33.7	28.30	5.01	N/A	1.192	N/A	1.064	60
3	1.40	33.7	26.02	4.57	N/A	1.296	N/A	1.158	60
4	2.00	33.7	23.74	4.12	N/A	1.421	N/A	1.271	60
5	2.60	33.7	21.46	3.68	N/A	1.572	N/A	1.408	60
6	3.20	33.7	22.16	3.23	N/A	1.523	N/A	1.385	60
7	4.00	33.7	21.52	2.64	N/A	1.567	N/A	1.447	60
8	4.80	50.6	19.37	2.04	N/A	2.613	N/A	2.438	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	25.33	5.46	4.24	0.12	438.7	N/A	17.323	351.0	N/A	11.401
2	0.80	1.000	28.30	5.01	3.90	0.46	370.1	N/A	13.077	296.1	N/A	8.887
3	1.40	1.000	26.02	4.57	3.55	0.81	307.3	N/A	11.810	245.8	N/A	8.037
4	2.00	1.000	23.74	4.12	3.21	1.15	250.3	N/A	10.545	200.3	N/A	7.188
5	2.60	1.000	21.46	3.68	2.86	1.50	199.2	N/A	9.283	159.4	N/A	6.340
6	3.20	1.000	22.16	3.23	2.51	1.85	153.8	N/A	6.943	123.1	N/A	4.848
7	4.00	1.000	21.52	2.64	2.05	2.31	102.6	N/A	4.767	82.1	N/A	3.397
8	4.80	1.000	19.37	2.04	1.59	2.77	61.6	N/A	3.182	49.3	N/A	2.303

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	25.1	0.90	0.90	33.4	54.0	33.7	N/A	1.33	N/A	2.16	N/A	1.35	60
2	0.80	27.1	0.90	0.90	33.4	54.0	33.7	N/A	1.23	N/A	1.99	N/A	1.24	60
3	1.40	24.1	0.90	0.90	33.4	54.0	33.7	N/A	1.39	N/A	2.24	N/A	1.40	60
4	2.00	21.1	0.90	0.90	33.4	54.0	33.7	N/A	1.58	N/A	2.56	N/A	1.60	60
5	2.60	18.3	0.90	0.90	33.4	54.0	33.7	N/A	1.82	N/A	2.95	N/A	1.84	60
6	3.20	18.2	0.90	0.90	33.4	54.0	33.7	N/A	1.84	N/A	2.97	N/A	1.85	60
7	4.00	16.8	0.90	0.56	33.4	33.7	33.7	N/A	1.99	N/A	2.01	N/A	2.01	60
8	4.80	14.1	0.90	0.22	50.1	19.4	50.6	N/A	3.54	N/A	1.37	N/A	3.58	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	30.5	0.90	0.72	33.4	43.2	33.7	N/A	1.16	N/A	1.42	N/A	1.17	60
2	0.80	31.9	0.90	0.72	33.4	43.2	33.7	N/A	1.10	N/A	1.35	N/A	1.11	60
3	1.40	28.3	0.90	0.72	33.4	43.2	33.7	N/A	1.24	N/A	1.53	N/A	1.25	60
4	2.00	24.8	0.90	0.72	33.4	43.2	33.7	N/A	1.41	N/A	1.74	N/A	1.43	60
5	2.60	21.4	0.90	0.72	33.4	43.2	33.7	N/A	1.63	N/A	2.01	N/A	1.65	60
6	3.20	20.8	0.90	0.72	33.4	43.2	33.7	N/A	1.67	N/A	2.07	N/A	1.69	60
7	4.00	18.8	0.90	0.45	33.4	27.0	33.7	N/A	1.84	N/A	1.43	N/A	1.86	60
8	4.80	15.6	0.90	0.17	50.1	15.6	50.6	N/A	3.31	N/A	1.00	N/A	3.34	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type5-1(H=5.90m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

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Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 27.86　　N γ= 19.34

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959　　Kae (Kh = 0) = 0.3333　　Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

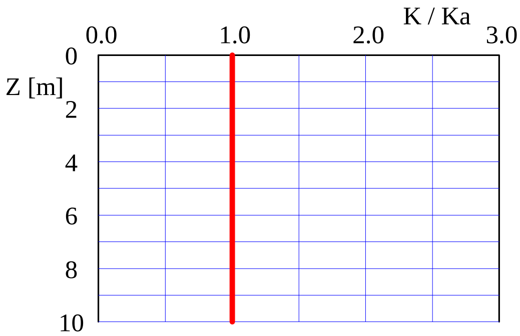
INPUT DATA: Geogrids
(Analysis)

D A T A		Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]		60.0	90.0	120.0	180.0	
Durability reduction factor, RFd		1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid		1.10	1.10	1.10	1.10	
Creep reduction factor, RFc		1.47	1.47	1.47	1.47	N/A
Fs-overall for strength		N/A	N/A	N/A	N/A	
Coverage ratio, Rc		1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface,	ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*		0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor,	α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

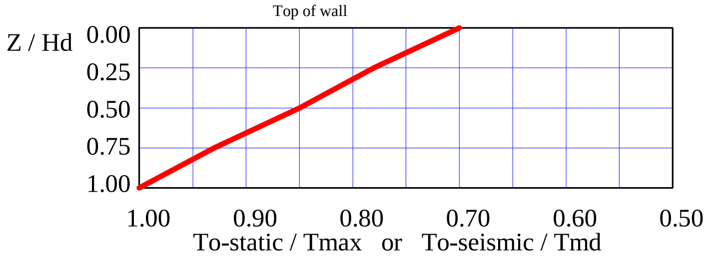
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

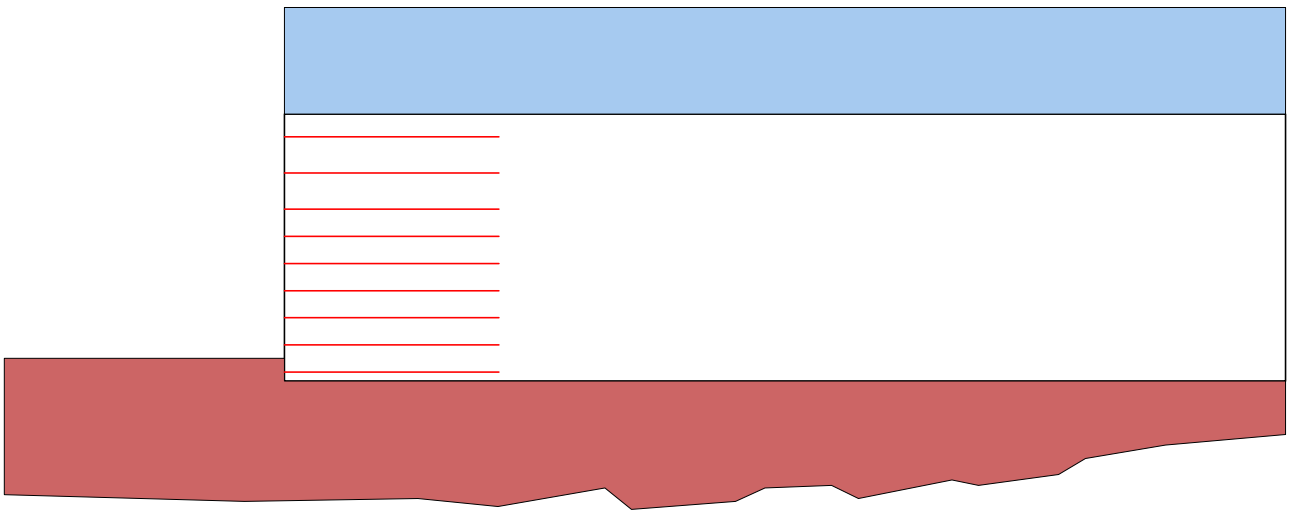
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	5.90	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 5.40 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 43.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.50, Meyerhof stress = 235.71 kPa.

Foundation Interface: Direct sliding, Fs = 1.849, Eccentricity, e/L = 0.1554, Fs-overturning = 3.22

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.74	2	3.00	1.86	1.88	1.859	18.991	1.583	0.1467	90
2	0.80	4.74	2	2.75	1.70	1.72	1.655	14.462	1.725	0.1218	90
3	1.40	4.74	1	2.04	1.26	1.28	1.192	13.190	1.899	0.0988	60
4	2.00	4.74	1	2.30	1.42	1.44	1.296	11.921	2.119	0.0778	60
5	2.60	4.74	1	2.62	1.62	1.64	1.421	10.653	2.408	0.0588	60
6	3.20	4.74	1	3.00	1.86	1.88	1.572	9.388	2.809	0.0419	60
7	3.80	4.74	1	3.01	1.86	1.88	1.523	7.036	3.414	0.0273	60
8	4.60	4.74	1	2.03	2.01	2.03	1.567	4.844	5.004	0.0119	60
9	5.40	4.74	2	1.38	3.56	3.59	2.613	3.247	11.352	0.0021	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

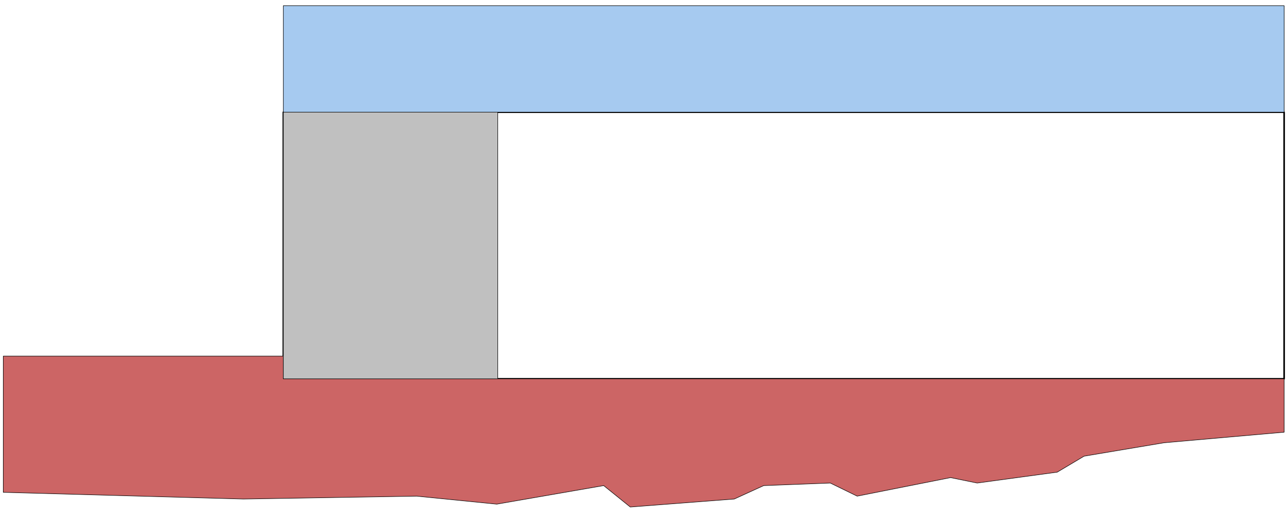
Bearing capacity, Fs = 2.03, Meyerhof stress = 261.59 kPa.

Foundation Interface: Direct sliding, Fs = 1.547, Eccentricity, e/L = 0.1937, Fs-overturning = 2.58

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.74	2	1.96	1.61	1.63	1.612	12.405	1.328	0.1821	90
2	0.80	4.74	2	1.86	1.51	1.53	1.470	9.763	1.460	0.1492	90
3	1.40	4.74	1	1.38	1.12	1.13	1.059	8.914	1.624	0.1193	60
4	2.00	4.74	1	1.56	1.27	1.28	1.153	8.066	1.834	0.0924	60
5	2.60	4.74	1	1.77	1.44	1.46	1.266	7.219	2.112	0.0686	60
6	3.20	4.74	1	2.04	1.66	1.67	1.402	6.374	2.502	0.0479	60
7	3.80	4.74	1	2.09	1.69	1.70	1.380	4.886	3.096	0.0306	60
8	4.60	4.74	1	1.44	1.85	1.87	1.442	3.435	4.674	0.0128	60
9	5.40	4.74	2	1.00	3.31	3.34	2.430	2.338	11.015	0.0022	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	588.3	530.1	[kPa]
Meyerhof stress, σ_V	235.71	261.6	[kPa]
Eccentricity, e	0.68	0.85	[m]
Eccentricity, e/L	0.143	0.179	
Fs calculated	2.50	2.03	
Base length	4.74	4.74	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.849 and Fs-seismic = 1.547

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.74	1.583	1.328	2	90
2	0.80	4.74	1.725	1.460	2	90
3	1.40	4.74	1.899	1.624	1	60
4	2.00	4.74	2.119	1.834	1	60
5	2.60	4.74	2.408	2.112	1	60
6	3.20	4.74	2.809	2.502	1	60
7	3.80	4.74	3.414	3.096	1	60
8	4.60	4.74	5.004	4.674	1	60
9	5.40	4.74	11.352	11.015	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1554, e/L seismic = 0.1937; Overturning: Fs-static = 3.22, Fs-seismic = 2.58

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.74	0.1467	0.1821	2	90
2	0.80	4.74	0.1218	0.1492	2	90
3	1.40	4.74	0.0988	0.1193	1	60
4	2.00	4.74	0.0778	0.0924	1	60
5	2.60	4.74	0.0588	0.0686	1	60
6	3.20	4.74	0.0419	0.0479	1	60
7	3.80	4.74	0.0273	0.0306	1	60
8	4.60	4.74	0.0119	0.0128	1	60
9	5.40	4.74	0.0021	0.0022	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	27.23	6.12	N/A	1.859	N/A	1.612	90
2	0.80	50.6	30.58	5.66	N/A	1.655	N/A	1.470	90
3	1.40	33.7	28.30	5.20	N/A	1.192	N/A	1.059	60
4	2.00	33.7	26.02	4.74	N/A	1.296	N/A	1.153	60
5	2.60	33.7	23.74	4.28	N/A	1.421	N/A	1.266	60
6	3.20	33.7	21.46	3.83	N/A	1.572	N/A	1.402	60
7	3.80	33.7	22.16	3.37	N/A	1.523	N/A	1.380	60
8	4.60	33.7	21.52	2.76	N/A	1.567	N/A	1.442	60
9	5.40	50.6	19.37	2.15	N/A	2.613	N/A	2.430	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	27.23	6.12	4.62	0.12	517.0	N/A	18.991	413.6	N/A	12.405
2	0.80	1.000	30.58	5.66	4.28	0.46	442.2	N/A	14.462	353.8	N/A	9.763
3	1.40	1.000	28.30	5.20	3.93	0.81	373.3	N/A	13.190	298.6	N/A	8.914
4	2.00	1.000	26.02	4.74	3.59	1.15	310.2	N/A	11.921	248.1	N/A	8.066
5	2.60	1.000	23.74	4.28	3.24	1.50	252.9	N/A	10.653	202.3	N/A	7.219
6	3.20	1.000	21.46	3.83	2.89	1.85	201.5	N/A	9.388	161.2	N/A	6.374
7	3.80	1.000	22.16	3.37	2.55	2.19	155.9	N/A	7.036	124.7	N/A	4.886
8	4.60	1.000	21.52	2.76	2.08	2.66	104.2	N/A	4.844	83.4	N/A	3.435
9	5.40	1.000	19.37	2.15	1.62	3.12	62.9	N/A	3.247	50.3	N/A	2.338

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	27.0	0.90	0.90	50.1	81.0	50.6	N/A	1.86	N/A	3.00	N/A	1.88	90
2	0.80	29.4	0.90	0.90	50.1	81.0	50.6	N/A	1.70	N/A	2.75	N/A	1.72	90
3	1.40	26.4	0.90	0.90	33.4	54.0	33.7	N/A	1.26	N/A	2.04	N/A	1.28	60
4	2.00	23.5	0.90	0.90	33.4	54.0	33.7	N/A	1.42	N/A	2.30	N/A	1.44	60
5	2.60	20.6	0.90	0.90	33.4	54.0	33.7	N/A	1.62	N/A	2.62	N/A	1.64	60
6	3.20	18.0	0.90	0.90	33.4	54.0	33.7	N/A	1.86	N/A	3.00	N/A	1.88	60
7	3.80	17.9	0.90	0.90	33.4	54.0	33.7	N/A	1.86	N/A	3.01	N/A	1.88	60
8	4.60	16.6	0.90	0.56	33.4	33.7	33.7	N/A	2.01	N/A	2.03	N/A	2.03	60
9	5.40	14.1	0.90	0.22	50.1	19.4	50.6	N/A	3.56	N/A	1.38	N/A	3.59	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	33.0	0.90	0.72	50.1	64.8	50.6	N/A	1.61	N/A	1.96	N/A	1.63	90
2	0.80	34.9	0.90	0.72	50.1	64.8	50.6	N/A	1.51	N/A	1.86	N/A	1.53	90
3	1.40	31.3	0.90	0.72	33.4	43.2	33.7	N/A	1.12	N/A	1.38	N/A	1.13	60
4	2.00	27.7	0.90	0.72	33.4	43.2	33.7	N/A	1.27	N/A	1.56	N/A	1.28	60
5	2.60	24.4	0.90	0.72	33.4	43.2	33.7	N/A	1.44	N/A	1.77	N/A	1.46	60
6	3.20	21.2	0.90	0.72	33.4	43.2	33.7	N/A	1.66	N/A	2.04	N/A	1.67	60
7	3.80	20.7	0.90	0.72	33.4	43.2	33.7	N/A	1.69	N/A	2.09	N/A	1.70	60
8	4.60	18.7	0.90	0.45	33.4	27.0	33.7	N/A	1.85	N/A	1.44	N/A	1.87	60
9	5.40	15.6	0.90	0.17	50.1	15.6	50.6	N/A	3.31	N/A	1.00	N/A	3.34	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type6(H=5.50m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:
.....진\type6(H=5.5m).BEN

Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	19.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	30.0
Equivalent cohesion, $c_{equiv.}$	15.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 30.14 N γ= 22.40

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

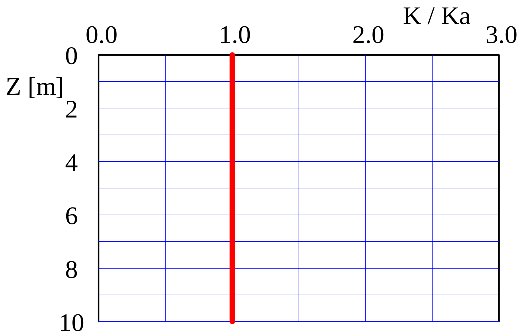
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텦aϕ	0.80텦an	0.80텦an	0.80텦an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

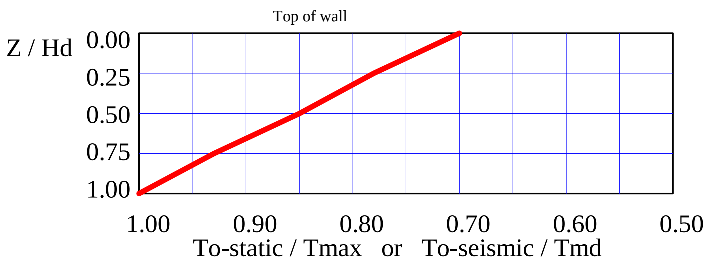
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

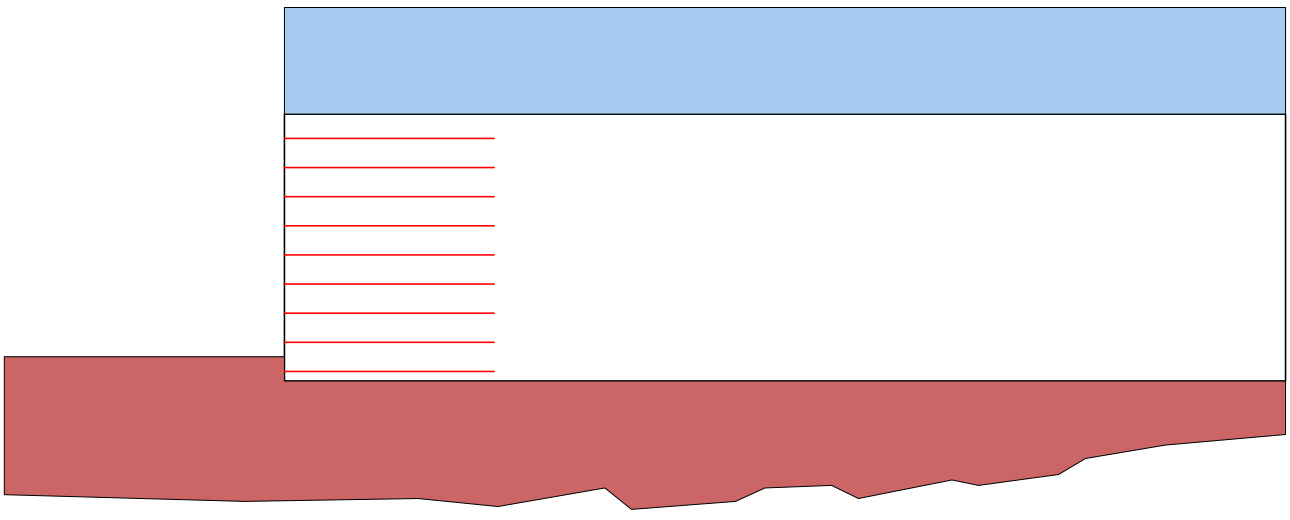
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	5.50	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 5.00 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 43.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 4.72, Meyerhof stress = 231.19 kPa.

Foundation Interface: Direct sliding, Fs = 1.854, Eccentricity, e/L = 0.1664, Fs-overturning = 3.01

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.32	1	2.10	1.30	1.31	1.299	17.199	1.526	0.1564	60
2	0.80	4.32	1	1.94	1.20	1.21	1.161	12.976	1.674	0.1279	60
3	1.40	4.32	1	2.17	1.34	1.36	1.260	11.715	1.859	0.1018	60
4	2.00	4.32	1	2.47	1.53	1.54	1.377	10.451	2.098	0.0781	60
5	2.60	4.32	1	2.83	1.75	1.77	1.518	9.197	2.424	0.0569	60
6	3.20	4.32	1	3.27	2.02	2.05	1.692	7.942	2.898	0.0385	60
7	3.80	4.32	1	3.13	2.37	2.40	1.910	6.694	3.675	0.0229	60
8	4.40	4.32	1	2.43	2.84	2.87	2.193	5.462	5.233	0.0106	60
9	5.00	4.32	2	1.57	4.05	4.09	2.983	3.275	10.346	0.0025	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

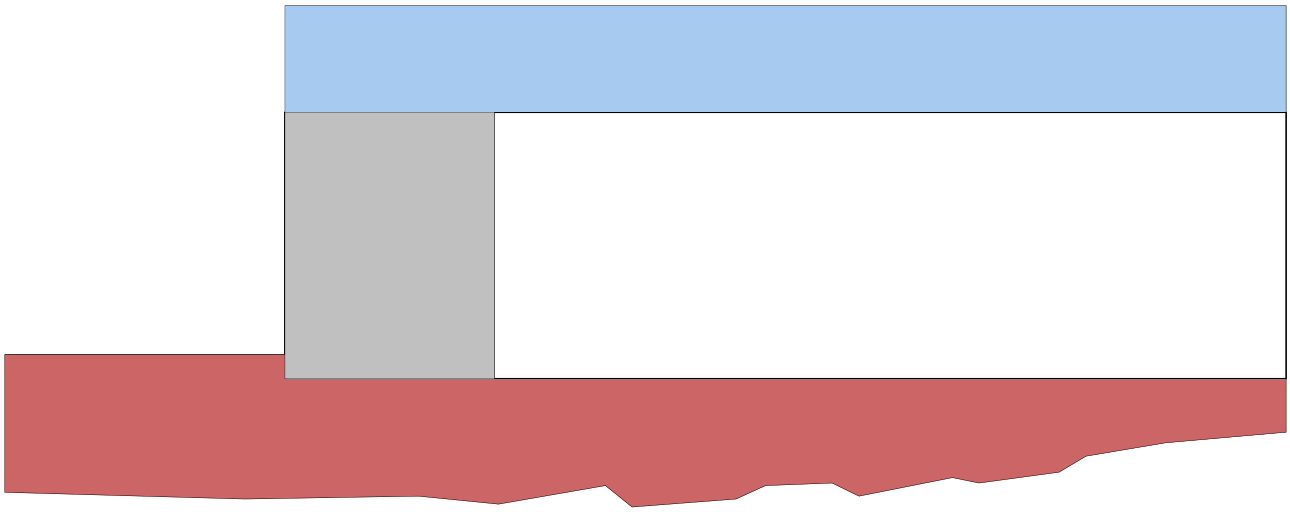
Bearing capacity, Fs = 3.97, Meyerhof stress = 257.97 kPa.

Foundation Interface: Direct sliding, Fs = 1.559, Eccentricity, e/L = 0.2056, Fs-overturning = 2.43

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.32	1	1.39	1.14	1.15	1.136	11.358	1.288	0.1924	60
2	0.80	4.32	1	1.32	1.07	1.08	1.038	8.848	1.427	0.1552	60
3	1.40	4.32	1	1.48	1.20	1.22	1.128	8.002	1.602	0.1216	60
4	2.00	4.32	1	1.69	1.37	1.38	1.235	7.154	1.832	0.0917	60
5	2.60	4.32	1	1.94	1.57	1.59	1.364	6.312	2.147	0.0656	60
6	3.20	4.32	1	2.25	1.82	1.84	1.524	5.468	2.612	0.0433	60
7	3.80	4.32	1	2.17	2.14	2.17	1.726	4.628	3.379	0.0252	60
8	4.40	4.32	1	1.69	2.58	2.60	1.989	3.796	4.930	0.0114	60
9	5.00	4.32	2	1.13	3.77	3.81	2.775	2.360	10.039	0.0026	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1090.4	1024.1	[kPa]
Meyerhof stress, σ_V	231.19	258.0	[kPa]
Eccentricity, e	0.66	0.82	[m]
Eccentricity, e/L	0.153	0.189	
Fs calculated	4.72	3.97	
Base length	4.32	4.32	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.854 and Fs-seismic = 1.559

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.32	1.526	1.288	1	60
2	0.80	4.32	1.674	1.427	1	60
3	1.40	4.32	1.859	1.602	1	60
4	2.00	4.32	2.098	1.832	1	60
5	2.60	4.32	2.424	2.147	1	60
6	3.20	4.32	2.898	2.612	1	60
7	3.80	4.32	3.675	3.379	1	60
8	4.40	4.32	5.233	4.930	1	60
9	5.00	4.32	10.346	10.039	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1664, e/L seismic = 0.2056; Overturning: Fs-static = 3.01, Fs-seismic = 2.43

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.32	0.1564	0.1924	1	60
2	0.80	4.32	0.1279	0.1552	1	60
3	1.40	4.32	0.1018	0.1216	1	60
4	2.00	4.32	0.0781	0.0917	1	60
5	2.60	4.32	0.0569	0.0656	1	60
6	3.20	4.32	0.0385	0.0433	1	60
7	3.80	4.32	0.0229	0.0252	1	60
8	4.40	4.32	0.0106	0.0114	1	60
9	5.00	4.32	0.0025	0.0026	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	25.96	5.49	N/A	1.299	N/A	1.136	60
2	0.80	33.7	29.06	5.04	N/A	1.161	N/A	1.038	60
3	1.40	33.7	26.78	4.58	N/A	1.260	N/A	1.128	60
4	2.00	33.7	24.50	4.13	N/A	1.377	N/A	1.235	60
5	2.60	33.7	22.22	3.68	N/A	1.518	N/A	1.364	60
6	3.20	33.7	19.94	3.23	N/A	1.692	N/A	1.524	60
7	3.80	33.7	17.66	2.78	N/A	1.910	N/A	1.726	60
8	4.40	33.7	15.38	2.32	N/A	2.193	N/A	1.989	60
9	5.00	50.6	16.96	1.87	N/A	2.983	N/A	2.775	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m] (see NOTE)	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	25.96	5.49	4.20	0.12	446.5	N/A	17.199	357.2	N/A	11.358
2	0.80	1.000	29.06	5.04	3.86	0.46	377.1	N/A	12.976	301.7	N/A	8.848
3	1.40	1.000	26.78	4.58	3.51	0.81	313.7	N/A	11.715	251.0	N/A	8.002
4	2.00	1.000	24.50	4.13	3.17	1.15	256.1	N/A	10.451	204.8	N/A	7.154
5	2.60	1.000	22.22	3.68	2.82	1.50	204.4	N/A	9.197	163.5	N/A	6.312
6	3.20	1.000	19.94	3.23	2.47	1.85	158.4	N/A	7.942	126.7	N/A	5.468
7	3.80	1.000	17.66	2.78	2.13	2.19	118.2	N/A	6.694	94.6	N/A	4.628
8	4.40	1.000	15.38	2.32	1.78	2.54	84.0	N/A	5.462	67.2	N/A	3.796
9	5.00	1.000	16.96	1.87	1.43	2.89	55.5	N/A	3.275	44.4	N/A	2.360

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	25.7	0.90	0.90	33.4	54.0	33.7	N/A	1.30	N/A	2.10	N/A	1.31	60
2	0.80	27.9	0.90	0.90	33.4	54.0	33.7	N/A	1.20	N/A	1.94	N/A	1.21	60
3	1.40	24.9	0.90	0.90	33.4	54.0	33.7	N/A	1.34	N/A	2.17	N/A	1.36	60
4	2.00	21.9	0.90	0.90	33.4	54.0	33.7	N/A	1.53	N/A	2.47	N/A	1.54	60
5	2.60	19.1	0.90	0.90	33.4	54.0	33.7	N/A	1.75	N/A	2.83	N/A	1.77	60
6	3.20	16.5	0.90	0.90	33.4	54.0	33.7	N/A	2.02	N/A	3.27	N/A	2.05	60
7	3.80	14.1	0.90	0.73	33.4	44.1	33.7	N/A	2.37	N/A	3.13	N/A	2.40	60
8	4.40	11.8	0.90	0.48	33.4	28.5	33.7	N/A	2.84	N/A	2.43	N/A	2.87	60
9	5.00	12.4	0.90	0.22	50.1	19.4	50.6	N/A	4.05	N/A	1.57	N/A	4.09	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	31.1	0.90	0.72	33.4	43.2	33.7	N/A	1.14	N/A	1.39	N/A	1.15	60
2	0.80	32.7	0.90	0.72	33.4	43.2	33.7	N/A	1.07	N/A	1.32	N/A	1.08	60
3	1.40	29.1	0.90	0.72	33.4	43.2	33.7	N/A	1.20	N/A	1.48	N/A	1.22	60
4	2.00	25.6	0.90	0.72	33.4	43.2	33.7	N/A	1.37	N/A	1.69	N/A	1.38	60
5	2.60	22.2	0.90	0.72	33.4	43.2	33.7	N/A	1.57	N/A	1.94	N/A	1.59	60
6	3.20	19.2	0.90	0.72	33.4	43.2	33.7	N/A	1.82	N/A	2.25	N/A	1.84	60
7	3.80	16.3	0.90	0.59	33.4	35.3	33.7	N/A	2.14	N/A	2.17	N/A	2.17	60
8	4.40	13.5	0.90	0.38	33.4	22.8	33.7	N/A	2.58	N/A	1.69	N/A	2.60	60
9	5.00	13.7	0.90	0.17	50.1	15.6	50.6	N/A	3.77	N/A	1.13	N/A	3.81	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type7(H=6.30m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

.....진\type7(H=6.3m).BEN

Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ 19.0 kN/m

Design value of internal angle of friction, ϕ 30.0

RETAINED SOIL

Unit weight, γ 19.0 kN/m

Design value of internal angle of friction, ϕ 30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$ 19.0 kN/m

Equivalent internal angle of friction, $\phi_{equiv.}$ 30.0

Equivalent cohesion, $c_{equiv.}$ 15.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 30.14 N γ= 22.40

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

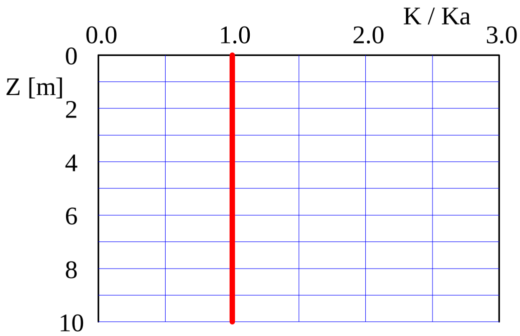
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

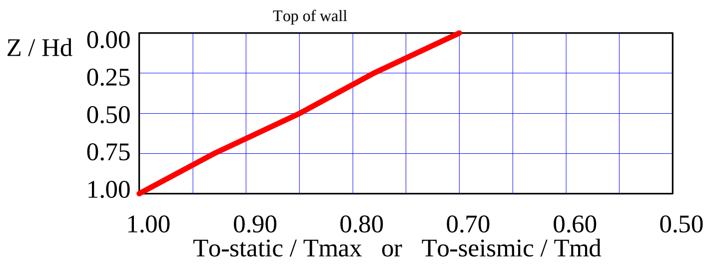
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

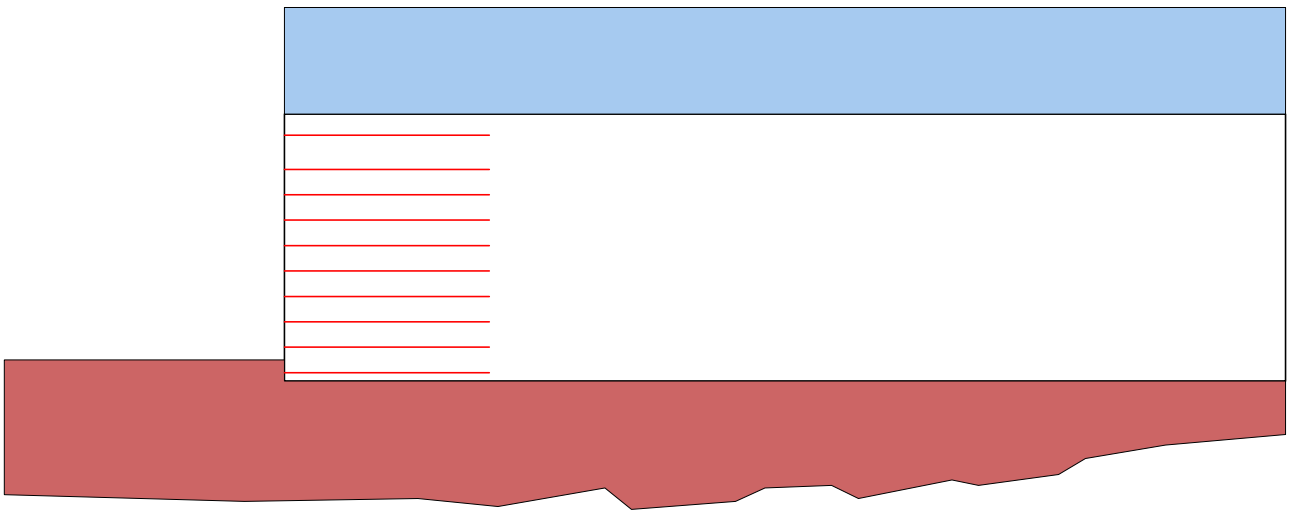
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	6.30	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 5.80 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 43.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 4.59, Meyerhof stress = 254.00 kPa.

Foundation Interface: Direct sliding, Fs = 1.869, Eccentricity, e/L = 0.1664, Fs-overturning = 3.00

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.84	2	2.87	1.77	1.79	1.776	19.466	1.533	0.1577	90
2	0.80	4.84	2	2.62	1.62	1.63	1.576	14.862	1.661	0.1325	90
3	1.40	4.84	1	1.93	1.19	1.21	1.131	13.593	1.816	0.1092	60
4	2.00	4.84	1	2.16	1.33	1.35	1.225	12.326	2.008	0.0878	60
5	2.60	4.84	1	2.43	1.51	1.52	1.335	11.061	2.253	0.0683	60
6	3.20	4.84	1	2.77	1.71	1.73	1.468	9.800	2.580	0.0507	60
7	3.80	4.84	1	3.18	1.96	1.98	1.630	8.549	3.044	0.0353	60
8	4.40	4.84	1	3.37	2.28	2.31	1.831	7.297	3.770	0.0221	60
9	5.00	4.84	1	2.36	2.34	2.37	1.813	5.251	5.110	0.0114	60
10	5.80	4.84	2	1.38	3.57	3.60	2.613	2.986	11.591	0.0020	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

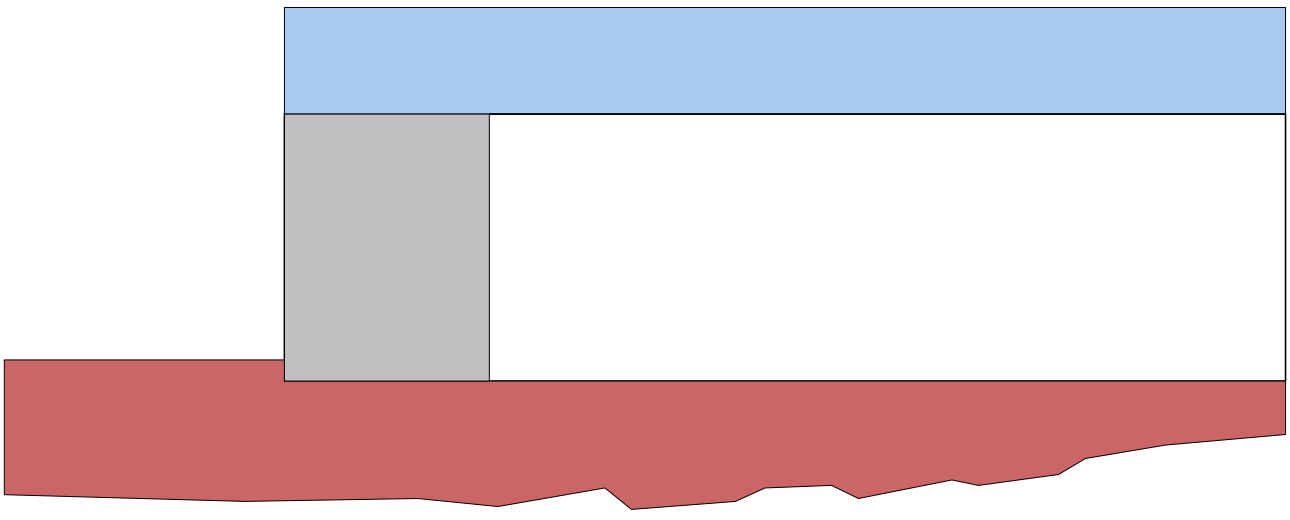
Bearing capacity, Fs = 3.78, Meyerhof stress = 286.66 kPa.

