

10. 전단연결재 설계

10.1 상부바닥판 전단연결재

1) 합성후 하중에 의한 수평 전단력

(도.설.해 3.9.5.2)

※ 고려하는 단면의 휨모멘트의 부호에 관계없이 바닥판 콘크리트의 단면을 유효로 하여 전단연결재의 계산을 하는 것으로 한다. (도.설.해 3.9.5.7)

여기서, S_v = 설계 대상 단면의 슬래브와 주거더 사이의 수평전단력 범위 (N/mm)

$$S_v = \frac{V \cdot Q_{vc}}{I_v}$$

V = 합성후 하중에 의한 수직전단력[활하중 포함] (N)

Q_{vc} = 정모멘트부 콘크리트의 환산단면 또는 부모멘트부 철근면적의 합성 단면 중립축에 대한 단면1차모멘트 (mm^3)

$$Q_{vc} = \frac{A_c}{n} \cdot d_{vc}$$

A_c = 바닥판 콘크리트 또는 철근의 단면적 (mm^2)

I_v = 합성단면의 단면2차모멘트 (mm^4)

d_{vc} = 합성단면 도심에서 바닥판 콘크리트 또는 철근 도심까지 거리(mm)

※ V_d : 합성후 고정하중에 의한 수직전단력, V_A : 합성후 고정하중에 의한 수직전단력을 제외한 전단력 (충격계수를 포함한 활하중 포함)

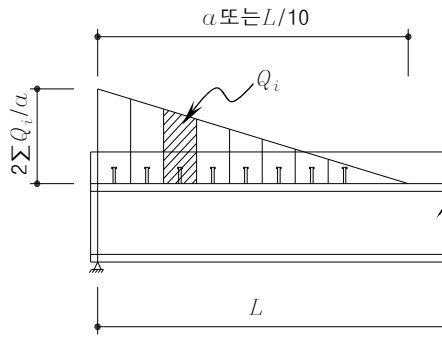
절점	단면 TYPE	A_c/n (mm^2)	d_{vc} (mm)	Q_{vc} (mm^3)	I_v (mm^4)	V_d (kN)	V_A (kN)	V_d+V_A (kN)	S_v (N/mm)
1	1	396,000.0	510.2	2.020E+08	5.802E+11	537.0	1,113.0	1,650.1	574.6
2	1	216,000.0	681.1	1.471E+08	4.428E+11	505.7	1,002.0	1,507.7	501.0
3	1	216,000.0	681.1	1.471E+08	4.428E+11	433.5	901.6	1,335.2	443.7
4	1	216,000.0	681.1	1.471E+08	4.428E+11	354.4	811.0	1,165.4	387.2
5	1	216,000.0	681.1	1.471E+08	4.428E+11	255.3	715.1	970.4	322.4
6	2	216,000.0	874.7	1.889E+08	6.254E+11	156.1	629.8	785.9	237.4
7	2	216,000.0	874.7	1.889E+08	6.254E+11	57.8	554.4	612.3	185.0
8	3	216,000.0	855.8	1.849E+08	6.307E+11	39.9	488.8	528.7	155.0
9	3	216,000.0	855.8	1.849E+08	6.307E+11	137.7	555.8	693.6	203.3
10	4	216,000.0	959.3	2.072E+08	7.431E+11	236.0	630.5	866.5	241.6
11	4	216,000.0	959.3	2.072E+08	7.431E+11	334.7	713.8	1,048.5	292.4
12	5	216,000.0	886.5	1.915E+08	6.585E+11	431.1	806.5	1,237.6	359.9
13	6	216,000.0	814.9	1.760E+08	5.542E+11	529.4	914.1	1,443.6	458.5
14	8	216,000.0	980.4	2.118E+08	7.232E+11	631.1	1,042.1	1,673.2	489.9
15	8	216,000.0	980.4	2.118E+08	7.232E+11	744.4	1,194.2	1,938.6	567.6
16	9	216,000.0	991.5	2.142E+08	8.904E+11	872.2	1,401.9	2,274.1	546.9
17	10	216,000.0	1,609.6	3.477E+08	1.616E+12	1,015.7	1,775.7	2,791.5	600.4
18	11	216,000.0	1,754.6	3.790E+08	2.161E+12	981.1	1,942.7	2,923.9	512.7
19	11	216,000.0	1,754.6	3.790E+08	2.161E+12	868.2	1,562.6	2,430.8	426.3
20	12	216,000.0	1,615.9	3.490E+08	1.675E+12	751.1	1,333.7	2,084.8	434.5
21	13	216,000.0	1,527.8	3.300E+08	1.198E+12	644.8	1,176.7	1,821.4	501.7
22	14	216,000.0	902.6	1.950E+08	6.165E+11	540.6	1,041.6	1,582.2	500.3
23	16	216,000.0	629.9	1.360E+08	3.572E+11	439.7	923.1	1,362.8	519.1
24	16	216,000.0	629.9	1.360E+08	3.572E+11	339.8	819.4	1,159.3	441.6
25	16	216,000.0	629.9	1.360E+08	3.572E+11	241.2	727.6	968.8	369.0
26	17	216,000.0	546.8	1.181E+08	2.995E+11	143.1	646.7	789.8	311.5
27	17	216,000.0	546.8	1.181E+08	2.995E+11	44.8	574.9	619.7	244.4
28	17	216,000.0	546.8	1.181E+08	2.995E+11	53.7	557.9	611.6	241.2
29	17	216,000.0	546.8	1.181E+08	2.995E+11	152.0	634.6	786.6	310.3
30	16	216,000.0	629.9	1.360E+08	3.572E+11	251.1	721.5	972.6	370.5
31	16	216,000.0	629.9	1.360E+08	3.572E+11	351.4	819.1	1,170.5	445.9
32	16	216,000.0	629.9	1.360E+08	3.572E+11	453.1	933.6	1,386.7	528.2
33	14	216,000.0	902.6	1.950E+08	6.165E+11	558.0	1,064.7	1,622.7	513.2