Foundation Interface: Direct sliding, Fs = 1.555, Eccentricity, e/L = 0.2090, Fs-overturning = 2.39

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.84	2	1.87	1.54	1.55	1.537	12.677	1.279	0.1972	90
2	0.80	4.84	2	1.76	1.43	1.45	1.398	10.009	1.398	0.1638	90
3	1.40	4.84	1	1.30	1.06	1.07	1.004	9.167	1.543	0.1332	60
4	2.00	4.84	1	1.46	1.19	1.20	1.088	8.326	1.724	0.1055	60
5	2.60	4.84	1	1.65	1.34	1.35	1.188	7.486	1.958	0.0807	60
6	3.20	4.84	1	1.88	1.53	1.54	1.308	6.648	2.274	0.0588	60
7	3.80	4.84	1	2.16	1.75	1.77	1.455	5.815	2.727	0.0401	60
8	4.40	4.84	1	2.30	2.04	2.06	1.639	4.981	3.442	0.0245	60
9	5.00	4.84	1	1.65	2.13	2.15	1.650	3.670	4.773	0.0123	60
10	5.80	4.84	2	1.00	3.33	3.36	2.437	2.160	11.248	0.0021	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1164.6	1083.4	[kPa]
Meyerhof stress, σ_V	254.00	286.7	[kPa]
Eccentricity, e	0.75	0.94	[m]
Eccentricity, e/L	0.154	0.194	
Fs calculated	4.59	3.78	
Base length	4.84	4.84	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.869 and Fs-seismic = 1.555

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.84	1.533	1.279	2	90
2	0.80	4.84	1.661	1.398	2	90
3	1.40	4.84	1.816	1.543	1	60
4	2.00	4.84	2.008	1.724	1	60
5	2.60	4.84	2.253	1.958	1	60
6	3.20	4.84	2.580	2.274	1	60
7	3.80	4.84	3.044	2.727	1	60
8	4.40	4.84	3.770	3.442	1	60
9	5.00	4.84	5.110	4.773	1	60
10	5.80	4.84	11.591	11.248	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1664, e/L seismic = 0.2090; Overturning: Fs-static = 3.00, Fs-seismic = 2.39

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.84	0.1577	0.1972	2	90
2	0.80	4.84	0.1325	0.1638	2	90
3	1.40	4.84	0.1092	0.1332	1	60
4	2.00	4.84	0.0878	0.1055	1	60
5	2.60	4.84	0.0683	0.0807	1	60
6	3.20	4.84	0.0507	0.0588	1	60
7	3.80	4.84	0.0353	0.0401	1	60
8	4.40	4.84	0.0221	0.0245	1	60
9	5.00	4.84	0.0114	0.0123	1	60
10	5.80	4.84	0.0020	0.0021	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	28.49	6.51	N/A	1.776	N/A	1.537	90
2	0.80	50.6	32.10	6.03	N/A	1.576	N/A	1.398	90
3	1.40	33.7	29.82	5.55	N/A	1.131	N/A	1.004	60
4	2.00	33.7	27.54	5.08	N/A	1.225	N/A	1.088	60
5	2.60	33.7	25.26	4.60	N/A	1.335	N/A	1.188	60
6	3.20	33.7	22.98	4.12	N/A	1.468	N/A	1.308	60
7	3.80	33.7	20.70	3.64	N/A	1.630	N/A	1.455	60
8	4.40	33.7	18.42	3.17	N/A	1.831	N/A	1.639	60
9	5.00	33.7	18.61	2.69	N/A	1.813	N/A	1.650	60
10	5.80	50.6	19.37	2.05	N/A	2.613	N/A	2.437	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	28.49	6.51	4.72	0.12	554.6	N/A	19.466	443.7	N/A	12.677
2	0.80	1.000	32.10	6.03	4.38	0.46	477.1	N/A	14.862	381.6	N/A	10.009
3	1.40	1.000	29.82	5.55	4.03	0.81	405.3	N/A	13.593	324.3	N/A	9.167
4	2.00	1.000	27.54	5.08	3.69	1.15	339.5	N/A	12.326	271.6	N/A	8.326
5	2.60	1.000	25.26	4.60	3.34	1.50	279.4	N/A	11.061	223.5	N/A	7.486
6	3.20	1.000	22.98	4.12	2.99	1.85	225.2	N/A	9.800	180.2	N/A	6.648
7	3.80	1.000	20.70	3.64	2.65	2.19	177.0	N/A	8.549	141.6	N/A	5.815
8	4.40	1.000	18.42	3.17	2.30	2.54	134.4	N/A	7.297	107.5	N/A	4.981
9	5.00	1.000	18.61	2.69	1.95	2.89	97.7	N/A	5.251	78.2	N/A	3.670
10	5.80	1.000	19.37	2.05	1.49	3.35	57.8	N/A	2.986	46.3	N/A	2.160

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	28.2	0.90	0.90	50.1	81.0	50.6	N/A	1.77	N/A	2.87	N/A	1.79	90
2	0.80	31.0	0.90	0.90	50.1	81.0	50.6	N/A	1.62	N/A	2.62	N/A	1.63	90
3	1.40	28.0	0.90	0.90	33.4	54.0	33.7	N/A	1.19	N/A	1.93	N/A	1.21	60
4	2.00	25.0	0.90	0.90	33.4	54.0	33.7	N/A	1.33	N/A	2.16	N/A	1.35	60
5	2.60	22.2	0.90	0.90	33.4	54.0	33.7	N/A	1.51	N/A	2.43	N/A	1.52	60
6	3.20	19.5	0.90	0.90	33.4	54.0	33.7	N/A	1.71	N/A	2.77	N/A	1.73	60
7	3.80	17.0	0.90	0.90	33.4	54.0	33.7	N/A	1.96	N/A	3.18	N/A	1.98	60
8	4.40	14.6	0.90	0.82	33.4	49.2	33.7	N/A	2.28	N/A	3.37	N/A	2.31	60
9	5.00	14.3	0.90	0.56	33.4	33.7	33.7	N/A	2.34	N/A	2.36	N/A	2.37	60
10	5.80	14.0	0.90	0.22	50.1	19.4	50.6	N/A	3.57	N/A	1.38	N/A	3.60	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	34.7	0.90	0.72	50.1	64.8	50.6	N/A	1.54	N/A	1.87	N/A	1.55	90
2	0.80	36.8	0.90	0.72	50.1	64.8	50.6	N/A	1.43	N/A	1.76	N/A	1.45	90
3	1.40	33.2	0.90	0.72	33.4	43.2	33.7	N/A	1.06	N/A	1.30	N/A	1.07	60
4	2.00	29.6	0.90	0.72	33.4	43.2	33.7	N/A	1.19	N/A	1.46	N/A	1.20	60
5	2.60	26.2	0.90	0.72	33.4	43.2	33.7	N/A	1.34	N/A	1.65	N/A	1.35	60
6	3.20	23.0	0.90	0.72	33.4	43.2	33.7	N/A	1.53	N/A	1.88	N/A	1.54	60
7	3.80	20.0	0.90	0.72	33.4	43.2	33.7	N/A	1.75	N/A	2.16	N/A	1.77	60
8	4.40	17.2	0.90	0.66	33.4	39.4	33.7	N/A	2.04	N/A	2.30	N/A	2.06	60
9	5.00	16.3	0.90	0.45	33.4	27.0	33.7	N/A	2.13	N/A	1.65	N/A	2.15	60
10	5.80	15.5	0.90	0.17	50.1	15.6	50.6	N/A	3.33	N/A	1.00	N/A	3.36	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type7-1(H=6.90m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

.....\type7-1(H=6.9m).BEN

Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	19.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	30.0
Equivalent cohesion, $c_{equiv.}$	15.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 30.14 N γ= 22.40

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

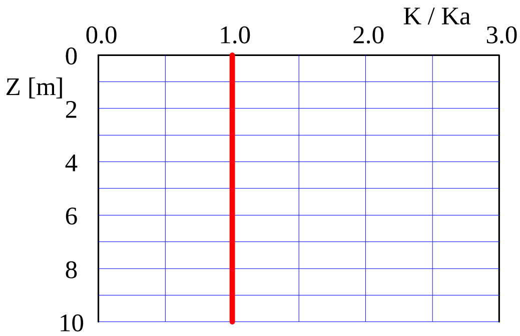
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80톒aϕ	0.80톒an	0.80톒an	0.80톒an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

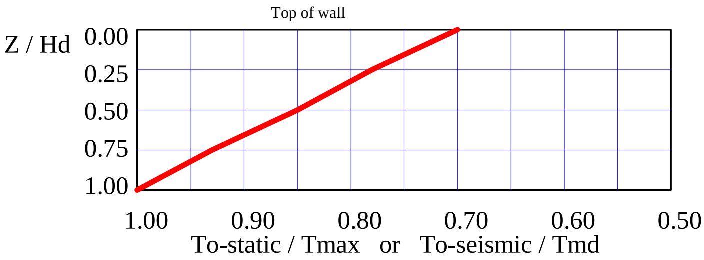
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

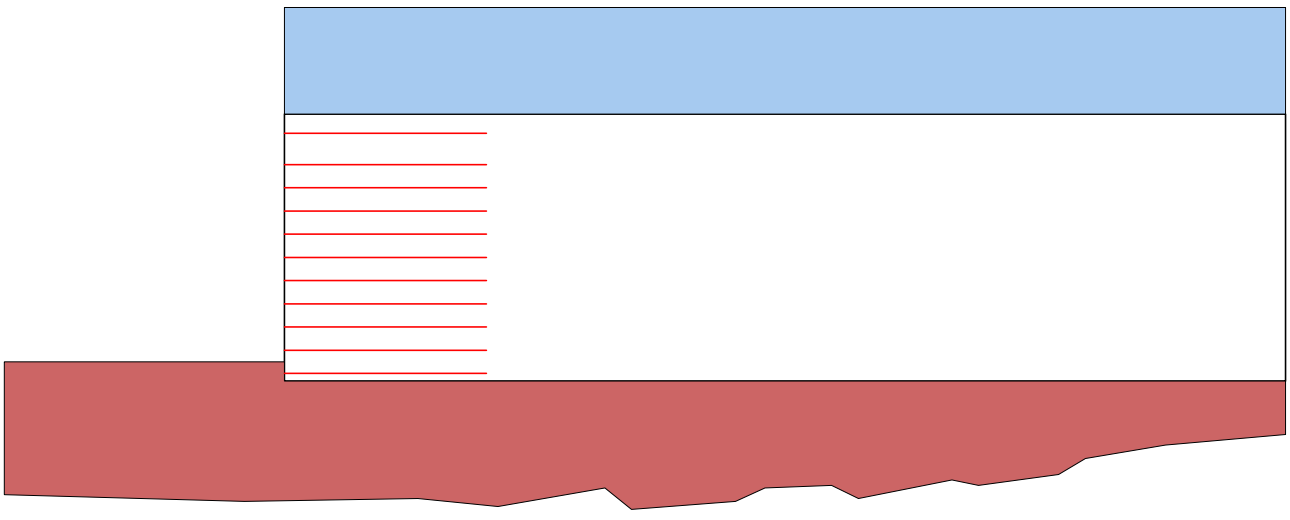
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	6.90	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 6.40 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 43.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 4.49, Meyerhof stress = 271.30 kPa.

Foundation Interface: Direct sliding, Fs = 1.877, Eccentricity, e/L = 0.1668, Fs-overturning = 3.00

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	5.22	2	2.69	1.66	1.68	1.665	21.135	1.537	0.1587	90
2	0.80	5.22	2	2.44	1.51	1.52	1.472	16.247	1.653	0.1355	90
3	1.40	5.22	2	2.68	1.65	1.67	1.576	14.981	1.792	0.1139	90
4	2.00	5.22	1	1.97	1.22	1.23	1.131	13.709	1.959	0.0939	60
5	2.60	5.22	1	2.20	1.36	1.38	1.225	12.439	2.166	0.0755	60
6	3.20	5.22	1	2.48	1.53	1.55	1.335	11.178	2.430	0.0587	60
7	3.80	5.22	1	2.81	1.74	1.76	1.468	9.914	2.782	0.0436	60
8	4.40	5.22	1	3.21	1.99	2.01	1.630	8.653	3.283	0.0303	60
9	5.00	5.22	1	3.40	2.30	2.33	1.831	7.404	4.066	0.0190	60
10	5.60	5.22	1	2.38	2.36	2.38	1.813	5.339	5.511	0.0098	60
11	6.40	5.22	2	1.39	3.58	3.61	2.613	3.054	12.502	0.0017	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

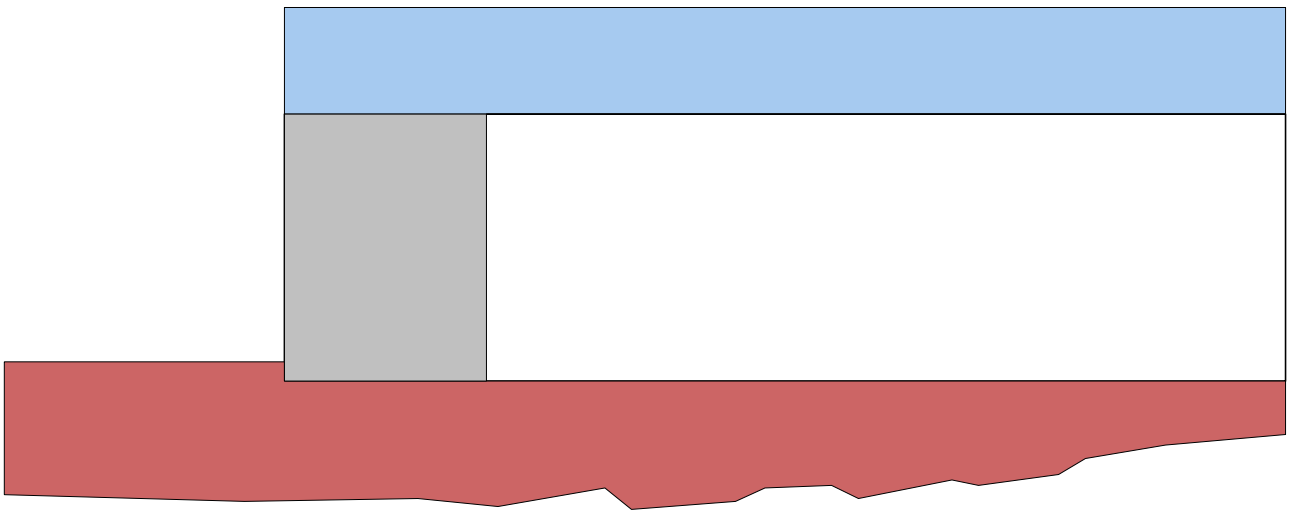
Bearing capacity, Fs = 3.65, Meyerhof stress = 308.72 kPa.

Foundation Interface: Direct sliding, Fs = 1.550, Eccentricity, e/L = 0.2117, Fs-overturning = 2.36

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	5.22	2	1.74	1.43	1.45	1.434	13.672	1.272	0.2007	90
2	0.80	5.22	2	1.63	1.33	1.34	1.299	10.876	1.379	0.1696	90
3	1.40	5.22	2	1.79	1.46	1.48	1.393	10.040	1.507	0.1408	90
4	2.00	5.22	1	1.32	1.08	1.09	1.000	9.200	1.664	0.1145	60
5	2.60	5.22	1	1.48	1.21	1.22	1.084	8.360	1.859	0.0907	60
6	3.20	5.22	1	1.67	1.36	1.37	1.184	7.527	2.112	0.0693	60
7	3.80	5.22	1	1.90	1.54	1.56	1.303	6.689	2.452	0.0506	60
8	4.40	5.22	1	2.18	1.77	1.79	1.450	5.854	2.941	0.0345	60
9	5.00	5.22	1	2.31	2.05	2.07	1.633	5.026	3.713	0.0211	60
10	5.60	5.22	1	1.66	2.14	2.16	1.644	3.713	5.147	0.0106	60
11	6.40	5.22	2	1.00	3.33	3.36	2.429	2.199	12.131	0.0018	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1218.3	1125.4	[kPa]
Meyerhof stress, σ_V	271.30	308.7	[kPa]
Eccentricity, e	0.81	1.03	[m]
Eccentricity, e/L	0.155	0.197	
Fs calculated	4.49	3.65	
Base length	5.22	5.22	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.877 and Fs-seismic = 1.550

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	5.22	1.537	1.272	2	90
2	0.80	5.22	1.653	1.379	2	90
3	1.40	5.22	1.792	1.507	2	90
4	2.00	5.22	1.959	1.664	1	60
5	2.60	5.22	2.166	1.859	1	60
6	3.20	5.22	2.430	2.112	1	60
7	3.80	5.22	2.782	2.452	1	60
8	4.40	5.22	3.283	2.941	1	60
9	5.00	5.22	4.066	3.713	1	60
10	5.60	5.22	5.511	5.147	1	60
11	6.40	5.22	12.502	12.131	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1668, e/L seismic = 0.2117; Overturning: Fs-static = 3.00, Fs-seismic = 2.36

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	5.22	0.1587	0.2007	2	90
2	0.80	5.22	0.1355	0.1696	2	90
3	1.40	5.22	0.1139	0.1408	2	90
4	2.00	5.22	0.0939	0.1145	1	60
5	2.60	5.22	0.0755	0.0907	1	60
6	3.20	5.22	0.0587	0.0693	1	60
7	3.80	5.22	0.0436	0.0506	1	60
8	4.40	5.22	0.0303	0.0345	1	60
9	5.00	5.22	0.0190	0.0211	1	60
10	5.60	5.22	0.0098	0.0106	1	60
11	6.40	5.22	0.0017	0.0018	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	30.39	7.19	N/A	1.665	N/A	1.434	90
2	0.80	50.6	34.38	6.71	N/A	1.472	N/A	1.299	90
3	1.40	50.6	32.10	6.22	N/A	1.576	N/A	1.393	90
4	2.00	33.7	29.82	5.73	N/A	1.131	N/A	1.000	60
5	2.60	33.7	27.54	5.24	N/A	1.225	N/A	1.084	60
6	3.20	33.7	25.26	4.75	N/A	1.335	N/A	1.184	60
7	3.80	33.7	22.98	4.26	N/A	1.468	N/A	1.303	60
8	4.40	33.7	20.70	3.78	N/A	1.630	N/A	1.450	60
9	5.00	33.7	18.42	3.29	N/A	1.831	N/A	1.633	60
10	5.60	33.7	18.61	2.80	N/A	1.813	N/A	1.644	60
11	6.40	50.6	19.37	2.15	N/A	2.613	N/A	2.429	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	30.39	7.19	5.10	0.12	642.3	N/A	21.135	513.9	N/A	13.672
2	0.80	1.000	34.38	6.71	4.76	0.46	558.6	N/A	16.247	446.9	N/A	10.876
3	1.40	1.000	32.10	6.22	4.41	0.81	480.9	N/A	14.981	384.7	N/A	10.040
4	2.00	1.000	29.82	5.73	4.07	1.15	408.8	N/A	13.709	327.0	N/A	9.200
5	2.60	1.000	27.54	5.24	3.72	1.50	342.6	N/A	12.439	274.1	N/A	8.360
6	3.20	1.000	25.26	4.75	3.37	1.85	282.4	N/A	11.178	225.9	N/A	7.527
7	3.80	1.000	22.98	4.26	3.03	2.19	227.8	N/A	9.914	182.3	N/A	6.689
8	4.40	1.000	20.70	3.78	2.68	2.54	179.1	N/A	8.653	143.3	N/A	5.854
9	5.00	1.000	18.42	3.29	2.33	2.89	136.4	N/A	7.404	109.1	N/A	5.026
10	5.60	1.000	18.61	2.80	1.99	3.23	99.4	N/A	5.339	79.5	N/A	3.713
11	6.40	1.000	19.37	2.15	1.52	3.70	59.1	N/A	3.054	47.3	N/A	2.199

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	30.1	0.90	0.90	50.1	81.0	50.6	N/A	1.66	N/A	2.69	N/A	1.68	90
2	0.80	33.3	0.90	0.90	50.1	81.0	50.6	N/A	1.51	N/A	2.44	N/A	1.52	90
3	1.40	30.3	0.90	0.90	50.1	81.0	50.6	N/A	1.65	N/A	2.68	N/A	1.67	90
4	2.00	27.4	0.90	0.90	33.4	54.0	33.7	N/A	1.22	N/A	1.97	N/A	1.23	60
5	2.60	24.5	0.90	0.90	33.4	54.0	33.7	N/A	1.36	N/A	2.20	N/A	1.38	60
6	3.20	21.8	0.90	0.90	33.4	54.0	33.7	N/A	1.53	N/A	2.48	N/A	1.55	60
7	3.80	19.2	0.90	0.90	33.4	54.0	33.7	N/A	1.74	N/A	2.81	N/A	1.76	60
8	4.40	16.8	0.90	0.90	33.4	54.0	33.7	N/A	1.99	N/A	3.21	N/A	2.01	60
9	5.00	14.5	0.90	0.82	33.4	49.2	33.7	N/A	2.30	N/A	3.40	N/A	2.33	60
10	5.60	14.1	0.90	0.56	33.4	33.7	33.7	N/A	2.36	N/A	2.38	N/A	2.38	60
11	6.40	14.0	0.90	0.22	50.1	19.4	50.6	N/A	3.58	N/A	1.39	N/A	3.61	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	37.3	0.90	0.72	50.1	64.8	50.6	N/A	1.43	N/A	1.74	N/A	1.45	90
2	0.80	39.8	0.90	0.72	50.1	64.8	50.6	N/A	1.33	N/A	1.63	N/A	1.34	90
3	1.40	36.1	0.90	0.72	50.1	64.8	50.6	N/A	1.46	N/A	1.79	N/A	1.48	90
4	2.00	32.6	0.90	0.72	33.4	43.2	33.7	N/A	1.08	N/A	1.32	N/A	1.09	60
5	2.60	29.2	0.90	0.72	33.4	43.2	33.7	N/A	1.21	N/A	1.48	N/A	1.22	60
6	3.20	25.9	0.90	0.72	33.4	43.2	33.7	N/A	1.36	N/A	1.67	N/A	1.37	60
7	3.80	22.8	0.90	0.72	33.4	43.2	33.7	N/A	1.54	N/A	1.90	N/A	1.56	60
8	4.40	19.9	0.90	0.72	33.4	43.2	33.7	N/A	1.77	N/A	2.18	N/A	1.79	60
9	5.00	17.1	0.90	0.66	33.4	39.4	33.7	N/A	2.05	N/A	2.31	N/A	2.07	60
10	5.60	16.3	0.90	0.45	33.4	27.0	33.7	N/A	2.14	N/A	1.66	N/A	2.16	60
11	6.40	15.6	0.90	0.17	50.1	15.6	50.6	N/A	3.33	N/A	1.00	N/A	3.36	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type8(H=5.90m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

.....진\type8(H=5.9m).BEN

Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	19.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	30.0
Equivalent cohesion, $c_{equiv.}$	15.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 30.14 N γ= 22.40

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

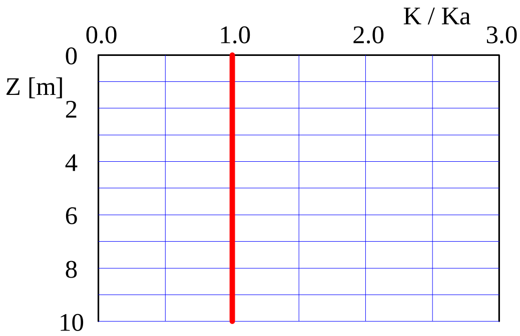
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

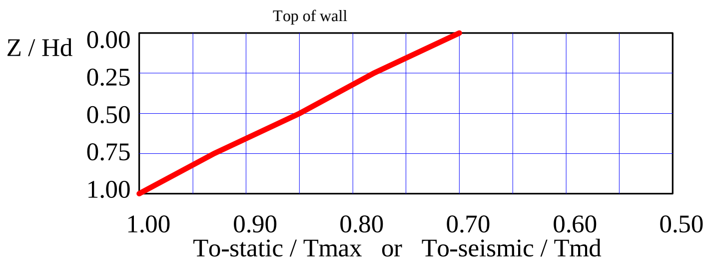
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

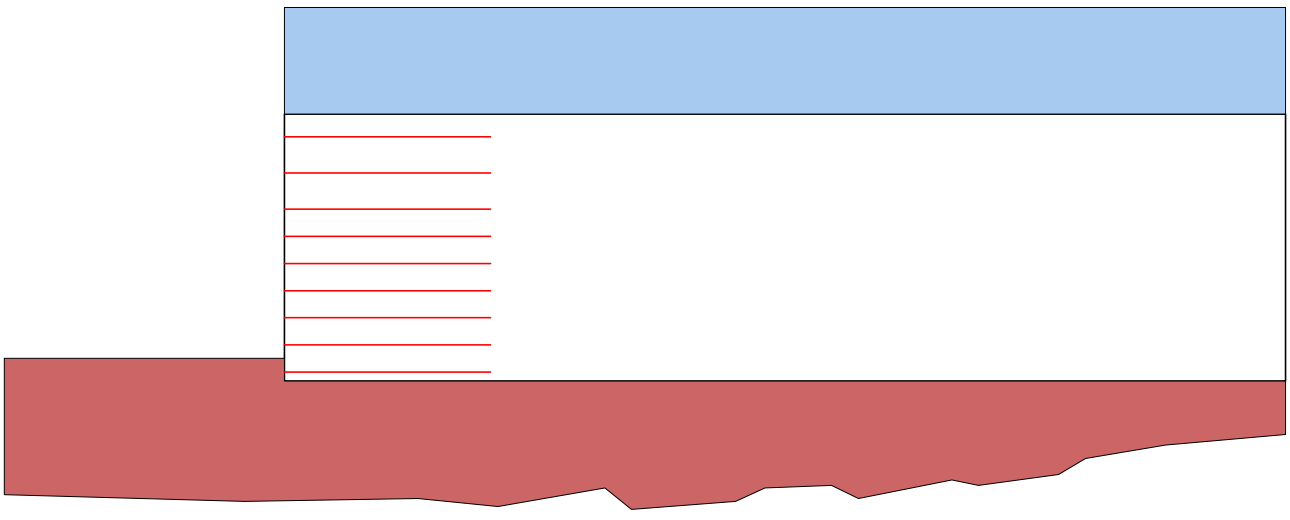
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	5.90	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 5.40 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 41.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 4.69, Meyerhof stress = 239.67 kPa.

Foundation Interface: Direct sliding, Fs = 1.862, Eccentricity, e/L = 0.1665, Fs-overturning = 3.00

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.56	2	3.04	1.88	1.90	1.882	18.231	1.530	0.1572	90
2	0.80	4.56	2	2.79	1.73	1.74	1.677	13.834	1.668	0.1305	90
3	1.40	4.56	1	2.07	1.28	1.30	1.209	12.566	1.836	0.1059	60
4	2.00	4.56	1	2.34	1.45	1.46	1.317	11.300	2.048	0.0834	60
5	2.60	4.56	1	2.66	1.65	1.66	1.445	10.043	2.326	0.0630	60
6	3.20	4.56	1	3.06	1.89	1.91	1.602	8.784	2.712	0.0450	60
7	3.80	4.56	1	3.08	1.90	1.92	1.555	6.521	3.292	0.0294	60
8	4.60	4.56	1	2.08	2.07	2.09	1.607	4.402	4.813	0.0128	60
9	5.40	4.56	2	1.42	3.67	3.71	2.696	2.867	10.862	0.0023	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

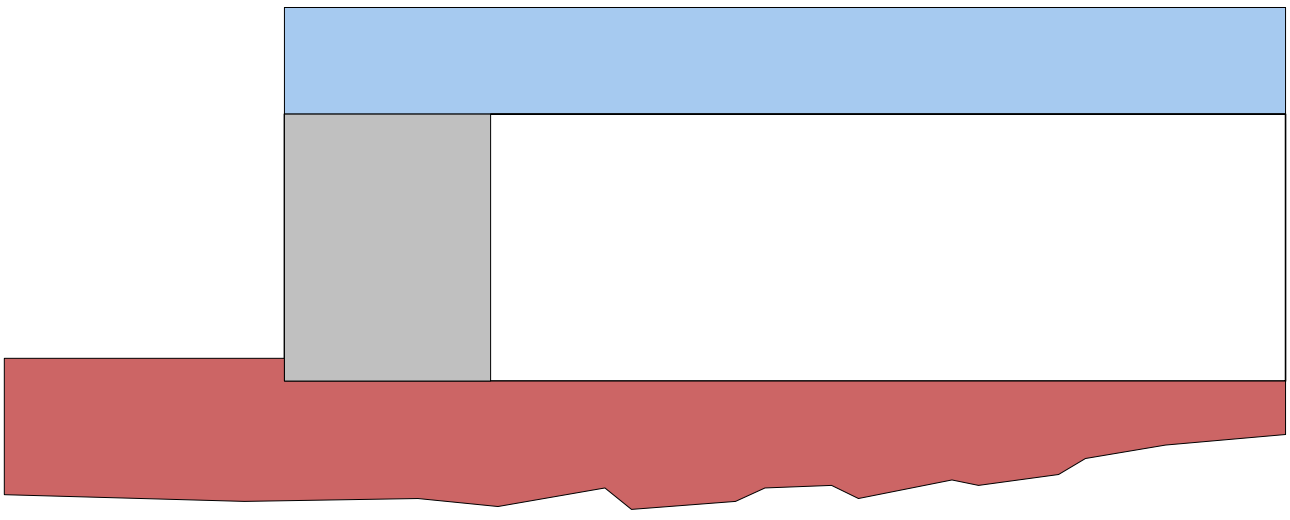
Bearing capacity, Fs = 3.89, Meyerhof stress = 269.69 kPa.

Foundation Interface: Direct sliding, Fs = 1.553, Eccentricity, e/L = 0.2084, Fs-overturning = 2.40

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.56	2	1.98	1.62	1.64	1.625	11.841	1.280	0.1959	90
2	0.80	4.56	2	1.87	1.53	1.54	1.484	9.297	1.407	0.1605	90
3	1.40	4.56	1	1.40	1.14	1.15	1.072	8.458	1.565	0.1283	60
4	2.00	4.56	1	1.58	1.28	1.30	1.169	7.620	1.767	0.0994	60
5	2.60	4.56	1	1.80	1.46	1.48	1.285	6.788	2.034	0.0739	60
6	3.20	4.56	1	2.07	1.69	1.70	1.427	5.953	2.409	0.0517	60
7	3.80	4.56	1	2.13	1.72	1.74	1.409	4.525	2.978	0.0330	60
8	4.60	4.56	1	1.48	1.90	1.92	1.479	3.124	4.486	0.0139	60
9	5.40	4.56	2	1.03	3.42	3.46	2.512	2.071	10.530	0.0023	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1124.7	1049.8	[kPa]
Meyerhof stress, σ_V	239.67	269.7	[kPa]
Eccentricity, e	0.70	0.88	[m]
Eccentricity, e/L	0.153	0.192	
Fs calculated	4.69	3.89	
Base length	4.56	4.56	[m]



SCALE:

0 2 4 6 [m]

Version 3.0 MSEW Version 3.0

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.862 and Fs-seismic = 1.553

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.56	1.530	1.280	2	90
2	0.80	4.56	1.668	1.407	2	90
3	1.40	4.56	1.836	1.565	1	60
4	2.00	4.56	2.048	1.767	1	60
5	2.60	4.56	2.326	2.034	1	60
6	3.20	4.56	2.712	2.409	1	60
7	3.80	4.56	3.292	2.978	1	60
8	4.60	4.56	4.813	4.486	1	60
9	5.40	4.56	10.862	10.530	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1665, e/L seismic = 0.2084; Overturning: Fs-static = 3.00, Fs-seismic = 2.40

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.56	0.1572	0.1959	2	90
2	0.80	4.56	0.1305	0.1605	2	90
3	1.40	4.56	0.1059	0.1283	1	60
4	2.00	4.56	0.0834	0.0994	1	60
5	2.60	4.56	0.0630	0.0739	1	60
6	3.20	4.56	0.0450	0.0517	1	60
7	3.80	4.56	0.0294	0.0330	1	60
8	4.60	4.56	0.0128	0.0139	1	60
9	5.40	4.56	0.0023	0.0023	2	90

Version 3.0 MSEW Version 3.0

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	26.89	6.23	N/A	1.882	N/A	1.625	90
2	0.80	50.6	30.18	5.74	N/A	1.677	N/A	1.484	90
3	1.40	33.7	27.90	5.26	N/A	1.209	N/A	1.072	60
4	2.00	33.7	25.62	4.77	N/A	1.317	N/A	1.169	60
5	2.60	33.7	23.34	4.29	N/A	1.445	N/A	1.285	60
6	3.20	33.7	21.06	3.80	N/A	1.602	N/A	1.427	60
7	3.80	33.7	21.69	3.32	N/A	1.555	N/A	1.409	60
8	4.60	33.7	20.99	2.67	N/A	1.607	N/A	1.479	60
9	5.40	50.6	18.77	2.02	N/A	2.696	N/A	2.512	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	26.89	6.23	4.44	0.12	490.3	N/A	18.231	392.2	N/A	11.841
2	0.80	1.000	30.18	5.74	4.10	0.46	417.5	N/A	13.834	334.0	N/A	9.297
3	1.40	1.000	27.90	5.26	3.75	0.81	350.6	N/A	12.566	280.5	N/A	8.458
4	2.00	1.000	25.62	4.77	3.41	1.15	289.5	N/A	11.300	231.6	N/A	7.620
5	2.60	1.000	23.34	4.29	3.06	1.50	234.4	N/A	10.043	187.5	N/A	6.788
6	3.20	1.000	21.06	3.80	2.71	1.85	185.0	N/A	8.784	148.0	N/A	5.953
7	3.80	1.000	21.69	3.32	2.37	2.19	141.4	N/A	6.521	113.1	N/A	4.525
8	4.60	1.000	20.99	2.67	1.90	2.66	92.4	N/A	4.402	73.9	N/A	3.124
9	5.40	1.000	18.77	2.02	1.44	3.12	53.8	N/A	2.867	43.0	N/A	2.071

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	26.6	0.90	0.90	50.1	81.0	50.6	N/A	1.88	N/A	3.04	N/A	1.90	90
2	0.80	29.0	0.90	0.90	50.1	81.0	50.6	N/A	1.73	N/A	2.79	N/A	1.74	90
3	1.40	26.0	0.90	0.90	33.4	54.0	33.7	N/A	1.28	N/A	2.07	N/A	1.30	60
4	2.00	23.1	0.90	0.90	33.4	54.0	33.7	N/A	1.45	N/A	2.34	N/A	1.46	60
5	2.60	20.3	0.90	0.90	33.4	54.0	33.7	N/A	1.65	N/A	2.66	N/A	1.66	60
6	3.20	17.7	0.90	0.90	33.4	54.0	33.7	N/A	1.89	N/A	3.06	N/A	1.91	60
7	3.80	17.6	0.90	0.90	33.4	54.0	33.7	N/A	1.90	N/A	3.08	N/A	1.92	60
8	4.60	16.2	0.90	0.56	33.4	33.7	33.7	N/A	2.07	N/A	2.08	N/A	2.09	60
9	5.40	13.6	0.90	0.22	50.1	19.4	50.6	N/A	3.67	N/A	1.42	N/A	3.71	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	32.8	0.90	0.72	50.1	64.8	50.6	N/A	1.62	N/A	1.98	N/A	1.64	90
2	0.80	34.6	0.90	0.72	50.1	64.8	50.6	N/A	1.53	N/A	1.87	N/A	1.54	90
3	1.40	31.0	0.90	0.72	33.4	43.2	33.7	N/A	1.14	N/A	1.40	N/A	1.15	60
4	2.00	27.4	0.90	0.72	33.4	43.2	33.7	N/A	1.28	N/A	1.58	N/A	1.30	60
5	2.60	24.0	0.90	0.72	33.4	43.2	33.7	N/A	1.46	N/A	1.80	N/A	1.48	60
6	3.20	20.8	0.90	0.72	33.4	43.2	33.7	N/A	1.69	N/A	2.07	N/A	1.70	60
7	3.80	20.2	0.90	0.72	33.4	43.2	33.7	N/A	1.72	N/A	2.13	N/A	1.74	60
8	4.60	18.2	0.90	0.45	33.4	27.0	33.7	N/A	1.90	N/A	1.48	N/A	1.92	60
9	5.40	15.1	0.90	0.17	50.1	15.6	50.6	N/A	3.42	N/A	1.03	N/A	3.46	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type8-1(H=6.90m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

.....\type8-1(H=6.9m).BEN

Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	19.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	30.0
Equivalent cohesion, $c_{equiv.}$	15.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 30.14 N γ= 22.40

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

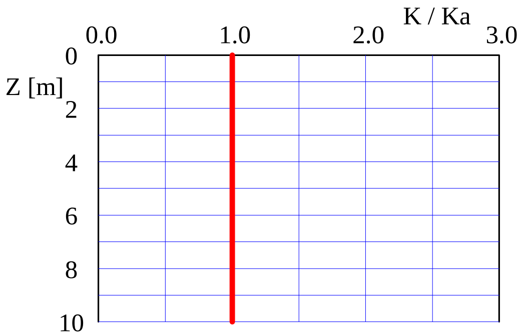
INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

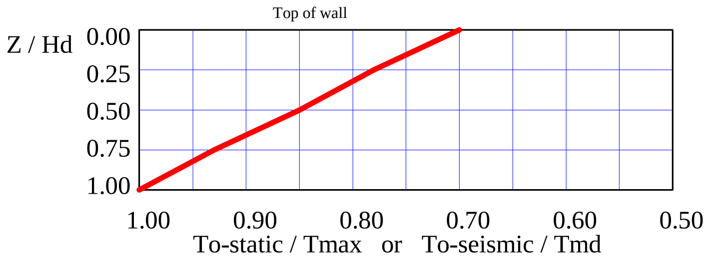
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

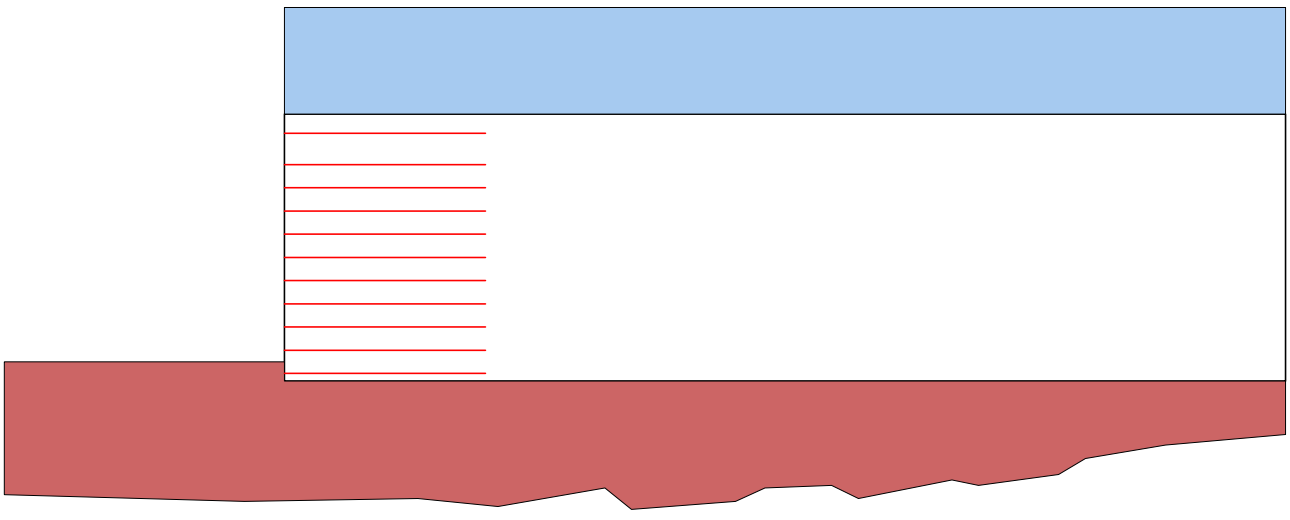
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	6.90	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 6.40 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 41.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 4.53, Meyerhof stress = 268.18 kPa.

Foundation Interface: Direct sliding, Fs = 1.879, Eccentricity, e/L = 0.1666, Fs-overturning = 3.00

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	5.20	2	2.72	1.68	1.70	1.683	21.038	1.538	0.1585	90
2	0.80	5.20	2	2.46	1.52	1.54	1.489	16.165	1.655	0.1354	90
3	1.40	5.20	2	2.71	1.68	1.69	1.596	14.891	1.794	0.1138	90
4	2.00	5.20	1	2.00	1.24	1.25	1.147	13.626	1.961	0.0938	60
5	2.60	5.20	1	2.24	1.38	1.40	1.243	12.355	2.168	0.0755	60
6	3.20	5.20	1	2.52	1.56	1.57	1.357	11.086	2.431	0.0587	60
7	3.80	5.20	1	2.86	1.77	1.79	1.494	9.828	2.782	0.0437	60
8	4.40	5.20	1	3.28	2.03	2.05	1.662	8.566	3.281	0.0304	60
9	5.00	5.20	1	3.47	2.35	2.38	1.872	7.309	4.058	0.0191	60
10	5.60	5.20	1	2.44	2.42	2.45	1.859	5.263	5.488	0.0099	60
11	6.40	5.20	2	1.43	3.69	3.73	2.696	2.989	12.387	0.0017	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

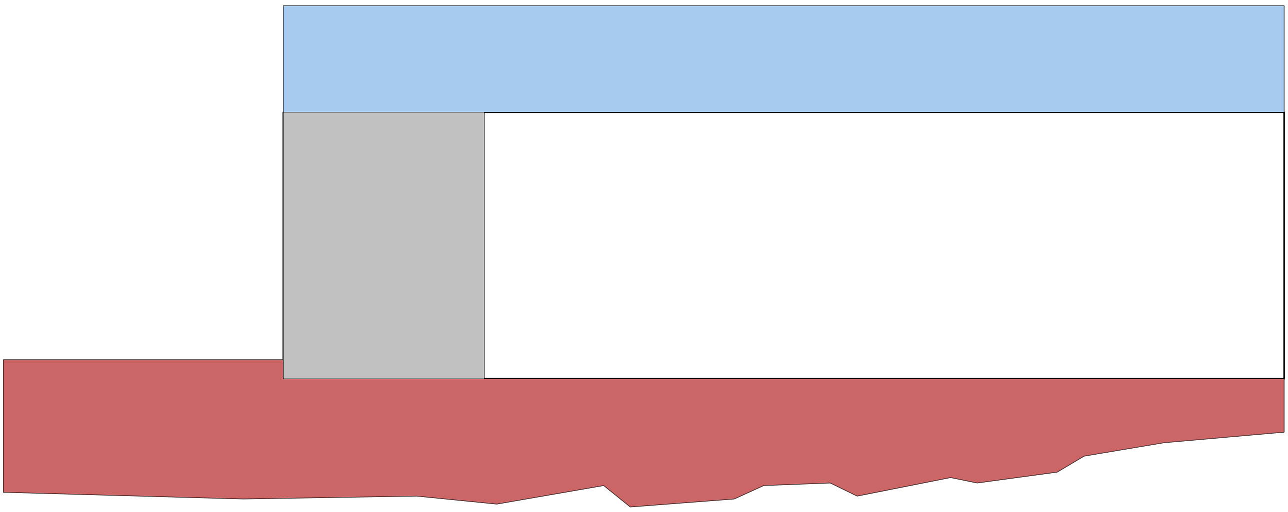
Bearing capacity, Fs = 3.67, Meyerhof stress = 305.92 kPa.