절점	단면 TYPE	A_c/n (mm ²)	d_{vc} (mm)	Q_{vc} (mm ³)	I_v (mm ⁴)	V_d (kN)	V_a (kN)	V_d+V_a (kN)	S_v (N/mm)
34	13	216,000.0	1,527.8	3.300E+08	1.198E+12	665.1	1,213.4	1,878.4	517.4
35	12	216,000.0	1,615.9	3.490E+08	1.675E+12	782.0	1,423.4	2,205.3	459.6
36	11	216,000.0	1,754.6	3.790E+08	2.161E+12	908.8	1,800.2	2,708.9	475.0
37	11	216,000.0	1,754.6	3.790E+08	2.161E+12	1,076.7	1,855.3	2,932.1	514.2
38	10	216,000.0	1,609.6	3.477E+08	1.616E+12	946.2	1,505.9	2,452.2	527.4
39	9	216,000.0	991.5	2.142E+08	8.904E+11	829.5	1,307.4	2,136.9	514.0
40	8	216,000.0	980.4	2.118E+08	7.232E+11	721.4	1,159.5	1,880.9	550.7
41	8	216,000.0	980.4	2.118E+08	7.232E+11	620.5	1,029.7	1,650.2	483.2
42	6	216,000.0	814.9	1.760E+08	5.542E+11	521.3	915.9	1,437.3	456.5
43	5	216,000.0	886.5	1.915E+08	6.585E+11	423.7	816.5	1,240.2	360.6
44	4	216,000.0	959.3	2.072E+08	7.431E+11	324.6	728.4	1,053.0	293.6
45	4	216,000.0	959.3	2.072E+08	7.431E+11	226.1	649.9	876.0	244.3
46	3	216,000.0	855.8	1.849E+08	6.307E+11	127.3	578.4	705.6	206.8
47	3	216,000.0	855.8	1.849E+08	6.307E+11	28.8	514.5	543.3	159.3
48	2	216,000.0	874.7	1.889E+08	6.254E+11	70.0	549.2	619.2	187.1
49	2	216,000.0	874.7	1.889E+08	6.254E+11	169.3	631.6	800.9	242.0
50	1	216,000.0	681.1	1.471E+08	4.428E+11	268.3	721.0	989.3	328.7
51	1	216,000.0	681.1	1.471E+08	4.428E+11	365.8	822.2	1,188.0	394.7
52	1	216,000.0	681.1	1.471E+08	4.428E+11	441.1	909.6	1,350.7	448.8
53	1	216,000.0	681.1	1.471E+08	4.428E+11	506.0	1,056.5	1,562.5	519.2
54	1	396,000.0	510.2	2.020E+08	5.802E+11	561.2	1,155.8	1,717.0	597.9
55	1	396,000.0	510.2	2.020E+08	5.802E+11	631.7	1,285.0	1,916.7	667.4
56	1	216,000.0	681.1	1.471E+08	4.428E+11	531.4	1,057.2	1,588.6	527.9
57	1	216,000.0	681.1	1.471E+08	4.428E+11	445.9	933.1	1,379.0	458.2
58	1	216,000.0	681.1	1.471E+08	4.428E+11	359.6	829.2	1,188.7	395.0
59	1	216,000.0	681.1	1.471E+08	4.428E+11	258.0	730.3	988.3	328.4
60	2	216,000.0	874.7	1.889E+08	6.254E+11	155.4	641.4	796.8	240.7
61	2	216,000.0	874.7	1.889E+08	6.254E+11	52.6	561.9	614.5	185.6
62	3	216,000.0	855.8	1.849E+08	6.307E+11	50.8	513.2	564.0	165.3
63	3	216,000.0	855.8	1.849E+08	6.307E+11	154.7	585.7	740.4	217.0
64	4	216,000.0	959.3	2.072E+08	7.431E+11	256.6	662.8	919.4	256.4
65	4	216,000.0	959.3	2.072E+08	7.431E+11	359.6	748.4	1,108.0	309.0
66	5	216,000.0	886.5	1.915E+08	6.585E+11	463.1	844.4	1,307.5	380.2
67	6	216,000.0	814.9	1.760E+08	5.542E+11	566.2	953.5	1,519.8	482.7
68	8	216,000.0	980.4	2.118E+08	7.232E+11	666.0	1,073.1	1,739.1	509.2
69	8	216,000.0	980.4	2.118E+08	7.232E+11	757.0	1,192.5	1,949.6	570.8
70	9	216,000.0	991.5	2.142E+08	8.904E+11	829.8	1,329.8	2,159.6	519.4
71	10	216,000.0	1,609.6	3.477E+08	1.616E+12	888.2	1,604.2	2,492.4	536.0
72	11	216,000.0	1,754.6	3.790E+08	2.161E+12	885.0	1,707.5	2,592.5	454.6
73	11	216,000.0	1,754.6	3.790E+08	2.161E+12	835.1	1,460.0	2,295.1	402.5
74	12	216,000.0	1,615.9	3.490E+08	1.675E+12	749.4	1,308.7	2,058.1	428.9
75	13	216,000.0	1,527.8	3.300E+08	1.198E+12	655.3	1,187.0	1,842.3	507.4
76	14	216,000.0	902.6	1.950E+08	6.165E+11	554.9	1,067.7	1,622.6	513.1
77	16	216,000.0	629.9	1.360E+08	3.572E+11	454.2	954.6	1,408.8	536.6
78	16	216,000.0	629.9	1.360E+08	3.572E+11	352.7	851.3	1,204.0	458.6
79	16	216,000.0	629.9	1.360E+08	3.572E+11	250.3	755.0	1,005.3	382.9
80	17	216,000.0	546.8	1.181E+08	2.995E+11	148.1	668.9	817.0	322.2
81	17	216,000.0	546.8	1.181E+08	2.995E+11	46.1	592.2	638.3	251.7
82	17	216,000.0	546.8	1.181E+08	2.995E+11	56.0	576.6	632.5	249.5
83	17	216,000.0	546.8	1.181E+08	2.995E+11	157.8	657.6	815.5	321.6
84	16	216,000.0	629.9	1.360E+08	3.572E+11	259.7	748.3	1,008.0	383.9
85	16	216,000.0	629.9	1.360E+08	3.572E+11	360.4	845.8	1,206.2	459.4

절점	단면 TYPE	A_c/n (mm ²)	d_{vc} (mm)	Q_{vc} (mm ³)	I_v (mm ⁴)	V_d (kN)	V_a (kN)	V_d+V_a (kN)	S_v (N/mm)
86	16	216,000.0	629.9	1.360E+08	3.572E+11	460.0	957.9	1,417.9	540.1
87	14	216,000.0	902.6	1.950E+08	6.165E+11	559.1	1,077.4	1,636.5	517.5
88	13	216,000.0	1,527.8	3.300E+08	1.198E+12	652.0	1,199.2	1,851.2	509.9
89	12	216,000.0	1,615.9	3.490E+08	1.675E+12	737.2	1,355.2	2,092.4	436.1
90	11	216,000.0	1,754.6	3.790E+08	2.161E+12	806.9	1,652.4	2,459.3	431.3
91	11	216,000.0	1,754.6	3.790E+08	2.161E+12	984.3	1,745.4	2,729.7	478.7
92	10	216,000.0	1,609.6	3.477E+08	1.616E+12	913.9	1,463.3	2,377.1	511.3
93	9	216,000.0	991.5	2.142E+08	8.904E+11	831.1	1,306.7	2,137.7	514.2
94	8	216,000.0	980.4	2.118E+08	7.232E+11	736.2	1,177.0	1,913.1	560.2
95	8	216,000.0	980.4	2.118E+08	7.232E+11	636.9	1,052.0	1,689.0	494.5
96	6	216,000.0	814.9	1.760E+08	5.542E+11	535.9	938.8	1,474.7	468.4
97	5	216,000.0	886.5	1.915E+08	6.585E+11	435.3	837.6	1,272.8	370.1
98	4	216,000.0	959.3	2.072E+08	7.431E+11	334.3	748.2	1,082.5	301.8
99	4	216,000.0	959.3	2.072E+08	7.431E+11	234.2	668.2	902.5	251.6
100	3	216,000.0	855.8	1.849E+08	6.307E+11	133.0	593.8	726.8	213.0
101	3	216,000.0	855.8	1.849E+08	6.307E+11	32.0	526.9	558.8	163.8
102	2	216,000.0	874.7	1.889E+08	6.254E+11	68.7	556.9	625.6	189.0
103	2	216,000.0	874.7	1.889E+08	6.254E+11	169.5	639.7	809.2	244.5
104	1	216,000.0	681.1	1.471E+08	4.428E+11	269.6	729.8	999.4	332.1
105	1	216,000.0	681.1	1.471E+08	4.428E+11	370.3	836.2	1,206.5	400.9
106	1	216,000.0	681.1	1.471E+08	4.428E+11	451.4	936.8	1,388.2	461.3
107	1	216,000.0	681.1	1.471E+08	4.428E+11	545.8	1,141.4	1,687.2	560.6
108	1	396,000.0	510.2	2.020E+08	4.428E+11	601.5	1,240.4	1,841.9	840.5

2) 건조수축 및 온도차에 의한 수평전단력

(도.설.해 3.9.5.3)



$$\begin{aligned} \text{주거더 간격 } a &= 2.400 \text{ m (시점부)} \\ L / 10 &= 257.000 / 10 = 25.700 \text{ m} \\ \therefore \text{전단 분포폭} &= 2.400 \text{ m (시점부)} \\ \text{주거더 간격 } a &= 2.400 \text{ m (종점부)} \\ L / 10 &= 257.000 / 10 = 25.700 \text{ m} \\ \therefore \text{전단 분포폭} &= 2.400 \text{ m (종점부)} \end{aligned}$$

※ L을 취하는 방법 : (1) 단순합성거더의 경우 L : 지간

(2) 연속합성거더의 경우 L : 지간의 합계

▪ 건조수축에 의한 전단력(GIRDER 계산 단면 TYPE -1 참조) (시점부)

$$n_2 = n \cdot (1 + \phi_1/2) = 7.0 \times (1 + 4.0 / 2) = 21.0$$

$$A_s = 127,200.0 \text{ mm}^2 \quad I_s = 1.560\text{E}+11 \text{ mm}^4$$

$$A_c = 1,512,000.0 \text{ mm}^2 \quad I_c = 2.903\text{E}+10 \text{ mm}^4$$

$$d = 1,858.4 \text{ mm} \quad (\text{강재도심과 Con'c중심간 거리})$$

$$p_2 = E_s \cdot \epsilon_s \cdot A_c / n_2 = 205,000 \times 0.00027 \times 1,512,000 / 21.0 = 3.985\text{E}+06 \text{ N}$$

$$E_s = 205,000.0 \text{ MPa} \quad (\text{강재의 탄성계수})$$

$$\epsilon_s = 0.000270 \quad (\text{콘크리트의 건조수축에 의한 최종수축율})$$

$$F_2 = \frac{1}{1 + \frac{A_c}{n_2 \cdot A_s} + \frac{A_c \cdot d^2}{I_c + n_2 \cdot I_s}}$$

$$F_2 = 1 + [1 + \{1,512,000 / (21 \times 127,200)\} + \{(1,512,000 \times 1,858^2) / (29,030,400,000 + 21.0 \times 155,984,340,845)\}] = 0.318$$

$$N_{cs} = p_2 \cdot F_2 = 3,985,200.0 \times 0.318 = 1.267\text{E}+06 \text{ N}$$

$$S_s = 2 \cdot N_{cs} / a = 2 \times 1,266,653.1 / 2.400 = 1,055.5 \text{ N/mm}$$

▪ 건조수축에 의한 전단력(GIRDER 계산 단면 TYPE -1 참조) (종점부)

$$n_2 = n \cdot (1 + \phi_1/2) = 7.0 \times (1 + 4.0 / 2) = 21.0$$

$$A_s = 127,200.0 \text{ mm}^2 \quad I_s = 1.560\text{E}+11 \text{ mm}^4$$

$$A_c = 1,512,000.0 \text{ mm}^2 \quad I_c = 2.903\text{E}+10 \text{ mm}^4$$

$$d = 1,858.4 \text{ mm} \quad (\text{강재도심과 Con'c중심간 거리})$$

$$p_2 = E_s \cdot \epsilon_s \cdot A_c / n_2 = 205,000 \times 0.00027 \times 1,512,000 / 21.0 = 3.985\text{E}+06 \text{ N}$$

$$E_s = 205,000.0 \text{ MPa} \quad (\text{강재의 탄성계수})$$

$$\epsilon_s = 0.000270 \quad (\text{콘크리트의 건조수축에 의한 최종수축율})$$

$$F_2 = \frac{1}{1 + \frac{A_c}{n_2 \cdot A_s} + \frac{A_c \cdot d^2}{I_c + n_2 \cdot I_s}}$$

$$F_2 = 1 + [1 + \{1,512,000 / (21 \times 127,200)\} + \{(1,512,000 \times 1,858^2) / (29,030,400,000 + 21.0 \times 155,984,340,845)\}] = 0.318$$

$$N_{cs} = p_2 \cdot F_2 = 3,985,200.0 \times 0.318 = 1.267\text{E}+06 \text{ N}$$

$$S_s = 2 \cdot N_{cs} / a = 2 \times 1,266,653.1 / 2.400 = 1,055.5 \text{ N/mm}$$

▪ 온도차에 의한 전단력 (시점부)

$$n = 7.0$$

$$A_s = 127,200.0 \text{ mm}^2 \quad I_s = 1.560\text{E}+11 \text{ mm}^4$$

$$A_c = 1,512,000.0 \text{ mm}^2 \quad I_c = 2.903\text{E}+10 \text{ mm}^4$$

$$d = 1,858.4 \text{ mm} \quad (\text{강재도심과 Con'c중심간 거리})$$

$$p_1 = E_s \cdot \alpha \cdot \Delta t \cdot A_c / n = 205,000 \times 0.000012 \times 10.0 \times 1,512,000 / 7.0 = 5.314\text{E}+06 \text{ N}$$

$$E_s = 205,000.0 \text{ MPa} \quad (\text{강재의 탄성계수})$$

$$\alpha = 0.000012 \quad (\text{강재 및 콘크리트의 선팅창계수})$$

$$\Delta t = 10.0 \text{ } ^\circ\text{C} \quad (\text{바닥판 콘크리트와 강재와의 온도차})$$

$$F_1 = \frac{1}{1 + \frac{A_c}{n \cdot A_s} + \frac{A_c \cdot d^2}{I_c + n \cdot I_s}}$$

$$F_1 = 1 + [1 + \{1,512,000 / (7 \times 127,200)\} + \{(1,512,000 \times 1,858^2) / (29,030,400,000 + 7.0 \times 155,984,340,845)\}] = 0.136$$

$$N_{cs} = p_1 \cdot F_2 = 5,313,600.0 \times 0.136 = 7.223\text{E}+05 \text{ N}$$

$$S_t = 2 \cdot N_{cs} / a = 2 \times 722,262.5 / 2.400 = 601.9 \text{ N/mm}$$

▪ 온도차에 의한 전단력 (중점부)

$$n = 7.0$$

$$A_s = 127,200.0 \text{ mm}^2 \quad I_s = 1.560\text{E}+11 \text{ mm}^4$$

$$A_c = 1,512,000.0 \text{ mm}^2 \quad I_c = 2.903\text{E}+10 \text{ mm}^4$$

$$d = 1,858.4 \text{ mm} \quad (\text{강재도심과 Con'c중심간 거리})$$

$$p_1 = E_s \cdot \alpha \cdot \Delta t \cdot A_c / n = 205,000 \times 0.000012 \times 10.0 \times 1,512,000 / 7.0 = 5.314\text{E}+06 \text{ N}$$

$$E_s = 205,000.0 \text{ MPa} \quad (\text{강재의 탄성계수})$$

$$\alpha = 0.000012 \quad (\text{강재 및 콘크리트의 선팅창계수})$$

$$\Delta t = 10.0 \text{ } ^\circ\text{C} \quad (\text{바닥판 콘크리트와 강재와의 온도차})$$

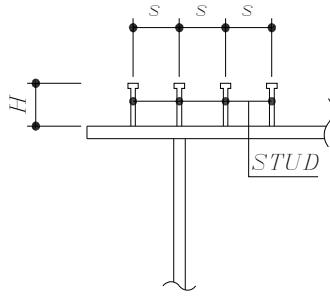
$$F_1 = \frac{1}{1 + \frac{A_c}{n \cdot A_s} + \frac{A_c \cdot d^2}{I_c + n \cdot I_s}}$$

$$F_1 = 1 + [1 + \{1,512,000 / (7 \times 127,200)\} + \{(1,512,000 \times 1,858^2) / (29,030,400,000 + 7.0 \times 155,984,340,845)\}] = 0.136$$

$$N_{cs} = p_1 \cdot F_2 = 5,313,600.0 \times 0.136 = 7.223\text{E}+05 \text{ N}$$

$$S_t = 2 \cdot N_{cs} / a = 2 \times 722,262.5 / 2.400 = 601.9 \text{ N/mm}$$

3) STUD의 설계



$s = 100.0 \text{ mm}$ (s : STUD의 횡방향 배치간격)

$d = 25.0 \text{ mm}$ (d : STUD의 직경)

$H = 150.0 \text{ mm}$ (H : STUD의 전높이)

$n = 8$ 본 (n : STUD의 횡방향 개수)

▪ STUD의 허용전단력 (도.설.해 3.9.5.6)

※ 전단연결재의 허용전단력은 다음 식으로 계산하고 바닥판 콘크리트와 강재 주거더의 플랜지 사이의 부착력은 무시한다.

$$H/d = 150.0 / 25.0 = 6.000 \geq 5.50$$

$$Q_a = 9.50 \times d^2 \times \sqrt{f_{ck}} = 30,852.2 \text{ N/본} \quad \therefore f_{ck} = 27.0 \text{ MPa}$$

$$\sum Q_a = 30,852.2 \times 8.0 = 246,817.2 \text{ N}$$

여기서, Q_a : 전단연결재의 허용전단력(N)

H : 스테드의 전 높이로서 150mm 정도를 표준으로 한다. (mm)

d : 스테드의 줄기의 지름으로서 19mm, 22mm, 25mm로 한다. (mm)

f_{ck} : 콘크리트의 설계기준강도 (MPa)