Foundation Interface: Direct sliding, Fs = 1.547, Eccentricity, e/L = 0.2124, Fs-overturning = 2.35

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	5.20	2	1.75	1.44	1.46	1.447	13.575	1.270	0.2014	90
2	0.80	5.20	2	1.65	1.34	1.36	1.313	10.798	1.377	0.1701	90
3	1.40	5.20	2	1.81	1.48	1.49	1.408	9.957	1.505	0.1413	90
4	2.00	5.20	1	1.34	1.09	1.10	1.012	9.122	1.661	0.1149	60
5	2.60	5.20	1	1.50	1.22	1.24	1.099	8.284	1.855	0.0910	60
6	3.20	5.20	1	1.69	1.38	1.39	1.201	7.446	2.107	0.0696	60
7	3.80	5.20	1	1.93	1.57	1.58	1.324	6.614	2.445	0.0508	60
8	4.40	5.20	1	2.21	1.80	1.82	1.475	5.779	2.931	0.0346	60
9	5.00	5.20	1	2.35	2.10	2.12	1.666	4.947	3.696	0.0212	60
10	5.60	5.20	1	1.69	2.19	2.21	1.683	3.649	5.116	0.0107	60
11	6.40	5.20	2	1.03	3.43	3.46	2.503	2.147	12.008	0.0018	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1215.9	1121.7	[kPa]
Meyerhof stress, σ_V	268.18	305.9	[kPa]
Eccentricity, e	0.81	1.03	[m]
Eccentricity, e/L	0.155	0.197	
Fs calculated	4.53	3.67	
Base length	5.20	5.20	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.879 and Fs-seismic = 1.547

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	5.20	1.538	1.270	2	90
2	0.80	5.20	1.655	1.377	2	90
3	1.40	5.20	1.794	1.505	2	90
4	2.00	5.20	1.961	1.661	1	60
5	2.60	5.20	2.168	1.855	1	60
6	3.20	5.20	2.431	2.107	1	60
7	3.80	5.20	2.782	2.445	1	60
8	4.40	5.20	3.281	2.931	1	60
9	5.00	5.20	4.058	3.696	1	60
10	5.60	5.20	5.488	5.116	1	60
11	6.40	5.20	12.387	12.008	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1666, e/L seismic = 0.2124; Overturning: Fs-static = 3.00, Fs-seismic = 2.35

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	5.20	0.1585	0.2014	2	90
2	0.80	5.20	0.1354	0.1701	2	90
3	1.40	5.20	0.1138	0.1413	2	90
4	2.00	5.20	0.0938	0.1149	1	60
5	2.60	5.20	0.0755	0.0910	1	60
6	3.20	5.20	0.0587	0.0696	1	60
7	3.80	5.20	0.0437	0.0508	1	60
8	4.40	5.20	0.0304	0.0346	1	60
9	5.00	5.20	0.0191	0.0212	1	60
10	5.60	5.20	0.0099	0.0107	1	60
11	6.40	5.20	0.0017	0.0018	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	30.06	7.21	N/A	1.683	N/A	1.447	90
2	0.80	50.6	33.98	6.72	N/A	1.489	N/A	1.313	90
3	1.40	50.6	31.70	6.23	N/A	1.596	N/A	1.408	90
4	2.00	33.7	29.42	5.74	N/A	1.147	N/A	1.012	60
5	2.60	33.7	27.14	5.24	N/A	1.243	N/A	1.099	60
6	3.20	33.7	24.86	4.75	N/A	1.357	N/A	1.201	60
7	3.80	33.7	22.58	4.26	N/A	1.494	N/A	1.324	60
8	4.40	33.7	20.30	3.77	N/A	1.662	N/A	1.475	60
9	5.00	33.7	18.02	3.28	N/A	1.872	N/A	1.666	60
10	5.60	33.7	18.14	2.79	N/A	1.859	N/A	1.683	60
11	6.40	50.6	18.77	2.13	N/A	2.696	N/A	2.503	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	30.06	7.21	5.08	0.12	632.4	N/A	21.038	505.9	N/A	13.575
2	0.80	1.000	33.98	6.72	4.74	0.46	549.3	N/A	16.165	439.4	N/A	10.798
3	1.40	1.000	31.70	6.23	4.39	0.81	472.1	N/A	14.891	377.6	N/A	9.957
4	2.00	1.000	29.42	5.74	4.05	1.15	400.9	N/A	13.626	320.7	N/A	9.122
5	2.60	1.000	27.14	5.24	3.70	1.50	335.3	N/A	12.355	268.3	N/A	8.284
6	3.20	1.000	24.86	4.75	3.35	1.85	275.6	N/A	11.086	220.5	N/A	7.446
7	3.80	1.000	22.58	4.26	3.01	2.19	221.9	N/A	9.828	177.5	N/A	6.614
8	4.40	1.000	20.30	3.77	2.66	2.54	173.9	N/A	8.566	139.1	N/A	5.779
9	5.00	1.000	18.02	3.28	2.31	2.89	131.7	N/A	7.309	105.4	N/A	4.947
10	5.60	1.000	18.14	2.79	1.97	3.23	95.5	N/A	5.263	76.4	N/A	3.649
11	6.40	1.000	18.77	2.13	1.50	3.70	56.1	N/A	2.989	44.9	N/A	2.147

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	29.8	0.90	0.90	50.1	81.0	50.6	N/A	1.68	N/A	2.72	N/A	1.70	90
2	0.80	32.9	0.90	0.90	50.1	81.0	50.6	N/A	1.52	N/A	2.46	N/A	1.54	90
3	1.40	29.9	0.90	0.90	50.1	81.0	50.6	N/A	1.68	N/A	2.71	N/A	1.69	90
4	2.00	27.0	0.90	0.90	33.4	54.0	33.7	N/A	1.24	N/A	2.00	N/A	1.25	60
5	2.60	24.1	0.90	0.90	33.4	54.0	33.7	N/A	1.38	N/A	2.24	N/A	1.40	60
6	3.20	21.4	0.90	0.90	33.4	54.0	33.7	N/A	1.56	N/A	2.52	N/A	1.57	60
7	3.80	18.9	0.90	0.90	33.4	54.0	33.7	N/A	1.77	N/A	2.86	N/A	1.79	60
8	4.40	16.5	0.90	0.90	33.4	54.0	33.7	N/A	2.03	N/A	3.28	N/A	2.05	60
9	5.00	14.2	0.90	0.82	33.4	49.2	33.7	N/A	2.35	N/A	3.47	N/A	2.38	60
10	5.60	13.8	0.90	0.56	33.4	33.7	33.7	N/A	2.42	N/A	2.44	N/A	2.45	60
11	6.40	13.6	0.90	0.22	50.1	19.4	50.6	N/A	3.69	N/A	1.43	N/A	3.73	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	37.0	0.90	0.72	50.1	64.8	50.6	N/A	1.44	N/A	1.75	N/A	1.46	90
2	0.80	39.4	0.90	0.72	50.1	64.8	50.6	N/A	1.34	N/A	1.65	N/A	1.36	90
3	1.40	35.8	0.90	0.72	50.1	64.8	50.6	N/A	1.48	N/A	1.81	N/A	1.49	90
4	2.00	32.2	0.90	0.72	33.4	43.2	33.7	N/A	1.09	N/A	1.34	N/A	1.10	60
5	2.60	28.8	0.90	0.72	33.4	43.2	33.7	N/A	1.22	N/A	1.50	N/A	1.24	60
6	3.20	25.5	0.90	0.72	33.4	43.2	33.7	N/A	1.38	N/A	1.69	N/A	1.39	60
7	3.80	22.4	0.90	0.72	33.4	43.2	33.7	N/A	1.57	N/A	1.93	N/A	1.58	60
8	4.40	19.5	0.90	0.72	33.4	43.2	33.7	N/A	1.80	N/A	2.21	N/A	1.82	60
9	5.00	16.8	0.90	0.66	33.4	39.4	33.7	N/A	2.10	N/A	2.35	N/A	2.12	60
10	5.60	15.9	0.90	0.45	33.4	27.0	33.7	N/A	2.19	N/A	1.69	N/A	2.21	60
11	6.40	15.1	0.90	0.17	50.1	15.6	50.6	N/A	3.43	N/A	1.03	N/A	3.46	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type9(H=6.30m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

.....진\type9(H=6.3m).BEN

Original date and time of creating this file:

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 27.86 $N\gamma$= 19.34

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

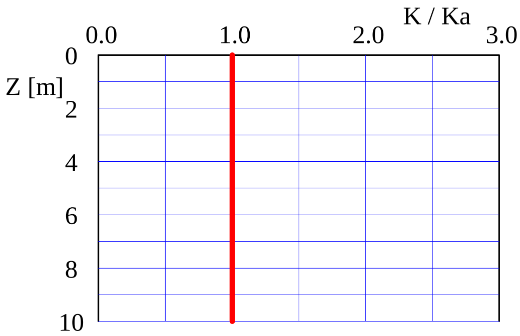
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

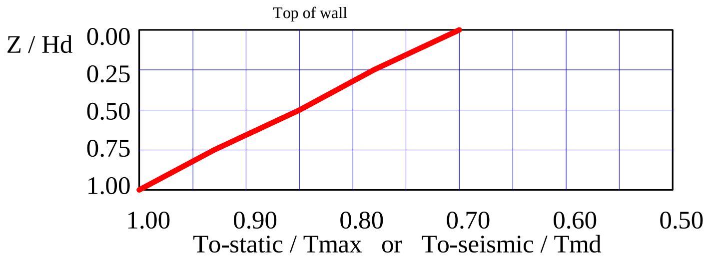
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

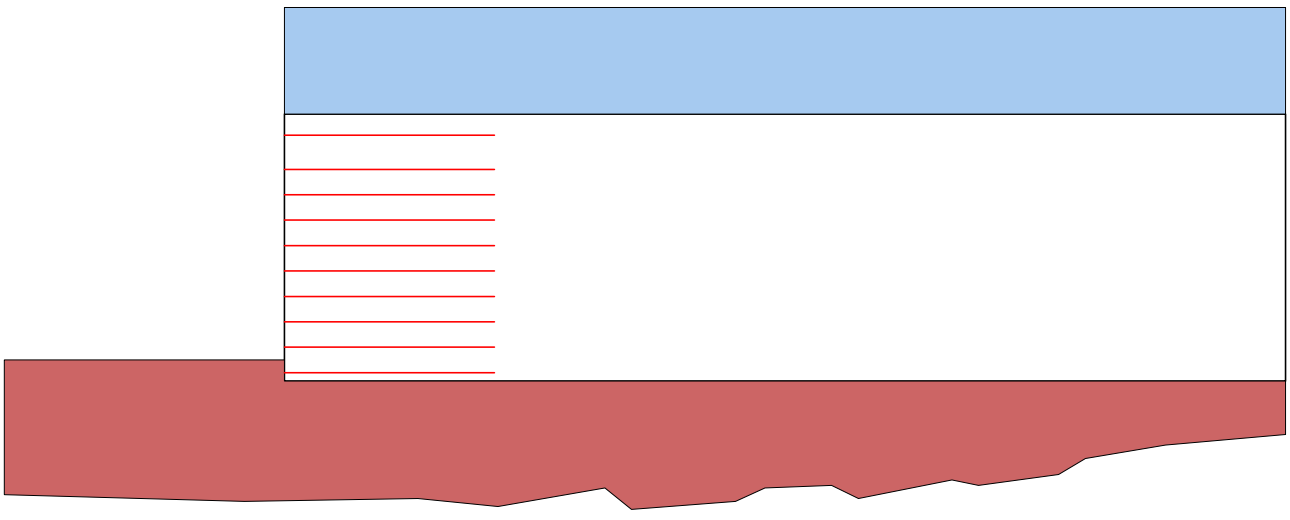
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	6.30	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 5.80 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 41.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.50, Meyerhof stress = 244.89 kPa.

Foundation Interface: Direct sliding, Fs = 1.848, Eccentricity, e/L = 0.1571, Fs-overturning = 3.18

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.96	2	2.90	1.79	1.81	1.797	19.943	1.579	0.1488	90
2	0.80	4.96	2	2.65	1.64	1.66	1.596	15.252	1.711	0.1251	90
3	1.40	4.96	1	1.96	1.21	1.22	1.147	13.980	1.871	0.1031	60
4	2.00	4.96	1	2.19	1.35	1.37	1.243	12.708	2.068	0.0829	60
5	2.60	4.96	1	2.47	1.53	1.55	1.357	11.438	2.319	0.0645	60
6	3.20	4.96	1	2.82	1.74	1.76	1.494	10.170	2.654	0.0480	60
7	3.80	4.96	1	3.24	2.00	2.02	1.662	8.905	3.129	0.0334	60
8	4.40	4.96	1	3.44	2.33	2.36	1.872	7.651	3.871	0.0209	60
9	5.00	4.96	1	2.42	2.40	2.43	1.859	5.548	5.235	0.0108	60
10	5.80	4.96	2	1.43	3.68	3.72	2.696	3.203	11.815	0.0019	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

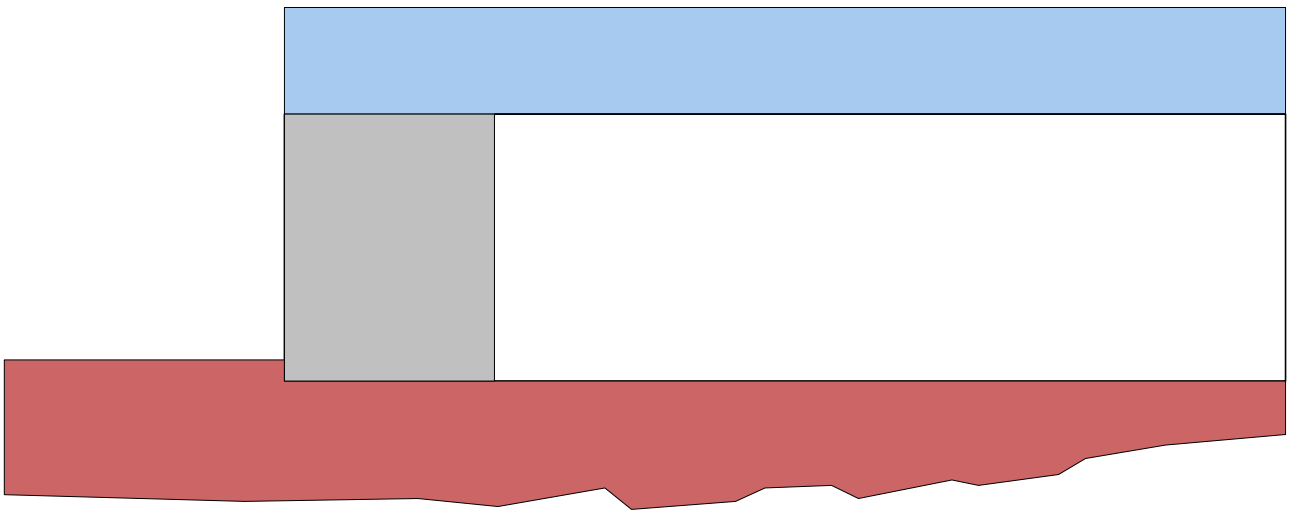
Bearing capacity, Fs = 1.99, Meyerhof stress = 274.25 kPa.

Foundation Interface: Direct sliding, Fs = 1.533, Eccentricity, e/L = 0.1981, Fs-overturning = 2.52

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.96	2	1.89	1.55	1.57	1.555	12.989	1.313	0.1870	90
2	0.80	4.96	2	1.78	1.45	1.47	1.415	10.268	1.435	0.1553	90
3	1.40	4.96	1	1.32	1.07	1.08	1.017	9.420	1.584	0.1263	60
4	2.00	4.96	1	1.48	1.20	1.21	1.103	8.572	1.770	0.1000	60
5	2.60	4.96	1	1.67	1.36	1.37	1.205	7.724	2.009	0.0765	60
6	3.20	4.96	1	1.91	1.55	1.57	1.329	6.878	2.332	0.0558	60
7	3.80	4.96	1	2.19	1.78	1.80	1.480	6.033	2.795	0.0381	60
8	4.40	4.96	1	2.34	2.08	2.10	1.670	5.195	3.526	0.0233	60
9	5.00	4.96	1	1.68	2.18	2.20	1.686	3.854	4.880	0.0117	60
10	5.80	4.96	2	1.03	3.42	3.45	2.502	2.300	11.453	0.0020	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	612.3	546.8	[kPa]
Meyerhof stress, σ_V	244.89	274.2	[kPa]
Eccentricity, e	0.72	0.91	[m]
Eccentricity, e/L	0.145	0.183	
Fs calculated	2.50	1.99	
Base length	4.96	4.96	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.848 and Fs-seismic = 1.533

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.96	1.579	1.313	2	90
2	0.80	4.96	1.711	1.435	2	90
3	1.40	4.96	1.871	1.584	1	60
4	2.00	4.96	2.068	1.770	1	60
5	2.60	4.96	2.319	2.009	1	60
6	3.20	4.96	2.654	2.332	1	60
7	3.80	4.96	3.129	2.795	1	60
8	4.40	4.96	3.871	3.526	1	60
9	5.00	4.96	5.235	4.880	1	60
10	5.80	4.96	11.815	11.453	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1571, e/L seismic = 0.1981; Overturning: Fs-static = 3.18, Fs-seismic = 2.52

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.96	0.1488	0.1870	2	90
2	0.80	4.96	0.1251	0.1553	2	90
3	1.40	4.96	0.1031	0.1263	1	60
4	2.00	4.96	0.0829	0.1000	1	60
5	2.60	4.96	0.0645	0.0765	1	60
6	3.20	4.96	0.0480	0.0558	1	60
7	3.80	4.96	0.0334	0.0381	1	60
8	4.40	4.96	0.0209	0.0233	1	60
9	5.00	4.96	0.0108	0.0117	1	60
10	5.80	4.96	0.0019	0.0020	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	28.16	6.43	N/A	1.797	N/A	1.555	90
2	0.80	50.6	31.70	5.97	N/A	1.596	N/A	1.415	90
3	1.40	33.7	29.42	5.51	N/A	1.147	N/A	1.017	60
4	2.00	33.7	27.14	5.05	N/A	1.243	N/A	1.103	60
5	2.60	33.7	24.86	4.59	N/A	1.357	N/A	1.205	60
6	3.20	33.7	22.58	4.13	N/A	1.494	N/A	1.329	60
7	3.80	33.7	20.30	3.67	N/A	1.662	N/A	1.480	60
8	4.40	33.7	18.02	3.21	N/A	1.872	N/A	1.670	60
9	5.00	33.7	18.14	2.75	N/A	1.859	N/A	1.686	60
10	5.80	50.6	18.77	2.14	N/A	2.696	N/A	2.502	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	28.16	6.43	4.84	0.12	561.6	N/A	19.943	449.2	N/A	12.989
2	0.80	1.000	31.70	5.97	4.50	0.46	483.5	N/A	15.252	386.8	N/A	10.268
3	1.40	1.000	29.42	5.51	4.15	0.81	411.3	N/A	13.980	329.0	N/A	9.420
4	2.00	1.000	27.14	5.05	3.81	1.15	344.9	N/A	12.708	275.9	N/A	8.572
5	2.60	1.000	24.86	4.59	3.46	1.50	284.4	N/A	11.438	227.5	N/A	7.724
6	3.20	1.000	22.58	4.13	3.11	1.85	229.6	N/A	10.170	183.7	N/A	6.878
7	3.80	1.000	20.30	3.67	2.77	2.19	180.8	N/A	8.905	144.6	N/A	6.033
8	4.40	1.000	18.02	3.21	2.42	2.54	137.9	N/A	7.651	110.3	N/A	5.195
9	5.00	1.000	18.14	2.75	2.07	2.89	100.7	N/A	5.548	80.5	N/A	3.854
10	5.80	1.000	18.77	2.14	1.61	3.35	60.1	N/A	3.203	48.1	N/A	2.300

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	27.9	0.90	0.90	50.1	81.0	50.6	N/A	1.79	N/A	2.90	N/A	1.81	90
2	0.80	30.6	0.90	0.90	50.1	81.0	50.6	N/A	1.64	N/A	2.65	N/A	1.66	90
3	1.40	27.6	0.90	0.90	33.4	54.0	33.7	N/A	1.21	N/A	1.96	N/A	1.22	60
4	2.00	24.7	0.90	0.90	33.4	54.0	33.7	N/A	1.35	N/A	2.19	N/A	1.37	60
5	2.60	21.8	0.90	0.90	33.4	54.0	33.7	N/A	1.53	N/A	2.47	N/A	1.55	60
6	3.20	19.1	0.90	0.90	33.4	54.0	33.7	N/A	1.74	N/A	2.82	N/A	1.76	60
7	3.80	16.7	0.90	0.90	33.4	54.0	33.7	N/A	2.00	N/A	3.24	N/A	2.02	60
8	4.40	14.3	0.90	0.82	33.4	49.2	33.7	N/A	2.33	N/A	3.44	N/A	2.36	60
9	5.00	13.9	0.90	0.56	33.4	33.7	33.7	N/A	2.40	N/A	2.42	N/A	2.43	60
10	5.80	13.6	0.90	0.22	50.1	19.4	50.6	N/A	3.68	N/A	1.43	N/A	3.72	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	34.3	0.90	0.72	50.1	64.8	50.6	N/A	1.55	N/A	1.89	N/A	1.57	90
2	0.80	36.3	0.90	0.72	50.1	64.8	50.6	N/A	1.45	N/A	1.78	N/A	1.47	90
3	1.40	32.8	0.90	0.72	33.4	43.2	33.7	N/A	1.07	N/A	1.32	N/A	1.08	60
4	2.00	29.2	0.90	0.72	33.4	43.2	33.7	N/A	1.20	N/A	1.48	N/A	1.21	60
5	2.60	25.9	0.90	0.72	33.4	43.2	33.7	N/A	1.36	N/A	1.67	N/A	1.37	60
6	3.20	22.6	0.90	0.72	33.4	43.2	33.7	N/A	1.55	N/A	1.91	N/A	1.57	60
7	3.80	19.7	0.90	0.72	33.4	43.2	33.7	N/A	1.78	N/A	2.19	N/A	1.80	60
8	4.40	16.9	0.90	0.66	33.4	39.4	33.7	N/A	2.08	N/A	2.34	N/A	2.10	60
9	5.00	16.0	0.90	0.45	33.4	27.0	33.7	N/A	2.18	N/A	1.68	N/A	2.20	60
10	5.80	15.2	0.90	0.17	50.1	15.6	50.6	N/A	3.42	N/A	1.03	N/A	3.45	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type12(H=5.90m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

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PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

Version 3.0 MSEW Version 3.0

SOIL DATA

REINFORCED SOIL

Unit weight, γ		19.0 kN/m
Design value of internal angle of friction,	ϕ	30.0

RETAINED SOIL

Unit weight, γ		19.0 kN/m
Design value of internal angle of friction,	ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$		19.0 kN/m
Equivalent internal angle of friction,	$\phi_{equiv.}$	30.0
Equivalent cohesion, $c_{equiv.}$		15.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 30.14 N γ= 22.40

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

Version 3.0 MSEW Version 3.0

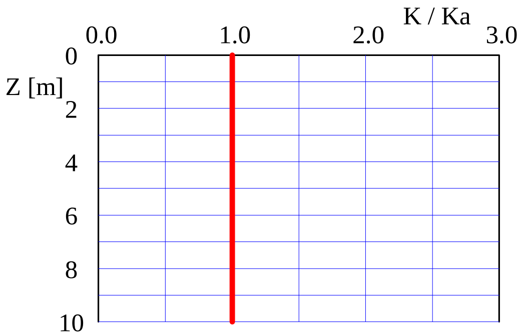
INPUT DATA: Geogrids
(Analysis)

D A T A		Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]		60.0	90.0	120.0	180.0	
Durability reduction factor, RFd		1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid		1.10	1.10	1.10	1.10	
Creep reduction factor, RFc		1.47	1.47	1.47	1.47	N/A
Fs-overall for strength		N/A	N/A	N/A	N/A	
Coverage ratio, Rc		1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface,	ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*		0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor,	α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

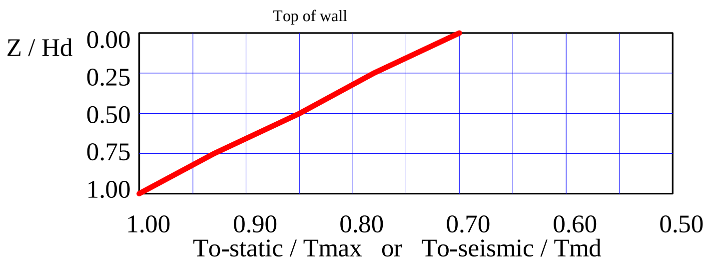
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

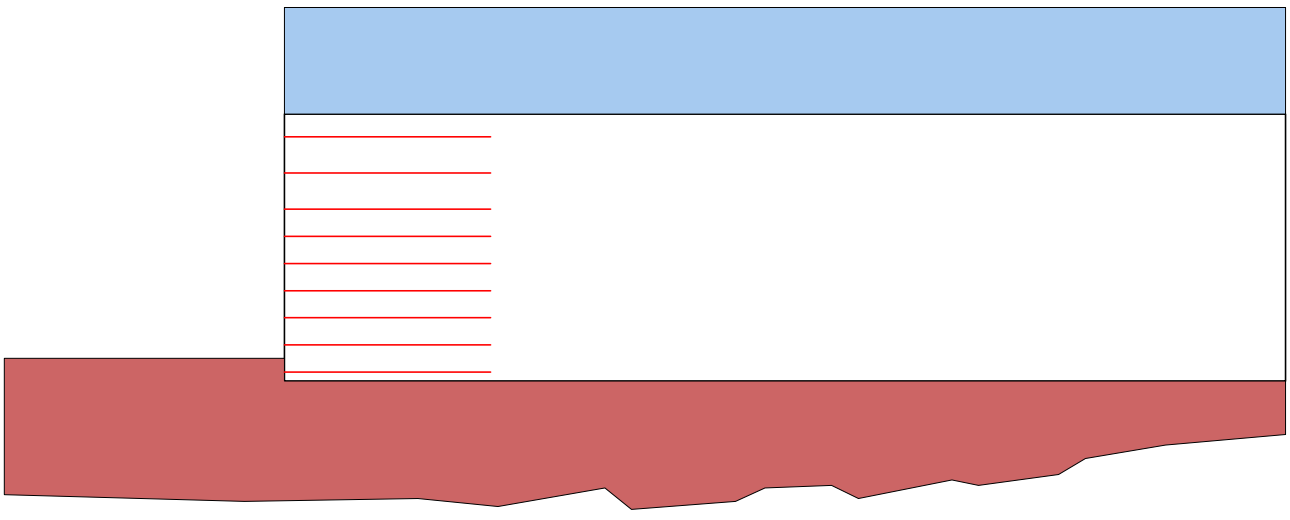
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	5.90	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 5.40 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 41.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 4.69, Meyerhof stress = 239.67 kPa.

Foundation Interface: Direct sliding, Fs = 1.862, Eccentricity, e/L = 0.1665, Fs-overturning = 3.00

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.56	2	3.04	1.88	1.90	1.882	18.231	1.530	0.1572	90
2	0.80	4.56	2	2.79	1.73	1.74	1.677	13.834	1.668	0.1305	90
3	1.40	4.56	1	2.07	1.28	1.30	1.209	12.566	1.836	0.1059	60
4	2.00	4.56	1	2.34	1.45	1.46	1.317	11.300	2.048	0.0834	60
5	2.60	4.56	1	2.66	1.65	1.66	1.445	10.043	2.326	0.0630	60
6	3.20	4.56	1	3.06	1.89	1.91	1.602	8.784	2.712	0.0450	60
7	3.80	4.56	1	3.08	1.90	1.92	1.555	6.521	3.292	0.0294	60
8	4.60	4.56	1	2.08	2.07	2.09	1.607	4.402	4.813	0.0128	60
9	5.40	4.56	2	1.42	3.67	3.71	2.696	2.867	10.862	0.0023	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

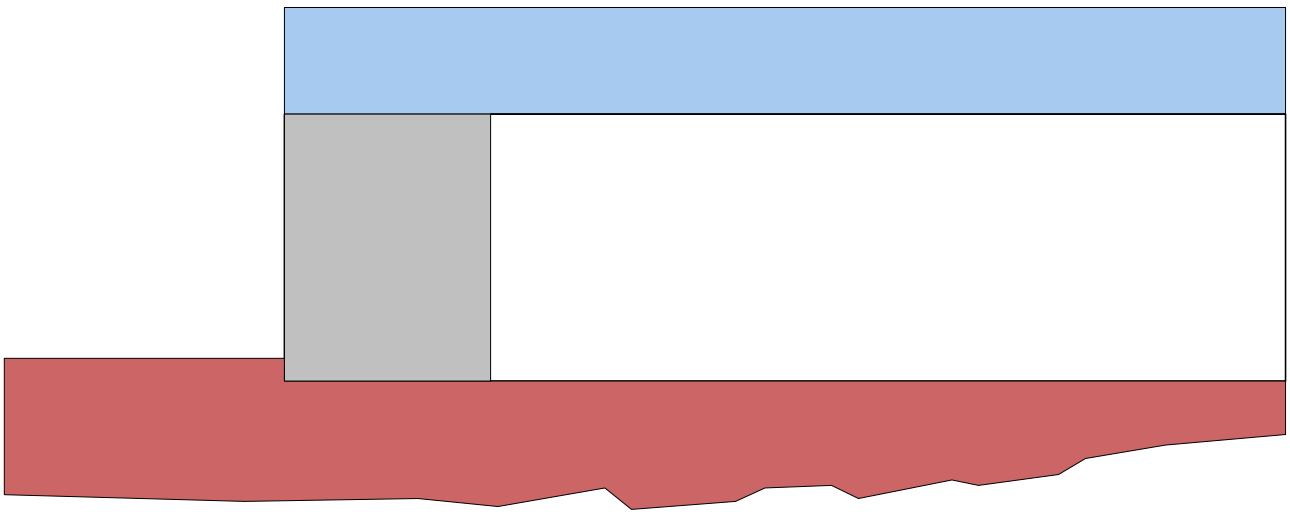
Bearing capacity, Fs = 3.89, Meyerhof stress = 269.69 kPa.

Foundation Interface: Direct sliding, Fs = 1.553, Eccentricity, e/L = 0.2084, Fs-overturning = 2.40

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.56	2	1.98	1.62	1.64	1.625	11.841	1.280	0.1959	90
2	0.80	4.56	2	1.87	1.53	1.54	1.484	9.297	1.407	0.1605	90
3	1.40	4.56	1	1.40	1.14	1.15	1.072	8.458	1.565	0.1283	60
4	2.00	4.56	1	1.58	1.28	1.30	1.169	7.620	1.767	0.0994	60
5	2.60	4.56	1	1.80	1.46	1.48	1.285	6.788	2.034	0.0739	60
6	3.20	4.56	1	2.07	1.69	1.70	1.427	5.953	2.409	0.0517	60
7	3.80	4.56	1	2.13	1.72	1.74	1.409	4.525	2.978	0.0330	60
8	4.60	4.56	1	1.48	1.90	1.92	1.479	3.124	4.486	0.0139	60
9	5.40	4.56	2	1.03	3.42	3.46	2.512	2.071	10.530	0.0023	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1124.7	1049.8	[kPa]
Meyerhof stress, σ_V	239.67	269.7	[kPa]
Eccentricity, e	0.70	0.88	[m]
Eccentricity, e/L	0.153	0.192	
Fs calculated	4.69	3.89	
Base length	4.56	4.56	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.862 and Fs-seismic = 1.553

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.56	1.530	1.280	2	90
2	0.80	4.56	1.668	1.407	2	90
3	1.40	4.56	1.836	1.565	1	60
4	2.00	4.56	2.048	1.767	1	60
5	2.60	4.56	2.326	2.034	1	60
6	3.20	4.56	2.712	2.409	1	60
7	3.80	4.56	3.292	2.978	1	60
8	4.60	4.56	4.813	4.486	1	60
9	5.40	4.56	10.862	10.530	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1665, e/L seismic = 0.2084; Overturning: Fs-static = 3.00, Fs-seismic = 2.40

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.56	0.1572	0.1959	2	90
2	0.80	4.56	0.1305	0.1605	2	90
3	1.40	4.56	0.1059	0.1283	1	60
4	2.00	4.56	0.0834	0.0994	1	60
5	2.60	4.56	0.0630	0.0739	1	60
6	3.20	4.56	0.0450	0.0517	1	60
7	3.80	4.56	0.0294	0.0330	1	60
8	4.60	4.56	0.0128	0.0139	1	60
9	5.40	4.56	0.0023	0.0023	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	26.89	6.23	N/A	1.882	N/A	1.625	90
2	0.80	50.6	30.18	5.74	N/A	1.677	N/A	1.484	90
3	1.40	33.7	27.90	5.26	N/A	1.209	N/A	1.072	60
4	2.00	33.7	25.62	4.77	N/A	1.317	N/A	1.169	60
5	2.60	33.7	23.34	4.29	N/A	1.445	N/A	1.285	60
6	3.20	33.7	21.06	3.80	N/A	1.602	N/A	1.427	60
7	3.80	33.7	21.69	3.32	N/A	1.555	N/A	1.409	60
8	4.60	33.7	20.99	2.67	N/A	1.607	N/A	1.479	60
9	5.40	50.6	18.77	2.02	N/A	2.696	N/A	2.512	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	26.89	6.23	4.44	0.12	490.3	N/A	18.231	392.2	N/A	11.841
2	0.80	1.000	30.18	5.74	4.10	0.46	417.5	N/A	13.834	334.0	N/A	9.297
3	1.40	1.000	27.90	5.26	3.75	0.81	350.6	N/A	12.566	280.5	N/A	8.458
4	2.00	1.000	25.62	4.77	3.41	1.15	289.5	N/A	11.300	231.6	N/A	7.620
5	2.60	1.000	23.34	4.29	3.06	1.50	234.4	N/A	10.043	187.5	N/A	6.788
6	3.20	1.000	21.06	3.80	2.71	1.85	185.0	N/A	8.784	148.0	N/A	5.953
7	3.80	1.000	21.69	3.32	2.37	2.19	141.4	N/A	6.521	113.1	N/A	4.525
8	4.60	1.000	20.99	2.67	1.90	2.66	92.4	N/A	4.402	73.9	N/A	3.124
9	5.40	1.000	18.77	2.02	1.44	3.12	53.8	N/A	2.867	43.0	N/A	2.071

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	26.6	0.90	0.90	50.1	81.0	50.6	N/A	1.88	N/A	3.04	N/A	1.90	90
2	0.80	29.0	0.90	0.90	50.1	81.0	50.6	N/A	1.73	N/A	2.79	N/A	1.74	90
3	1.40	26.0	0.90	0.90	33.4	54.0	33.7	N/A	1.28	N/A	2.07	N/A	1.30	60
4	2.00	23.1	0.90	0.90	33.4	54.0	33.7	N/A	1.45	N/A	2.34	N/A	1.46	60
5	2.60	20.3	0.90	0.90	33.4	54.0	33.7	N/A	1.65	N/A	2.66	N/A	1.66	60
6	3.20	17.7	0.90	0.90	33.4	54.0	33.7	N/A	1.89	N/A	3.06	N/A	1.91	60
7	3.80	17.6	0.90	0.90	33.4	54.0	33.7	N/A	1.90	N/A	3.08	N/A	1.92	60
8	4.60	16.2	0.90	0.56	33.4	33.7	33.7	N/A	2.07	N/A	2.08	N/A	2.09	60
9	5.40	13.6	0.90	0.22	50.1	19.4	50.6	N/A	3.67	N/A	1.42	N/A	3.71	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	32.8	0.90	0.72	50.1	64.8	50.6	N/A	1.62	N/A	1.98	N/A	1.64	90
2	0.80	34.6	0.90	0.72	50.1	64.8	50.6	N/A	1.53	N/A	1.87	N/A	1.54	90
3	1.40	31.0	0.90	0.72	33.4	43.2	33.7	N/A	1.14	N/A	1.40	N/A	1.15	60
4	2.00	27.4	0.90	0.72	33.4	43.2	33.7	N/A	1.28	N/A	1.58	N/A	1.30	60
5	2.60	24.0	0.90	0.72	33.4	43.2	33.7	N/A	1.46	N/A	1.80	N/A	1.48	60
6	3.20	20.8	0.90	0.72	33.4	43.2	33.7	N/A	1.69	N/A	2.07	N/A	1.70	60
7	3.80	20.2	0.90	0.72	33.4	43.2	33.7	N/A	1.72	N/A	2.13	N/A	1.74	60
8	4.60	18.2	0.90	0.45	33.4	27.0	33.7	N/A	1.90	N/A	1.48	N/A	1.92	60
9	5.40	15.1	0.90	0.17	50.1	15.6	50.6	N/A	3.42	N/A	1.03	N/A	3.46	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

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Company's information:

Name:
Street:

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Telephone #:
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Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	19.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	30.0
Equivalent cohesion, $c_{equiv.}$	15.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 30.14 N γ= 22.40

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

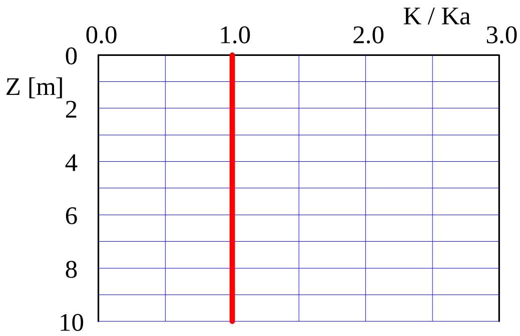
INPUT DATA: Geogrids (Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

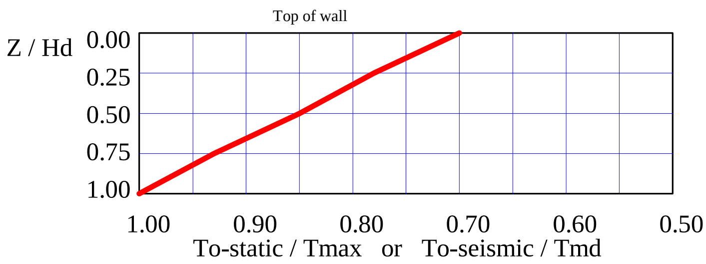
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [1]	CRu [2]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	6.30	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 5.80 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

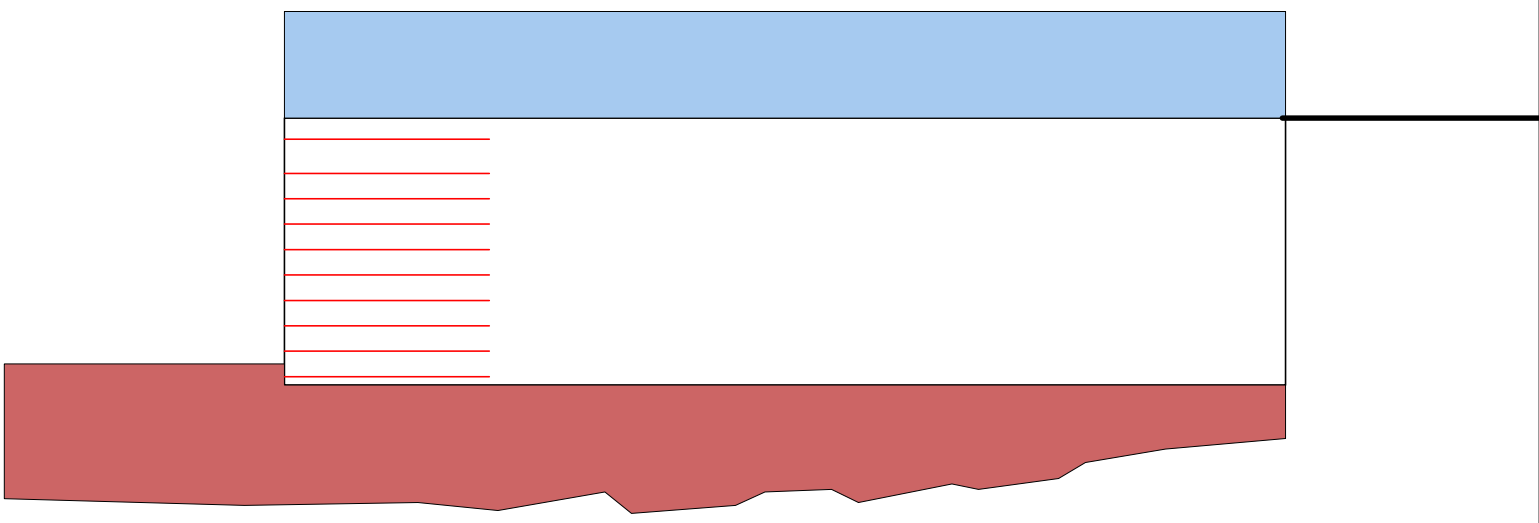
U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 43.0 [kPa], and live load is 13.0 [kPa]

OTHER EXTERNAL LOAD(S)

[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=23.4 [m]. Distance of center of footing from wall face, d = 35.3 [m] @ depth of 0.0 [m] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 4.59, Meyerhof stress = 254.00 kPa.

Foundation Interface: Direct sliding, Fs = 1.869, Eccentricity, e/L = 0.1664, Fs-overturning = 3.00

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.84	2	2.87	1.77	1.79	1.776	19.466	1.533	0.1577	90
2	0.80	4.84	2	2.62	1.62	1.63	1.576	14.862	1.661	0.1325	90
3	1.40	4.84	1	1.93	1.19	1.21	1.131	13.593	1.816	0.1092	60
4	2.00	4.84	1	2.16	1.33	1.35	1.225	12.326	2.008	0.0878	60
5	2.60	4.84	1	2.43	1.51	1.52	1.335	11.061	2.253	0.0683	60
6	3.20	4.84	1	2.77	1.71	1.73	1.468	9.800	2.580	0.0507	60
7	3.80	4.84	1	3.18	1.96	1.98	1.630	8.549	3.044	0.0353	60
8	4.40	4.84	1	3.37	2.28	2.31	1.831	7.297	3.770	0.0221	60
9	5.00	4.84	1	2.36	2.34	2.37	1.813	5.251	5.110	0.0114	60
10	5.80	4.84	2	1.38	3.57	3.60	2.613	2.986	11.591	0.0020	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

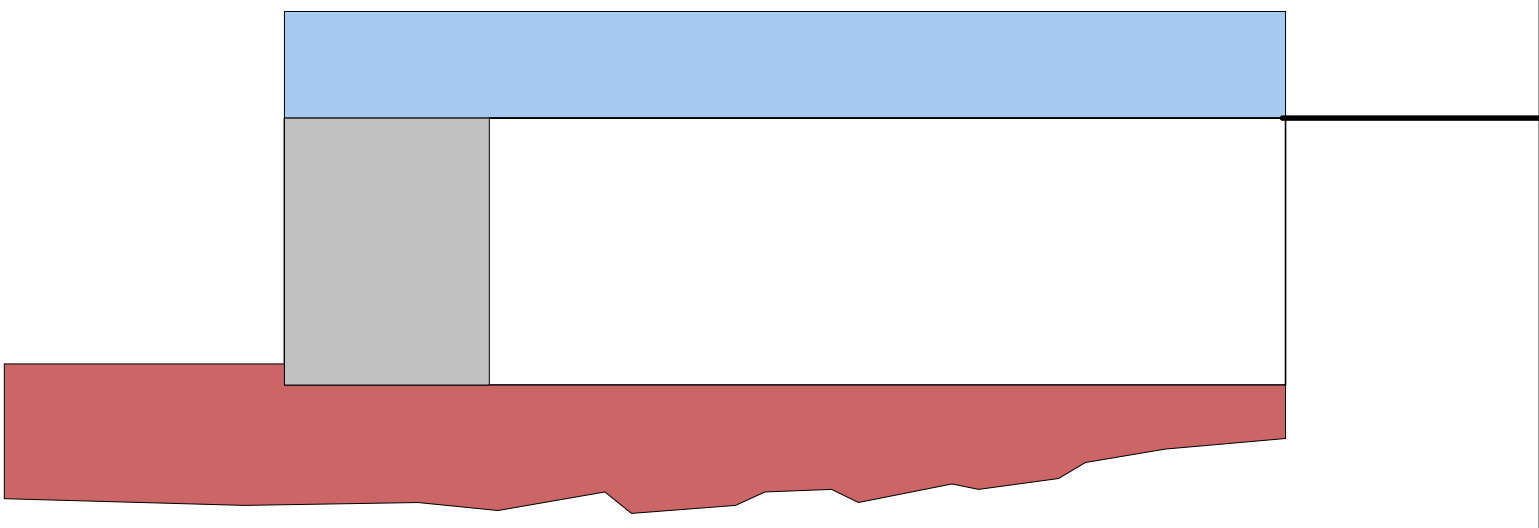
Bearing capacity, Fs = 3.78, Meyerhof stress = 286.66 kPa.