4) 하중조합 및 STUD의 배치

▪ STUD의 배치간격

$$d_o = \sum Q_a / S \quad (S : \text{수평전단력})$$

절점	하 중 조 합 (N/mm)					횡방향 개수 n	소요 간격 d_o	배치 간격	비 고	
	S_v	S_s	S_t	S_v+S_t	S_s+S_t					
1	574.6	1,055.5	601.9	1,176.5	1,657.4	8	148.9mm	125.0mm	0.K	A1
2	501.0	0.0	0.0	501.0	0.0	8	492.7mm	250.0mm	0.K	
3	443.7	0.0	0.0	443.7	0.0	8	556.3mm	450.0mm	0.K	
4	387.2	0.0	0.0	387.2	0.0	8	637.4mm	450.0mm	0.K	
5	322.4	0.0	0.0	322.4	0.0	8	765.5mm	450.0mm	0.K	
6	237.4	0.0	0.0	237.4	0.0	8	1039.6mm	450.0mm	0.K	
7	185.0	0.0	0.0	185.0	0.0	8	1334.4mm	450.0mm	0.K	
8	155.0	0.0	0.0	155.0	0.0	8	1592.5mm	450.0mm	0.K	
9	203.3	0.0	0.0	203.3	0.0	8	1214.0mm	450.0mm	0.K	
10	241.6	0.0	0.0	241.6	0.0	8	1021.6mm	450.0mm	0.K	
11	292.4	0.0	0.0	292.4	0.0	8	844.2mm	450.0mm	0.K	
12	359.9	0.0	0.0	359.9	0.0	8	685.8mm	450.0mm	0.K	
13	458.5	0.0	0.0	458.5	0.0	8	538.3mm	450.0mm	0.K	
14	489.9	0.0	0.0	489.9	0.0	8	503.8mm	450.0mm	0.K	
15	567.6	0.0	0.0	567.6	0.0	8	434.8mm	400.0mm	0.K	
16	546.9	0.0	0.0	546.9	0.0	8	451.3mm	400.0mm	0.K	
17	600.4	0.0	0.0	600.4	0.0	8	411.1mm	400.0mm	0.K	
18	512.7	0.0	0.0	512.7	0.0	8	481.4mm	400.0mm	0.K	P1
19	426.3	0.0	0.0	426.3	0.0	8	579.0mm	400.0mm	0.K	
20	434.5	0.0	0.0	434.5	0.0	8	568.1mm	400.0mm	0.K	
21	501.7	0.0	0.0	501.7	0.0	8	492.0mm	400.0mm	0.K	
22	500.3	0.0	0.0	500.3	0.0	8	493.3mm	450.0mm	0.K	
23	519.1	0.0	0.0	519.1	0.0	8	475.5mm	450.0mm	0.K	

절점	하 중 조 합 (N/mm)					횡방향 개수 n	소요 간격 d _o	배치 간격	비 고	
	S _v	S _s	S _t	S _v +S _t	S _s +S _t					
24	441.6	0.0	0.0	441.6	0.0	8	559.0mm	450.0mm	0.K	
25	369.0	0.0	0.0	369.0	0.0	8	668.8mm	450.0mm	0.K	
26	311.5	0.0	0.0	311.5	0.0	8	792.3mm	450.0mm	0.K	
27	244.4	0.0	0.0	244.4	0.0	8	1009.8mm	450.0mm	0.K	
28	241.2	0.0	0.0	241.2	0.0	8	1023.2mm	450.0mm	0.K	
29	310.3	0.0	0.0	310.3	0.0	8	795.5mm	450.0mm	0.K	
30	370.5	0.0	0.0	370.5	0.0	8	666.3mm	450.0mm	0.K	
31	445.9	0.0	0.0	445.9	0.0	8	553.6mm	450.0mm	0.K	
32	528.2	0.0	0.0	528.2	0.0	8	467.3mm	450.0mm	0.K	
33	513.2	0.0	0.0	513.2	0.0	8	481.0mm	450.0mm	0.K	
34	517.4	0.0	0.0	517.4	0.0	8	477.1mm	400.0mm	0.K	
35	459.6	0.0	0.0	459.6	0.0	8	537.0mm	400.0mm	0.K	
36	475.0	0.0	0.0	475.0	0.0	8	519.6mm	400.0mm	0.K	
37	514.2	0.0	0.0	514.2	0.0	8	480.0mm	400.0mm	0.K	P2
38	527.4	0.0	0.0	527.4	0.0	8	468.0mm	400.0mm	0.K	
39	514.0	0.0	0.0	514.0	0.0	8	480.2mm	400.0mm	0.K	
40	550.7	0.0	0.0	550.7	0.0	8	448.2mm	400.0mm	0.K	
41	483.2	0.0	0.0	483.2	0.0	8	510.8mm	450.0mm	0.K	
42	456.5	0.0	0.0	456.5	0.0	8	540.7mm	450.0mm	0.K	
43	360.6	0.0	0.0	360.6	0.0	8	684.4mm	450.0mm	0.K	
44	293.6	0.0	0.0	293.6	0.0	8	840.6mm	450.0mm	0.K	
45	244.3	0.0	0.0	244.3	0.0	8	1010.4mm	450.0mm	0.K	
46	206.8	0.0	0.0	206.8	0.0	8	1193.3mm	450.0mm	0.K	
47	159.3	0.0	0.0	159.3	0.0	8	1549.7mm	450.0mm	0.K	
48	187.1	0.0	0.0	187.1	0.0	8	1319.4mm	450.0mm	0.K	
49	242.0	0.0	0.0	242.0	0.0	8	1020.1mm	450.0mm	0.K	
50	328.7	0.0	0.0	328.7	0.0	8	750.8mm	450.0mm	0.K	
51	394.7	0.0	0.0	394.7	0.0	8	625.3mm	450.0mm	0.K	
52	448.8	0.0	0.0	448.8	0.0	8	549.9mm	450.0mm	0.K	
53	519.2	0.0	0.0	519.2	0.0	8	475.4mm	250.0mm	0.K	
54	597.9	1,055.5	601.9	1,199.8	1,657.4	8	148.9mm	125.0mm	0.K	A2
55	667.4	1,055.5	601.9	1,269.3	1,657.4	8	148.9mm	125.0mm	0.K	A1
56	527.9	0.0	0.0	527.9	0.0	8	467.6mm	250.0mm	0.K	
57	458.2	0.0	0.0	458.2	0.0	8	538.7mm	450.0mm	0.K	
58	395.0	0.0	0.0	395.0	0.0	8	624.9mm	450.0mm	0.K	
59	328.4	0.0	0.0	328.4	0.0	8	751.5mm	450.0mm	0.K	
60	240.7	0.0	0.0	240.7	0.0	8	1025.4mm	450.0mm	0.K	
61	185.6	0.0	0.0	185.6	0.0	8	1329.6mm	450.0mm	0.K	
62	165.3	0.0	0.0	165.3	0.0	8	1493.0mm	450.0mm	0.K	
63	217.0	0.0	0.0	217.0	0.0	8	1137.3mm	450.0mm	0.K	
64	256.4	0.0	0.0	256.4	0.0	8	962.7mm	450.0mm	0.K	
65	309.0	0.0	0.0	309.0	0.0	8	798.9mm	450.0mm	0.K	
66	380.2	0.0	0.0	380.2	0.0	8	649.2mm	450.0mm	0.K	
67	482.7	0.0	0.0	482.7	0.0	8	511.3mm	450.0mm	0.K	
68	509.2	0.0	0.0	509.2	0.0	8	484.7mm	450.0mm	0.K	
69	570.8	0.0	0.0	570.8	0.0	8	432.4mm	400.0mm	0.K	
70	519.4	0.0	0.0	519.4	0.0	8	475.2mm	400.0mm	0.K	
71	536.0	0.0	0.0	536.0	0.0	8	460.4mm	400.0mm	0.K	
72	454.6	0.0	0.0	454.6	0.0	8	542.9mm	400.0mm	0.K	P1
73	402.5	0.0	0.0	402.5	0.0	8	613.3mm	400.0mm	0.K	
74	428.9	0.0	0.0	428.9	0.0	8	575.5mm	400.0mm	0.K	
75	507.4	0.0	0.0	507.4	0.0	8	486.4mm	400.0mm	0.K	

절점	하 중 조 합 (N/mm)					횡방향 개수 n	소요 간격 d _o	배치 간격	비 고	
	S _v	S _s	S _t	S _v +S _t	S _s +S _t					
76	513.1	0.0	0.0	513.1	0.0	8	481.0mm	450.0mm	0.K	
77	536.6	0.0	0.0	536.6	0.0	8	460.0mm	450.0mm	0.K	
78	458.6	0.0	0.0	458.6	0.0	8	538.2mm	450.0mm	0.K	
79	382.9	0.0	0.0	382.9	0.0	8	644.6mm	450.0mm	0.K	
80	322.2	0.0	0.0	322.2	0.0	8	765.9mm	450.0mm	0.K	
81	251.7	0.0	0.0	251.7	0.0	8	980.4mm	450.0mm	0.K	
82	249.5	0.0	0.0	249.5	0.0	8	989.3mm	450.0mm	0.K	
83	321.6	0.0	0.0	321.6	0.0	8	767.4mm	450.0mm	0.K	
84	383.9	0.0	0.0	383.9	0.0	8	642.9mm	450.0mm	0.K	
85	459.4	0.0	0.0	459.4	0.0	8	537.2mm	450.0mm	0.K	
86	540.1	0.0	0.0	540.1	0.0	8	457.0mm	450.0mm	0.K	
87	517.5	0.0	0.0	517.5	0.0	8	477.0mm	450.0mm	0.K	
88	509.9	0.0	0.0	509.9	0.0	8	484.1mm	400.0mm	0.K	
89	436.1	0.0	0.0	436.1	0.0	8	566.0mm	400.0mm	0.K	
90	431.3	0.0	0.0	431.3	0.0	8	572.3mm	400.0mm	0.K	
91	478.7	0.0	0.0	478.7	0.0	8	515.6mm	400.0mm	0.K	P2
92	511.3	0.0	0.0	511.3	0.0	8	482.8mm	400.0mm	0.K	
93	514.2	0.0	0.0	514.2	0.0	8	480.0mm	400.0mm	0.K	
94	560.2	0.0	0.0	560.2	0.0	8	440.6mm	400.0mm	0.K	
95	494.5	0.0	0.0	494.5	0.0	8	499.1mm	450.0mm	0.K	
96	468.4	0.0	0.0	468.4	0.0	8	526.9mm	450.0mm	0.K	
97	370.1	0.0	0.0	370.1	0.0	8	666.8mm	450.0mm	0.K	
98	301.8	0.0	0.0	301.8	0.0	8	817.7mm	450.0mm	0.K	
99	251.6	0.0	0.0	251.6	0.0	8	980.8mm	450.0mm	0.K	
100	213.0	0.0	0.0	213.0	0.0	8	1158.5mm	450.0mm	0.K	
101	163.8	0.0	0.0	163.8	0.0	8	1506.7mm	450.0mm	0.K	
102	189.0	0.0	0.0	189.0	0.0	8	1305.9mm	450.0mm	0.K	
103	244.5	0.0	0.0	244.5	0.0	8	1009.6mm	450.0mm	0.K	
104	332.1	0.0	0.0	332.1	0.0	8	743.3mm	450.0mm	0.K	
105	400.9	0.0	0.0	400.9	0.0	8	615.7mm	450.0mm	0.K	
106	461.3	0.0	0.0	461.3	0.0	8	535.1mm	450.0mm	0.K	
107	560.6	0.0	0.0	560.6	0.0	8	440.3mm	250.0mm	0.K	
108	840.5	1,055.5	601.9	1,442.4	1,657.4	8	148.9mm	125.0mm	0.K	A2

5) STUD 배치 간격 검토

(도.설.해 3.9.5.4, 3.9.5.5)

▪ STUD의 최대간격

※ 전단연결재의 최대 간격은 바닥판 콘크리트의 두께의 3배로 하고 600mm를 넘지 않도록 한다.

다만, 연속교의 내부지점부의 경우 높은 인장응력이 발생하는 곳의 전단연결재 설치를 피하기 위해 이 간격을 넓힐 수도 있다.

$$\begin{aligned} \text{최대 간격} \Rightarrow \text{바닥판 두께의 3배} &= 470.0 \times 3 = 1,410.0 \text{ mm 또는 } 600.0 \text{ mm} \Rightarrow 600.0 \text{ mm 적용} \\ \text{적용 최대 간격} &= 450.0 \text{ mm} \leq 600.0 \text{ mm} \quad \dots\dots \mathbf{O.K!!} \end{aligned}$$

▪ STUD의 최소간격

- 교축방향 : $5 \cdot d = 125.0 \text{ mm}$ 또는 $100.0 \text{ mm} \leq 125.0 \text{ mm} \quad \dots\dots \mathbf{O.K!!}$
- 교축직각방향 : $d+30 = 55.0 \text{ mm} \leq 100.0 \text{ mm} \quad \dots\dots \mathbf{O.K!!}$
- 최소연단순간격 : $25.0 \text{ mm} \leq 130.0 - 12.5 = 117.5 \text{ mm} \quad \dots\dots \mathbf{O.K!!}$

6) 전단연결재의 피로설계

(도.설.해 3.9.5.9)

▪ 수평전단력 범위

여기서, S_r = 설계 대상 단면의 슬래브와 주거더 사이의 수평전단력 범위 (N/mm)
 V_r = 합성후 하중에 의한 수직전단력[활하중 포함] (N)
 Q = 정모멘트부 콘크리트의 환산단면 또는 부모멘트부 철근면적의 합성 단면 중립축에 대한 단면1차모멘트 (mm^3)
 A_c = 바닥판 콘크리트의 단면적 (mm^2)
 I_v = 합성단면의 단면2차모멘트 (mm^4)
 d_{vc} = 합성단면의 도심에서 바닥판 콘크리트 도심까지의 거리 (mm)

$$S_r = \frac{V_r \cdot Q}{I_v}$$

▪ 허용수평전단력 범위

$$\begin{aligned} Z_r = \beta \cdot d^2 &\Rightarrow 39.0 \times 25.0^2 = 24,375.0 \text{ N (DB 하중의 경우)} \\ &\Rightarrow 74.0 \times 25.0^2 = 46,250.0 \text{ N (DL 하중의 경우)} \end{aligned}$$

여기서, Z_r : 전단연결재의 허용수평 전단력 범위 (N)
 β : 39.0 (하중 반복회수 : DB 하중 = 2,000,000이상)
 74.0 (하중 반복회수 : DL 하중 = 500,000.0)

▪ 피로를 고려한 전단연결재의 필요간격

$$d_o = \sum Z_r / S_r$$

※ 피로설계에 의한 위치별 전단연결재 간격 검토 (DB하중에 대한 검토)