Foundation Interface: Direct sliding, Fs = 1.555, Eccentricity, e/L = 0.2090, Fs-overturning = 2.39

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	4.84	2	1.87	1.54	1.55	1.537	12.677	1.279	0.1972	90
2	0.80	4.84	2	1.76	1.43	1.45	1.398	10.009	1.398	0.1638	90
3	1.40	4.84	1	1.30	1.06	1.07	1.004	9.167	1.543	0.1332	60
4	2.00	4.84	1	1.46	1.19	1.20	1.088	8.326	1.724	0.1055	60
5	2.60	4.84	1	1.65	1.34	1.35	1.188	7.486	1.958	0.0807	60
6	3.20	4.84	1	1.88	1.53	1.54	1.308	6.648	2.274	0.0588	60
7	3.80	4.84	1	2.16	1.75	1.77	1.455	5.815	2.727	0.0401	60
8	4.40	4.84	1	2.30	2.04	2.06	1.639	4.981	3.442	0.0245	60
9	5.00	4.84	1	1.65	2.13	2.15	1.650	3.670	4.773	0.0123	60
10	5.80	4.84	2	1.00	3.33	3.36	2.437	2.160	11.248	0.0021	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1164.6	1083.4	[kPa]
Meyerhof stress, σ_V	254.00	286.7	[kPa]
Eccentricity, e	0.75	0.94	[m]
Eccentricity, e/L	0.154	0.194	
Fs calculated	4.59	3.78	
Base length	4.84	4.84	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.869 and Fs-seismic = 1.555

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.84	1.533	1.279	2	90
2	0.80	4.84	1.661	1.398	2	90
3	1.40	4.84	1.816	1.543	1	60
4	2.00	4.84	2.008	1.724	1	60
5	2.60	4.84	2.253	1.958	1	60
6	3.20	4.84	2.580	2.274	1	60
7	3.80	4.84	3.044	2.727	1	60
8	4.40	4.84	3.770	3.442	1	60
9	5.00	4.84	5.110	4.773	1	60
10	5.80	4.84	11.591	11.248	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1664, e/L seismic = 0.2090; Overturning: Fs-static = 3.00, Fs-seismic = 2.39

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.84	0.1577	0.1972	2	90
2	0.80	4.84	0.1325	0.1638	2	90
3	1.40	4.84	0.1092	0.1332	1	60
4	2.00	4.84	0.0878	0.1055	1	60
5	2.60	4.84	0.0683	0.0807	1	60
6	3.20	4.84	0.0507	0.0588	1	60
7	3.80	4.84	0.0353	0.0401	1	60
8	4.40	4.84	0.0221	0.0245	1	60
9	5.00	4.84	0.0114	0.0123	1	60
10	5.80	4.84	0.0020	0.0021	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	28.49	6.51	N/A	1.776	N/A	1.537	90
2	0.80	50.6	32.10	6.03	N/A	1.576	N/A	1.398	90
3	1.40	33.7	29.82	5.55	N/A	1.131	N/A	1.004	60
4	2.00	33.7	27.54	5.08	N/A	1.225	N/A	1.088	60
5	2.60	33.7	25.26	4.60	N/A	1.335	N/A	1.188	60
6	3.20	33.7	22.98	4.12	N/A	1.468	N/A	1.308	60
7	3.80	33.7	20.70	3.64	N/A	1.630	N/A	1.455	60
8	4.40	33.7	18.42	3.17	N/A	1.831	N/A	1.639	60
9	5.00	33.7	18.61	2.69	N/A	1.813	N/A	1.650	60
10	5.80	50.6	19.37	2.05	N/A	2.613	N/A	2.437	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	28.49	6.51	4.72	0.12	554.6	N/A	19.466	443.7	N/A	12.677
2	0.80	1.000	32.10	6.03	4.38	0.46	477.1	N/A	14.862	381.6	N/A	10.009
3	1.40	1.000	29.82	5.55	4.03	0.81	405.3	N/A	13.593	324.3	N/A	9.167
4	2.00	1.000	27.54	5.08	3.69	1.15	339.5	N/A	12.326	271.6	N/A	8.326
5	2.60	1.000	25.26	4.60	3.34	1.50	279.4	N/A	11.061	223.5	N/A	7.486
6	3.20	1.000	22.98	4.12	2.99	1.85	225.2	N/A	9.800	180.2	N/A	6.648
7	3.80	1.000	20.70	3.64	2.65	2.19	177.0	N/A	8.549	141.6	N/A	5.815
8	4.40	1.000	18.42	3.17	2.30	2.54	134.4	N/A	7.297	107.5	N/A	4.981
9	5.00	1.000	18.61	2.69	1.95	2.89	97.7	N/A	5.251	78.2	N/A	3.670
10	5.80	1.000	19.37	2.05	1.49	3.35	57.8	N/A	2.986	46.3	N/A	2.160

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	28.2	0.90	0.90	50.1	81.0	50.6	N/A	1.77	N/A	2.87	N/A	1.79	90
2	0.80	31.0	0.90	0.90	50.1	81.0	50.6	N/A	1.62	N/A	2.62	N/A	1.63	90
3	1.40	28.0	0.90	0.90	33.4	54.0	33.7	N/A	1.19	N/A	1.93	N/A	1.21	60
4	2.00	25.0	0.90	0.90	33.4	54.0	33.7	N/A	1.33	N/A	2.16	N/A	1.35	60
5	2.60	22.2	0.90	0.90	33.4	54.0	33.7	N/A	1.51	N/A	2.43	N/A	1.52	60
6	3.20	19.5	0.90	0.90	33.4	54.0	33.7	N/A	1.71	N/A	2.77	N/A	1.73	60
7	3.80	17.0	0.90	0.90	33.4	54.0	33.7	N/A	1.96	N/A	3.18	N/A	1.98	60
8	4.40	14.6	0.90	0.82	33.4	49.2	33.7	N/A	2.28	N/A	3.37	N/A	2.31	60
9	5.00	14.3	0.90	0.56	33.4	33.7	33.7	N/A	2.34	N/A	2.36	N/A	2.37	60
10	5.80	14.0	0.90	0.22	50.1	19.4	50.6	N/A	3.57	N/A	1.38	N/A	3.60	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	34.7	0.90	0.72	50.1	64.8	50.6	N/A	1.54	N/A	1.87	N/A	1.55	90
2	0.80	36.8	0.90	0.72	50.1	64.8	50.6	N/A	1.43	N/A	1.76	N/A	1.45	90
3	1.40	33.2	0.90	0.72	33.4	43.2	33.7	N/A	1.06	N/A	1.30	N/A	1.07	60
4	2.00	29.6	0.90	0.72	33.4	43.2	33.7	N/A	1.19	N/A	1.46	N/A	1.20	60
5	2.60	26.2	0.90	0.72	33.4	43.2	33.7	N/A	1.34	N/A	1.65	N/A	1.35	60
6	3.20	23.0	0.90	0.72	33.4	43.2	33.7	N/A	1.53	N/A	1.88	N/A	1.54	60
7	3.80	20.0	0.90	0.72	33.4	43.2	33.7	N/A	1.75	N/A	2.16	N/A	1.77	60
8	4.40	17.2	0.90	0.66	33.4	39.4	33.7	N/A	2.04	N/A	2.30	N/A	2.06	60
9	5.00	16.3	0.90	0.45	33.4	27.0	33.7	N/A	2.13	N/A	1.65	N/A	2.15	60
10	5.80	15.5	0.90	0.17	50.1	15.6	50.6	N/A	3.33	N/A	1.00	N/A	3.36	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 구조부

Description:

type15(H=7.70m)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

.....?type15(H=7.7m).BEN

Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 27.86 N γ= 19.34

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3959 Kae (Kh = 0) = 0.3333 Δ Kae = 0.0626
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

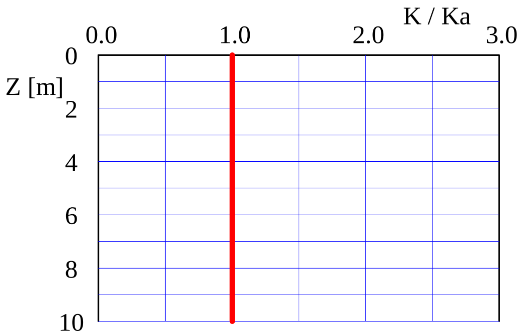
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

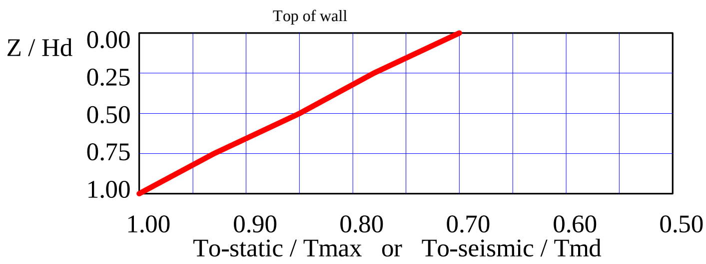
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

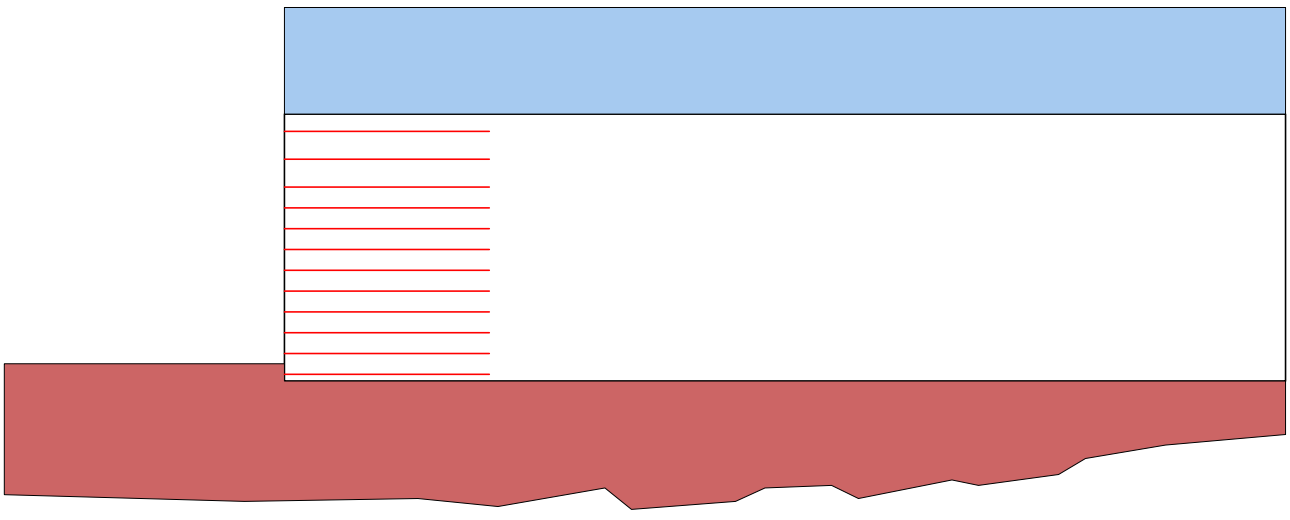
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	7.70	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 7.20 m }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 41.0 [kPa], and live load is 13.0 [kPa]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 2.59, Meyerhof stress = 282.23 kPa.

Foundation Interface: Direct sliding, Fs = 1.880, Eccentricity, e/L = 0.1552, Fs-overturning = 3.22

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	5.91	2	2.50	1.55	1.56	1.553	24.109	1.600	0.1485	90
2	0.80	5.91	2	2.25	1.39	1.41	1.367	18.716	1.709	0.1290	90
3	1.40	5.91	2	2.46	1.52	1.53	1.456	17.439	1.835	0.1107	90
4	2.00	5.91	2	2.69	1.66	1.68	1.559	16.162	1.983	0.0936	90
5	2.60	5.91	2	2.98	1.84	1.86	1.677	14.885	2.161	0.0777	90
6	3.20	5.91	1	2.21	1.36	1.38	1.209	13.610	2.379	0.0630	60
7	3.80	5.91	1	2.47	1.53	1.55	1.317	12.335	2.654	0.0496	60
8	4.40	5.91	1	2.79	1.72	1.74	1.445	11.061	3.015	0.0375	60
9	5.00	5.91	1	3.17	1.96	1.98	1.602	9.789	3.515	0.0268	60
10	5.60	5.91	1	3.17	1.96	1.98	1.555	7.376	4.266	0.0175	60
11	6.40	5.91	1	2.13	2.11	2.13	1.607	5.122	6.238	0.0076	60
12	7.20	5.91	2	1.44	3.70	3.74	2.696	3.484	14.078	0.0014	90

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

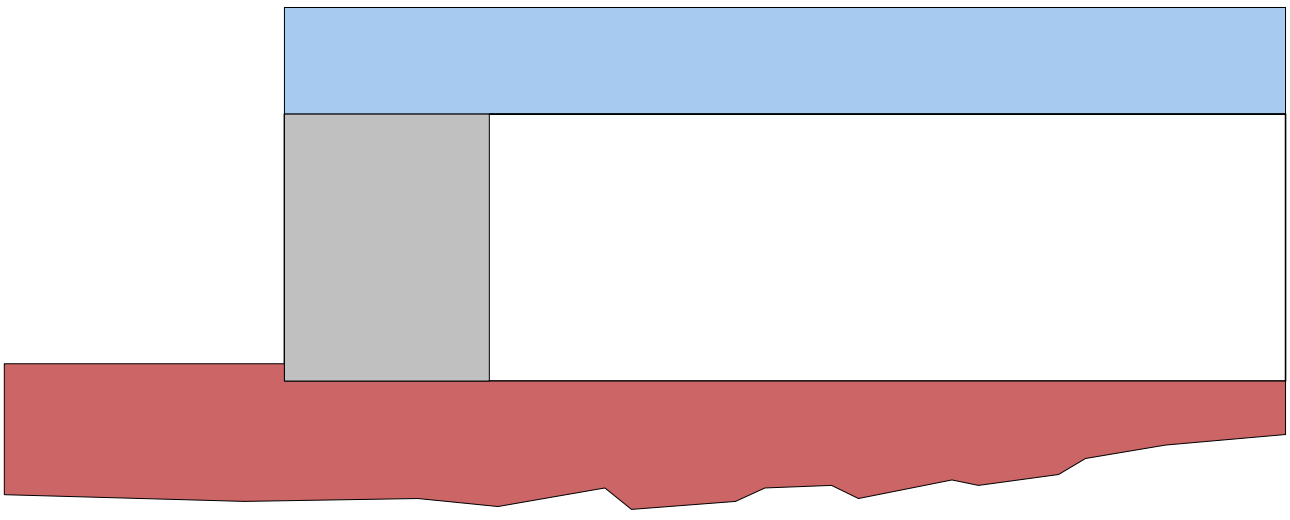
Bearing capacity, Fs = 2.01, Meyerhof stress = 320.46 kPa.

Foundation Interface: Direct sliding, Fs = 1.535, Eccentricity, e/L = 0.2005, Fs-overturning = 2.49

GEOGRID				CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	5.91	2	1.60	1.32	1.34	1.328	15.441	1.309	0.1912	90
2	0.80	5.91	2	1.49	1.22	1.23	1.199	12.413	1.407	0.1644	90
3	1.40	5.91	2	1.63	1.33	1.35	1.278	11.570	1.522	0.1396	90
4	2.00	5.91	2	1.79	1.46	1.48	1.368	10.728	1.659	0.1166	90
5	2.60	5.91	2	1.98	1.62	1.63	1.472	9.885	1.824	0.0955	90
6	3.20	5.91	1	1.47	1.20	1.21	1.062	9.043	2.029	0.0764	60
7	3.80	5.91	1	1.64	1.34	1.36	1.157	8.201	2.290	0.0592	60
8	4.40	5.91	1	1.85	1.52	1.53	1.270	7.360	2.637	0.0440	60
9	5.00	5.91	1	2.11	1.73	1.74	1.409	6.520	3.122	0.0308	60
10	5.60	5.91	1	2.16	1.75	1.77	1.392	5.031	3.859	0.0196	60
11	6.40	5.91	1	1.48	1.92	1.94	1.460	3.569	5.815	0.0083	60
12	7.20	5.91	2	1.02	3.40	3.44	2.476	2.465	13.647	0.0014	90

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	730.0	642.9	[kPa]
Meyerhof stress, σ_V	282.23	320.5	[kPa]
Eccentricity, e	0.86	1.11	[m]
Eccentricity, e/L	0.145	0.187	
Fs calculated	2.59	2.01	
Base length	5.91	5.91	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.880 and Fs-seismic = 1.535

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	5.91	1.600	1.309	2	90
2	0.80	5.91	1.709	1.407	2	90
3	1.40	5.91	1.835	1.522	2	90
4	2.00	5.91	1.983	1.659	2	90
5	2.60	5.91	2.161	1.824	2	90
6	3.20	5.91	2.379	2.029	1	60
7	3.80	5.91	2.654	2.290	1	60
8	4.40	5.91	3.015	2.637	1	60
9	5.00	5.91	3.515	3.122	1	60
10	5.60	5.91	4.266	3.859	1	60
11	6.40	5.91	6.238	5.815	1	60
12	7.20	5.91	14.078	13.647	2	90

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.1552, e/L seismic = 0.2005; Overturning: Fs-static = 3.22, Fs-seismic = 2.49

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	5.91	0.1485	0.1912	2	90
2	0.80	5.91	0.1290	0.1644	2	90
3	1.40	5.91	0.1107	0.1396	2	90
4	2.00	5.91	0.0936	0.1166	2	90
5	2.60	5.91	0.0777	0.0955	2	90
6	3.20	5.91	0.0630	0.0764	1	60
7	3.80	5.91	0.0496	0.0592	1	60
8	4.40	5.91	0.0375	0.0440	1	60
9	5.00	5.91	0.0268	0.0308	1	60
10	5.60	5.91	0.0175	0.0196	1	60
11	6.40	5.91	0.0076	0.0083	1	60
12	7.20	5.91	0.0014	0.0014	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	32.59	8.12	N/A	1.553	N/A	1.328	90
2	0.80	50.6	37.02	7.63	N/A	1.367	N/A	1.199	90
3	1.40	50.6	34.74	7.15	N/A	1.456	N/A	1.278	90
4	2.00	50.6	32.46	6.66	N/A	1.559	N/A	1.368	90
5	2.60	50.6	30.18	6.18	N/A	1.677	N/A	1.472	90
6	3.20	33.7	27.90	5.69	N/A	1.209	N/A	1.062	60
7	3.80	33.7	25.62	5.21	N/A	1.317	N/A	1.157	60
8	4.40	33.7	23.34	4.72	N/A	1.445	N/A	1.270	60
9	5.00	33.7	21.06	4.24	N/A	1.602	N/A	1.409	60
10	5.60	33.7	21.69	3.75	N/A	1.555	N/A	1.392	60
11	6.40	33.7	20.99	3.10	N/A	1.607	N/A	1.460	60
12	7.20	50.6	18.77	2.46	N/A	2.696	N/A	2.476	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	32.59	8.12	5.79	0.12	785.7	N/A	24.109	628.6	N/A	15.441
2	0.80	1.000	37.02	7.63	5.45	0.46	692.9	N/A	18.716	554.3	N/A	12.413
3	1.40	1.000	34.74	7.15	5.10	0.81	605.8	N/A	17.439	484.7	N/A	11.570
4	2.00	1.000	32.46	6.66	4.76	1.15	524.6	N/A	16.162	419.7	N/A	10.728
5	2.60	1.000	30.18	6.18	4.41	1.50	449.2	N/A	14.885	359.4	N/A	9.885
6	3.20	1.000	27.90	5.69	4.06	1.85	379.7	N/A	13.610	303.8	N/A	9.043
7	3.80	1.000	25.62	5.21	3.72	2.19	316.0	N/A	12.335	252.8	N/A	8.201
8	4.40	1.000	23.34	4.72	3.37	2.54	258.2	N/A	11.061	206.5	N/A	7.360
9	5.00	1.000	21.06	4.24	3.02	2.89	206.1	N/A	9.789	164.9	N/A	6.520
10	5.60	1.000	21.69	3.75	2.68	3.23	160.0	N/A	7.376	128.0	N/A	5.031
11	6.40	1.000	20.99	3.10	2.21	3.70	107.5	N/A	5.122	86.0	N/A	3.569
12	7.20	1.000	18.77	2.46	1.75	4.16	65.4	N/A	3.484	52.3	N/A	2.465

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	32.4	0.90	0.90	50.1	81.0	50.6	N/A	1.55	N/A	2.50	N/A	1.56	90
2	0.80	35.9	0.90	0.90	50.1	81.0	50.6	N/A	1.39	N/A	2.25	N/A	1.41	90
3	1.40	33.0	0.90	0.90	50.1	81.0	50.6	N/A	1.52	N/A	2.46	N/A	1.53	90
4	2.00	30.1	0.90	0.90	50.1	81.0	50.6	N/A	1.66	N/A	2.69	N/A	1.68	90
5	2.60	27.2	0.90	0.90	50.1	81.0	50.6	N/A	1.84	N/A	2.98	N/A	1.86	90
6	3.20	24.5	0.90	0.90	33.4	54.0	33.7	N/A	1.36	N/A	2.21	N/A	1.38	60
7	3.80	21.8	0.90	0.90	33.4	54.0	33.7	N/A	1.53	N/A	2.47	N/A	1.55	60
8	4.40	19.4	0.90	0.90	33.4	54.0	33.7	N/A	1.72	N/A	2.79	N/A	1.74	60
9	5.00	17.0	0.90	0.90	33.4	54.0	33.7	N/A	1.96	N/A	3.17	N/A	1.98	60
10	5.60	17.1	0.90	0.90	33.4	54.0	33.7	N/A	1.96	N/A	3.17	N/A	1.98	60
11	6.40	15.8	0.90	0.56	33.4	33.7	33.7	N/A	2.11	N/A	2.13	N/A	2.13	60
12	7.20	13.5	0.90	0.22	50.1	19.4	50.6	N/A	3.70	N/A	1.44	N/A	3.74	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	40.4	0.90	0.72	50.1	64.8	50.6	N/A	1.32	N/A	1.60	N/A	1.34	90
2	0.80	43.4	0.90	0.72	50.1	64.8	50.6	N/A	1.22	N/A	1.49	N/A	1.23	90
3	1.40	39.8	0.90	0.72	50.1	64.8	50.6	N/A	1.33	N/A	1.63	N/A	1.35	90
4	2.00	36.3	0.90	0.72	50.1	64.8	50.6	N/A	1.46	N/A	1.79	N/A	1.48	90
5	2.60	32.8	0.90	0.72	50.1	64.8	50.6	N/A	1.62	N/A	1.98	N/A	1.63	90
6	3.20	29.5	0.90	0.72	33.4	43.2	33.7	N/A	1.20	N/A	1.47	N/A	1.21	60
7	3.80	26.3	0.90	0.72	33.4	43.2	33.7	N/A	1.34	N/A	1.64	N/A	1.36	60
8	4.40	23.3	0.90	0.72	33.4	43.2	33.7	N/A	1.52	N/A	1.85	N/A	1.53	60
9	5.00	20.4	0.90	0.72	33.4	43.2	33.7	N/A	1.73	N/A	2.11	N/A	1.74	60
10	5.60	20.0	0.90	0.72	33.4	43.2	33.7	N/A	1.75	N/A	2.16	N/A	1.77	60
11	6.40	18.2	0.90	0.45	33.4	27.0	33.7	N/A	1.92	N/A	1.48	N/A	1.94	60
12	7.20	15.3	0.90	0.17	50.1	15.6	50.6	N/A	3.40	N/A	1.02	N/A	3.44	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 복현2교 A1앞성토 옥산

Description:

H=4.90m

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

.....?type16(H=4.9m).BEN

Original date and time of creating this file: Mon Mar 18 14:09:23 2013

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.5518 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 27.86 N γ= 19.34

SEISMICITY

Note: specified A combined with I and δ produced a square root of -0.04 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.9535 Kae (Kh = 0) = 0.5293 Δ Kae = 0.4242
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

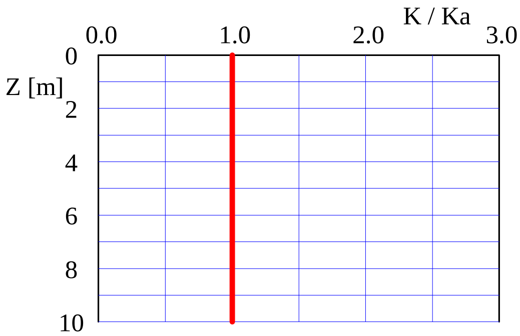
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

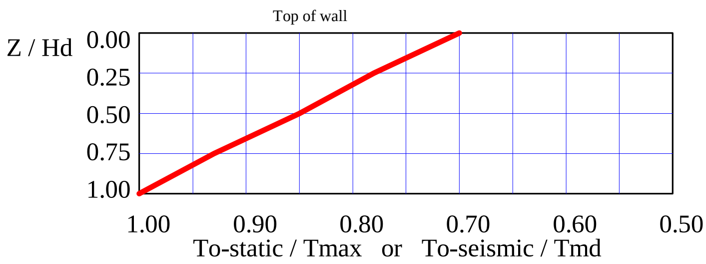
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

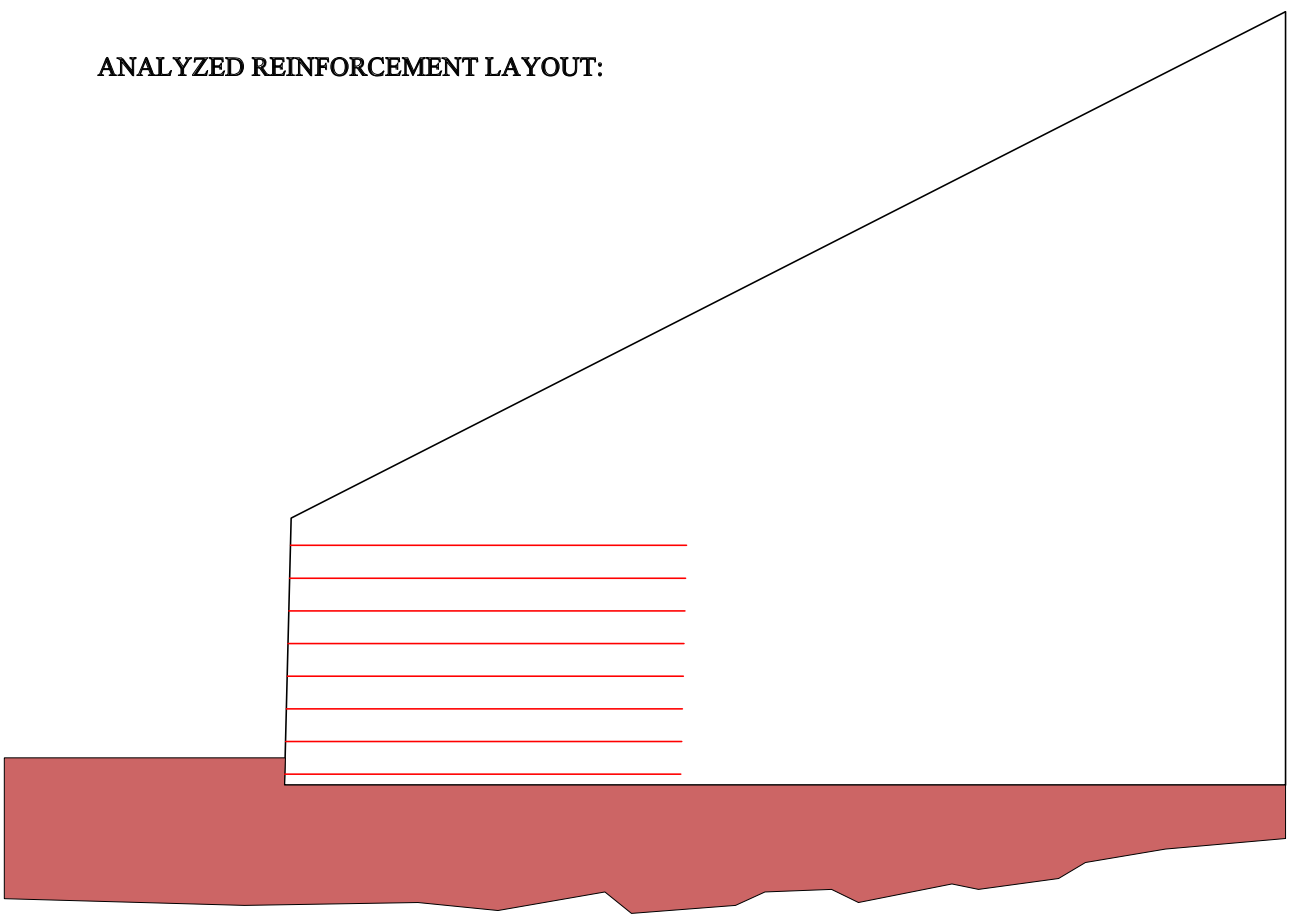
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	4.90	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 4.40 m }
Batter, ω	1.4	[deg]	
Backslope, β	27.0	[deg]	
Backslope rise	9.4	[m]	Broken back equivalent angle, I = 27.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=23.4 [m]. Distance of center of footing from wall face, d = 30.1 [m] @ depth of 0.0 [m] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 8.38, Meyerhof stress = 150.56 kPa.

Foundation Interface: Direct sliding, Fs = 1.776, Eccentricity, e/L = 0.0011, Fs-overturning = 5.08

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	7.27	1	3.12	1.93	1.95	1.928	37.467	1.502	-0.0034	60
2	0.80	7.27	1	2.99	1.85	1.87	1.785	30.489	1.570	-0.0171	60
3	1.40	7.27	1	3.54	2.19	2.21	2.030	30.205	1.644	-0.0310	60
4	2.00	7.27	1	4.28	2.65	2.67	2.352	30.150	1.724	-0.0456	60
5	2.60	7.27	1	5.32	3.29	3.32	2.797	30.478	1.809	-0.0613	60
6	3.20	7.27	1	5.58	4.23	4.27	3.449	31.441	1.898	-0.0792	60
7	3.80	7.27	1	4.93	5.77	5.83	4.497	33.605	1.983	-0.1011	60
8	4.40	7.27	1	2.74	7.06	7.13	5.227	31.210	2.053	-0.1306	60

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

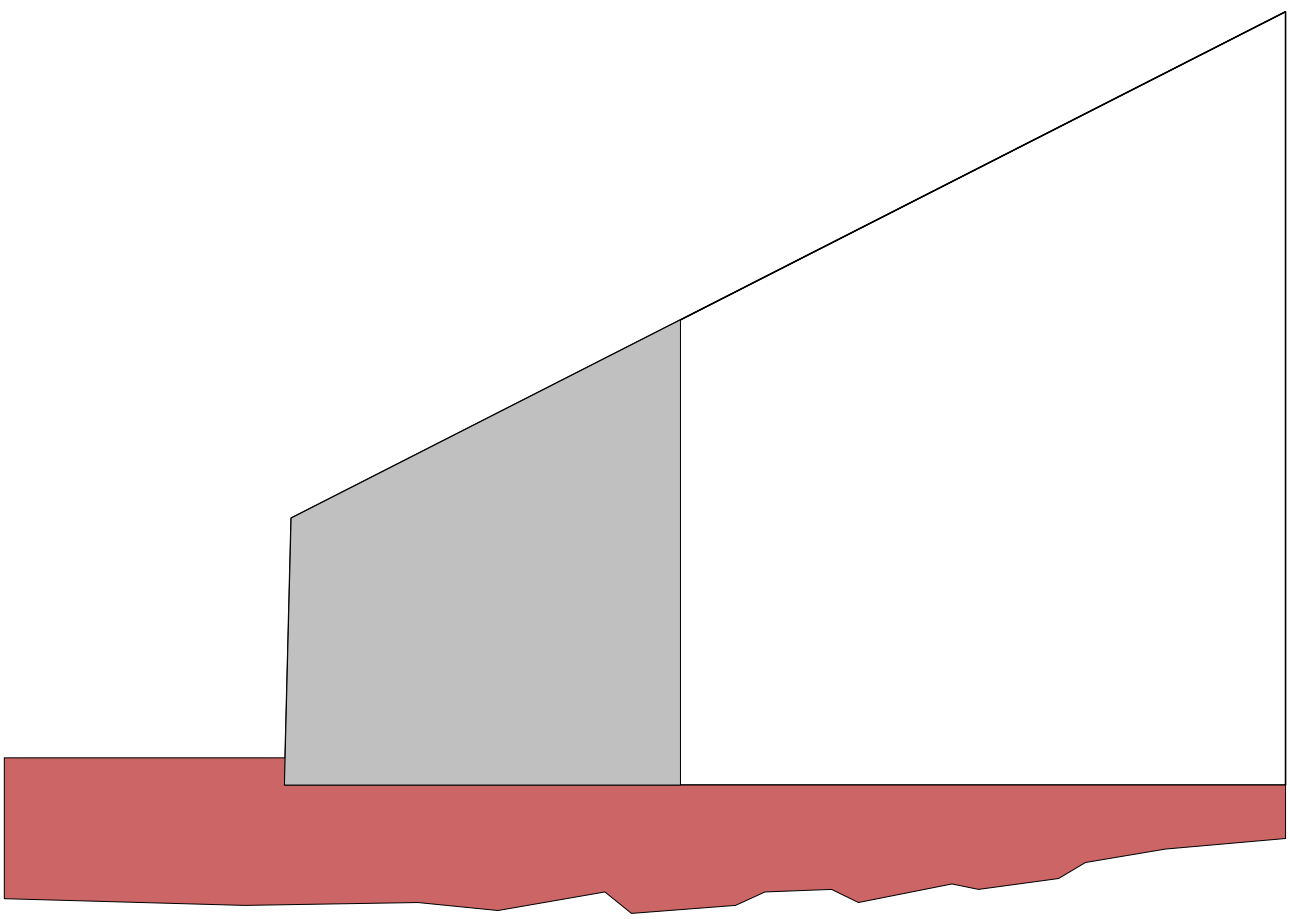
Bearing capacity, Fs = 6.38, Meyerhof stress = 175.56 kPa.

Foundation Interface: Direct sliding, Fs = 1.391, Eccentricity, e/L = 0.0506, Fs-overturning = 3.71

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	7.27	1	1.92	1.60	1.62	1.602	23.057	1.184	0.0425	60
2	0.80	7.27	1	1.89	1.57	1.58	1.512	19.285	1.268	0.0190	60
3	1.40	7.27	1	2.20	1.83	1.85	1.699	18.783	1.363	-0.0037	60
4	2.00	7.27	1	2.60	2.18	2.20	1.937	18.341	1.474	-0.0260	60
5	2.60	7.27	1	3.14	2.65	2.68	2.253	18.001	1.601	-0.0484	60
6	3.20	7.27	1	3.16	3.30	3.34	2.693	17.810	1.743	-0.0717	60
7	3.80	7.27	1	2.62	4.29	4.34	3.347	17.860	1.894	-0.0977	60
8	4.40	7.27	1	1.42	5.14	5.19	3.804	16.113	2.027	-0.1298	60

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1262.3	1120.8	[kPa]
Meyerhof stress, σ_V	150.56	175.6	[kPa]
Eccentricity, e	0.01	0.41	[m]
Eccentricity, e/L	0.001	0.057	
Fs calculated	8.38	6.38	
Base length	7.27	7.27	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.776 and Fs-seismic = 1.391

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	7.27	1.502	1.184	1	60
2	0.80	7.27	1.570	1.268	1	60
3	1.40	7.27	1.644	1.363	1	60
4	2.00	7.27	1.724	1.474	1	60
5	2.60	7.27	1.809	1.601	1	60
6	3.20	7.27	1.898	1.743	1	60
7	3.80	7.27	1.983	1.894	1	60
8	4.40	7.27	2.053	2.027	1	60

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.0011, e/L seismic = 0.0506; Overturning: Fs-static = 5.08, Fs-seismic = 3.71

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	7.27	-0.0034	0.0425	1	60
2	0.80	7.27	-0.0171	0.0190	1	60
3	1.40	7.27	-0.0310	-0.0037	1	60
4	2.00	7.27	-0.0456	-0.0260	1	60
5	2.60	7.27	-0.0613	-0.0484	1	60
6	3.20	7.27	-0.0792	-0.0717	1	60
7	3.80	7.27	-0.1011	-0.0977	1	60
8	4.40	7.27	-0.1306	-0.1298	1	60

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	17.49	5.25	N/A	1.928	N/A	1.602	60
2	0.80	33.7	18.90	5.00	N/A	1.785	N/A	1.512	60
3	1.40	33.7	16.62	4.76	N/A	2.030	N/A	1.699	60
4	2.00	33.7	14.34	4.52	N/A	2.352	N/A	1.937	60
5	2.60	33.7	12.06	4.28	N/A	2.797	N/A	2.253	60
6	3.20	33.7	9.78	4.03	N/A	3.449	N/A	2.693	60
7	3.80	33.7	7.50	3.79	N/A	4.497	N/A	3.347	60
8	4.40	33.7	6.45	3.55	N/A	5.227	N/A	3.804	60

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	17.49	5.25	7.16	0.11	655.4	N/A	37.467	524.3	N/A	23.057
2	0.80	1.000	18.90	5.00	6.83	0.44	576.3	N/A	30.489	461.0	N/A	19.285
3	1.40	1.000	16.62	4.76	6.50	0.77	502.0	N/A	30.205	401.6	N/A	18.783
4	2.00	1.000	14.34	4.52	6.16	1.10	432.4	N/A	30.150	345.9	N/A	18.341
5	2.60	1.000	12.06	4.28	5.83	1.44	367.6	N/A	30.478	294.1	N/A	18.001
6	3.20	1.000	9.78	4.03	5.50	1.77	307.5	N/A	31.441	246.0	N/A	17.810
7	3.80	1.000	7.50	3.79	5.17	2.10	252.1	N/A	33.605	201.6	N/A	17.860
8	4.40	1.000	6.45	3.55	4.84	2.43	201.4	N/A	31.210	161.1	N/A	16.113

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	17.3	0.90	0.90	33.4	54.0	33.7	N/A	1.93	N/A	3.12	N/A	1.95	60
2	0.80	18.0	0.90	0.90	33.4	54.0	33.7	N/A	1.85	N/A	2.99	N/A	1.87	60
3	1.40	15.3	0.90	0.90	33.4	54.0	33.7	N/A	2.19	N/A	3.54	N/A	2.21	60
4	2.00	12.6	0.90	0.90	33.4	54.0	33.7	N/A	2.65	N/A	4.28	N/A	2.67	60
5	2.60	10.1	0.90	0.90	33.4	54.0	33.7	N/A	3.29	N/A	5.32	N/A	3.32	60
6	3.20	7.9	0.90	0.73	33.4	44.1	33.7	N/A	4.23	N/A	5.58	N/A	4.27	60
7	3.80	5.8	0.90	0.48	33.4	28.5	33.7	N/A	5.77	N/A	4.93	N/A	5.83	60
8	4.40	4.7	0.90	0.22	33.4	13.0	33.7	N/A	7.06	N/A	2.74	N/A	7.13	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	22.5	0.90	0.72	33.4	43.2	33.7	N/A	1.60	N/A	1.92	N/A	1.62	60
2	0.80	22.8	0.90	0.72	33.4	43.2	33.7	N/A	1.57	N/A	1.89	N/A	1.58	60
3	1.40	19.6	0.90	0.72	33.4	43.2	33.7	N/A	1.83	N/A	2.20	N/A	1.85	60
4	2.00	16.6	0.90	0.72	33.4	43.2	33.7	N/A	2.18	N/A	2.60	N/A	2.20	60
5	2.60	13.7	0.90	0.72	33.4	43.2	33.7	N/A	2.65	N/A	3.14	N/A	2.68	60
6	3.20	11.1	0.90	0.59	33.4	35.3	33.7	N/A	3.30	N/A	3.16	N/A	3.34	60
7	3.80	8.7	0.90	0.38	33.4	22.8	33.7	N/A	4.29	N/A	2.62	N/A	4.34	60
8	4.40	7.3	0.90	0.17	33.4	10.4	33.7	N/A	5.14	N/A	1.42	N/A	5.19	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 복현2교 A1앞성토 옥산

Description:

H=3.50m

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

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Original date and time of creating this file:

PROGRAM MODE:

ANALYSIS
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.5518 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 27.86 N γ= 19.34

SEISMICITY

Note: specified A combined with I and δ produced a square root of -0.04 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.9535 Kae (Kh = 0) = 0.5293 Δ Kae = 0.4242
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.

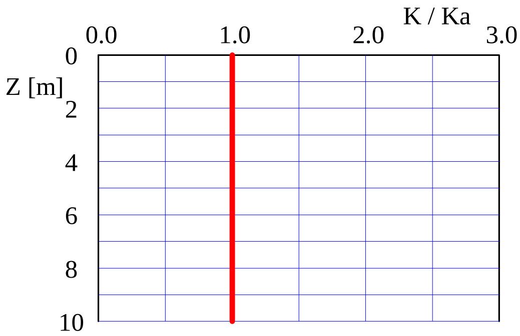
INPUT DATA: Geogrids
(Analysis)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	N/A	N/A	N/A	N/A	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔an	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

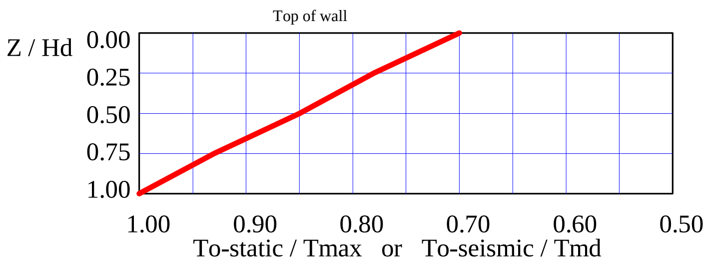
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection
(Analysis)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1)		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-c / Tult
(3) CRs = Tpo-c / Tult

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	N/A	N/A	N/A	N/A	N/A
Overall factor of safety: connection pullout, Fs	N/A	N/A	N/A	N/A	N/A

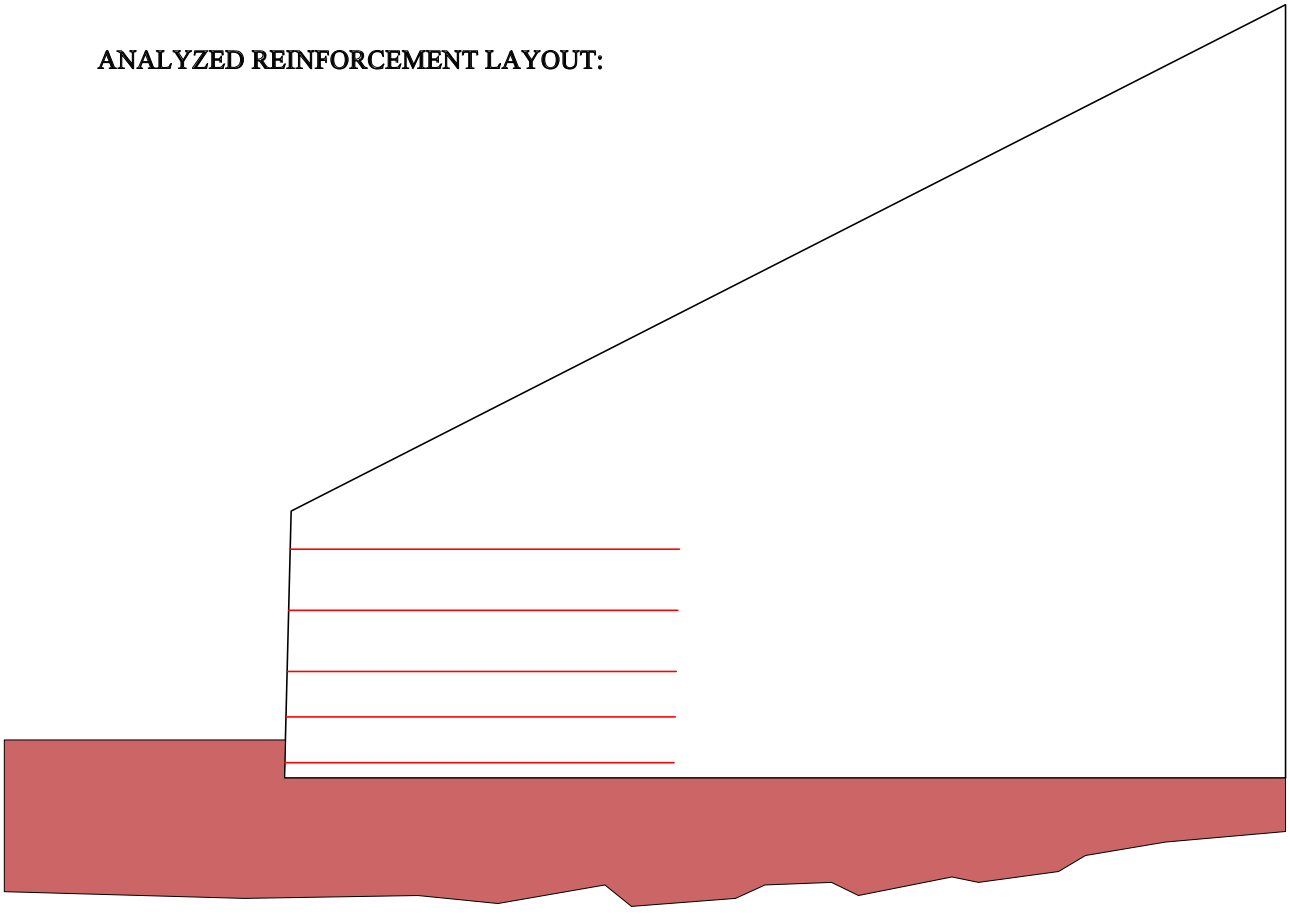
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	3.50	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 3.00 m }
Batter, ω	1.4	[deg]	
Backslope, β	27.0	[deg]	
Backslope rise	9.4	[m]	Broken back equivalent angle, I = 27.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=23.4 [m]. Distance of center of footing from wall face, d = 30.1 [m] @ depth of 0.0 [m] below soil surface.

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 8.21, Meyerhof stress = 107.56 kPa.

Foundation Interface: Direct sliding, Fs = 1.766, Eccentricity, e/L = 0.0031, Fs-overturning = 5.00

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	5.10	1	4.47	2.77	2.79	2.750	26.209	1.502	-0.0034	60
2	0.80	5.10	1	4.57	2.82	2.85	2.670	21.133	1.601	-0.0230	60
3	1.40	5.10	1	5.16	3.19	3.23	2.845	18.311	1.712	-0.0433	60
4	2.20	5.10	1	4.25	4.21	4.25	3.460	16.202	1.875	-0.0744	60
5	3.00	5.10	1	2.84	7.31	7.39	5.509	17.514	2.032	-0.1190	60

ANALYSIS: CALCULATED FACTORS (Seismic conditions)

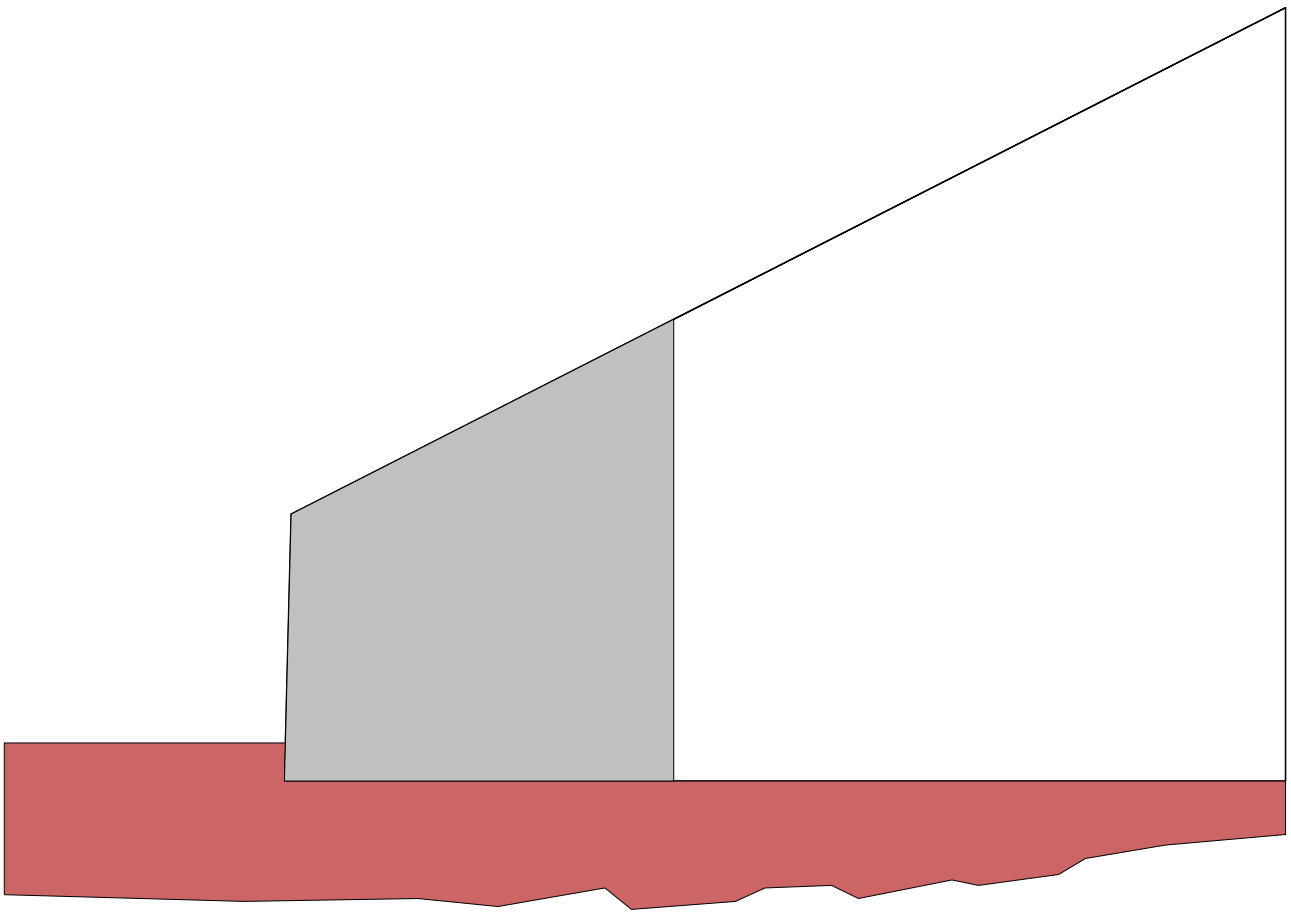
Bearing capacity, Fs = 6.20, Meyerhof stress = 126.02 kPa.

Foundation Interface: Direct sliding, Fs = 1.379, Eccentricity, e/L = 0.0540, Fs-overturning = 3.63

	GEOGRID			CONNECTION							
#	Elevation [m]	Length [m]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [geogrid strength]	Geogrid strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	0.20	5.10	1	2.67	2.24	2.27	2.230	15.617	1.184	0.0425	60
2	0.80	5.10	1	2.79	2.33	2.36	2.205	12.899	1.307	0.0093	60
3	1.40	5.10	1	3.16	2.64	2.67	2.353	11.204	1.456	-0.0227	60
4	2.20	5.10	1	2.54	3.43	3.46	2.817	9.704	1.706	-0.0657	60
5	3.00	5.10	1	1.54	5.53	5.59	4.166	9.507	1.985	-0.1174	60

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	882.9	780.7	[kPa]
Meyerhof stress, σ_V	107.56	126.0	[kPa]
Eccentricity, e	0.02	0.31	[m]
Eccentricity, e/L	0.003	0.061	
Fs calculated	8.21	6.20	
Base length	5.10	5.10	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for GIVEN LAYOUT (for GEOGRID reinforcements)

Along reinforced and foundation soils interface: Fs-static = 1.766 and Fs-seismic = 1.379

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	5.10	1.502	1.184	1	60
2	0.80	5.10	1.601	1.307	1	60
3	1.40	5.10	1.712	1.456	1	60
4	2.20	5.10	1.875	1.706	1	60
5	3.00	5.10	2.032	1.985	1	60

ECCENTRICITY for GIVEN LAYOUT

At interface with foundation: e/L static = 0.0031, e/L seismic = 0.0540; Overturning: Fs-static = 5.00, Fs-seismic = 3.63

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	5.10	-0.0034	0.0425	1	60
2	0.80	5.10	-0.0230	0.0093	1	60
3	1.40	5.10	-0.0433	-0.0227	1	60
4	2.20	5.10	-0.0744	-0.0657	1	60
5	3.00	5.10	-0.1190	-0.1174	1	60

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	12.27	4.20	N/A	2.750	N/A	2.230	60
2	0.80	33.7	12.63	3.92	N/A	2.670	N/A	2.205	60
3	1.40	33.7	11.86	3.65	N/A	2.845	N/A	2.353	60
4	2.20	33.7	9.75	3.27	N/A	3.460	N/A	2.817	60
5	3.00	33.7	6.12	2.90	N/A	5.509	N/A	4.166	60

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	12.27	4.20	4.99	0.11	321.5	N/A	26.209	257.2	N/A	15.617
2	0.80	1.000	12.63	3.92	4.66	0.44	266.9	N/A	21.133	213.6	N/A	12.899
3	1.40	1.000	11.86	3.65	4.33	0.77	217.1	N/A	18.311	173.7	N/A	11.204
4	2.20	1.000	9.75	3.27	3.89	1.22	158.0	N/A	16.202	126.4	N/A	9.704
5	3.00	1.000	6.12	2.90	3.45	1.66	107.2	N/A	17.514	85.8	N/A	9.507

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	12.1	0.90	0.90	33.4	54.0	33.7	N/A	2.77	N/A	4.47	N/A	2.79	60
2	0.80	11.8	0.90	0.90	33.4	54.0	33.7	N/A	2.82	N/A	4.57	N/A	2.85	60
3	1.40	10.5	0.90	0.90	33.4	54.0	33.7	N/A	3.19	N/A	5.16	N/A	3.23	60
4	2.20	7.9	0.90	0.56	33.4	33.7	33.7	N/A	4.21	N/A	4.25	N/A	4.25	60
5	3.00	4.6	0.90	0.22	33.4	13.0	33.7	N/A	7.31	N/A	2.84	N/A	7.39	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	16.2	0.90	0.72	33.4	43.2	33.7	N/A	2.24	N/A	2.67	N/A	2.27	60
2	0.80	15.5	0.90	0.72	33.4	43.2	33.7	N/A	2.33	N/A	2.79	N/A	2.36	60
3	1.40	13.7	0.90	0.72	33.4	43.2	33.7	N/A	2.64	N/A	3.16	N/A	2.67	60
4	2.20	10.6	0.90	0.45	33.4	27.0	33.7	N/A	3.43	N/A	2.54	N/A	3.46	60
5	3.00	6.7	0.90	0.17	33.4	10.4	33.7	N/A	5.53	N/A	1.54	N/A	5.59	60

도 로 부

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 옥산JCT R-D STA.1+279.05~1+353.39

Description:

H=7.10m(STA.1+300)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

Original date and time of creating this file:

PROGRAM MODE:

DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 4.97 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.3864 Kae (Kh = 0) = 0.3238 Δ Kae = 0.0626

DIRECT SLIDING / ECCENTRICITY

Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY

Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY

Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

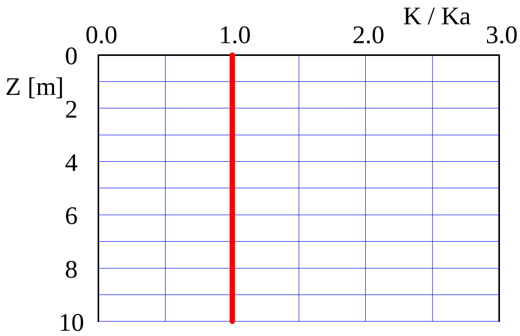
INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

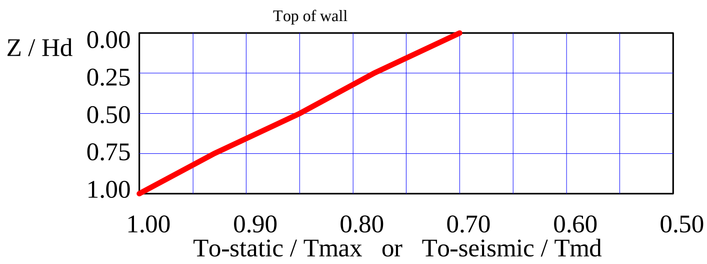
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [(1)]	CRu [(2)]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [(3)]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-connection / Tult-geogrid
(3) CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

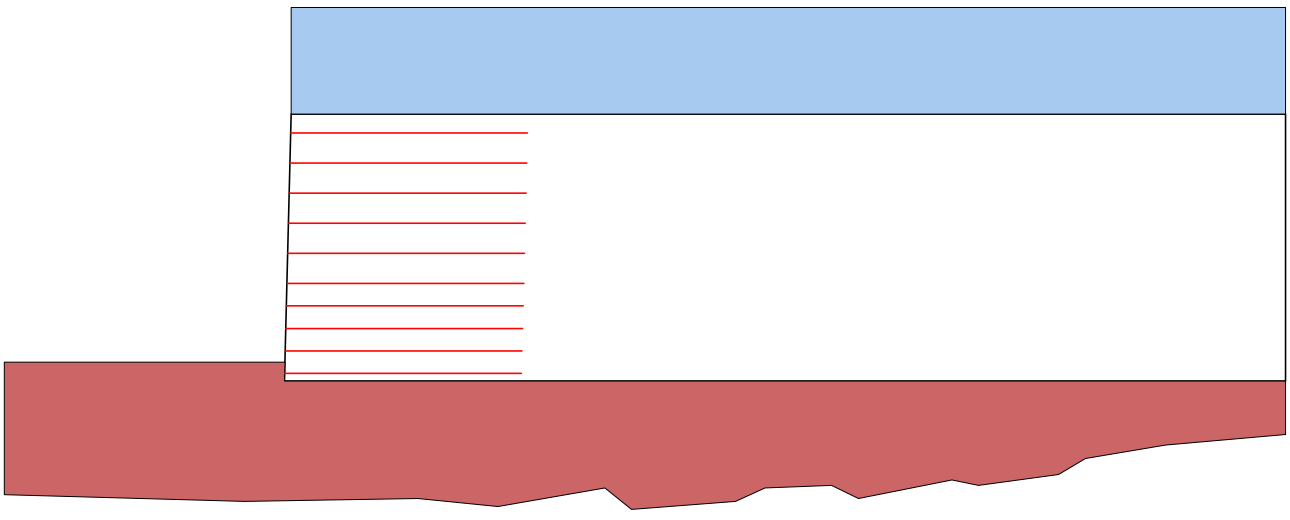
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	7.10	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 6.60 m }
Batter, ω	1.4	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[m]	Broken back equivalent angle, I = 0.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [kPa], and live load is 13.0 [kPa]

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

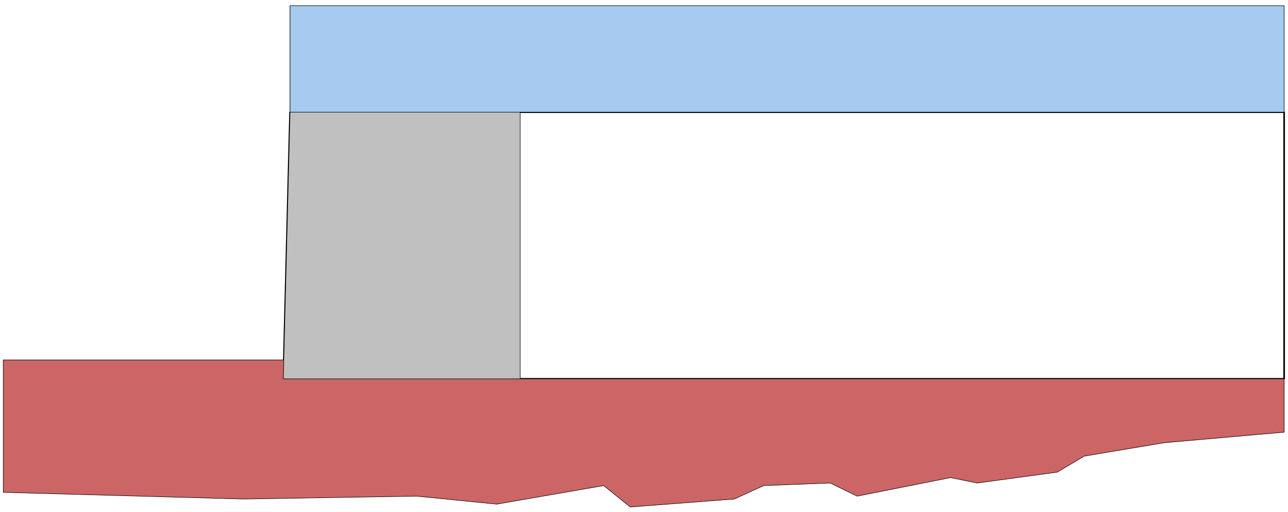
LEGEND: (1) Connection strength √ Satisfactory
(2) Geogrid strength ⊗ Unsatisfactory
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	6.30	2	√	√	√	√	√
2	0.80	6.30	2	√	√	√	√	√
3	1.40	6.30	2	√	√	√	√	√
4	2.00	6.30	2	√	√	√	√	√
5	2.60	6.30	2	√	√	√	√	√
6	3.40	6.30	1	√	√	√	√	√
7	4.20	6.30	1	√	√	√	√	√
8	5.00	6.30	1	√	√	√	√	√
9	5.80	6.30	1	√	√	√	√	√
10	6.60	6.30	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	928.7	842.8	[kPa]
Meyerhof stress, σ_V	171.99	189.5	[kPa]
Eccentricity, e	0.48	0.73	[m]
Eccentricity, e/L	0.077	0.116	
Fs calculated	5.40	4.45	
Base length	6.30	6.30	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 2.440 and Fs-seismic = 1.846

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	6.30	2.083	1.578	2	90
2	0.80	6.30	2.249	1.710	2	90
3	1.40	6.30	2.443	1.866	2	90
4	2.00	6.30	2.673	2.052	2	90
5	2.60	6.30	2.949	2.279	2	90
6	3.40	6.30	3.420	2.672	1	60
7	4.20	6.30	4.068	3.227	1	60
8	5.00	6.30	5.014	4.069	1	60
9	5.80	6.30	6.528	5.500	1	60
10	6.60	6.30	9.337	8.468	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0852, e/L seismic = 0.1281; Overturning: Fs-static = 5.50, Fs-seismic = 3.75

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	6.30	0.0808	0.1213	2	90
2	0.80	6.30	0.0683	0.1021	2	90
3	1.40	6.30	0.0569	0.0845	2	90
4	2.00	6.30	0.0465	0.0686	2	90
5	2.60	6.30	0.0372	0.0543	2	90
6	3.40	6.30	0.0263	0.0379	1	60
7	4.20	6.30	0.0173	0.0244	1	60
8	5.00	6.30	0.0102	0.0139	1	60
9	5.80	6.30	0.0048	0.0062	1	60
10	6.60	6.30	0.0013	0.0015	1	60

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	23.9	7.2	1.500	2.121	1.001	1.759	90
2	0.80	50.6	26.5	6.8	1.500	1.907	1.001	1.623	90
3	1.40	50.6	24.3	6.4	1.500	2.086	1.001	1.767	90
4	2.00	50.6	22.0	6.1	1.500	2.302	1.001	1.939	90
5	2.60	50.6	22.8	5.7	1.500	2.223	1.001	1.901	90
6	3.40	33.7	22.2	5.2	1.500	1.519	1.001	1.312	60
7	4.20	33.7	18.2	4.6	1.500	1.858	1.001	1.583	60
8	5.00	33.7	14.1	4.1	1.500	2.391	1.001	1.995	60
9	5.80	33.7	10.1	3.6	1.500	3.355	1.001	2.697	60
10	6.60	33.7	6.5	3.1	1.500	5.218	1.001	3.937	60

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	23.86	7.21	6.19	0.11	598.7	1.500	25.094	479.0	1.099	15.416
2	0.80	1.000	26.54	6.82	5.86	0.44	518.2	1.500	19.523	414.5	1.099	12.424
3	1.40	1.000	24.26	6.44	5.53	0.77	442.3	1.500	18.233	353.9	1.099	11.528
4	2.00	1.000	21.98	6.05	5.20	1.10	372.1	1.500	16.929	297.7	1.099	10.620
5	2.60	1.000	22.76	5.67	4.87	1.44	307.3	1.500	13.501	245.8	1.099	8.648
6	3.40	1.000	22.21	5.15	4.42	1.88	229.7	1.500	10.342	183.8	1.099	6.716
7	4.20	1.000	18.16	4.64	3.98	2.32	162.1	1.500	8.925	129.7	1.099	5.688
8	5.00	1.000	14.11	4.12	3.54	2.76	104.3	1.500	7.397	83.5	1.099	4.580
9	5.80	1.000	10.05	3.61	3.10	3.20	56.5	1.500	5.624	45.2	1.099	3.311
10	6.60	1.000	6.47	3.09	2.66	3.65	18.6	1.500	2.884	14.9	1.099	1.561

RESULTS for CONNECTION (static conditions)
Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	23.7	0.90	0.90	50.1	81.0	50.6	1.00	2.12	1.50	3.42	1.50	2.14	90
2	0.80	25.7	0.90	0.90	50.1	81.0	50.6	1.00	1.95	1.50	3.15	1.50	1.97	90
3	1.40	22.9	0.90	0.90	50.1	81.0	50.6	1.00	2.19	1.50	3.53	1.50	2.21	90
4	2.00	20.2	0.90	0.90	50.1	81.0	50.6	1.00	2.48	1.50	4.01	1.50	2.50	90
5	2.60	20.3	0.90	0.90	50.1	81.0	50.6	1.00	2.46	1.50	3.99	1.50	2.49	90
6	3.40	19.0	0.90	0.90	33.4	54.0	33.7	1.00	1.75	1.50	2.84	1.50	1.77	60
7	4.20	15.0	0.90	0.90	33.4	54.0	33.7	1.00	2.23	1.50	3.61	1.50	2.25	60
8	5.00	11.2	0.90	0.90	33.4	54.0	33.7	1.00	2.99	1.50	4.83	1.50	3.02	60
9	5.80	7.6	0.90	0.56	33.4	33.7	33.7	1.00	4.38	1.50	4.42	1.50	4.42	60
10	6.60	4.7	0.90	0.22	33.4	13.0	33.7	1.00	7.15	1.50	2.77	1.50	7.22	60

RESULTS for CONNECTION (seismic conditions)
Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	30.8	0.90	0.72	50.1	64.8	50.6	0.67	1.76	1.00	2.10	1.00	1.77	90
2	0.80	32.3	0.90	0.72	50.1	64.8	50.6	0.67	1.66	1.00	2.01	1.00	1.68	90
3	1.40	29.0	0.90	0.72	50.1	64.8	50.6	0.67	1.85	1.00	2.23	1.00	1.87	90
4	2.00	25.8	0.90	0.72	50.1	64.8	50.6	0.67	2.09	1.00	2.51	1.00	2.11	90
5	2.60	25.4	0.90	0.72	50.1	64.8	50.6	0.67	2.11	1.00	2.55	1.00	2.13	90
6	3.40	23.4	0.90	0.72	33.4	43.2	33.7	0.67	1.52	1.00	1.84	1.00	1.53	60
7	4.20	18.8	0.90	0.72	33.4	43.2	33.7	0.67	1.90	1.00	2.30	1.00	1.92	60
8	5.00	14.5	0.90	0.72	33.4	43.2	33.7	0.67	2.49	1.00	2.99	1.00	2.52	60
9	5.80	10.4	0.90	0.45	33.4	27.0	33.7	0.67	3.52	1.00	2.60	1.00	3.56	60
10	6.60	6.9	0.90	0.17	33.4	10.4	33.7	0.67	5.39	1.00	1.50	1.00	5.45	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title:	옥산~오창 고속도로 민간투자사업
Project Number:	
Client:	
Designer:	.
Station Number:	옥산JCT R-C STA.0+958.98~1+030

Description:

H=8.10m(STA.0+980)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

Original date and time of creating this file:

PROGRAM MODE:

DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 5.67 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.5194 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Note: specified A combined with I and δ produced a square root of -0.02 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.9437 Kae (Kh = 0) = 0.4985 Δ Kae = 0.4452

DIRECT SLIDING / ECCENTRICITY

Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY

Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY

Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

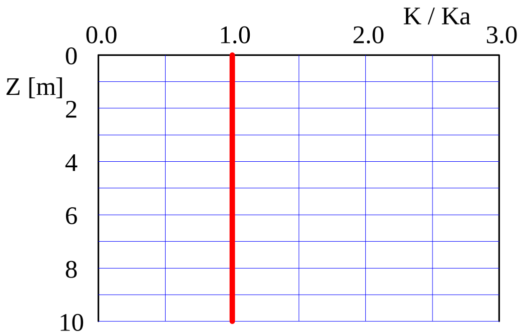
INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

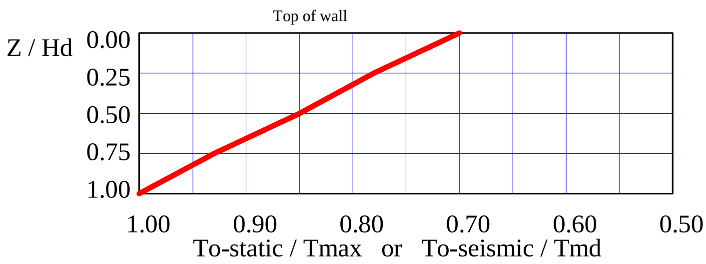
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ [(1)]	CRu [(2)]	σ	CRu	σ	CRu	σ	CRu	σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1		Geogrid Type #2		Geogrid Type #3		Geogrid Type #4		Geogrid Type #5	
σ	CRs [(3)]	σ	CRs	σ	CRs	σ	CRs	σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-connection / Tult-geogrid
(3) CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

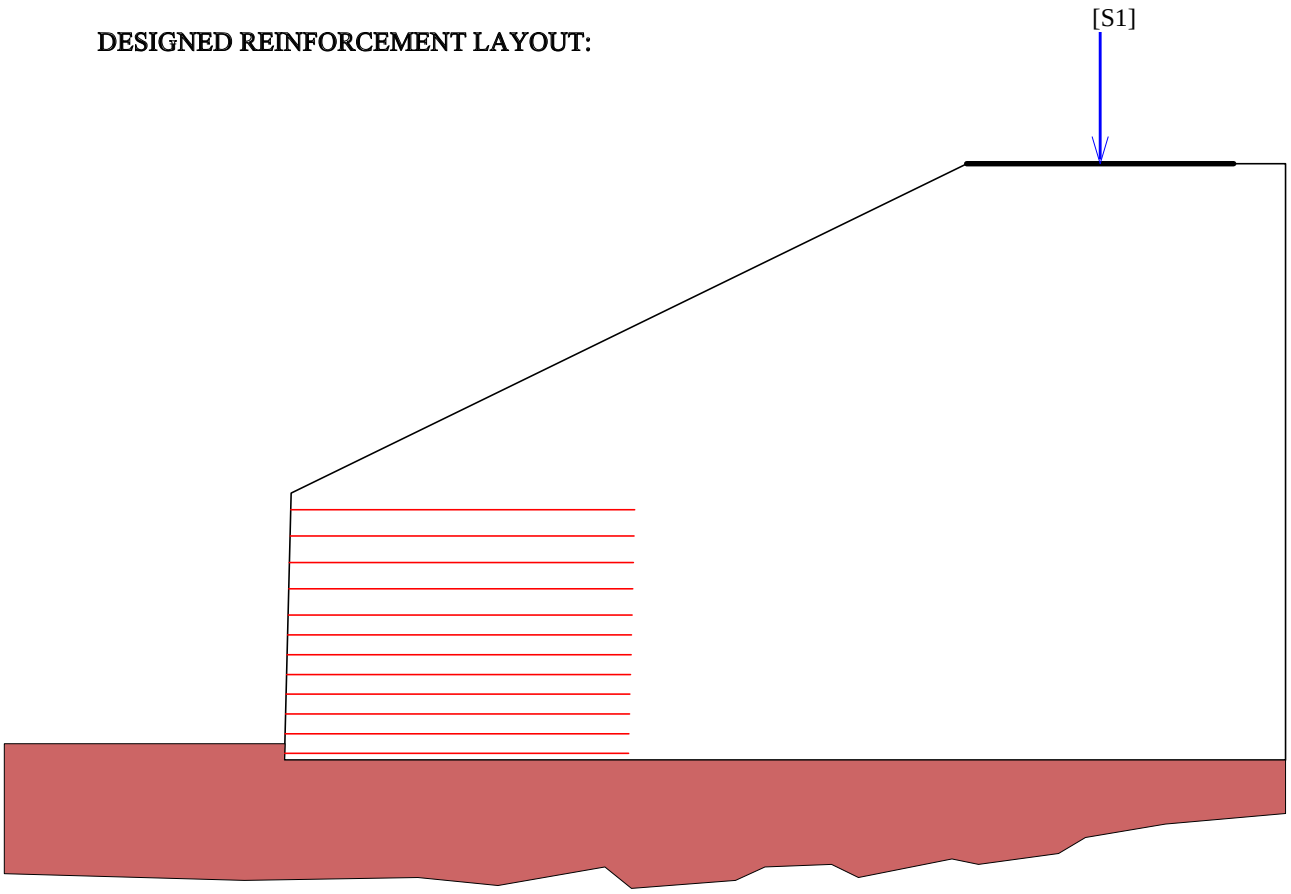
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	8.10	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 7.60 m }
Batter, ω	1.4	[deg]	
Backslope, β	26.0	[deg]	
Backslope rise	10.0	[m]	Broken back equivalent angle, I = 26.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=8.1 [m]. Distance of center of footing from wall face, d = 24.6 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

LEGEND: (1) Connection strength √ Satisfactory
(2) Geogrid strength ⊗ Unsatisfactory
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

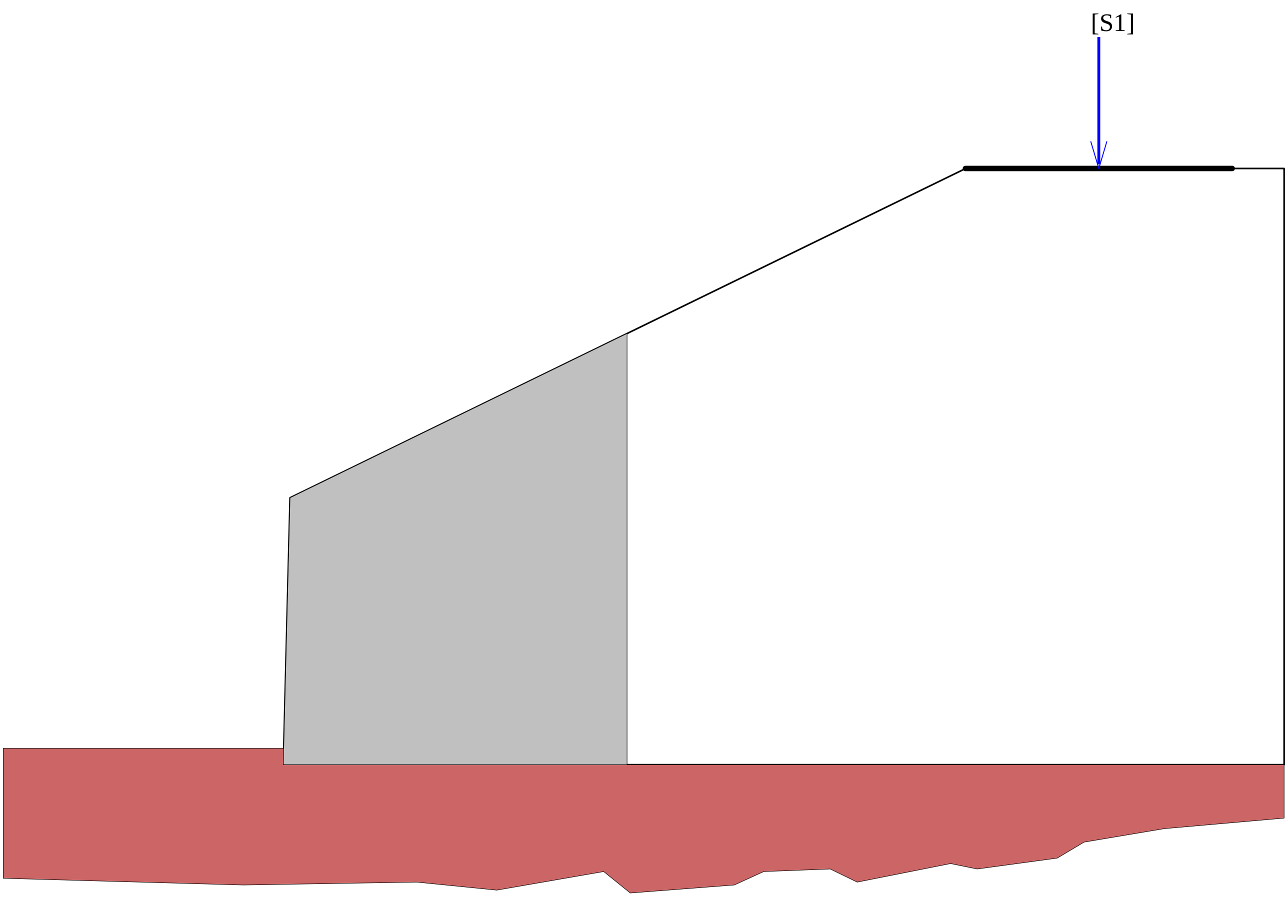
Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	10.44	2	√	√	√	√	√
2	0.80	10.44	2	√	√	√	√	√
3	1.40	10.44	2	√	√	√	√	√
4	2.00	10.44	2	√	√	√	√	√
5	2.60	10.44	2	√	√	√	√	√
6	3.20	10.44	2	√	√	√	√	√

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
7	3.80	10.44	1	√	√	√	√	√
8	4.40	10.44	1	√	√	√	√	√
9	5.20	10.44	1	√	√	√	√	√
10	6.00	10.44	1	√	√	√	√	√
11	6.80	10.44	1	√	√	√	√	√
12	7.60	10.44	2	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1755.6	1490.8	[kPa]
Meyerhof stress, σ_V	242.51	297.7	[kPa]
Eccentricity, e	0.17	0.93	[m]
Eccentricity, e/L	0.017	0.090	
Fs calculated	7.24	5.01	
Base length	10.44	10.44	[m]



DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.784 and Fs-seismic = 1.329

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	10.44	1.502	1.123	2	90
2	0.80	10.44	1.548	1.174	2	90
3	1.40	10.44	1.598	1.231	2	90
4	2.00	10.44	1.650	1.293	2	90
5	2.60	10.44	1.707	1.363	2	90
6	3.20	10.44	1.766	1.440	2	90
7	3.80	10.44	1.829	1.526	1	60
8	4.40	10.44	1.895	1.622	1	60
9	5.20	10.44	1.988	1.765	1	60
10	6.00	10.44	2.082	1.923	1	60
11	6.80	10.44	2.171	2.087	1	60
12	7.60	10.44	2.238	2.221	2	90

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0167, e/L seismic = 0.0824; Overturning: Fs-static = 4.72, Fs-seismic = 3.18

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	10.44	0.0136	0.0765	2	90
2	0.80	10.44	0.0043	0.0591	2	90
3	1.40	10.44	-0.0048	0.0422	2	90
4	2.00	10.44	-0.0140	0.0259	2	90
5	2.60	10.44	-0.0233	0.0099	2	90
6	3.20	10.44	-0.0328	-0.0057	2	90
7	3.80	10.44	-0.0426	-0.0212	1	60
8	4.40	10.44	-0.0529	-0.0365	1	60
9	5.20	10.44	-0.0681	-0.0575	1	60
10	6.00	10.44	-0.0858	-0.0799	1	60
11	6.80	10.44	-0.1081	-0.1056	1	60
12	7.60	10.44	-0.1391	-0.1387	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	29.2	9.7	1.500	1.731	1.001	1.413	90
2	0.80	50.6	33.0	9.4	1.500	1.534	1.001	1.286	90
3	1.40	50.6	30.7	9.0	1.500	1.647	1.001	1.372	90
4	2.00	50.6	28.4	8.7	1.500	1.779	1.001	1.472	90
5	2.60	50.6	26.2	8.4	1.500	1.935	1.001	1.587	90
6	3.20	50.6	23.9	8.1	1.500	2.119	1.001	1.721	90
7	3.80	33.7	21.6	7.8	1.500	1.562	1.001	1.254	60
8	4.40	33.7	22.3	7.5	1.500	1.512	1.001	1.231	60
9	5.20	33.7	21.7	7.1	1.500	1.555	1.001	1.272	60
10	6.00	33.7	17.6	6.7	1.500	1.912	1.001	1.521	60
11	6.80	33.7	13.6	6.3	1.500	2.482	1.001	1.890	60
12	7.60	50.6	10.4	5.8	1.500	4.844	1.001	3.509	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	29.24	9.67	10.32	0.11	1501.7	1.500	51.362	1201.3	1.099	30.879
2	0.80	1.000	32.99	9.36	9.99	0.44	1384.1	1.500	41.948	1107.2	1.099	26.145
3	1.40	1.000	30.71	9.05	9.66	0.77	1268.7	1.500	41.306	1015.0	1.099	25.527
4	2.00	1.000	28.43	8.74	9.33	1.10	1158.1	1.500	40.728	926.5	1.099	24.925
5	2.60	1.000	26.15	8.43	9.00	1.44	1052.2	1.500	40.232	841.8	1.099	24.344
6	3.20	1.000	23.87	8.12	8.67	1.77	951.2	1.500	39.841	760.9	1.099	23.787
7	3.80	1.000	21.59	7.80	8.34	2.10	854.9	1.500	39.588	683.9	1.099	23.262
8	4.40	1.000	22.31	7.49	8.00	2.43	763.3	1.500	34.212	610.7	1.099	20.488
9	5.20	1.000	21.70	7.08	7.56	2.87	648.6	1.500	29.891	518.9	1.099	18.029
10	6.00	1.000	17.65	6.67	7.12	3.31	542.6	1.500	30.751	434.1	1.099	17.855
11	6.80	1.000	13.59	6.25	6.68	3.76	444.8	1.500	32.728	355.9	1.099	17.932
12	7.60	1.000	10.45	5.84	6.24	4.20	355.8	1.500	34.056	284.6	1.099	17.476

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	29.0	0.90	0.90	50.1	81.0	50.6	1.00	1.73	1.50	2.79	1.50	1.74	90
2	0.80	32.1	0.90	0.90	50.1	81.0	50.6	1.00	1.56	1.50	2.52	1.50	1.58	90
3	1.40	29.2	0.90	0.90	50.1	81.0	50.6	1.00	1.71	1.50	2.77	1.50	1.73	90
4	2.00	26.5	0.90	0.90	50.1	81.0	50.6	1.00	1.89	1.50	3.06	1.50	1.91	90
5	2.60	23.7	0.90	0.90	50.1	81.0	50.6	1.00	2.11	1.50	3.41	1.50	2.13	90
6	3.20	21.1	0.90	0.90	50.1	81.0	50.6	1.00	2.37	1.50	3.84	1.50	2.40	90
7	3.80	18.6	0.90	0.90	33.4	54.0	33.7	1.00	1.80	1.50	2.91	1.50	1.82	60
8	4.40	18.7	0.90	0.90	33.4	54.0	33.7	1.00	1.79	1.50	2.89	1.50	1.80	60
9	5.20	17.6	0.90	0.90	33.4	54.0	33.7	1.00	1.90	1.50	3.07	1.50	1.92	60
10	6.00	13.8	0.90	0.90	33.4	54.0	33.7	1.00	2.42	1.50	3.91	1.50	2.44	60
11	6.80	10.2	0.90	0.56	33.4	33.7	33.7	1.00	3.27	1.50	3.30	1.50	3.30	60
12	7.60	7.5	0.90	0.22	50.1	19.4	50.6	1.00	6.66	1.50	2.59	1.50	6.73	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	38.6	0.90	0.72	50.1	64.8	50.6	0.67	1.41	1.00	1.68	1.00	1.42	90
2	0.80	41.2	0.90	0.72	50.1	64.8	50.6	0.67	1.31	1.00	1.57	1.00	1.32	90
3	1.40	37.8	0.90	0.72	50.1	64.8	50.6	0.67	1.43	1.00	1.71	1.00	1.44	90
4	2.00	34.6	0.90	0.72	50.1	64.8	50.6	0.67	1.57	1.00	1.87	1.00	1.58	90
5	2.60	31.4	0.90	0.72	50.1	64.8	50.6	0.67	1.73	1.00	2.07	1.00	1.75	90
6	3.20	28.3	0.90	0.72	50.1	64.8	50.6	0.67	1.93	1.00	2.29	1.00	1.95	90
7	3.80	25.3	0.90	0.72	33.4	43.2	33.7	0.67	1.44	1.00	1.71	1.00	1.46	60
8	4.40	25.0	0.90	0.72	33.4	43.2	33.7	0.67	1.45	1.00	1.73	1.00	1.47	60
9	5.20	23.3	0.90	0.72	33.4	43.2	33.7	0.67	1.55	1.00	1.85	1.00	1.57	60
10	6.00	19.0	0.90	0.72	33.4	43.2	33.7	0.67	1.92	1.00	2.27	1.00	1.94	60
11	6.80	14.9	0.90	0.45	33.4	27.0	33.7	0.67	2.49	1.00	1.81	1.00	2.52	60
12	7.60	11.7	0.90	0.17	50.1	15.6	50.6	0.67	4.83	1.00	1.33	1.00	4.88	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 서오창IC R-I STA.0+440~0+490

Description:

H=2.90m(STA.0+440)

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

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PROGRAM MODE:

DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 2.03 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 $N\gamma = 19.34$

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.5518 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Note: specified A combined with I and δ produced a square root of -0.04 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.9535 Kae (Kh = 0) = 0.5293 Δ Kae = 0.4242

DIRECT SLIDING / ECCENTRICITY

Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY

Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY

Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

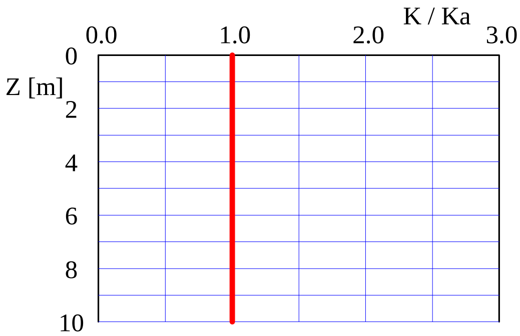
INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

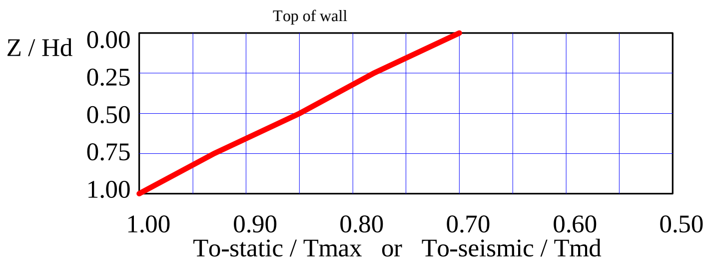
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [(1)]	CRu [(2)]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [(3)]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-connection / Tult-geogrid
(3) CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

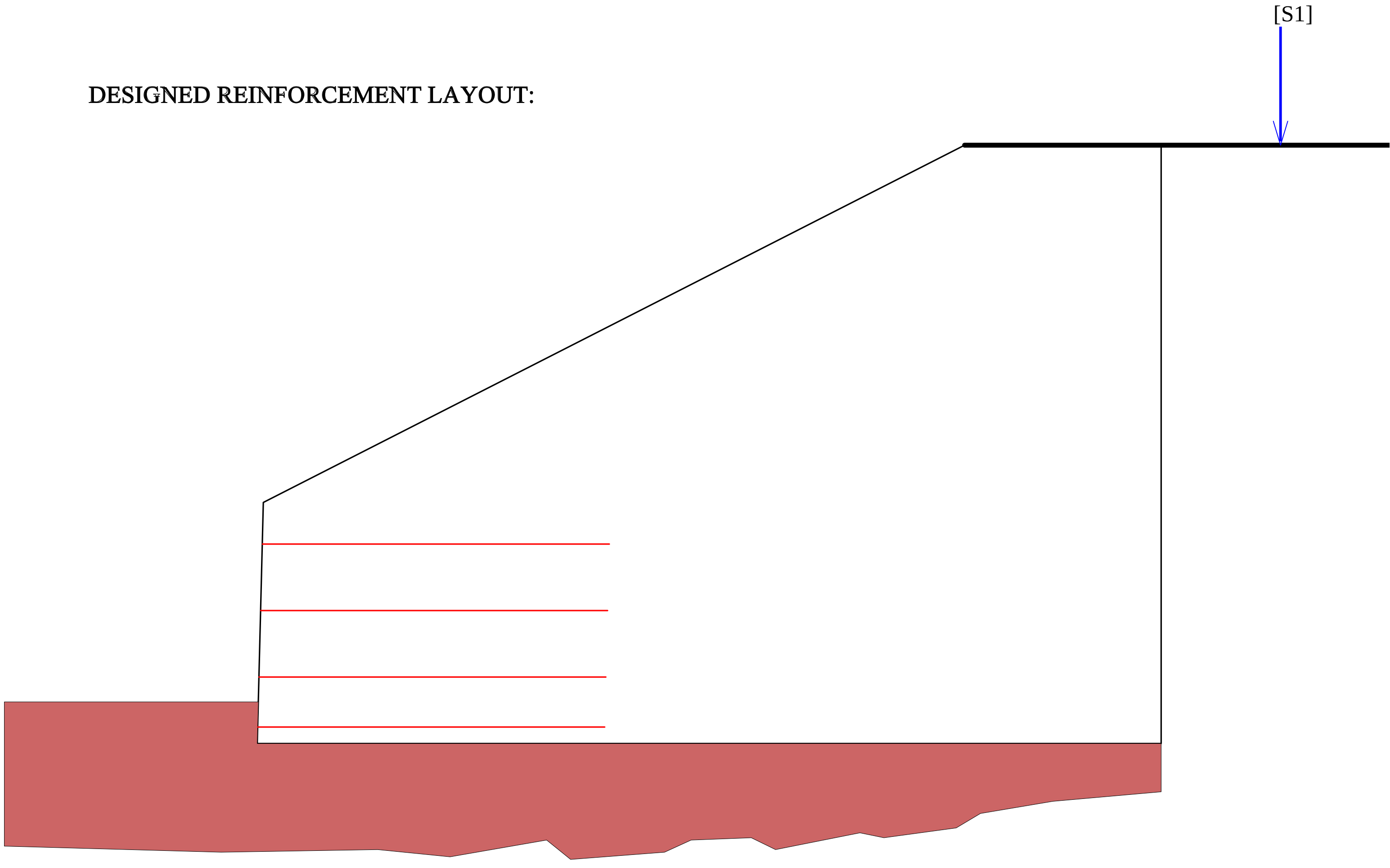
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	2.90	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 2.40 m }
Batter, ω	1.4	[deg]	
Backslope, β	27.0	[deg]	
Backslope rise	4.3	[m]	Broken back equivalent angle, I = 27.00? (see Fig. 25 in DEMO 82)