절점	A_c/n (mm ²)	d_{vc} (mm)	Q_{vc} (mm ³)	I_v (mm ⁴)	V_r (N)	S_r (N/mm)	n	$\sum Z_r$ (N)	소요 간격 d_o	배치 간격	비고	
1	396,000.0	510.2	2.020E+08	5.802E+11	8.770E+05	305.4	8	1.950E+05	638.5mm	125.0mm	0.K	A1
2	216,000.0	681.1	1.471E+08	4.428E+11	8.248E+05	274.1	8	1.950E+05	711.5mm	250.0mm	0.K	
3	216,000.0	681.1	1.471E+08	4.428E+11	8.074E+05	268.3	8	1.950E+05	726.8mm	450.0mm	0.K	
4	216,000.0	681.1	1.471E+08	4.428E+11	7.954E+05	264.3	8	1.950E+05	737.8mm	450.0mm	0.K	
5	216,000.0	681.1	1.471E+08	4.428E+11	7.945E+05	264.0	8	1.950E+05	738.7mm	450.0mm	0.K	
6	216,000.0	874.7	1.889E+08	6.254E+11	7.887E+05	238.3	8	1.950E+05	818.4mm	450.0mm	0.K	
7	216,000.0	874.7	1.889E+08	6.254E+11	7.829E+05	236.5	8	1.950E+05	824.5mm	450.0mm	0.K	
8	216,000.0	855.8	1.849E+08	6.307E+11	7.851E+05	230.1	8	1.950E+05	847.4mm	450.0mm	0.K	
9	216,000.0	855.8	1.849E+08	6.307E+11	7.888E+05	231.2	8	1.950E+05	843.3mm	450.0mm	0.K	
10	216,000.0	959.3	2.072E+08	7.431E+11	7.933E+05	221.2	8	1.950E+05	881.5mm	450.0mm	0.K	
11	216,000.0	959.3	2.072E+08	7.431E+11	8.016E+05	223.5	8	1.950E+05	872.4mm	450.0mm	0.K	
12	216,000.0	886.5	1.915E+08	6.585E+11	8.116E+05	236.0	8	1.950E+05	826.3mm	450.0mm	0.K	
13	216,000.0	814.9	1.760E+08	5.542E+11	8.194E+05	260.2	8	1.950E+05	749.3mm	450.0mm	0.K	
14	216,000.0	980.4	2.118E+08	7.232E+11	8.258E+05	241.8	8	1.950E+05	806.5mm	450.0mm	0.K	
15	216,000.0	980.4	2.118E+08	7.232E+11	8.383E+05	245.5	8	1.950E+05	794.4mm	400.0mm	0.K	
16	216,000.0	991.5	2.142E+08	8.904E+11	8.476E+05	203.9	8	1.950E+05	956.5mm	400.0mm	0.K	
17	216,000.0	1,609.6	3.477E+08	1.616E+12	9.049E+05	194.6	8	1.950E+05	1002.0mm	400.0mm	0.K	
18	216,000.0	1,754.6	3.790E+08	2.161E+12	1.045E+06	183.3	8	1.950E+05	1063.6mm	400.0mm	0.K	P1
19	216,000.0	1,754.6	3.790E+08	2.161E+12	9.334E+05	163.7	8	1.950E+05	1191.4mm	400.0mm	0.K	
20	216,000.0	1,615.9	3.490E+08	1.675E+12	8.784E+05	183.1	8	1.950E+05	1065.2mm	400.0mm	0.K	
21	216,000.0	1,527.8	3.300E+08	1.198E+12	8.523E+05	234.7	8	1.950E+05	830.7mm	400.0mm	0.K	
22	216,000.0	902.6	1.950E+08	6.165E+11	8.303E+05	262.6	8	1.950E+05	742.7mm	450.0mm	0.K	
23	216,000.0	629.9	1.360E+08	3.572E+11	8.141E+05	310.1	8	1.950E+05	628.8mm	450.0mm	0.K	
24	216,000.0	629.9	1.360E+08	3.572E+11	7.996E+05	304.5	8	1.950E+05	640.3mm	450.0mm	0.K	
25	216,000.0	629.9	1.360E+08	3.572E+11	7.880E+05	300.1	8	1.950E+05	649.7mm	450.0mm	0.K	
26	216,000.0	546.8	1.181E+08	2.995E+11	7.837E+05	309.1	8	1.950E+05	630.9mm	450.0mm	0.K	
27	216,000.0	546.8	1.181E+08	2.995E+11	7.818E+05	308.3	8	1.950E+05	632.4mm	450.0mm	0.K	
28	216,000.0	546.8	1.181E+08	2.995E+11	7.826E+05	308.7	8	1.950E+05	631.8mm	450.0mm	0.K	
29	216,000.0	546.8	1.181E+08	2.995E+11	7.859E+05	310.0	8	1.950E+05	629.1mm	450.0mm	0.K	
30	216,000.0	629.9	1.360E+08	3.572E+11	7.966E+05	303.4	8	1.950E+05	642.7mm	450.0mm	0.K	
31	216,000.0	629.9	1.360E+08	3.572E+11	8.092E+05	308.2	8	1.950E+05	632.7mm	450.0mm	0.K	
32	216,000.0	629.9	1.360E+08	3.572E+11	8.218E+05	313.0	8	1.950E+05	623.0mm	450.0mm	0.K	
33	216,000.0	902.6	1.950E+08	6.165E+11	8.410E+05	265.9	8	1.950E+05	733.3mm	450.0mm	0.K	
34	216,000.0	1,527.8	3.300E+08	1.198E+12	8.629E+05	237.7	8	1.950E+05	820.5mm	400.0mm	0.K	
35	216,000.0	1,615.9	3.490E+08	1.675E+12	8.810E+05	183.6	8	1.950E+05	1062.1mm	400.0mm	0.K	
36	216,000.0	1,754.6	3.790E+08	2.161E+12	9.541E+05	167.3	8	1.950E+05	1165.5mm	400.0mm	0.K	
37	216,000.0	1,754.6	3.790E+08	2.161E+12	9.804E+05	171.9	8	1.950E+05	1134.2mm	400.0mm	0.K	P2
38	216,000.0	1,609.6	3.477E+08	1.616E+12	8.663E+05	186.3	8	1.950E+05	1046.6mm	400.0mm	0.K	
39	216,000.0	991.5	2.142E+08	8.904E+11	8.433E+05	202.8	8	1.950E+05	961.4mm	400.0mm	0.K	
40	216,000.0	980.4	2.118E+08	7.232E+11	8.336E+05	244.1	8	1.950E+05	798.9mm	400.0mm	0.K	
41	216,000.0	980.4	2.118E+08	7.232E+11	8.201E+05	240.1	8	1.950E+05	812.1mm	450.0mm	0.K	
42	216,000.0	814.9	1.760E+08	5.542E+11	8.091E+05	257.0	8	1.950E+05	758.8mm	450.0mm	0.K	
43	216,000.0	886.5	1.915E+08	6.585E+11	8.032E+05	233.6	8	1.950E+05	834.9mm	450.0mm	0.K	
44	216,000.0	959.3	2.072E+08	7.431E+11	7.974E+05	222.3	8	1.950E+05	877.0mm	450.0mm	0.K	
45	216,000.0	959.3	2.072E+08	7.431E+11	7.930E+05	221.1	8	1.950E+05	881.9mm	450.0mm	0.K	
46	216,000.0	855.8	1.849E+08	6.307E+11	7.892E+05	231.3	8	1.950E+05	843.0mm	450.0mm	0.K	
47	216,000.0	855.8	1.849E+08	6.307E+11	7.874E+05	230.8	8	1.950E+05	844.8mm	450.0mm	0.K	
48	216,000.0	874.7	1.889E+08	6.254E+11	7.938E+05	239.8	8	1.950E+05	813.2mm	450.0mm	0.K	
49	216,000.0	874.7	1.889E+08	6.254E+11	8.003E+05	241.8	8	1.950E+05	806.5mm	450.0mm	0.K	
50	216,000.0	681.1	1.471E+08	4.428E+11	8.066E+05	268.0	8	1.950E+05	727.5mm	450.0mm	0.K	
51	216,000.0	681.1	1.471E+08	4.428E+11	8.189E+05	272.1	8	1.950E+05	716.6mm	450.0mm	0.K	
52	216,000.0	681.1	1.471E+08	4.428E+11	8.143E+05	270.6	8	1.950E+05	720.7mm	450.0mm	0.K	
53	216,000.0	681.1	1.471E+08	4.428E+11	8.225E+05	273.3	8	1.950E+05	713.5mm	250.0mm	0.K	
54	396,000.0	510.2	2.020E+08	5.802E+11	8.998E+05	313.3	8	1.950E+05	622.3mm	125.0mm	0.K	A2

※ 피로설계에 의한 위치별 전단연결재 간격 검토 (DB하중에 대한 검토)