U N I F O R M   S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=7.6 [m]. Distance of center of footing from wall face, d = 12.2 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

LEGEND:
(1) Connection strength
(2) Geogrid strength
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

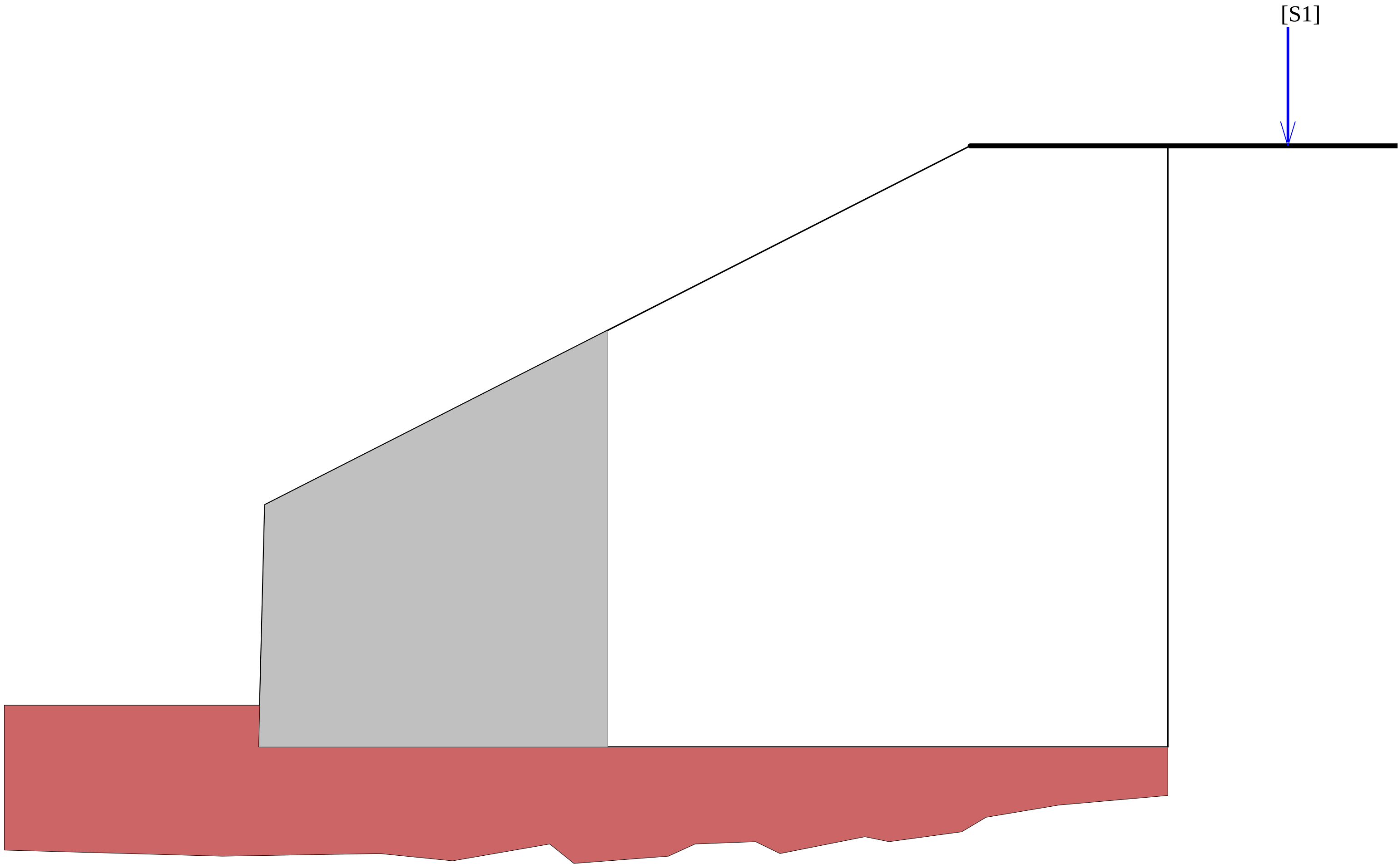
√ Satisfactory
⊗ Unsatisfactory

Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	4.18	1	√	√	√	√	√
2	0.80	4.18	1	√	√	√	√	√
3	1.60	4.18	1	√	√	√	√	√
4	2.40	4.18	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	720.2	635.0	[kPa]
Meyerhof stress, σ_V	89.14	104.8	[kPa]
Eccentricity, e	0.02	0.26	[m]
Eccentricity, e/L	0.005	0.063	
Fs calculated	8.08	6.06	
Base length	4.18	4.18	[m]



SCALE:

0 2 4 6 [m]

Version 3.0 MSEW Version 3.0

DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.758 and Fs-seismic = 1.370

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.18	1.502	1.184	1	60
2	0.80	4.18	1.624	1.337	1	60
3	1.60	4.18	1.815	1.609	1	60
4	2.40	4.18	2.013	1.949	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0045, e/L seismic = 0.0566; Overturning: Fs-static = 4.94, Fs-seismic = 3.58

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.18	-0.0034	0.0425	1	60
2	0.80	4.18	-0.0274	0.0021	1	60
3	1.60	4.18	-0.0623	-0.0498	1	60
4	2.40	4.18	-0.1112	-0.1090	1	60

Version 3.0 MSEW Version 3.0

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	10.0	3.6	1.500	3.363	1.001	2.704	60
2	0.80	33.7	11.4	3.3	1.500	2.964	1.001	2.476	60
3	1.60	33.7	9.2	2.9	1.500	3.664	1.001	3.016	60
4	2.40	33.7	5.5	2.5	1.500	6.119	1.001	4.668	60

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	10.03	3.59	4.07	0.11	214.5	1.500	21.387	171.6	1.099	12.597
2	0.80	1.000	11.38	3.30	3.73	0.44	170.4	1.500	14.969	136.3	1.099	9.284
3	1.60	1.000	9.21	2.91	3.29	0.88	118.9	1.500	12.912	95.1	1.099	7.850
4	2.40	1.000	5.51	2.52	2.85	1.33	75.8	1.500	13.758	60.7	1.099	7.555

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	9.8	0.90	0.90	33.4	54.0	33.7	1.00	3.40	1.50	5.49	1.50	3.43	60
2	0.80	10.5	0.90	0.90	33.4	54.0	33.7	1.00	3.18	1.50	5.15	1.50	3.22	60
3	1.60	7.7	0.90	0.56	33.4	33.7	33.7	1.00	4.34	1.50	4.38	1.50	4.39	60
4	2.40	4.2	0.90	0.22	33.4	13.0	33.7	1.00	8.02	1.50	3.11	1.50	8.10	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	13.4	0.90	0.72	33.4	43.2	33.7	0.67	2.73	1.00	3.23	1.00	2.76	60
2	0.80	13.5	0.90	0.72	33.4	43.2	33.7	0.67	2.66	1.00	3.19	1.00	2.69	60
3	1.60	10.1	0.90	0.45	33.4	27.0	33.7	0.67	3.57	1.00	2.66	1.00	3.61	60
4	2.40	6.1	0.90	0.17	33.4	10.4	33.7	0.67	6.12	1.00	1.71	1.00	6.18	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: STA.7+570~7+613.05

Description:

H=3.50m(STA.7+600)

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name:
Original date and time of creating this file:

PROGRAM MODE: DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 2.45 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.4724 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.7961 Kae (Kh = 0) = 0.4539 Δ Kae = 0.3423

DIRECT SLIDING / ECCENTRICITY

Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY

Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY

Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

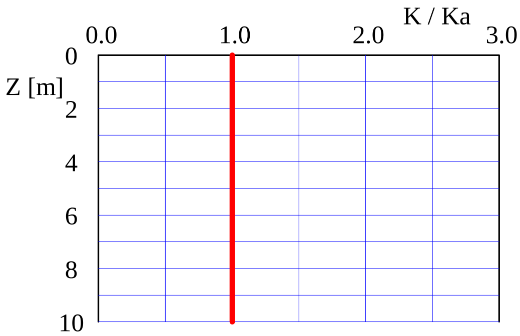
INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

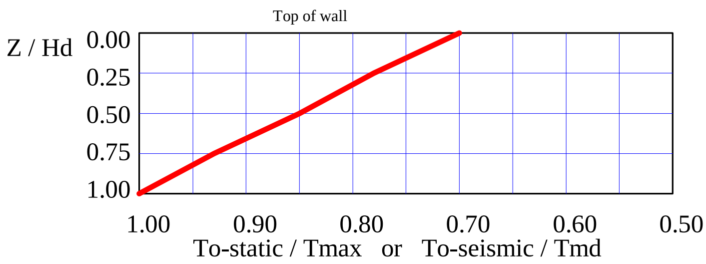
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [1]	CRu [2]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [3]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-connection / Tult-geogrid
(3) CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

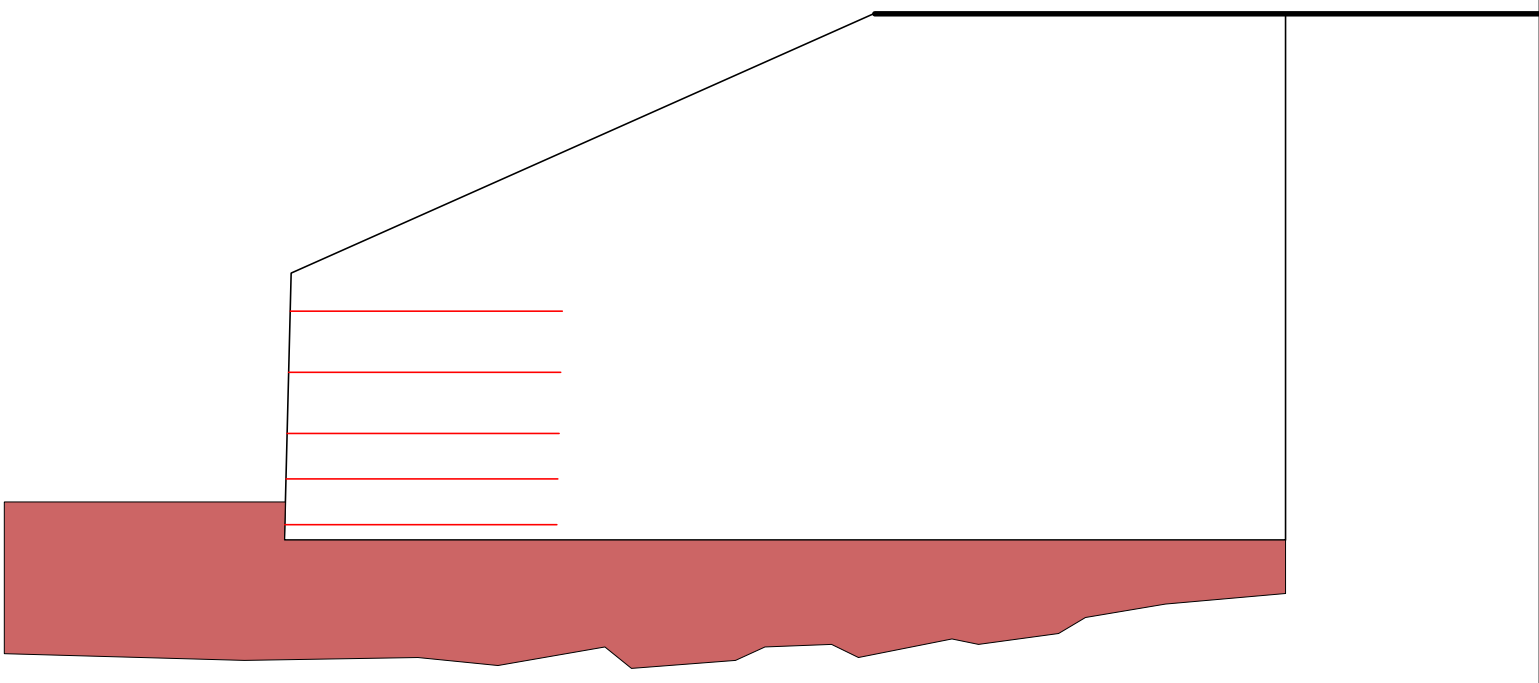
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	3.50	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 3.00 m }
Batter, ω	1.4	[deg]	
Backslope, β	24.0	[deg]	
Backslope rise	3.4	[m]	Broken back equivalent angle, I = 24.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=23.4 [m]. Distance of center of footing from wall face, d = 19.4 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

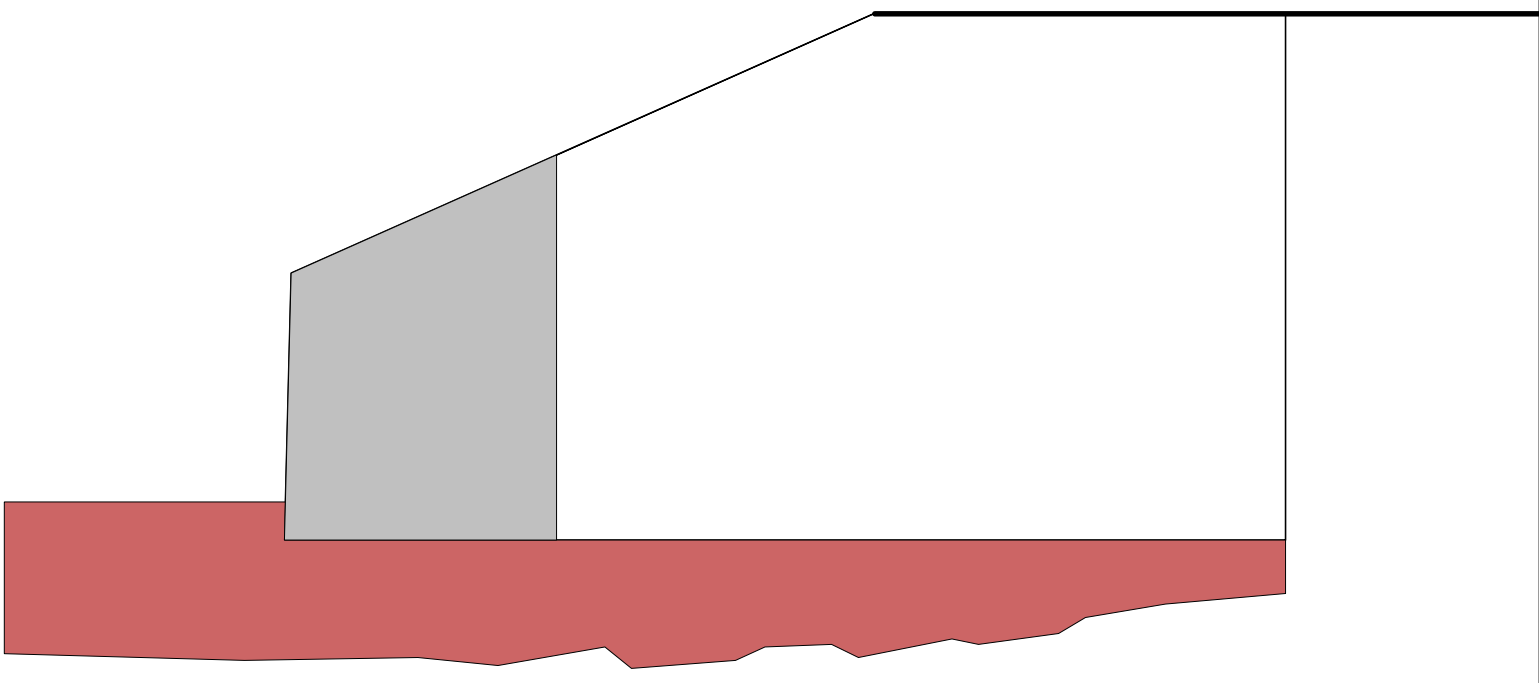
LEGEND: (1) Connection strength √ Satisfactory
(2) Geogrid strength ⊗ Unsatisfactory
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	3.57	1	√	√	√	√	√
2	0.80	3.57	1	√	√	√	√	√
3	1.40	3.57	1	√	√	√	√	√
4	2.20	3.57	1	√	√	√	√	√
5	3.00	3.57	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	561.9	451.4	[kPa]
Meyerhof stress, σ_V	102.80	133.0	[kPa]
Eccentricity, e	0.17	0.49	[m]
Eccentricity, e/L	0.047	0.136	
Fs calculated	5.47	3.39	
Base length	3.57	3.57	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.761 and Fs-seismic = 1.273

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	3.57	1.509	1.101	1	60
2	0.80	3.57	1.654	1.246	1	60
3	1.40	3.57	1.829	1.438	1	60
4	2.20	3.57	2.123	1.810	1	60
5	3.00	3.57	2.472	2.356	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0472, e/L seismic = 0.1309; Overturning: Fs-static = 4.05, Fs-seismic = 2.58

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	3.57	0.0382	0.1135	1	60
2	0.80	3.57	0.0121	0.0645	1	60
3	1.40	3.57	-0.0132	0.0199	1	60
4	2.20	3.57	-0.0489	-0.0351	1	60
5	3.00	3.57	-0.0998	-0.0974	1	60

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	12.0	4.3	1.500	2.807	1.001	2.254	60
2	0.80	33.7	12.3	3.9	1.500	2.735	1.001	2.250	60
3	1.40	33.7	11.5	3.5	1.500	2.932	1.001	2.429	60
4	2.20	33.7	9.4	2.9	1.500	3.608	1.001	2.971	60
5	3.00	33.7	5.7	2.4	1.500	5.945	1.001	4.621	60

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	12.02	4.33	3.46	0.11	197.9	1.500	16.470	158.4	1.099	9.687
2	0.80	1.000	12.33	3.91	3.12	0.44	156.2	1.500	12.664	124.9	1.099	7.690
3	1.40	1.000	11.51	3.50	2.79	0.77	119.2	1.500	10.363	95.4	1.099	6.357
4	2.20	1.000	9.35	2.94	2.35	1.22	77.5	1.500	8.290	62.0	1.099	5.043
5	3.00	1.000	5.67	2.39	1.91	1.66	44.4	1.500	7.821	35.5	1.099	4.402

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	11.8	0.90	0.90	33.4	54.0	33.7	1.00	2.82	1.50	4.57	1.50	2.85	60
2	0.80	11.5	0.90	0.90	33.4	54.0	33.7	1.00	2.89	1.50	4.68	1.50	2.92	60
3	1.40	10.1	0.90	0.90	33.4	54.0	33.7	1.00	3.29	1.50	5.32	1.50	3.32	60
4	2.20	7.6	0.90	0.56	33.4	33.7	33.7	1.00	4.39	1.50	4.43	1.50	4.43	60
5	3.00	4.2	0.90	0.22	33.4	13.0	33.7	1.00	7.89	1.50	3.06	1.50	7.97	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	16.1	0.90	0.72	33.4	43.2	33.7	0.67	2.27	1.00	2.69	1.00	2.29	60
2	0.80	15.2	0.90	0.72	33.4	43.2	33.7	0.67	2.38	1.00	2.84	1.00	2.40	60
3	1.40	13.2	0.90	0.72	33.4	43.2	33.7	0.67	2.73	1.00	3.26	1.00	2.75	60
4	2.20	10.0	0.90	0.45	33.4	27.0	33.7	0.67	3.61	1.00	2.69	1.00	3.65	60
5	3.00	6.0	0.90	0.17	33.4	10.4	33.7	0.67	6.13	1.00	1.72	1.00	6.20	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: STA.7+626.04~7+670

Description:

H=3.90m(STA.7+626.04)

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

Original date and time of creating this file:

PROGRAM MODE:

DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 2.73 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3986 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.5245 Kae (Kh = 0) = 0.3841 Δ Kae = 0.1404

DIRECT SLIDING / ECCENTRICITY

Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY

Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY

Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

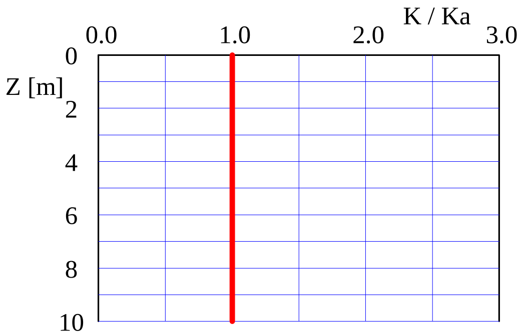
INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

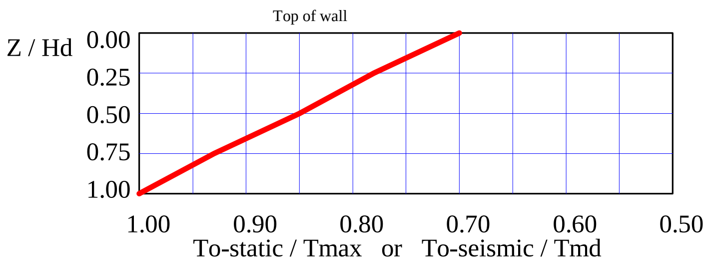
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection
(Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [1]	CRu [2]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [3]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

[1] σ = Confining stress in between stacked blocks [kPa]
[2] CRu = Tult-connection / Tult-geogrid
[3] CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd 3.90 [m] { Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 3.40 m }

Batter, ω 1.4 [deg]

Backslope, β 24.0 [deg]

Backslope rise 2.6 [m] Broken back equivalent angle, I = 18.43? (see Fig. 25 in DEMO 82)

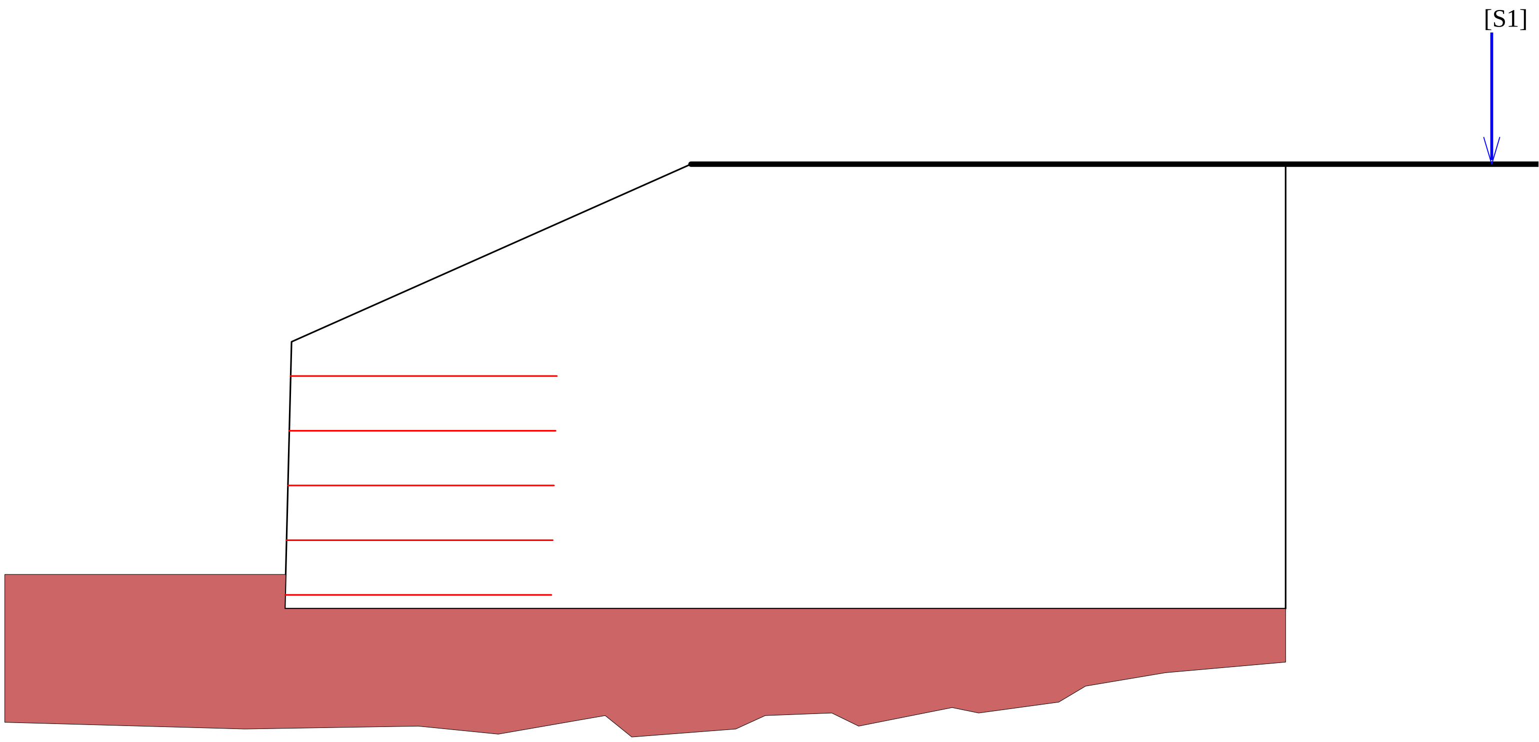
U N I F O R M   S U R C H A R G E

Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)

[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=23.4 [m]. Distance of center of footing from wall face, d = 17.5 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

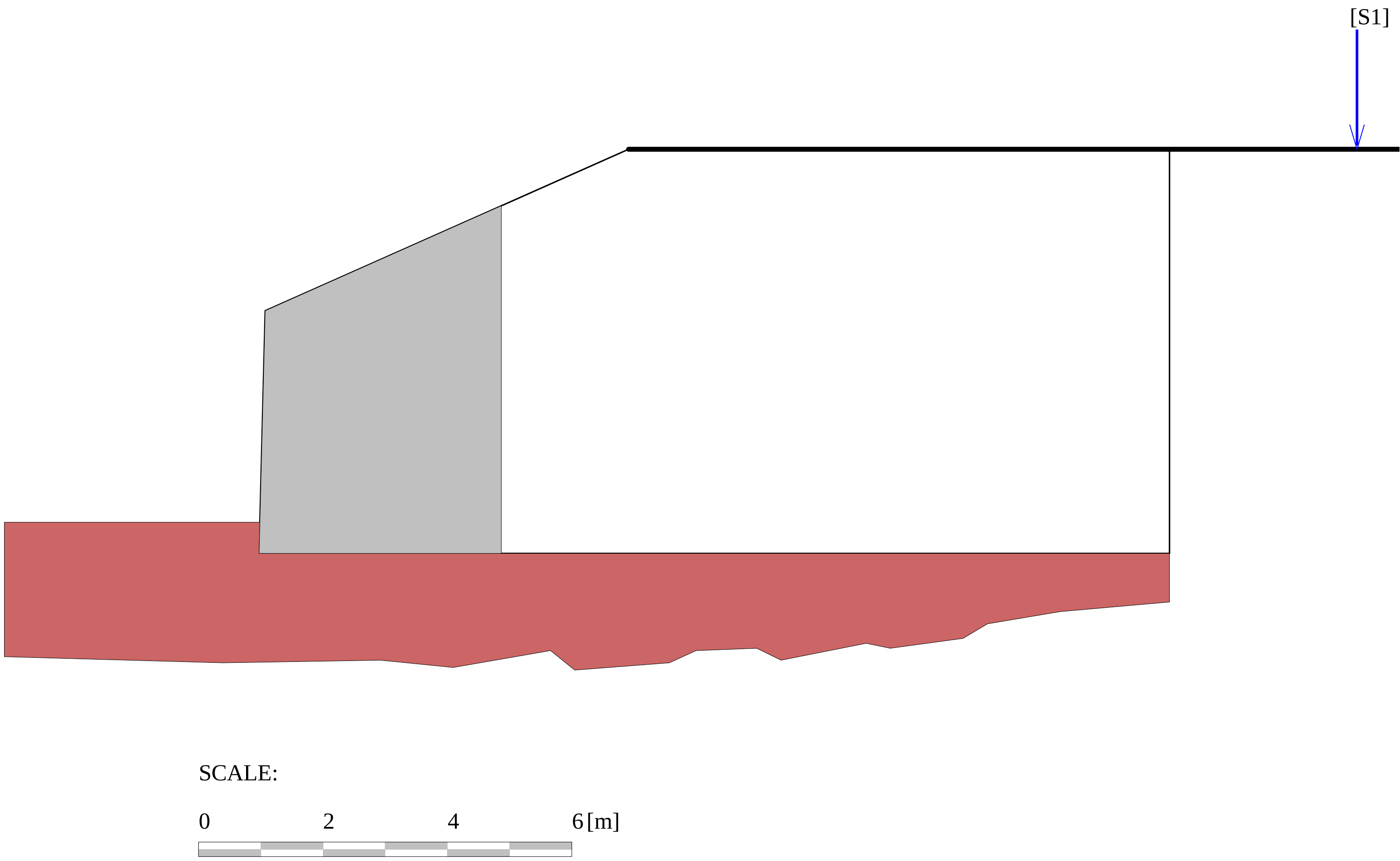
LEGEND: (1) Connection strength √ Satisfactory
(2) Geogrid strength ⊗ Unsatisfactory
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	3.89	1	√	√	√	√	√
2	1.00	3.89	1	√	√	√	√	√
3	1.80	3.89	1	√	√	√	√	√
4	2.60	3.89	1	√	√	√	√	√
5	3.40	3.89	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	591.7	510.5	[kPa]
Meyerhof stress, σ_V	113.60	133.4	[kPa]
Eccentricity, e	0.25	0.48	[m]
Eccentricity, e/L	0.063	0.123	
Fs calculated	5.21	3.83	
Base length	3.89	3.89	[m]



DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.753 and Fs-seismic = 1.374

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	3.89	1.502	1.184	1	60
2	1.00	3.89	1.696	1.380	1	60
3	1.80	3.89	1.971	1.669	1	60
4	2.60	3.89	2.394	2.141	1	60
5	3.40	3.89	2.760	2.674	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0630, e/L seismic = 0.1202; Overturning: Fs-static = 3.95, Fs-seismic = 2.85

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	3.89	0.0540	0.1055	1	60
2	1.00	3.89	0.0195	0.0512	1	60
3	1.80	3.89	-0.0130	0.0035	1	60
4	2.60	3.89	-0.0464	-0.0401	1	60
5	3.40	3.89	-0.0965	-0.0956	1	60

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	16.0	5.5	1.500	2.110	1.001	1.708	60
2	1.00	33.7	17.8	4.9	1.500	1.898	1.001	1.599	60
3	1.80	33.7	13.7	4.2	1.500	2.459	1.001	2.032	60
4	2.60	33.7	9.7	3.6	1.500	3.490	1.001	2.785	60
5	3.40	33.7	6.0	2.9	1.500	5.595	1.001	4.199	60

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	15.99	5.53	3.78	0.11	241.4	1.500	15.099	193.1	1.099	8.973
2	1.00	1.000	17.77	4.89	3.34	0.55	180.7	1.500	10.167	144.6	1.099	6.379
3	1.80	1.000	13.72	4.24	2.90	0.99	128.6	1.500	9.377	102.9	1.099	5.730
4	2.60	1.000	9.67	3.59	2.45	1.44	85.1	1.500	8.807	68.1	1.099	5.136
5	3.40	1.000	6.03	2.95	2.01	1.88	50.2	1.500	8.328	40.2	1.099	4.475

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	15.8	0.90	0.90	33.4	54.0	33.7	1.00	2.12	1.50	3.43	1.50	2.14	60
2	1.00	16.5	0.90	0.90	33.4	54.0	33.7	1.00	2.02	1.50	3.27	1.50	2.05	60
3	1.80	11.8	0.90	0.90	33.4	54.0	33.7	1.00	2.82	1.50	4.56	1.50	2.85	60
4	2.60	7.8	0.90	0.56	33.4	33.7	33.7	1.00	4.30	1.50	4.34	1.50	4.34	60
5	3.40	4.5	0.90	0.22	33.4	13.0	33.7	1.00	7.47	1.50	2.90	1.50	7.55	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	21.2	0.90	0.72	33.4	43.2	33.7	0.67	1.72	1.00	2.04	1.00	1.73	60
2	1.00	21.0	0.90	0.72	33.4	43.2	33.7	0.67	1.71	1.00	2.05	1.00	1.72	60
3	1.80	15.5	0.90	0.72	33.4	43.2	33.7	0.67	2.33	1.00	2.79	1.00	2.36	60
4	2.60	10.7	0.90	0.45	33.4	27.0	33.7	0.67	3.43	1.00	2.53	1.00	3.47	60
5	3.40	6.7	0.90	0.17	33.4	10.4	33.7	0.67	5.61	1.00	1.56	1.00	5.67	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: STA.11+030~11+140

Description:

H=8.30m

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:
Original date and time of creating this file:

PROGRAM MODE: DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 5.81 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3682 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.4602 Kae (Kh = 0) = 0.3555 Δ Kae = 0.1047

DIRECT SLIDING / ECCENTRICITY
Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY
Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

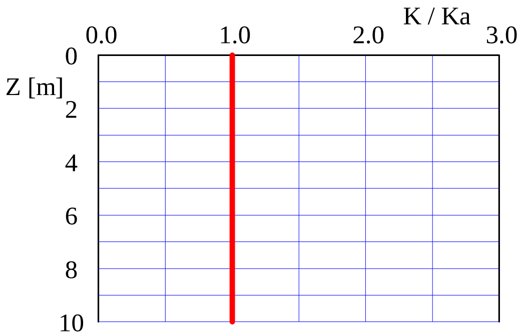
INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

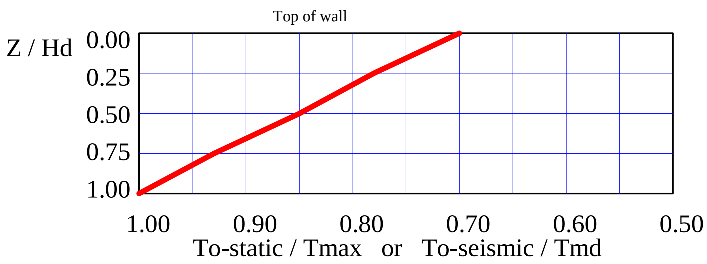
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [(1)]	CRu [(2)]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [(3)]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-connection / Tult-geogrid
(3) CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

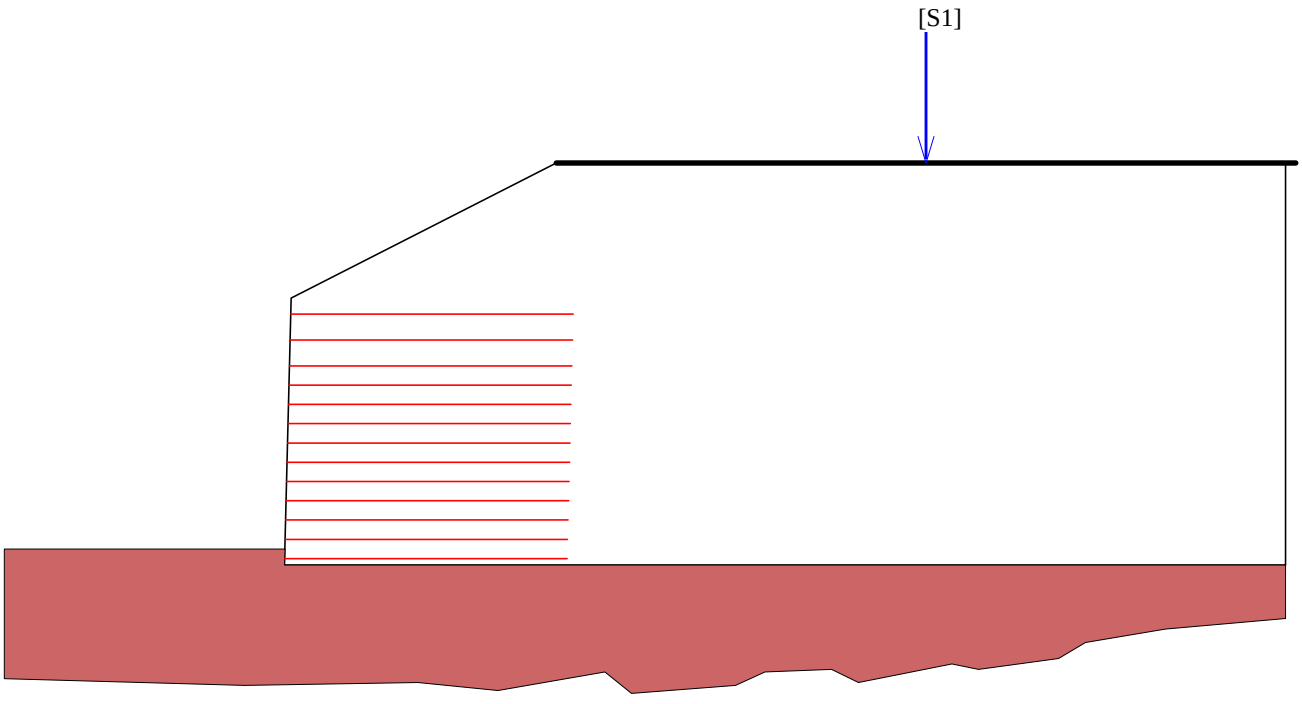
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	8.30	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 7.80 m }
Batter, ω	1.4	[deg]	
Backslope, β	27.0	[deg]	
Backslope rise	4.2	[m]	Broken back equivalent angle, I = 14.20? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=23.0 [m]. Distance of center of footing from wall face, d = 19.7 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

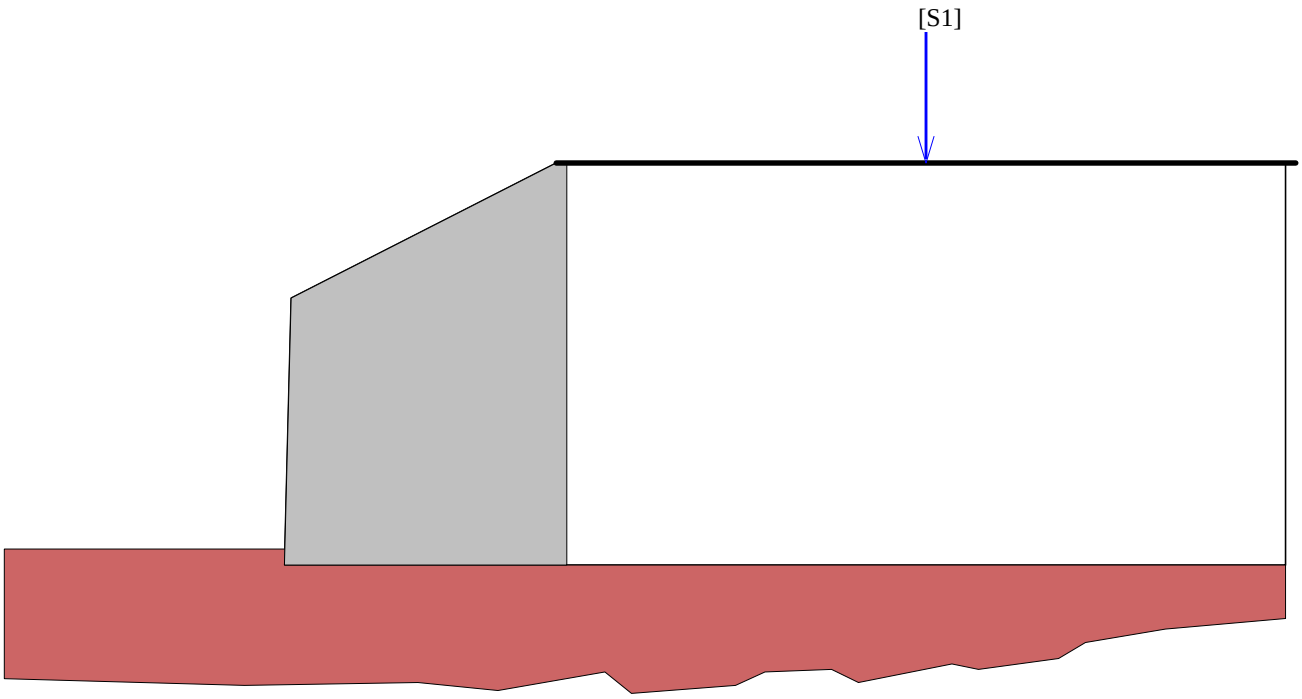
LEGEND:
(1) Connection strength — √ Satisfactory
(2) Geogrid strength — ⊗ Unsatisfactory
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	8.78	3	√	√	√	√	√
2	0.80	8.78	3	√	√	√	√	√
3	1.40	8.78	2	√	√	√	√	√
4	2.00	8.78	2	√	√	√	√	√
5	2.60	8.78	2	√	√	√	√	√
6	3.20	8.78	2	√	√	√	√	√
7	3.80	8.78	2	√	√	√	√	√
8	4.40	8.78	1	√	√	√	√	√
9	5.00	8.78	1	√	√	√	√	√
10	5.60	8.78	1	√	√	√	√	√
11	6.20	8.78	1	√	√	√	√	√
12	7.00	8.78	1	√	√	√	√	√
13	7.80	8.78	2	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1287.1	1126.9	[kPa]
Meyerhof stress, σ_V	253.58	291.9	[kPa]
Eccentricity, e	0.69	1.15	[m]
Eccentricity, e/L	0.079	0.131	
Fs calculated	5.08	3.86	
Base length	8.78	8.78	[m]



SCALE:

0 2 4 6 [m]

DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.783 and Fs-seismic = 1.417

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	8.78	1.502	1.198	3	120
2	0.80	8.78	1.553	1.253	3	120
3	1.40	8.78	1.607	1.312	2	90
4	2.00	8.78	1.664	1.378	2	90
5	2.60	8.78	1.725	1.449	2	90
6	3.20	8.78	1.790	1.528	2	90
7	3.80	8.78	1.859	1.614	2	90
8	4.40	8.78	1.931	1.709	1	60
9	5.00	8.78	2.007	1.811	1	60
10	5.60	8.78	2.083	1.922	1	60
11	6.20	8.78	2.159	2.036	1	60
12	7.00	8.78	2.250	2.186	1	60
13	7.80	8.78	2.308	2.294	2	90

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0802, e/L seismic = 0.1302; Overturning: Fs-static = 3.68, Fs-seismic = 2.78

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	8.78	0.0760	0.1236	3	120
2	0.80	8.78	0.0637	0.1042	3	120
3	1.40	8.78	0.0516	0.0856	2	90
4	2.00	8.78	0.0396	0.0677	2	90
5	2.60	8.78	0.0277	0.0504	2	90
6	3.20	8.78	0.0158	0.0336	2	90
7	3.80	8.78	0.0036	0.0173	2	90
8	4.40	8.78	-0.0089	0.0011	1	60
9	5.00	8.78	-0.0220	-0.0150	1	60
10	5.60	8.78	-0.0362	-0.0317	1	60
11	6.20	8.78	-0.0520	-0.0494	1	60
12	7.00	8.78	-0.0776	-0.0767	1	60
13	7.80	8.78	-0.1131	-0.1130	2	90