절점	A_c/n (mm ²)	d_{vc} (mm)	Q_{vc} (mm ³)	I_v (mm ⁴)	V_r (N)	S_r (N/mm)	n	$\sum Z_r$ (N)	소요 간격 d_o	배치 간격	비고	
55	396,000.0	510.2	2.020E+08	5.802E+11	9.708E+05	338.1	8	1.950E+05	584.8mm	125.0mm	O.K	A1
56	216,000.0	681.1	1.471E+08	4.428E+11	8.637E+05	287.0	8	1.950E+05	704.4mm	250.0mm	O.K	
57	216,000.0	681.1	1.471E+08	4.428E+11	8.324E+05	276.6	8	1.950E+05	705.0mm	450.0mm	O.K	
58	216,000.0	681.1	1.471E+08	4.428E+11	8.158E+05	271.1	8	1.950E+05	719.3mm	450.0mm	O.K	
59	216,000.0	681.1	1.471E+08	4.428E+11	8.151E+05	270.9	8	1.950E+05	719.9mm	450.0mm	O.K	
60	216,000.0	874.7	1.889E+08	6.254E+11	8.107E+05	244.9	8	1.950E+05	796.2mm	450.0mm	O.K	
61	216,000.0	874.7	1.889E+08	6.254E+11	8.071E+05	243.8	8	1.950E+05	799.8mm	450.0mm	O.K	
62	216,000.0	855.8	1.849E+08	6.307E+11	8.110E+05	237.7	8	1.950E+05	820.3mm	450.0mm	O.K	
63	216,000.0	855.8	1.849E+08	6.307E+11	8.152E+05	238.9	8	1.950E+05	816.1mm	450.0mm	O.K	
64	216,000.0	959.3	2.072E+08	7.431E+11	8.196E+05	228.5	8	1.950E+05	853.3mm	450.0mm	O.K	
65	216,000.0	959.3	2.072E+08	7.431E+11	8.283E+05	231.0	8	1.950E+05	844.3mm	450.0mm	O.K	
66	216,000.0	886.5	1.915E+08	6.585E+11	8.415E+05	244.7	8	1.950E+05	796.9mm	450.0mm	O.K	
67	216,000.0	814.9	1.760E+08	5.542E+11	8.525E+05	270.8	8	1.950E+05	720.2mm	450.0mm	O.K	
68	216,000.0	980.4	2.118E+08	7.232E+11	8.604E+05	251.9	8	1.950E+05	774.0mm	450.0mm	O.K	
69	216,000.0	980.4	2.118E+08	7.232E+11	8.681E+05	254.2	8	1.950E+05	767.1mm	400.0mm	O.K	
70	216,000.0	991.5	2.142E+08	8.904E+11	8.646E+05	207.9	8	1.950E+05	937.8mm	400.0mm	O.K	
71	216,000.0	1,609.6	3.477E+08	1.616E+12	9.349E+05	201.1	8	1.950E+05	969.8mm	400.0mm	O.K	
72	216,000.0	1,754.6	3.790E+08	2.161E+12	9.729E+05	170.6	8	1.950E+05	1143.0mm	400.0mm	O.K	P1
73	216,000.0	1,754.6	3.790E+08	2.161E+12	8.855E+05	155.3	8	1.950E+05	1255.8mm	400.0mm	O.K	
74	216,000.0	1,615.9	3.490E+08	1.675E+12	8.742E+05	182.2	8	1.950E+05	1070.4mm	400.0mm	O.K	
75	216,000.0	1,527.8	3.300E+08	1.198E+12	8.650E+05	238.2	8	1.950E+05	818.5mm	400.0mm	O.K	
76	216,000.0	902.6	1.950E+08	6.165E+11	8.514E+05	269.2	8	1.950E+05	724.3mm	450.0mm	O.K	
77	216,000.0	629.9	1.360E+08	3.572E+11	8.369E+05	318.8	8	1.950E+05	611.8mm	450.0mm	O.K	
78	216,000.0	629.9	1.360E+08	3.572E+11	8.227E+05	313.4	8	1.950E+05	622.3mm	450.0mm	O.K	
79	216,000.0	629.9	1.360E+08	3.572E+11	8.100E+05	308.5	8	1.950E+05	632.1mm	450.0mm	O.K	
80	216,000.0	546.8	1.181E+08	2.995E+11	8.047E+05	317.4	8	1.950E+05	614.4mm	450.0mm	O.K	
81	216,000.0	546.8	1.181E+08	2.995E+11	8.023E+05	316.4	8	1.950E+05	616.2mm	450.0mm	O.K	
82	216,000.0	546.8	1.181E+08	2.995E+11	8.032E+05	316.8	8	1.950E+05	615.6mm	450.0mm	O.K	
83	216,000.0	546.8	1.181E+08	2.995E+11	8.071E+05	318.3	8	1.950E+05	612.5mm	450.0mm	O.K	
84	216,000.0	629.9	1.360E+08	3.572E+11	8.191E+05	312.0	8	1.950E+05	625.0mm	450.0mm	O.K	
85	216,000.0	629.9	1.360E+08	3.572E+11	8.318E+05	316.8	8	1.950E+05	615.5mm	450.0mm	O.K	
86	216,000.0	629.9	1.360E+08	3.572E+11	8.442E+05	321.5	8	1.950E+05	606.5mm	450.0mm	O.K	
87	216,000.0	902.6	1.950E+08	6.165E+11	8.622E+05	272.7	8	1.950E+05	715.2mm	450.0mm	O.K	
88	216,000.0	1,527.8	3.300E+08	1.198E+12	8.740E+05	240.7	8	1.950E+05	810.1mm	400.0mm	O.K	
89	216,000.0	1,615.9	3.490E+08	1.675E+12	8.775E+05	182.9	8	1.950E+05	1066.4mm	400.0mm	O.K	
90	216,000.0	1,754.6	3.790E+08	2.161E+12	9.483E+05	166.3	8	1.950E+05	1180.6mm	400.0mm	O.K	
91	216,000.0	1,754.6	3.790E+08	2.161E+12	9.796E+05	171.8	8	1.950E+05	1160.2mm	400.0mm	O.K	P2
92	216,000.0	1,609.6	3.477E+08	1.616E+12	8.698E+05	187.1	8	1.950E+05	1042.4mm	400.0mm	O.K	
93	216,000.0	991.5	2.142E+08	8.904E+11	8.574E+05	206.2	8	1.950E+05	945.6mm	400.0mm	O.K	
94	216,000.0	980.4	2.118E+08	7.232E+11	8.526E+05	249.6	8	1.950E+05	781.1mm	400.0mm	O.K	
95	216,000.0	980.4	2.118E+08	7.232E+11	8.396E+05	245.8	8	1.950E+05	793.2mm	450.0mm	O.K	
96	216,000.0	814.9	1.760E+08	5.542E+11	8.287E+05	263.2	8	1.950E+05	740.9mm	450.0mm	O.K	
97	216,000.0	886.5	1.915E+08	6.585E+11	8.219E+05	239.0	8	1.950E+05	815.9mm	450.0mm	O.K	
98	216,000.0	959.3	2.072E+08	7.431E+11	8.159E+05	227.5	8	1.950E+05	857.1mm	450.0mm	O.K	
99	216,000.0	959.3	2.072E+08	7.431E+11	8.116E+05	226.3	8	1.950E+05	861.7mm	450.0mm	O.K	
100	216,000.0	855.8	1.849E+08	6.307E+11	8.075E+05	236.7	8	1.950E+05	823.9mm	450.0mm	O.K	
101	216,000.0	855.8	1.849E+08	6.307E+11	8.041E+05	235.7	8	1.950E+05	827.3mm	450.0mm	O.K	
102	216,000.0	874.7	1.889E+08	6.254E+11	8.093E+05	244.5	8	1.950E+05	797.6mm	450.0mm	O.K	
103	216,000.0	874.7	1.889E+08	6.254E+11	8.159E+05	246.5	8	1.950E+05	791.1mm	450.0mm	O.K	
104	216,000.0	681.1	1.471E+08	4.428E+11	8.224E+05	273.3	8	1.950E+05	713.6mm	450.0mm	O.K	
105	216,000.0	681.1	1.471E+08	4.428E+11	8.344E+05	277.3	8	1.950E+05	703.3mm	450.0mm	O.K	
106	216,000.0	681.1	1.471E+08	4.428E+11	8.334E+05	276.9	8	1.950E+05	704.2mm	450.0mm	O.K	
107	216,000.0	681.1	1.471E+08	4.428E+11	8.681E+05	288.5	8	1.950E+05	676.0mm	250.0mm	O.K	
108	396,000.0	510.2	2.020E+08	4.428E+11	9.509E+05	433.9	8	1.950E+05	449.4mm	125.0mm	O.K	A2

※ 피로설계에 의한 위치별 전단연결재 간격 검토 (DL하중에 대한 검토)