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	67.5	30.2	10.1	1.500	2.236	1.001	1.821	120
2	0.80	67.5	34.1	9.7	1.500	1.977	1.001	1.656	120
3	1.40	50.6	31.8	9.3	1.500	1.589	1.001	1.325	90
4	2.00	50.6	29.6	9.0	1.500	1.711	1.001	1.419	90
5	2.60	50.6	27.3	8.6	1.500	1.854	1.001	1.528	90
6	3.20	50.6	25.0	8.2	1.500	2.024	1.001	1.655	90
7	3.80	50.6	22.7	7.8	1.500	2.227	1.001	1.805	90
8	4.40	33.7	20.4	7.4	1.500	1.650	1.001	1.324	60
9	5.00	33.7	18.2	7.0	1.500	1.857	1.001	1.470	60
10	5.60	33.7	15.9	6.6	1.500	2.124	1.001	1.654	60
11	6.20	33.7	15.7	6.2	1.500	2.155	1.001	1.695	60
12	7.00	33.7	14.1	5.7	1.500	2.395	1.001	1.876	60
13	7.80	50.6	11.0	5.2	1.500	4.599	1.001	3.477	90

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	30.18	10.11	8.67	0.11	1246.3	1.500	41.296	997.0	1.099	24.745
2	0.80	1.000	34.12	9.73	8.34	0.44	1141.7	1.500	33.456	913.3	1.099	20.828
3	1.40	1.000	31.84	9.34	8.01	0.77	1039.0	1.500	32.628	831.2	1.099	20.183
4	2.00	1.000	29.56	8.95	7.68	1.10	941.1	1.500	31.833	752.9	1.099	19.547
5	2.60	1.000	27.28	8.57	7.35	1.44	848.0	1.500	31.079	678.4	1.099	18.922
6	3.20	1.000	25.00	8.18	7.01	1.77	759.9	1.500	30.390	607.9	1.099	18.320
7	3.80	1.000	22.72	7.79	6.68	2.10	676.2	1.500	29.756	541.0	1.099	17.726
8	4.40	1.000	20.44	7.41	6.35	2.43	597.2	1.500	29.211	477.8	1.099	17.154
9	5.00	1.000	18.16	7.02	6.02	2.76	523.0	1.500	28.791	418.4	1.099	16.613
10	5.60	1.000	15.88	6.63	5.69	3.09	453.5	1.500	28.548	362.8	1.099	16.111
11	6.20	1.000	15.65	6.25	5.36	3.42	388.9	1.500	24.852	311.2	1.099	14.210
12	7.00	1.000	14.09	5.73	4.91	3.87	309.9	1.500	21.997	247.9	1.099	12.508
13	7.80	1.000	11.00	5.22	4.47	4.31	239.4	1.500	21.758	191.5	1.099	11.808

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	30.0	0.90	0.90	66.8	108.0	67.5	1.00	2.23	1.50	3.60	1.50	2.25	120
2	0.80	33.2	0.90	0.90	66.8	108.0	67.5	1.00	2.01	1.50	3.25	1.50	2.03	120
3	1.40	30.3	0.90	0.90	50.1	81.0	50.6	1.00	1.65	1.50	2.67	1.50	1.67	90
4	2.00	27.6	0.90	0.90	50.1	81.0	50.6	1.00	1.82	1.50	2.94	1.50	1.84	90
5	2.60	24.8	0.90	0.90	50.1	81.0	50.6	1.00	2.02	1.50	3.26	1.50	2.04	90
6	3.20	22.2	0.90	0.90	50.1	81.0	50.6	1.00	2.26	1.50	3.65	1.50	2.28	90
7	3.80	19.6	0.90	0.90	50.1	81.0	50.6	1.00	2.55	1.50	4.13	1.50	2.58	90
8	4.40	17.2	0.90	0.90	33.4	54.0	33.7	1.00	1.94	1.50	3.14	1.50	1.96	60
9	5.00	14.9	0.90	0.90	33.4	54.0	33.7	1.00	2.24	1.50	3.62	1.50	2.26	60
10	5.60	12.7	0.90	0.90	33.4	54.0	33.7	1.00	2.62	1.50	4.24	1.50	2.65	60
11	6.20	12.2	0.90	0.90	33.4	54.0	33.7	1.00	2.73	1.50	4.42	1.50	2.76	60
12	7.00	10.6	0.90	0.56	33.4	33.7	33.7	1.00	3.16	1.50	3.19	1.50	3.19	60
13	7.80	7.9	0.90	0.22	50.1	19.4	50.6	1.00	6.33	1.50	2.46	1.50	6.39	90

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	40.0	0.90	0.72	66.8	86.4	67.5	0.67	1.81	1.00	2.16	1.00	1.83	120
2	0.80	42.7	0.90	0.72	66.8	86.4	67.5	0.67	1.68	1.00	2.02	1.00	1.70	120
3	1.40	39.2	0.90	0.72	50.1	64.8	50.6	0.67	1.38	1.00	1.65	1.00	1.39	90
4	2.00	35.9	0.90	0.72	50.1	64.8	50.6	0.67	1.51	1.00	1.80	1.00	1.52	90
5	2.60	32.6	0.90	0.72	50.1	64.8	50.6	0.67	1.66	1.00	1.99	1.00	1.68	90
6	3.20	29.4	0.90	0.72	50.1	64.8	50.6	0.67	1.85	1.00	2.20	1.00	1.87	90
7	3.80	26.4	0.90	0.72	50.1	64.8	50.6	0.67	2.07	1.00	2.46	1.00	2.09	90
8	4.40	23.4	0.90	0.72	33.4	43.2	33.7	0.67	1.56	1.00	1.84	1.00	1.57	60
9	5.00	20.7	0.90	0.72	33.4	43.2	33.7	0.67	1.77	1.00	2.09	1.00	1.79	60
10	5.60	18.0	0.90	0.72	33.4	43.2	33.7	0.67	2.04	1.00	2.39	1.00	2.06	60
11	6.20	17.1	0.90	0.72	33.4	43.2	33.7	0.67	2.15	1.00	2.53	1.00	2.17	60
12	7.00	14.9	0.90	0.45	33.4	27.0	33.7	0.67	2.48	1.00	1.81	1.00	2.50	60
13	7.80	11.7	0.90	0.17	50.1	15.6	50.6	0.67	4.79	1.00	1.33	1.00	4.83	90

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 13.1

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 오창JCT R-A 시점앞성토

Description:

H=4.30m

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name:

Original date and time of creating this file:

PROGRAM MODE:

DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 3.01 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.5518 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Note: specified A combined with I and δ produced a square root of -0.04 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.9535 Kae (Kh = 0) = 0.5293 Δ Kae = 0.4242

DIRECT SLIDING / ECCENTRICITY

Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY

Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY

Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

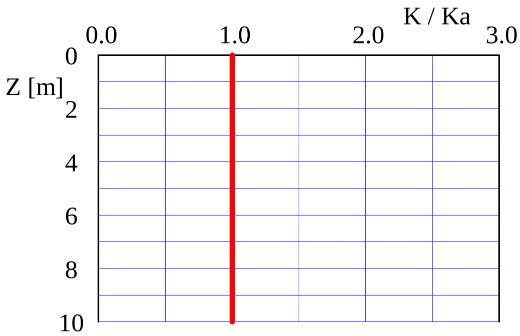
INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A		Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]		60.0	90.0	120.0	180.0	
Durability reduction factor, RFd		1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid		1.10	1.10	1.10	1.10	
Creep reduction factor, RFc		1.47	1.47	1.47	1.47	N/A
Fs-overall for strength		1.50	1.50	1.50	1.50	
Coverage ratio, Rc		1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface,	ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*		0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor,	α	0.8	0.8	0.8	0.8	

Note: Z for calculating K/Ka and F* is measured from top of the wall at the face (AASHTO).

Variation of Lateral Earth Pressure Coefficient With Depth

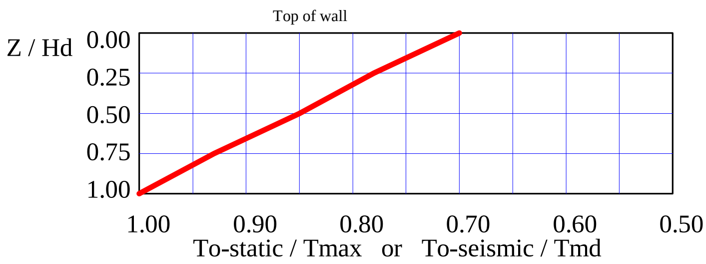
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [(1)]	CRu [(2)]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [(3)]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-connection / Tult-geogrid
(3) CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

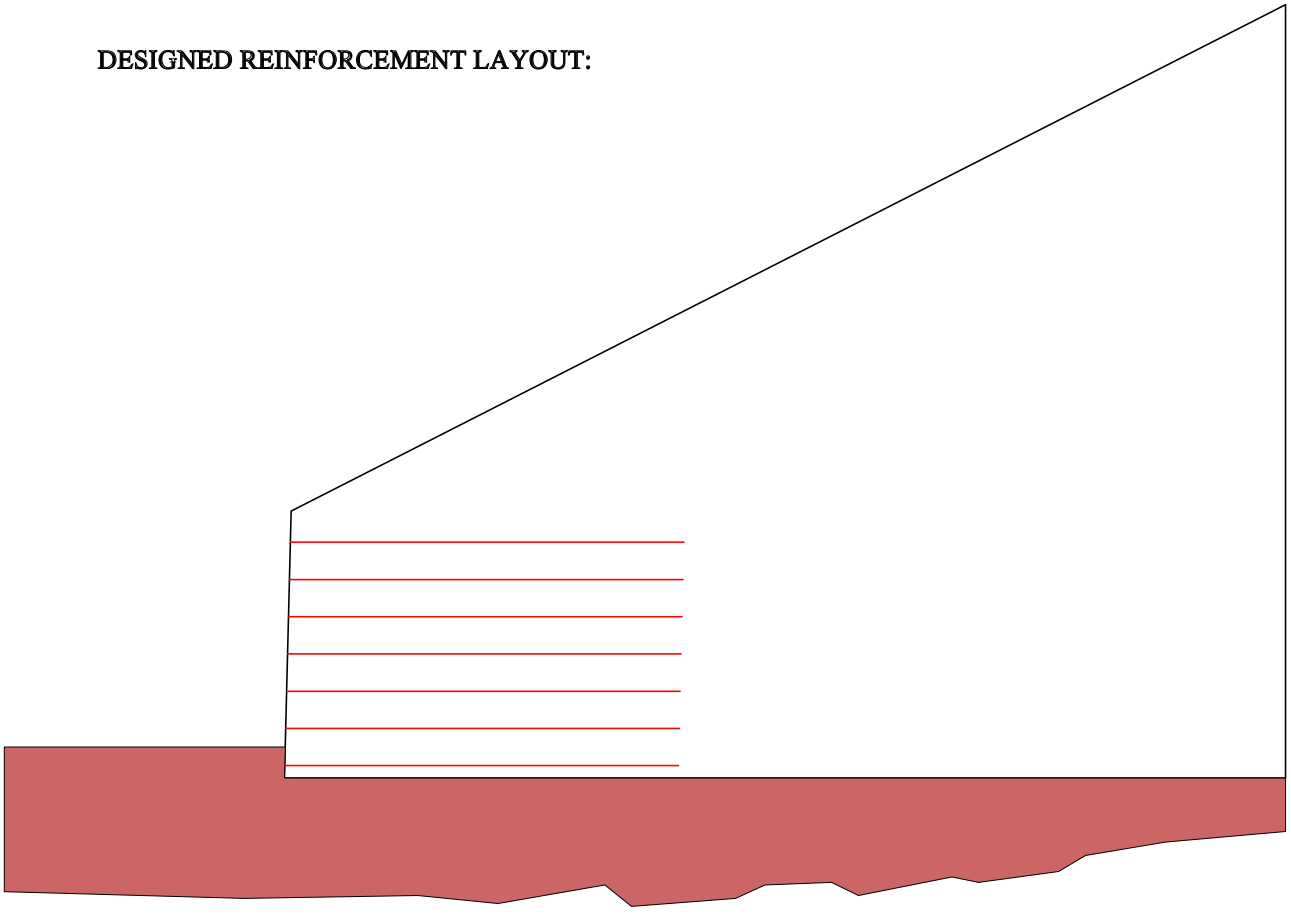
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	4.30	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 3.80 m }
Batter, ω	1.4	[deg]	
Backslope, β	27.0	[deg]	
Backslope rise	11.5	[m]	Broken back equivalent angle, I = 27.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=23.0 [m]. Distance of center of footing from wall face, d = 34.1 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

LEGEND:
(1) Connection strength
(2) Geogrid strength
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

√ Satisfactory
⊗ Unsatisfactory

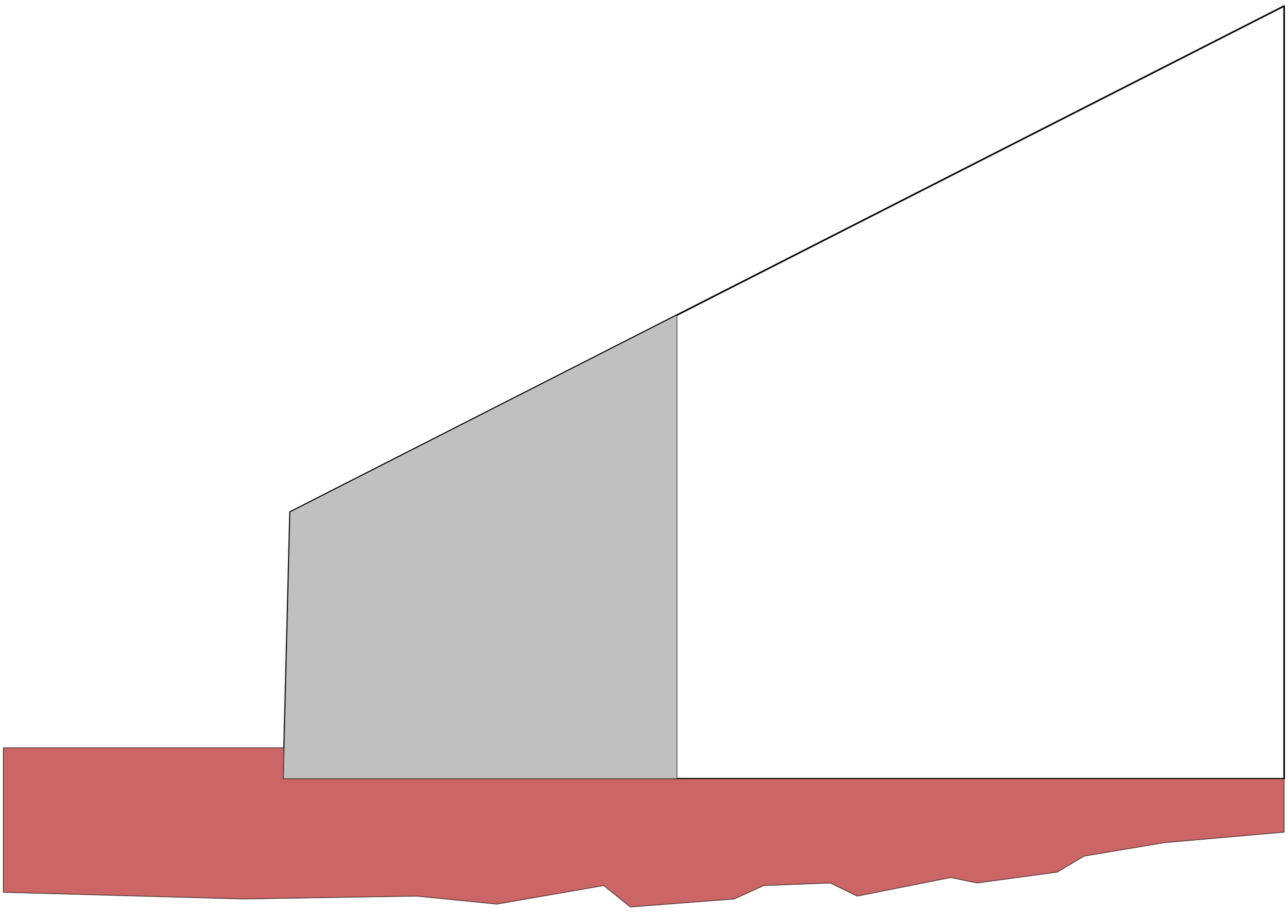
Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	6.34	1	√	√	√	√	√
2	0.80	6.34	1	√	√	√	√	√
3	1.40	6.34	1	√	√	√	√	√
4	2.00	6.34	1	√	√	√	√	√

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
5	2.60	6.34	1	√	√	√	√	√
6	3.20	6.34	1	√	√	√	√	√
7	3.80	6.34	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1099.7	975.0	[kPa]
Meyerhof stress, σ_V	132.13	154.3	[kPa]
Eccentricity, e	0.01	0.37	[m]
Eccentricity, e/L	0.002	0.058	
Fs calculated	8.32	6.32	
Base length	6.34	6.34	[m]



DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.773 and Fs-seismic = 1.387

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	6.34	1.502	1.184	1	60
2	0.80	6.34	1.580	1.281	1	60
3	1.40	6.34	1.667	1.394	1	60
4	2.00	6.34	1.761	1.528	1	60
5	2.60	6.34	1.861	1.683	1	60
6	3.20	6.34	1.961	1.854	1	60
7	3.80	6.34	2.046	2.014	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0018, e/L seismic = 0.0518; Overturning: Fs-static = 5.05, Fs-seismic = 3.69

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	6.34	-0.0034	0.0425	1	60
2	0.80	6.34	-0.0191	0.0156	1	60
3	1.40	6.34	-0.0352	-0.0103	1	60
4	2.00	6.34	-0.0523	-0.0358	1	60
5	2.60	6.34	-0.0715	-0.0618	1	60
6	3.20	6.34	-0.0947	-0.0903	1	60
7	3.80	6.34	-0.1264	-0.1254	1	60

RESULTS for STRENGTH Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	15.3	4.6	1.500	2.211	1.001	1.835	60
2	0.80	33.7	16.2	4.4	1.500	2.080	1.001	1.759	60
3	1.40	33.7	13.9	4.1	1.500	2.421	1.001	2.016	60
4	2.00	33.7	11.7	3.9	1.500	2.895	1.001	2.361	60
5	2.60	33.7	9.4	3.6	1.500	3.599	1.001	2.849	60
6	3.20	33.7	7.1	3.4	1.500	4.755	1.001	3.591	60
7	3.80	33.7	5.9	3.1	1.500	5.706	1.001	4.193	60

RESULTS for PULLOUT Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	15.25	4.60	6.23	0.11	497.8	1.500	32.637	398.3	1.099	20.055
2	0.80	1.000	16.21	4.36	5.90	0.44	429.3	1.500	26.480	343.5	1.099	16.695
3	1.40	1.000	13.93	4.11	5.57	0.77	365.5	1.500	26.229	292.4	1.099	16.200
4	2.00	1.000	11.65	3.87	5.24	1.10	306.4	1.500	26.295	245.2	1.099	15.792
5	2.60	1.000	9.37	3.62	4.91	1.44	252.0	1.500	26.887	201.6	1.099	15.511
6	3.20	1.000	7.09	3.38	4.57	1.77	202.4	1.500	28.525	161.9	1.099	15.456
7	3.80	1.000	5.91	3.13	4.24	2.10	157.5	1.500	26.639	126.0	1.099	13.926

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	15.1	0.90	0.90	33.4	54.0	33.7	1.00	2.22	1.50	3.59	1.50	2.24	60
2	0.80	15.4	0.90	0.90	33.4	54.0	33.7	1.00	2.17	1.50	3.51	1.50	2.19	60
3	1.40	12.6	0.90	0.90	33.4	54.0	33.7	1.00	2.65	1.50	4.28	1.50	2.67	60
4	2.00	10.0	0.90	0.90	33.4	54.0	33.7	1.00	3.33	1.50	5.38	1.50	3.36	60
5	2.60	7.7	0.90	0.73	33.4	44.1	33.7	1.00	4.34	1.50	5.73	1.50	4.38	60
6	3.20	5.5	0.90	0.48	33.4	28.5	33.7	1.00	6.02	1.50	5.14	1.50	6.08	60
7	3.80	4.4	0.90	0.22	33.4	13.0	33.7	1.00	7.66	1.50	2.97	1.50	7.74	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break Specified	Fs-overall connection break Actual	Fs-overall connection pullout Specified	Fs-overall connection pullout Actual	Fs-overall Geogrid strength Specified	Fs-overall Geogrid strength Actual	Product name
1	0.20	19.6	0.90	0.72	33.4	43.2	33.7	0.67	1.84	1.00	2.20	1.00	1.86	60
2	0.80	19.5	0.90	0.72	33.4	43.2	33.7	0.67	1.84	1.00	2.22	1.00	1.86	60
3	1.40	16.3	0.90	0.72	33.4	43.2	33.7	0.67	2.20	1.00	2.64	1.00	2.23	60
4	2.00	13.4	0.90	0.72	33.4	43.2	33.7	0.67	2.71	1.00	3.23	1.00	2.74	60
5	2.60	10.7	0.90	0.59	33.4	35.3	33.7	0.67	3.44	1.00	3.30	1.00	3.47	60
6	3.20	8.2	0.90	0.38	33.4	22.8	33.7	0.67	4.55	1.00	2.79	1.00	4.59	60
7	3.80	6.7	0.90	0.17	33.4	10.4	33.7	0.67	5.63	1.00	1.55	1.00	5.69	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 14.93

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 서오창IC Ramp-A,F,G

Description:

H=3.50m

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Documents and Settings\KIM\바탕 화면\t11(H=3.5m).BEN
Original date and time of creating this file:

PROGRAM MODE: DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 2.45 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.	
Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.5194 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Note: specified A combined with I and δ produced a square root of -0.02 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.9437 Kae (Kh = 0) = 0.4985 Δ Kae = 0.4452

DIRECT SLIDING / ECCENTRICITY
Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY
Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

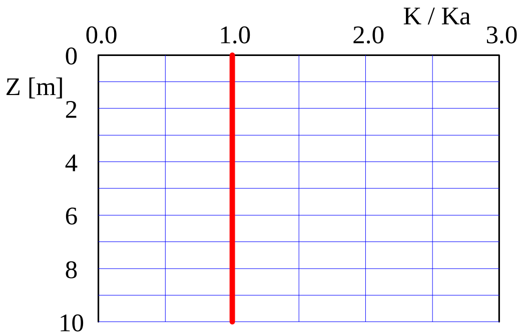
INTERNAL STABILITY
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Variation of Lateral Earth Pressure Coefficient With Depth

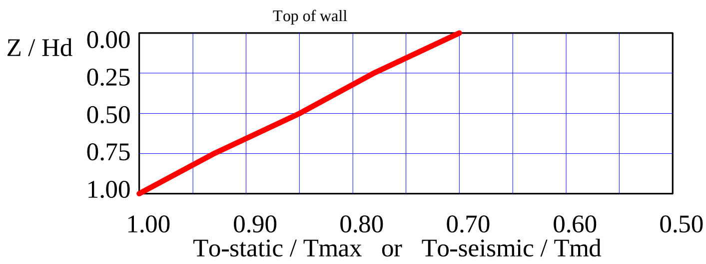
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [1]	CRu [2]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [3]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

[1] σ = Confining stress in between stacked blocks [kPa]
[2] CRu = Tult-connection / Tult-geogrid
[3] CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

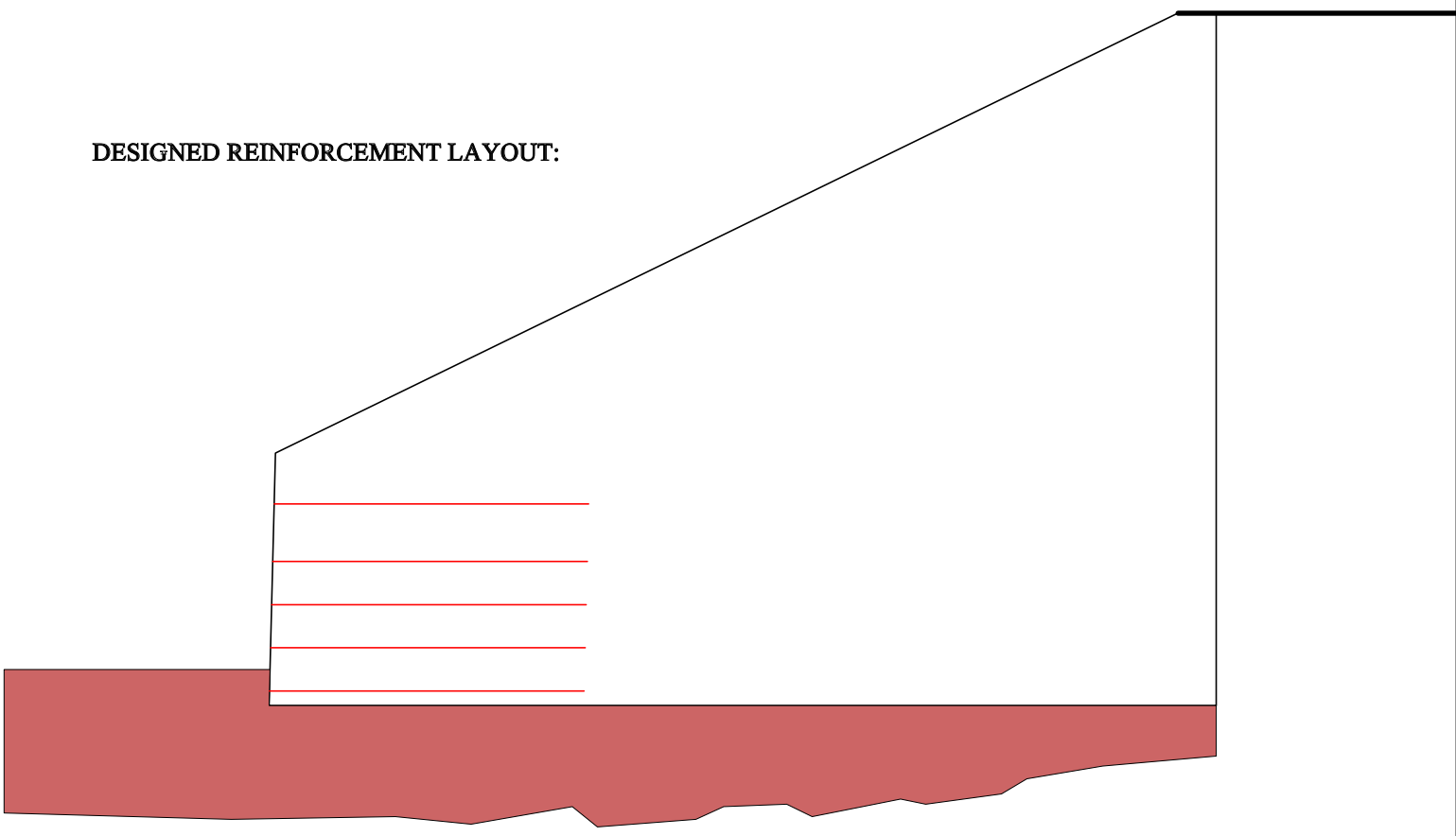
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	3.50	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 3.00 m }
Batter, ω	1.4	[deg]	
Backslope, β	26.0	[deg]	
Backslope rise	6.1	[m]	Broken back equivalent angle, I = 26.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=18.3 [m]. Distance of center of footing from wall face, d = 21.7 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

LEGEND:
(1) Connection strength
(2) Geogrid strength
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

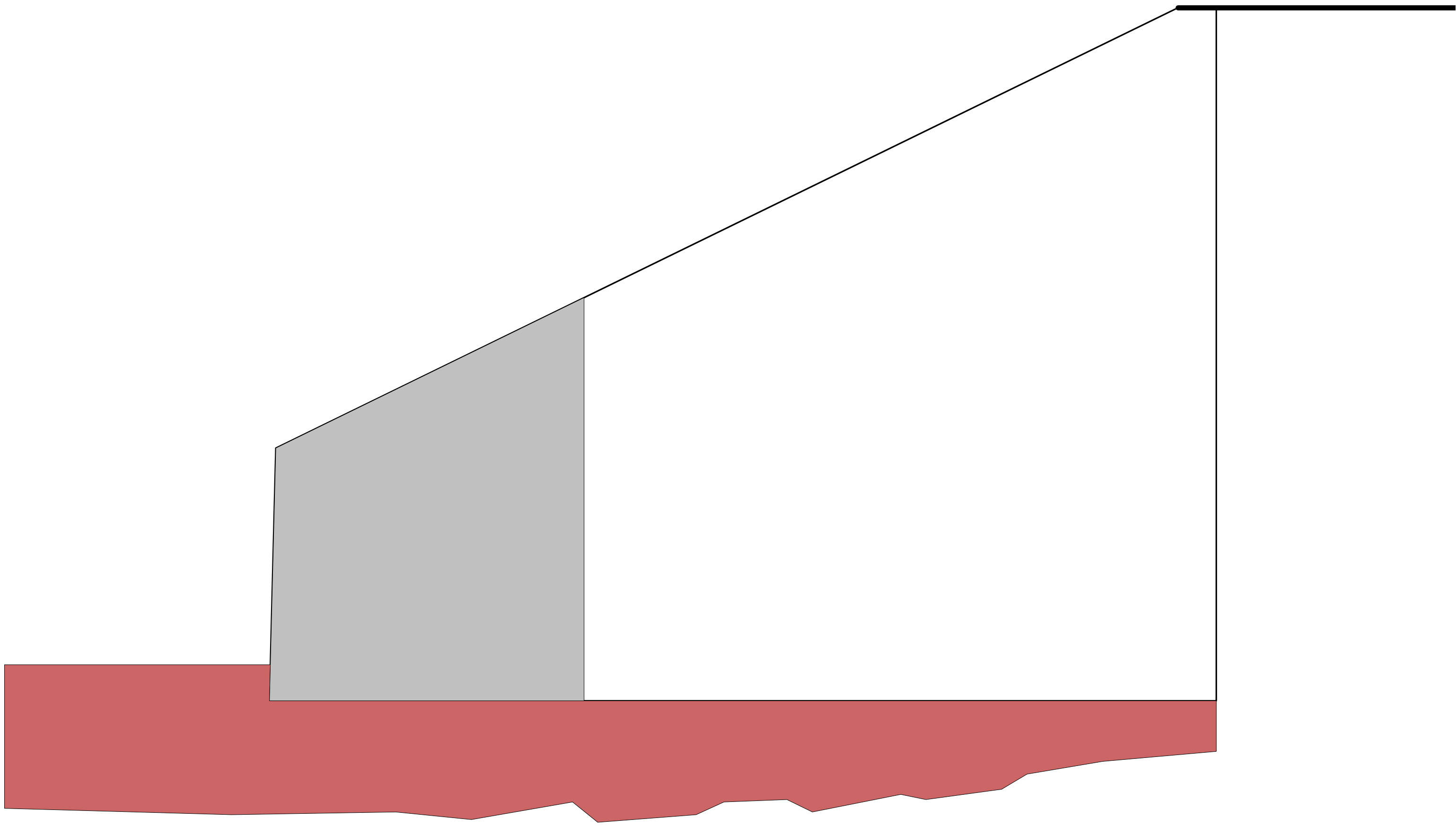
√ Satisfactory
⊗ Unsatisfactory

Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	4.36	1	√	√	√	√	√
2	0.80	4.36	1	√	√	√	√	√
3	1.40	4.36	1	√	√	√	√	√
4	2.00	4.36	1	√	√	√	√	√
5	2.80	4.36	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	726.8	610.0	[kPa]
Meyerhof stress, σ_V	105.11	130.8	[kPa]
Eccentricity, e	0.09	0.43	[m]
Eccentricity, e/L	0.021	0.098	
Fs calculated	6.91	4.67	
Base length	4.36	4.36	[m]



DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.760 and Fs-seismic = 1.303

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	4.36	1.502	1.123	1	60
2	0.80	4.36	1.618	1.255	1	60
3	1.40	4.36	1.753	1.423	1	60
4	2.00	4.36	1.908	1.640	1	60
5	2.80	4.36	2.130	2.011	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0210, e/L seismic = 0.0908; Overturning: Fs-static = 4.56, Fs-seismic = 3.04

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	4.36	0.0136	0.0765	1	60
2	0.80	4.36	-0.0085	0.0357	1	60
3	1.40	4.36	-0.0308	-0.0024	1	60
4	2.00	4.36	-0.0549	-0.0394	1	60
5	2.80	4.36	-0.0969	-0.0929	1	60

Version 3.0 MSEW Version 3.0

RESULTS for STRENGTH

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	12.2	4.2	1.500	2.769	1.001	2.242	60
2	0.80	33.7	12.5	3.9	1.500	2.692	1.001	2.224	60
3	1.40	33.7	10.3	3.6	1.500	3.291	1.001	2.663	60
4	2.00	33.7	9.1	3.2	1.500	3.716	1.001	2.993	60
5	2.80	33.7	8.0	2.8	1.500	4.220	1.001	3.411	60

RESULTS for PULLOUT

Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m]	La [m] (see NOTE)	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	12.18	4.21	4.25	0.11	259.5	1.500	21.295	207.6	1.099	12.664
2	0.80	1.000	12.53	3.88	3.92	0.44	211.1	1.500	16.844	168.8	1.099	10.290
3	1.40	1.000	10.25	3.55	3.59	0.77	167.4	1.500	16.334	133.9	1.099	9.706
4	2.00	1.000	9.08	3.22	3.25	1.10	128.6	1.500	14.164	102.9	1.099	8.363
5	2.80	1.000	7.99	2.78	2.81	1.55	84.2	1.500	10.528	67.3	1.099	6.247

Version 3.0 MSEW Version 3.0

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	12.0	0.90	0.90	33.4	54.0	33.7	1.00	2.79	1.50	4.50	1.50	2.81	60
2	0.80	11.7	0.90	0.90	33.4	54.0	33.7	1.00	2.85	1.50	4.60	1.50	2.88	60
3	1.40	9.0	0.90	0.90	33.4	54.0	33.7	1.00	3.69	1.50	5.97	1.50	3.73	60
4	2.00	7.5	0.90	0.65	33.4	38.9	33.7	1.00	4.43	1.50	5.16	1.50	4.48	60
5	2.80	6.1	0.90	0.30	33.4	18.1	33.7	1.00	5.47	1.50	2.97	1.50	5.52	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	16.1	0.90	0.72	33.4	43.2	33.7	0.67	2.26	1.00	2.68	1.00	2.28	60
2	0.80	15.4	0.90	0.72	33.4	43.2	33.7	0.67	2.35	1.00	2.81	1.00	2.38	60
3	1.40	12.2	0.90	0.72	33.4	43.2	33.7	0.67	2.99	1.00	3.55	1.00	3.02	60
4	2.00	10.2	0.90	0.52	33.4	31.1	33.7	0.67	3.57	1.00	3.05	1.00	3.61	60
5	2.80	8.2	0.90	0.24	33.4	14.5	33.7	0.67	4.42	1.00	1.76	1.00	4.47	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 14.93

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 오창JCT Ramp-A

Description:

H=6.1m

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name:
Original date and time of creating this file:

PROGRAM MODE: DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 4.27 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.5518 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Note: specified A combined with I and δ produced a square root of -0.04 in M-O equ.
MSEW set this square root to ZERO so that the Kae could be calculated. Be aware that the end results are likely erroneous and ARE PROVIDED FOR INFORMATION ONLY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.9535 Kae (Kh = 0) = 0.5293 Δ Kae = 0.4242

DIRECT SLIDING / ECCENTRICITY

Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY

Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY

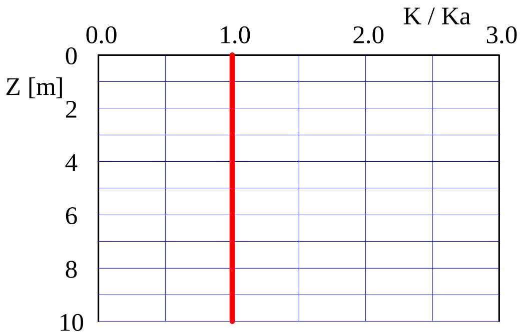
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텔aϕ	0.80텔aϕ	0.80텔an	0.80텔an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Variation of Lateral Earth Pressure Coefficient With Depth

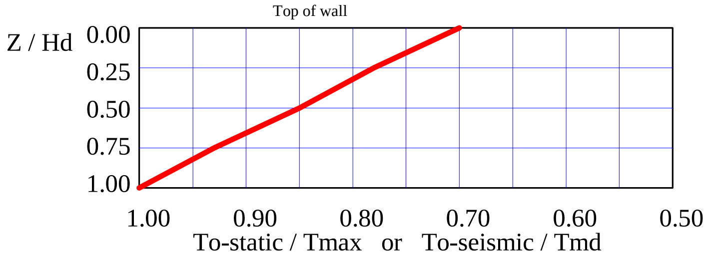
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [1]	CRu [2]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [3]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

[1] σ = Confining stress in between stacked blocks [kPa]
[2] CRu = Tult-connection / Tult-geogrid
[3] CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

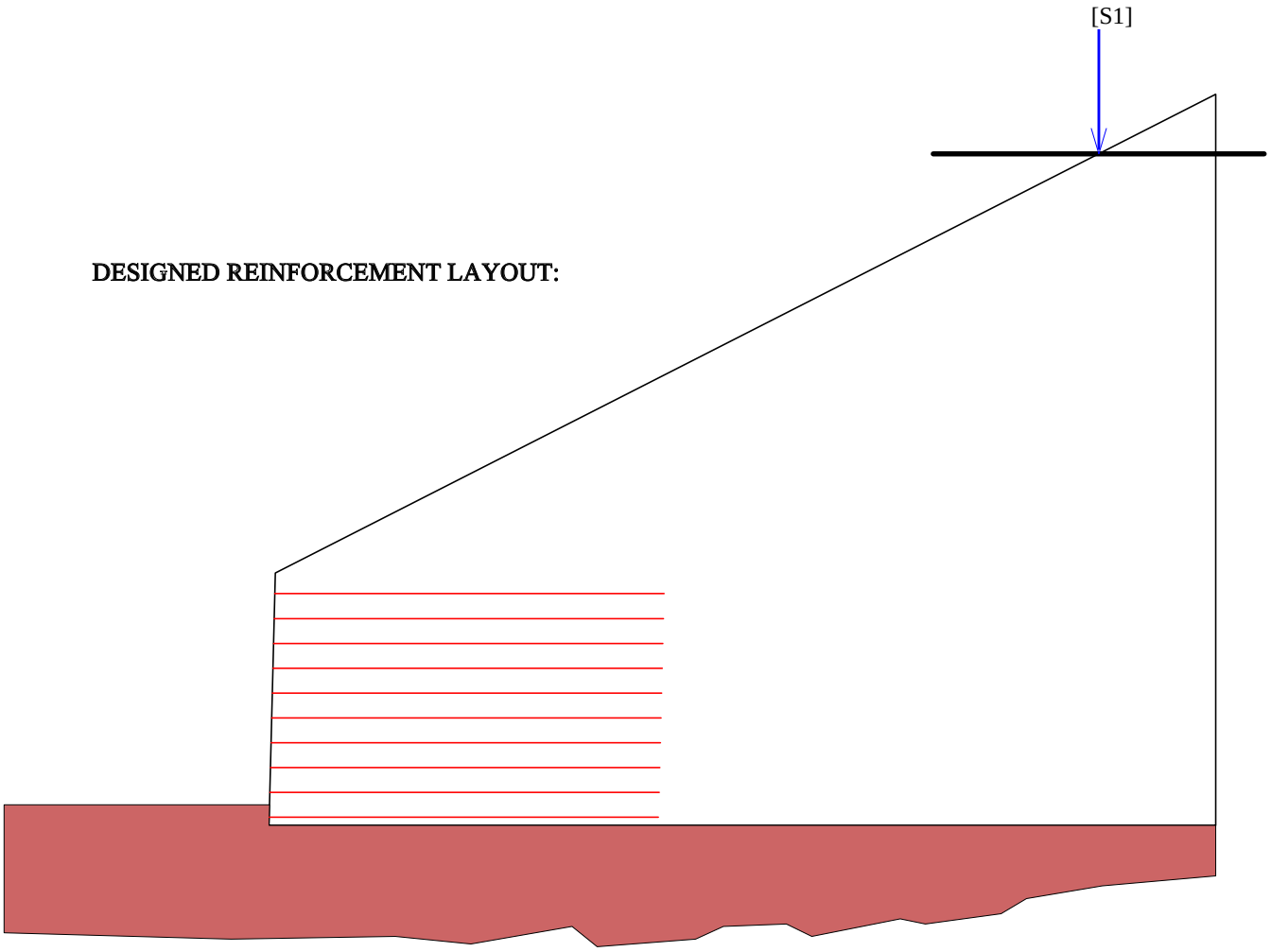
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	6.10	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 5.60 m }
Batter, ω	1.4	[deg]	
Backslope, β	27.0	[deg]	
Backslope rise	19.0	[m]	Broken back equivalent angle, I = 27.00? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=8.0 [m]. Distance of center of footing from wall face, d = 19.9 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

LEGEND: (1) Connection strength √ Satisfactory
(2) Geogrid strength ⊗ Unsatisfactory
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

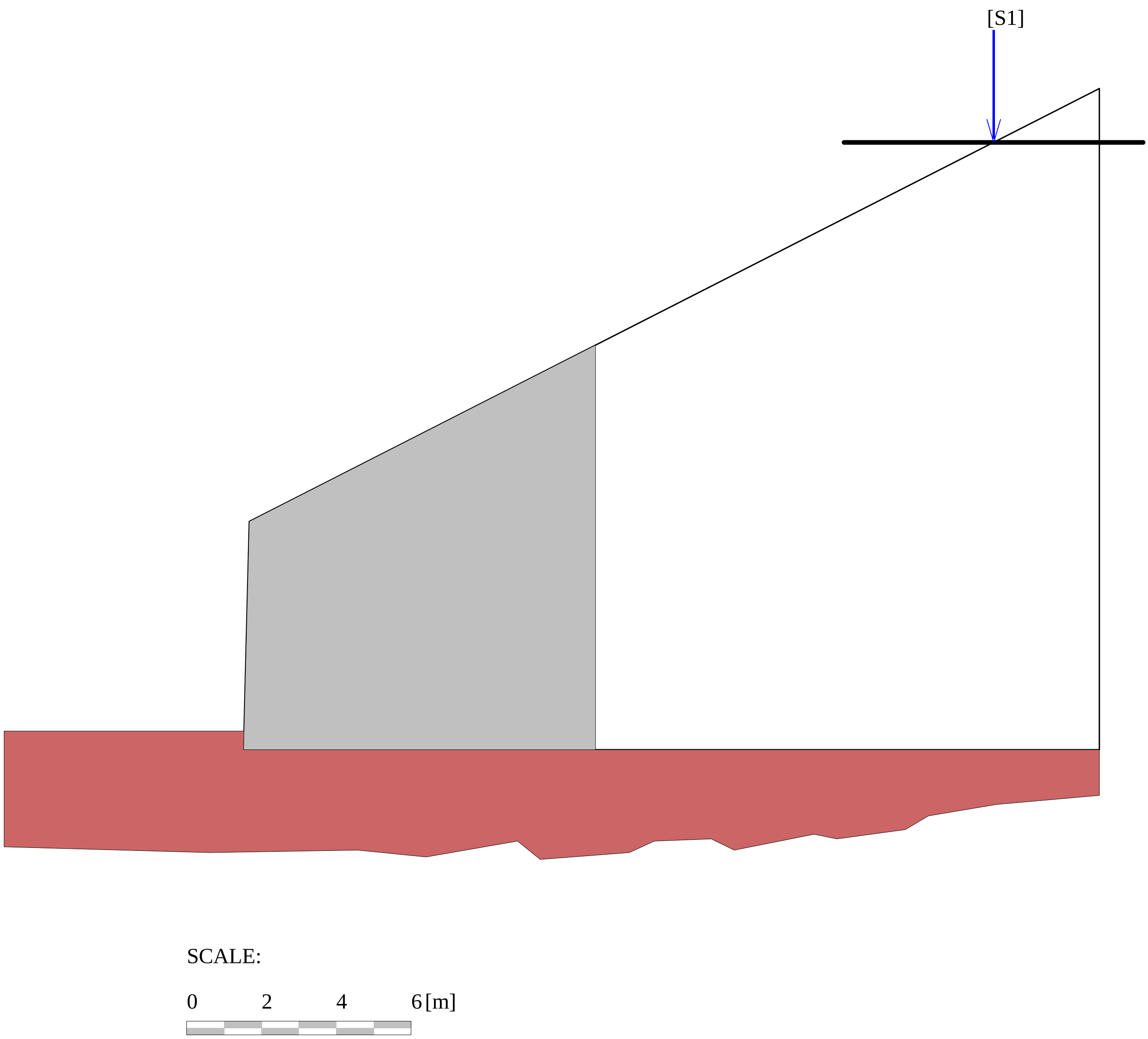
Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	9.41	2	√	√	√	√	√
2	0.80	9.41	2	√	√	√	√	√
3	1.40	9.41	1	√	√	√	√	√
4	2.00	9.41	1	√	√	√	√	√
5	2.60	9.41	1	√	√	√	√	√

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
6	3.20	9.41	1	√	√	√	√	√
7	3.80	9.41	1	√	√	√	√	√
8	4.40	9.41	1	√	√	√	√	√
9	5.00	9.41	1	√	√	√	√	√
10	5.60	9.41	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	1626.0	1476.5	[kPa]
Meyerhof stress, σ_V	190.30	216.6	[kPa]
Eccentricity, e	-0.03	0.46	[m]
Eccentricity, e/L	-0.003	0.049	
Fs calculated	8.54	6.82	
Base length	9.41	9.41	[m]



DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.781 and Fs-seismic = 1.408

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	9.41	1.502	1.194	2	90
2	0.80	9.41	1.556	1.259	2	90
3	1.40	9.41	1.615	1.333	1	60
4	2.00	9.41	1.678	1.416	1	60
5	2.60	9.41	1.746	1.510	1	60
6	3.20	9.41	1.818	1.614	1	60
7	3.80	9.41	1.886	1.724	1	60
8	4.40	9.41	1.954	1.840	1	60
9	5.00	9.41	2.015	1.954	1	60
10	5.60	9.41	2.063	2.046	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = -0.0034, e/L seismic = 0.0427; Overturning: Fs-static = 5.25, Fs-seismic = 3.89

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	9.41	-0.0070	0.0365	2	90
2	0.80	9.41	-0.0176	0.0184	2	90
3	1.40	9.41	-0.0283	0.0008	1	60
4	2.00	9.41	-0.0393	-0.0164	1	60
5	2.60	9.41	-0.0507	-0.0335	1	60
6	3.20	9.41	-0.0630	-0.0506	1	60
7	3.80	9.41	-0.0768	-0.0686	1	60
8	4.40	9.41	-0.0927	-0.0880	1	60
9	5.00	9.41	-0.1122	-0.1101	1	60
10	5.60	9.41	-0.1376	-0.1371	1	60

RESULTS for STRENGTH

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	50.6	22.0	6.5	1.500	2.303	1.001	1.918	90
2	0.80	50.6	24.3	6.3	1.500	2.085	1.001	1.773	90
3	1.40	33.7	22.0	6.0	1.500	1.534	1.001	1.293	60
4	2.00	33.7	19.7	5.8	1.500	1.711	1.001	1.426	60
5	2.60	33.7	17.4	5.6	1.500	1.935	1.001	1.590	60
6	3.20	33.7	15.2	5.3	1.500	2.226	1.001	1.796	60
7	3.80	33.7	12.9	5.1	1.500	2.620	1.001	2.064	60
8	4.40	33.7	10.6	4.9	1.500	3.184	1.001	2.425	60
9	5.00	33.7	8.3	4.6	1.500	4.057	1.001	2.941	60
10	5.60	33.7	7.5	4.4	1.500	4.475	1.001	3.201	60

RESULTS for PULLOUT

Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	21.97	6.49	9.30	0.11	1076.4	1.500	48.995	861.1	1.099	30.254
2	0.80	1.000	24.27	6.26	8.97	0.44	974.3	1.500	40.136	779.4	1.099	25.525
3	1.40	1.000	21.99	6.03	8.63	0.77	876.9	1.500	39.870	701.5	1.099	25.033
4	2.00	1.000	19.71	5.80	8.30	1.10	784.0	1.500	39.769	627.2	1.099	24.584
5	2.60	1.000	17.43	5.57	7.97	1.44	695.8	1.500	39.912	556.7	1.099	24.202
6	3.20	1.000	15.15	5.34	7.64	1.77	612.4	1.500	40.411	489.9	1.099	23.910
7	3.80	1.000	12.87	5.10	7.31	2.10	533.7	1.500	41.454	426.9	1.099	23.748
8	4.40	1.000	10.59	4.87	6.98	2.43	459.7	1.500	43.392	367.8	1.099	23.778
9	5.00	1.000	8.31	4.64	6.65	2.76	390.4	1.500	46.963	312.4	1.099	24.111
10	5.60	1.000	7.54	4.41	6.31	3.09	326.1	1.500	43.255	260.9	1.099	21.833

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	21.8	0.90	0.90	50.1	81.0	50.6	1.00	2.30	1.50	3.72	1.50	2.32	90
2	0.80	23.4	0.90	0.90	50.1	81.0	50.6	1.00	2.14	1.50	3.46	1.50	2.16	90
3	1.40	20.6	0.90	0.90	33.4	54.0	33.7	1.00	1.62	1.50	2.62	1.50	1.64	60
4	2.00	17.8	0.90	0.90	33.4	54.0	33.7	1.00	1.87	1.50	3.03	1.50	1.89	60
5	2.60	15.2	0.90	0.90	33.4	54.0	33.7	1.00	2.19	1.50	3.55	1.50	2.21	60
6	3.20	12.8	0.90	0.90	33.4	54.0	33.7	1.00	2.61	1.50	4.23	1.50	2.64	60
7	3.80	10.5	0.90	0.90	33.4	54.0	33.7	1.00	3.18	1.50	5.14	1.50	3.21	60
8	4.40	8.3	0.90	0.73	33.4	44.1	33.7	1.00	4.00	1.50	5.28	1.50	4.04	60
9	5.00	6.3	0.90	0.48	33.4	28.5	33.7	1.00	5.30	1.50	4.53	1.50	5.35	60
10	5.60	5.5	0.90	0.22	33.4	13.0	33.7	1.00	6.10	1.50	2.37	1.50	6.16	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	28.2	0.90	0.72	50.1	64.8	50.6	0.67	1.92	1.00	2.30	1.00	1.94	90
2	0.80	29.4	0.90	0.72	50.1	64.8	50.6	0.67	1.82	1.00	2.20	1.00	1.84	90
3	1.40	26.2	0.90	0.72	33.4	43.2	33.7	0.67	1.37	1.00	1.65	1.00	1.38	60
4	2.00	23.1	0.90	0.72	33.4	43.2	33.7	0.67	1.56	1.00	1.87	1.00	1.58	60
5	2.60	20.1	0.90	0.72	33.4	43.2	33.7	0.67	1.80	1.00	2.15	1.00	1.82	60
6	3.20	17.3	0.90	0.72	33.4	43.2	33.7	0.67	2.11	1.00	2.50	1.00	2.13	60
7	3.80	14.7	0.90	0.72	33.4	43.2	33.7	0.67	2.51	1.00	2.95	1.00	2.53	60
8	4.40	12.2	0.90	0.59	33.4	35.3	33.7	0.67	3.05	1.00	2.89	1.00	3.08	60
9	5.00	9.8	0.90	0.38	33.4	22.8	33.7	0.67	3.84	1.00	2.32	1.00	3.88	60
10	5.60	8.7	0.90	0.17	33.4	10.4	33.7	0.67	4.36	1.00	1.19	1.00	4.41	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 14.93

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 서오창IC Ramp-A,F,G

Description:

H=3.50m

Company's information:

Name:
Street:
,
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Documents and Settings\KIM\바탕 화면\t12(H=3.7m).BEN
Original date and time of creating this file:

PROGRAM MODE: DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 2.59 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.	
Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.4610 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.7216 Kae (Kh = 0) = 0.4431 Δ Kae = 0.2785

DIRECT SLIDING / ECCENTRICITY
Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY
Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

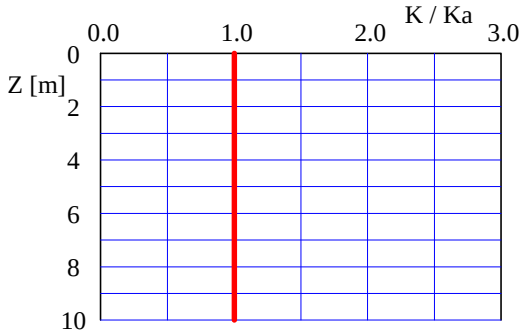
INTERNAL STABILITY
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텡aϕ	0.80텡aϕ	0.80텡an	0.80텡an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Variation of Lateral Earth Pressure Coefficient With Depth

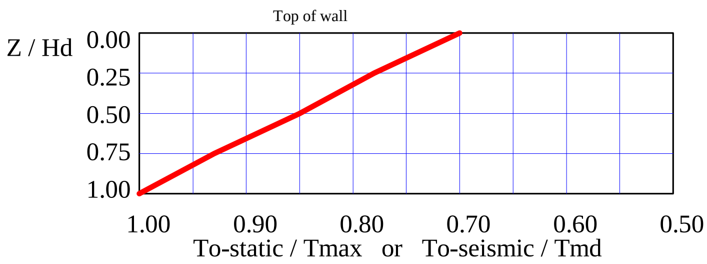
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [(1)]	CRu [(2)]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [(3)]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-connection / Tult-geogrid
(3) CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

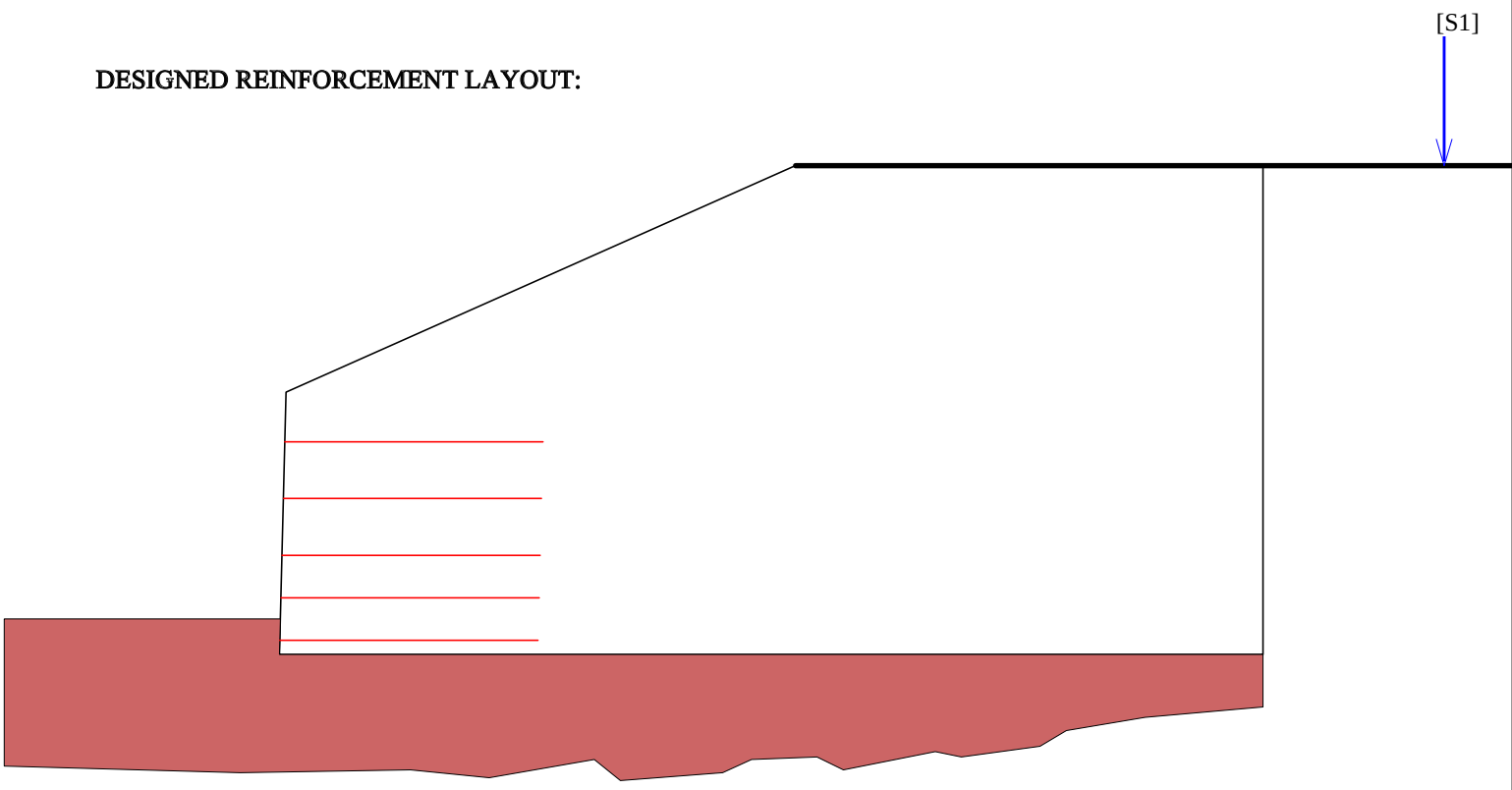
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	3.70	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 3.20 m }
Batter, ω	1.4	[deg]	
Backslope, β	24.0	[deg]	
Backslope rise	3.2	[m]	Broken back equivalent angle, I = 23.39? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=18.3 [m]. Distance of center of footing from wall face, d = 16.3 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

LEGEND:
(1) Connection strength
(2) Geogrid strength
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

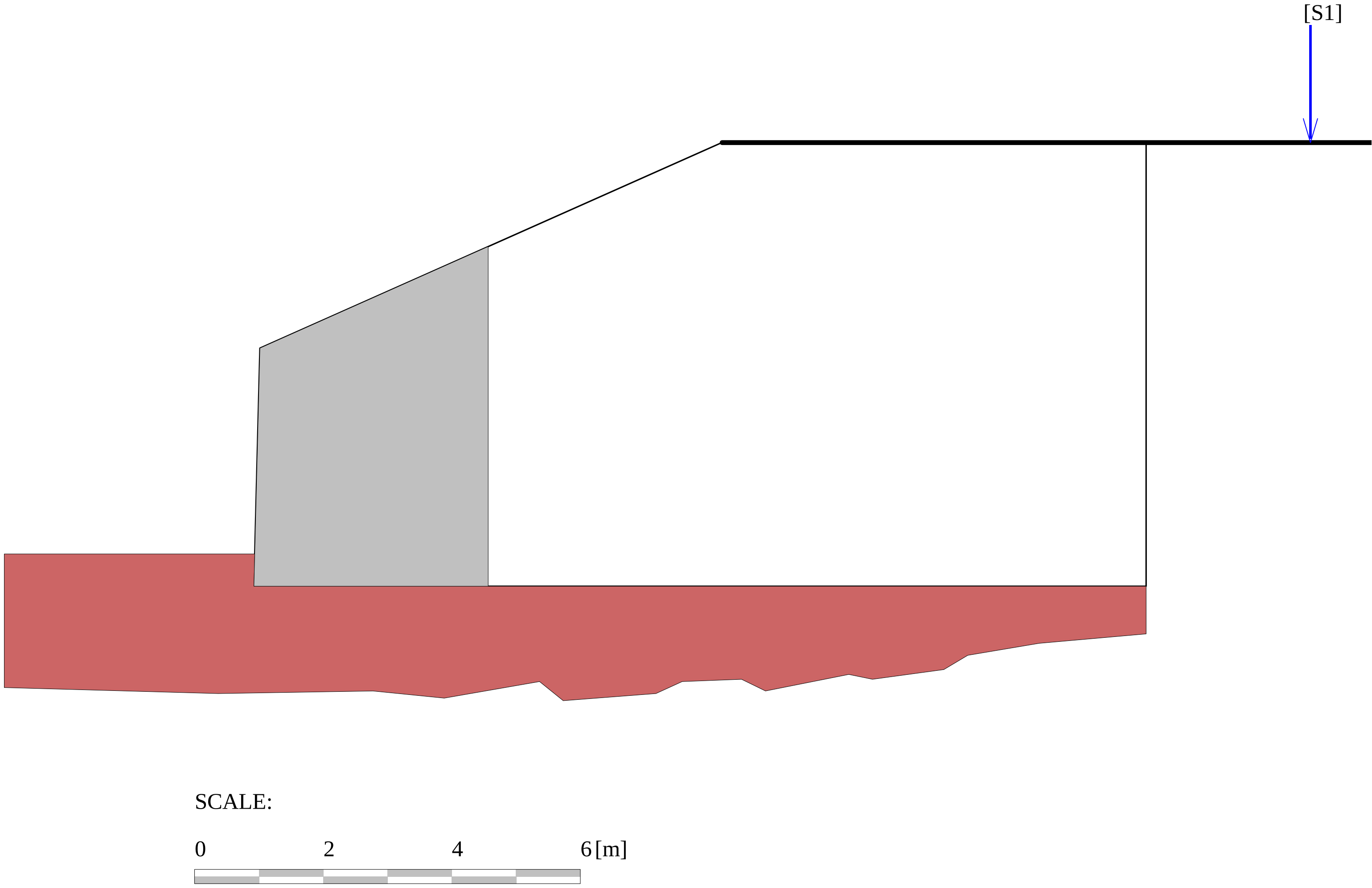
√ Satisfactory
⊗ Unsatisfactory

Bearing capacity: √
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	3.64	1	√	√	√	√	√
2	0.80	3.64	1	√	√	√	√	√
3	1.40	3.64	1	√	√	√	√	√
4	2.20	3.64	1	√	√	√	√	√
5	3.00	3.64	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	565.9	459.8	[kPa]
Meyerhof stress, σ_V	109.04	138.6	[kPa]
Eccentricity, e	0.20	0.50	[m]
Eccentricity, e/L	0.054	0.137	
Fs calculated	5.19	3.32	
Base length	3.64	3.64	[m]



DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.753 and Fs-seismic = 1.291

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	3.64	1.502	1.115	1	60
2	0.80	3.64	1.640	1.252	1	60
3	1.40	3.64	1.806	1.432	1	60
4	2.20	3.64	2.085	1.770	1	60
5	3.00	3.64	2.429	2.268	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.0536, e/L seismic = 0.1328; Overturning: Fs-static = 3.92, Fs-seismic = 2.57

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	3.64	0.0447	0.1162	1	60
2	0.80	3.64	0.0189	0.0695	1	60
3	1.40	3.64	-0.0059	0.0270	1	60
4	2.20	3.64	-0.0399	-0.0251	1	60
5	3.00	3.64	-0.0840	-0.0804	1	60

RESULTS for STRENGTH

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	12.8	4.8	1.500	2.646	1.001	2.105	60
2	0.80	33.7	13.2	4.4	1.500	2.553	1.001	2.085	60
3	1.40	33.7	12.5	3.9	1.500	2.692	1.001	2.221	60
4	2.20	33.7	10.5	3.3	1.500	3.206	1.001	2.642	60
5	3.00	33.7	7.8	2.7	1.500	4.298	1.001	3.482	60

RESULTS for PULLOUT

Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	12.75	4.81	3.53	0.11	213.0	1.500	16.707	170.4	1.099	9.704
2	0.80	1.000	13.21	4.36	3.20	0.44	169.7	1.500	12.842	135.7	1.099	7.725
3	1.40	1.000	12.53	3.91	2.87	0.77	131.2	1.500	10.470	105.0	1.099	6.385
4	2.20	1.000	10.52	3.31	2.43	1.22	87.3	1.500	8.302	69.9	1.099	5.054
5	3.00	1.000	7.85	2.70	1.98	1.66	52.1	1.500	6.644	41.7	1.099	3.953

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	12.6	0.90	0.90	33.4	54.0	33.7	1.00	2.66	1.50	4.30	1.50	2.69	60
2	0.80	12.4	0.90	0.90	33.4	54.0	33.7	1.00	2.69	1.50	4.35	1.50	2.72	60
3	1.40	11.1	0.90	0.90	33.4	54.0	33.7	1.00	3.00	1.50	4.85	1.50	3.03	60
4	2.20	8.7	0.90	0.65	33.4	38.9	33.7	1.00	3.85	1.50	4.49	1.50	3.89	60
5	3.00	6.0	0.90	0.30	33.4	18.1	33.7	1.00	5.59	1.50	3.04	1.50	5.65	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	17.3	0.90	0.72	33.4	43.2	33.7	0.67	2.12	1.00	2.50	1.00	2.14	60
2	0.80	16.5	0.90	0.72	33.4	43.2	33.7	0.67	2.20	1.00	2.62	1.00	2.22	60
3	1.40	14.6	0.90	0.72	33.4	43.2	33.7	0.67	2.47	1.00	2.96	1.00	2.50	60
4	2.20	11.4	0.90	0.52	33.4	31.1	33.7	0.67	3.18	1.00	2.73	1.00	3.21	60
5	3.00	8.0	0.90	0.24	33.4	14.5	33.7	0.67	4.53	1.00	1.81	1.00	4.58	60

AASHTO 98 ASD DESIGN METHOD
옥산~오창 고속도로 민간투자사업

MSEW(3.0): Update # 14.93

PROJECT IDENTIFICATION

Title: 옥산~오창 고속도로 민간투자사업
Project Number:
Client:
Designer: .
Station Number: 서오창IC Ramp-A,F,G

Description:

H=4.50m

Company's information:

Name:
Street:

,
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Documents and Settings\KIM\바탕 화면\t13(H=4.5m).BEN
Original date and time of creating this file:

PROGRAM MODE: DESIGN
of a SIMPLE STRUCTURE
using GEOGRID as reinforcing material.

DESIGN DATA

DESIGN OBJECTIVES

Minimum factor of safety against pullout, Fs-po	1.50
Minimum factor of safety against direct sliding, Fs-sliding	1.50
Maximum allowable eccentricity ratio at each reinforcement level, e/L	0.1667
Minimum factor of safety against compound and overall failure, Fs-comp-static	1.50
Minimum factor of safety against compound and overall failure, Fs-comp-seismic	1.13

Prescribed minimum resistive length to prevent pullout, Le = 1.00 m.
Prescribed minimum normalized length of each layer is: L/Hd = 0.70 --> L = 3.15 m.
Prescribed minimum absolute total length of each layer is: L = 2.50 m.

BEARING CAPACITY

Bearing capacity is controlled by general shear.

Maximum permissible eccentricity ratio (soil), e/L	0.1667
Minimum factor of safety with respect to ultimate bearing capacity (Meyerhof approach)	2.50

Bearing capacity coefficients: Nc = 27.86 N γ= 19.34

SOIL DATA

REINFORCED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

RETAINED SOIL

Unit weight, γ	19.0 kN/m
Design value of internal angle of friction, ϕ	30.0

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	18.0 kN/m
Equivalent internal angle of friction, $\phi_{equiv.}$	29.0
Equivalent cohesion, $c_{equiv.}$	0.0 kPa

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.3333 (if batter is less than 10? Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Inclination of internal slip plane, ψ = 60.00? (see Fig. 28 in DEMO 82).
Ka (external stability) = 0.3396 (if batter is less than 10? Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

SEISMICITY

Maximum ground acceleration coefficient, A = 0.154
Design acceleration coefficient in Internal Stability: Kh = Am = 0.200
Design acceleration coefficient in External Stability: Kh_d = 0.099 => Kh = Am = 0.099
(Kh in External Stability is based on allowable displacement, d = 25 mm. using FHWA-NHI-00-043 equation)

Kae (Kh > 0) = 0.4036 Kae (Kh = 0) = 0.3290 Δ Kae = 0.0746

DIRECT SLIDING / ECCENTRICITY

Seismic safety factor is 73.3% of specified static FS for direct sliding.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

BEARING CAPACITY

Seismic safety factor is 80.0% of specified static FS for bearing capacity.
Maximum allowable eccentricity, e/L, under seismic conditions is: 0.2500

INTERNAL STABILITY

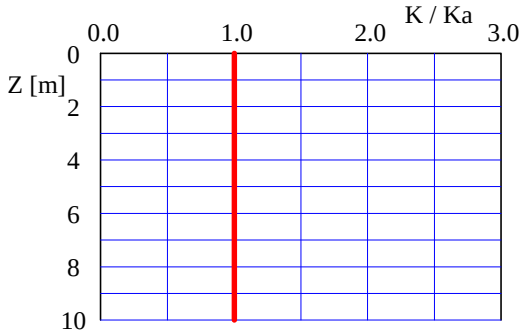
Seismic soil-geogrid friction coefficient, F* is 80.0% of its specified static value.
Seismic factor of safety against pullout, Fs-po, is 73.3% of its specified static value.
Seismic overall factor of safety, Fs-overall, is 66.7% of its specified static value.
The reduction of Fs-overall pertains to geogrid strength and to connection strength for both break and pullout modes of failure.

INPUT DATA: Geogrids
(Multiple type reinforcement)

D A T A	Geogrid type #1	Geogrid type #2	Geogrid type #3	Geogrid type #4	Geogrid type #5
Tult [kN/m]	60.0	90.0	120.0	180.0	
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	
Installation-damage reduction factor, RFid	1.10	1.10	1.10	1.10	
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Fs-overall for strength	1.50	1.50	1.50	1.50	
Coverage ratio, Rc	1.000	1.000	1.000	1.000	
Friction angle along geogrid-soil interface, ρ	24.79	24.79	24.79	24.79	
Pullout resistance factor, F*	0.80텡aϕ	0.80텡aϕ	0.80텡an	0.80텡an	N/A
Scale-effect correction factor, α	0.8	0.8	0.8	0.8	

Variation of Lateral Earth Pressure Coefficient With Depth

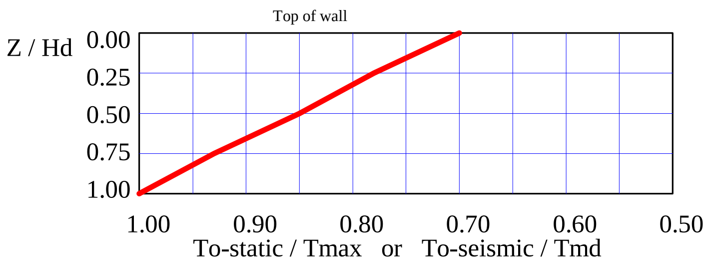
Z	K / Ka
0 m	1.00
1 m	1.00
2 m	1.00
3 m	1.00
4 m	1.00
5 m	1.00
6 m	1.00



INPUT DATA: Facia and Connection (Design)

FACIA type: Facing enabling frictional connection of reinforcement (e.g., modular concrete blocks, gabions)
Depth/height of block is 0.43/0.20 m. Horizontal distance to Center of Gravity of block is 0.22 m.
Average unit weight of block is γ_f = 24.00 kN/m

Z / Hd	To-static / Tmax or To-seismic / Tmd
0.00	0.70
0.25	0.78
0.50	0.85
0.75	0.93
1.00	1.00



To-static, To-seismic = connection force, static and superimposed dynamic component, respectively.

Geogrid Type #1 σ [1]	CRu [2]	Geogrid Type #2 σ	CRu	Geogrid Type #3 σ	CRu	Geogrid Type #4 σ	CRu	Geogrid Type #5 σ	CRu
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90		
100.0	0.90	100.0	0.90	100.0	0.90	100.0	0.90	N/A	

Geogrid Type #1 σ	CRs [3]	Geogrid Type #2 σ	CRs	Geogrid Type #3 σ	CRs	Geogrid Type #4 σ	CRs	Geogrid Type #5 σ	CRs
0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00		
50.0	0.90	50.0	0.90	50.0	0.90	50.0	0.90	N/A	

(1) σ = Confining stress in between stacked blocks [kPa]
(2) CRu = Tult-connection / Tult-geogrid
(3) CRs = Tpo-connection / Tult-geogrid

In seismic analysis, Tc-pullout is reduced to 80% of its static value.

D A T A (for connection only)	Type #1	Type #2	Type #3	Type #4	Type #5
Product Name	60	90	120	180	N/A
Durability reduction factor, RFd	1.10	1.10	1.10	1.10	N/A
Creep reduction factor, RFc	1.47	1.47	1.47	1.47	N/A
Overall factor of safety: connection break, Fs	1.00	1.00	1.00	1.00	N/A
Overall factor of safety: connection pullout, Fs	1.50	1.50	1.50	1.50	N/A

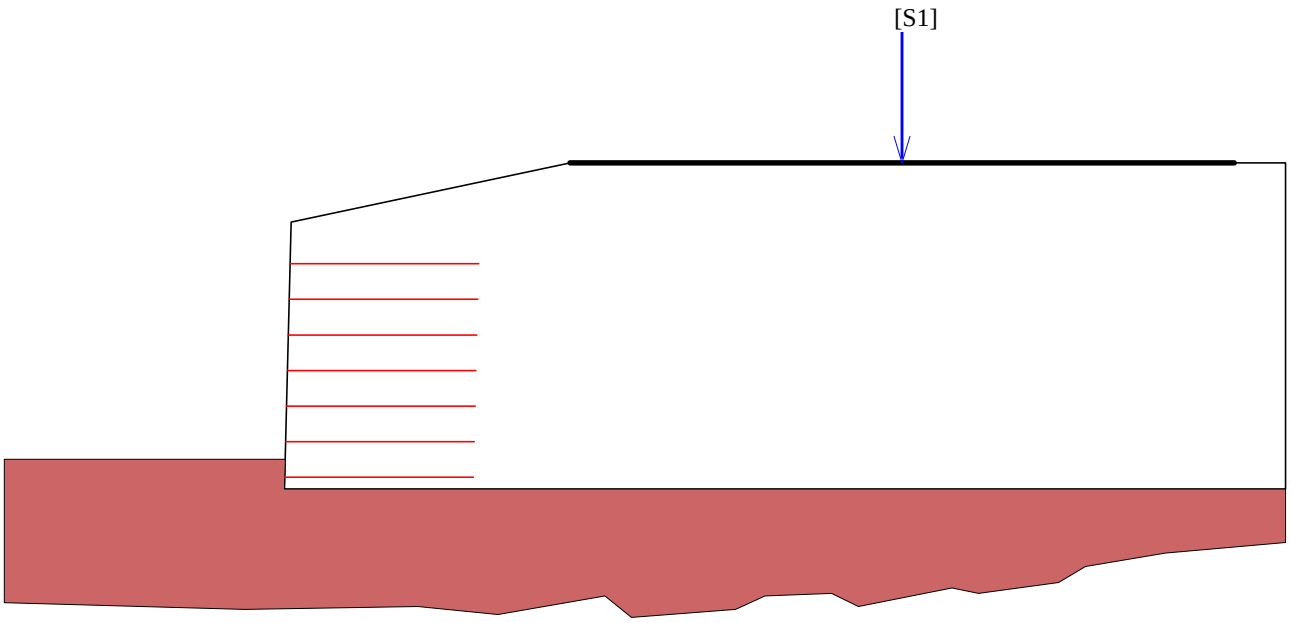
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	4.50	[m]	{ Embedded depth is E = 0.50 m, and height above top of finished bottom grade is H = 4.00 m }
Batter, ω	1.4	[deg]	
Backslope, β	12.0	[deg]	
Backslope rise	1.0	[m]	Broken back equivalent angle, I = 6.34? (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [kPa]

OTHER EXTERNAL LOAD(S)
[S1] Strip Load, Qv-d = 0.0 and Qv-l = 13.0 [kPa].
Footing width, b=11.2 [m]. Distance of center of footing from wall face, d = 10.3 [m] @ depth of 0.0 [m] below soil surface.

DESIGNED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 [m]

REINFORCEMENT LAYOUT AND DESIGN CRITERIA

LEGEND: (1) Connection strength √ Satisfactory
(2) Geogrid strength ⊗ Unsatisfactory
(3) Pullout resistance
(4) Direct sliding
(5) Eccentricity

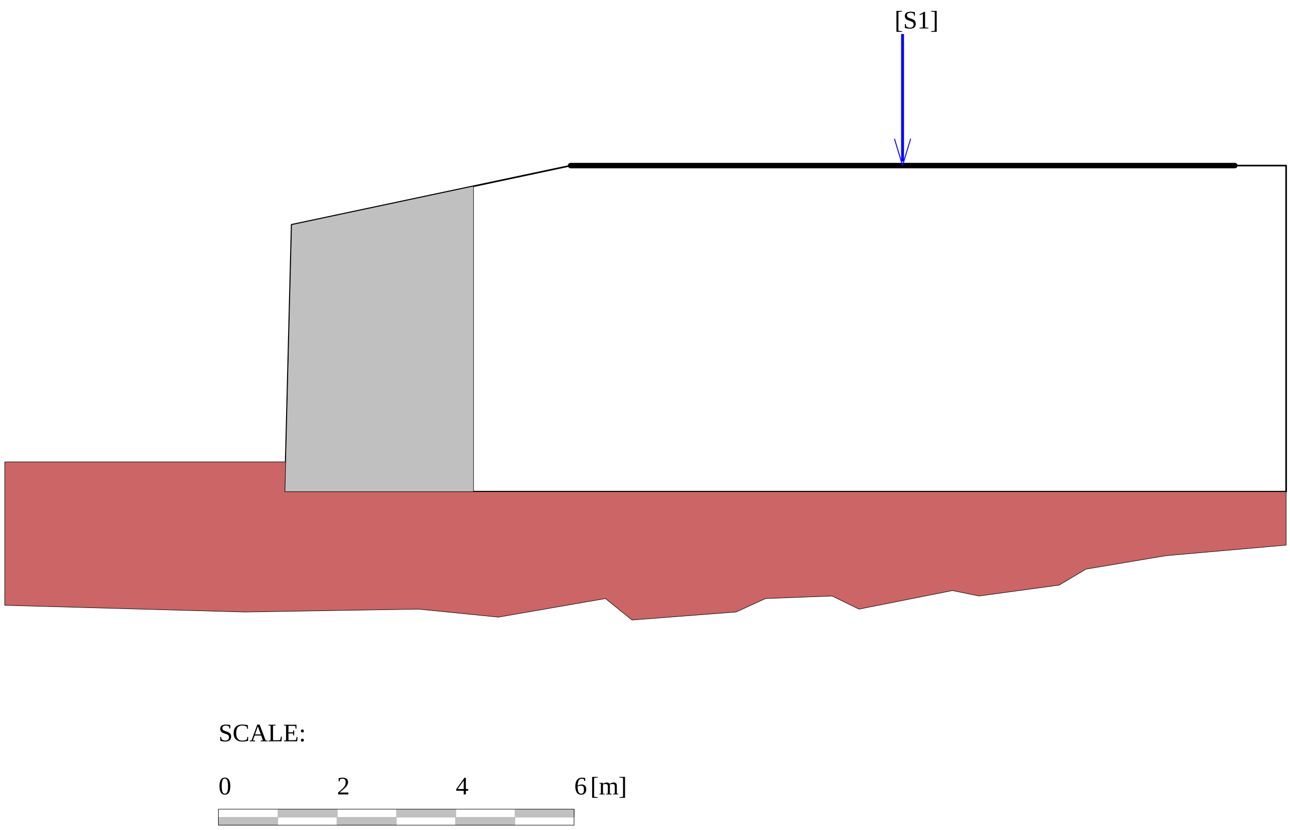
Bearing capacity: ⊗
Foudation Interface: Direct sliding √ Eccentricity √

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
1	0.20	3.18	1	√	√	√	√	√
2	0.80	3.18	1	√	√	√	√	√
3	1.40	3.18	1	√	√	√	√	√
4	2.00	3.18	1	√	√	√	√	√

#	Geogrid Elevation [m]	Length [m]	Type #	(1)	(2)	(3)	(4)	(5)
5	2.60	3.18	1	√	√	√	√	√
6	3.20	3.18	1	√	√	√	√	√
7	3.80	3.18	1	√	√	√	√	√

BEARING CAPACITY for DESIGNED LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Ultimate bearing capacity, q-ult	411.8	321.0	[kPa]
Meyerhof stress, σ_V	125.29	161.2	[kPa]
Eccentricity, e	0.41	0.67	[m]
Eccentricity, e/L	0.128	0.210	
Fs calculated	3.29	1.99	
Base length	3.18	3.18	[m]



DIRECT SLIDING for DESIGNED LAYOUT (for GEOGRID reinforcements)

Specified Fs-static = 1.500 and Fs-seismic = 1.100

Along reinforced and foundation soils interface: Fs-static = 1.777 and Fs-seismic = 1.338

#	Geogrid Elevation [m]	Geogrid Length [m]	Fs Static	Fs Seismic	Geogrid Type #	Product name
1	0.20	3.18	1.536	1.160	1	60
2	0.80	3.18	1.734	1.322	1	60
3	1.40	3.18	2.004	1.543	1	60
4	2.00	3.18	2.404	1.874	1	60
5	2.60	3.18	2.978	2.368	1	60
6	3.20	3.18	3.698	3.069	1	60
7	3.80	3.18	4.823	4.296	1	60

ECCENTRICITY for DESIGNED LAYOUT

At interface with foundation: e/L static = 0.1281, e/L seismic = 0.2093; Overturning: Fs-static = 3.26, Fs-seismic = 2.18

#	Geogrid Elevation [m]	Geogrid Length [m]	e / L Static	e / L Seismic	Geogrid Type #	Product name
1	0.20	3.18	0.1161	0.1902	1	60
2	0.80	3.18	0.0827	0.1372	1	60
3	1.40	3.18	0.0530	0.0910	1	60
4	2.00	3.18	0.0273	0.0517	1	60
5	2.60	3.18	0.0050	0.0188	1	60
6	3.20	3.18	-0.0173	-0.0112	1	60
7	3.80	3.18	-0.0464	-0.0448	1	60

RESULTS for STRENGTH

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Tavailable [kN/m]	Tmax [kN/m]	Tmd [kN/m]	Specified minimum Fs-overall static	Actual calculated Fs-overall static	Specified minimum Fs-overall seismic	Actual calculated Fs-overall seismic	Product name
1	0.20	33.7	14.5	5.1	1.500	2.323	1.001	1.877	60
2	0.80	33.7	15.3	4.5	1.500	2.200	1.001	1.832	60
3	1.40	33.7	13.1	4.0	1.500	2.584	1.001	2.140	60
4	2.00	33.7	10.8	3.4	1.500	3.131	1.001	2.573	60
5	2.60	33.7	8.5	2.9	1.500	3.972	1.001	3.226	60
6	3.20	33.7	6.2	2.3	1.500	5.430	1.001	4.323	60
7	3.80	33.7	5.3	1.8	1.500	6.380	1.001	5.186	60

RESULTS for PULLOUT

Live Load included in calculating Tmax

NOTE: Live load is not included in calculating the overburden pressure used to assess pullout resistance.

#	Geogrid Elevation [m]	Coverage Ratio	Tmax [kN/m]	Tmd [kN/m]	Le [m] (see NOTE)	La [m]	Avail.Static Pullout, Pr [kN/m]	Specified Static Fs	Actual Static Fs	Avail.Seism. Pullout, Pr [kN/m]	Specified Seismic Fs	Actual Seismic Fs
1	0.20	1.000	14.52	5.08	3.07	0.11	199.4	1.500	13.737	159.6	1.099	8.141
2	0.80	1.000	15.33	4.53	2.74	0.44	156.3	1.500	10.193	125.0	1.099	6.294
3	1.40	1.000	13.05	3.98	2.41	0.77	118.4	1.500	9.069	94.7	1.099	5.559
4	2.00	1.000	10.77	3.44	2.08	1.10	85.7	1.500	7.960	68.6	1.099	4.828
5	2.60	1.000	8.49	2.89	1.74	1.44	58.3	1.500	6.863	46.6	1.099	4.098
6	3.20	1.000	6.21	2.34	1.41	1.77	36.1	1.500	5.804	28.8	1.099	3.374
7	3.80	1.000	5.29	1.79	1.08	2.10	19.1	1.500	3.611	15.3	1.099	2.158

RESULTS for CONNECTION (static conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	14.3	0.90	0.90	33.4	54.0	33.7	1.00	2.33	1.50	3.77	1.50	2.35	60
2	0.80	14.6	0.90	0.90	33.4	54.0	33.7	1.00	2.29	1.50	3.71	1.50	2.32	60
3	1.40	11.9	0.90	0.90	33.4	54.0	33.7	1.00	2.81	1.50	4.54	1.50	2.84	60
4	2.00	9.3	0.90	0.90	33.4	54.0	33.7	1.00	3.57	1.50	5.78	1.50	3.61	60
5	2.60	7.0	0.90	0.82	33.4	49.2	33.7	1.00	4.75	1.50	7.00	1.50	4.80	60
6	3.20	4.9	0.90	0.56	33.4	33.7	33.7	1.00	6.80	1.50	6.86	1.50	6.87	60
7	3.80	4.0	0.90	0.30	33.4	18.1	33.7	1.00	8.42	1.50	4.58	1.50	8.51	60

RESULTS for CONNECTION (seismic conditions)

Live Load included in calculating Tmax

#	Geogrid Elevation [m]	Connection force, To [kN/m]	Reduction factor for connection break, CRu	Reduction factor for connection pullout, CRs	Available connection strength, Tc-break criterion [kN/m]	Available connection strength, Tc-pullout criterion [kN/m]	Available Geogrid strength, Tavailable [kN/m]	Fs-overall connection break		Fs-overall connection pullout		Fs-overall Geogrid strength		Product name
								Specified	Actual	Specified	Actual	Specified	Actual	
1	0.20	19.4	0.90	0.72	33.4	43.2	33.7	0.67	1.88	1.00	2.23	1.00	1.90	60
2	0.80	18.9	0.90	0.72	33.4	43.2	33.7	0.67	1.91	1.00	2.29	1.00	1.93	60
3	1.40	15.5	0.90	0.72	33.4	43.2	33.7	0.67	2.33	1.00	2.79	1.00	2.35	60
4	2.00	12.3	0.90	0.72	33.4	43.2	33.7	0.67	2.94	1.00	3.50	1.00	2.97	60
5	2.60	9.4	0.90	0.66	33.4	39.4	33.7	0.67	3.86	1.00	4.18	1.00	3.90	60
6	3.20	6.8	0.90	0.45	33.4	27.0	33.7	0.67	5.41	1.00	3.99	1.00	5.47	60
7	3.80	5.3	0.90	0.24	33.4	14.5	33.7	0.67	6.85	1.00	2.74	1.00	6.92	60