절점	A_c/n (mm ²)	d_{vc} (mm)	Q_{vc} (mm ³)	I_v (mm ⁴)	V_r (N)	S_r (N/mm)	n	$\sum Z_r$ (N)	소요 간격 d_o	배치 간격	비고	
1	396,000.0	510.2	2.020E+08	5.802E+11	1.223E+06	425.8	8	3.700E+05	868.9mm	125.0mm	0.K	A1
2	216,000.0	681.1	1.471E+08	4.428E+11	1.185E+06	393.6	8	3.700E+05	940.1mm	250.0mm	0.K	
3	216,000.0	681.1	1.471E+08	4.428E+11	1.133E+06	376.5	8	3.700E+05	982.7mm	450.0mm	0.K	
4	216,000.0	681.1	1.471E+08	4.428E+11	1.076E+06	357.7	8	3.700E+05	1034.4mm	450.0mm	0.K	
5	216,000.0	681.1	1.471E+08	4.428E+11	1.025E+06	340.5	8	3.700E+05	1086.8mm	450.0mm	0.K	
6	216,000.0	874.7	1.889E+08	6.254E+11	9.830E+05	297.0	8	3.700E+05	1245.9mm	450.0mm	0.K	
7	216,000.0	874.7	1.889E+08	6.254E+11	9.574E+05	289.2	8	3.700E+05	1279.2mm	450.0mm	0.K	
8	216,000.0	855.8	1.849E+08	6.307E+11	9.502E+05	278.5	8	3.700E+05	1328.3mm	450.0mm	0.K	
9	216,000.0	855.8	1.849E+08	6.307E+11	9.578E+05	280.8	8	3.700E+05	1317.8mm	450.0mm	0.K	
10	216,000.0	959.3	2.072E+08	7.431E+11	9.806E+05	273.4	8	3.700E+05	1353.2mm	450.0mm	0.K	
11	216,000.0	959.3	2.072E+08	7.431E+11	1.017E+06	283.7	8	3.700E+05	1304.3mm	450.0mm	0.K	
12	216,000.0	886.5	1.915E+08	6.585E+11	1.072E+06	311.8	8	3.700E+05	1186.6mm	450.0mm	0.K	
13	216,000.0	814.9	1.760E+08	5.542E+11	1.143E+06	362.9	8	3.700E+05	1019.6mm	450.0mm	0.K	
14	216,000.0	980.4	2.118E+08	7.232E+11	1.228E+06	359.6	8	3.700E+05	1029.0mm	450.0mm	0.K	
15	216,000.0	980.4	2.118E+08	7.232E+11	1.349E+06	394.9	8	3.700E+05	937.0mm	400.0mm	0.K	
16	216,000.0	991.5	2.142E+08	8.904E+11	1.515E+06	364.5	8	3.700E+05	1015.2mm	400.0mm	0.K	
17	216,000.0	1,609.6	3.477E+08	1.616E+12	1.830E+06	393.5	8	3.700E+05	940.2mm	400.0mm	0.K	
18	216,000.0	1,754.6	3.790E+08	2.161E+12	2.135E+06	374.3	8	3.700E+05	988.4mm	400.0mm	0.K	P1
19	216,000.0	1,754.6	3.790E+08	2.161E+12	1.735E+06	304.2	8	3.700E+05	1216.2mm	400.0mm	0.K	
20	216,000.0	1,615.9	3.490E+08	1.675E+12	1.491E+06	310.8	8	3.700E+05	1190.6mm	400.0mm	0.K	
21	216,000.0	1,527.8	3.300E+08	1.198E+12	1.361E+06	375.0	8	3.700E+05	986.8mm	400.0mm	0.K	
22	216,000.0	902.6	1.950E+08	6.165E+11	1.257E+06	397.5	8	3.700E+05	930.8mm	450.0mm	0.K	
23	216,000.0	629.9	1.360E+08	3.572E+11	1.175E+06	447.5	8	3.700E+05	826.8mm	450.0mm	0.K	
24	216,000.0	629.9	1.360E+08	3.572E+11	1.110E+06	422.9	8	3.700E+05	874.9mm	450.0mm	0.K	
25	216,000.0	629.9	1.360E+08	3.572E+11	1.064E+06	405.3	8	3.700E+05	912.8mm	450.0mm	0.K	
26	216,000.0	546.8	1.181E+08	2.995E+11	1.036E+06	408.8	8	3.700E+05	905.1mm	450.0mm	0.K	
27	216,000.0	546.8	1.181E+08	2.995E+11	1.025E+06	404.4	8	3.700E+05	915.0mm	450.0mm	0.K	
28	216,000.0	546.8	1.181E+08	2.995E+11	1.030E+06	406.3	8	3.700E+05	910.6mm	450.0mm	0.K	
29	216,000.0	546.8	1.181E+08	2.995E+11	1.052E+06	414.8	8	3.700E+05	892.1mm	450.0mm	0.K	
30	216,000.0	629.9	1.360E+08	3.572E+11	1.091E+06	415.5	8	3.700E+05	890.5mm	450.0mm	0.K	
31	216,000.0	629.9	1.360E+08	3.572E+11	1.148E+06	437.1	8	3.700E+05	846.4mm	450.0mm	0.K	
32	216,000.0	629.9	1.360E+08	3.572E+11	1.220E+06	464.6	8	3.700E+05	796.4mm	450.0mm	0.K	
33	216,000.0	902.6	1.950E+08	6.165E+11	1.313E+06	415.2	8	3.700E+05	891.2mm	450.0mm	0.K	
34	216,000.0	1,527.8	3.300E+08	1.198E+12	1.427E+06	393.1	8	3.700E+05	941.3mm	400.0mm	0.K	
35	216,000.0	1,615.9	3.490E+08	1.675E+12	1.607E+06	334.8	8	3.700E+05	1105.1mm	400.0mm	0.K	
36	216,000.0	1,754.6	3.790E+08	2.161E+12	1.965E+06	344.6	8	3.700E+05	1073.7mm	400.0mm	0.K	
37	216,000.0	1,754.6	3.790E+08	2.161E+12	1.898E+06	332.8	8	3.700E+05	1111.9mm	400.0mm	0.K	P2
38	216,000.0	1,609.6	3.477E+08	1.616E+12	1.564E+06	336.5	8	3.700E+05	1099.6mm	400.0mm	0.K	
39	216,000.0	991.5	2.142E+08	8.904E+11	1.389E+06	334.2	8	3.700E+05	1107.3mm	400.0mm	0.K	
40	216,000.0	980.4	2.118E+08	7.232E+11	1.271E+06	372.3	8	3.700E+05	993.9mm	400.0mm	0.K	
41	216,000.0	980.4	2.118E+08	7.232E+11	1.179E+06	345.3	8	3.700E+05	1071.6mm	450.0mm	0.K	
42	216,000.0	814.9	1.760E+08	5.542E+11	1.103E+06	350.4	8	3.700E+05	1055.8mm	450.0mm	0.K	
43	216,000.0	886.5	1.915E+08	6.585E+11	1.044E+06	303.5	8	3.700E+05	1219.2mm	450.0mm	0.K	
44	216,000.0	959.3	2.072E+08	7.431E+11	1.002E+06	279.4	8	3.700E+05	1324.2mm	450.0mm	0.K	
45	216,000.0	959.3	2.072E+08	7.431E+11	9.745E+05	271.7	8	3.700E+05	1361.6mm	450.0mm	0.K	
46	216,000.0	855.8	1.849E+08	6.307E+11	9.616E+05	281.9	8	3.700E+05	1312.6mm	450.0mm	0.K	
47	216,000.0	855.8	1.849E+08	6.307E+11	9.629E+05	282.2	8	3.700E+05	1310.9mm	450.0mm	0.K	
48	216,000.0	874.7	1.889E+08	6.254E+11	9.818E+05	296.6	8	3.700E+05	1247.4mm	450.0mm	0.K	
49	216,000.0	874.7	1.889E+08	6.254E+11	1.016E+06	306.9	8	3.700E+05	1205.5mm	450.0mm	0.K	
50	216,000.0	681.1	1.471E+08	4.428E+11	1.059E+06	351.9	8	3.700E+05	1051.4mm	450.0mm	0.K	
51	216,000.0	681.1	1.471E+08	4.428E+11	1.116E+06	370.8	8	3.700E+05	998.0mm	450.0mm	0.K	
52	216,000.0	681.1	1.471E+08	4.428E+11	1.163E+06	386.4	8	3.700E+05	957.6mm	450.0mm	0.K	
53	216,000.0	681.1	1.471E+08	4.428E+11	1.227E+06	407.6	8	3.700E+05	907.7mm	250.0mm	0.K	
54	396,000.0	510.2	2.020E+08	5.802E+11	1.292E+06	449.8	8	3.700E+05	822.6mm	125.0mm	0.K	A2

※ 피로설계에 의한 위치별 전단연결재 간격 검토 (DL하중에 대한 검토)

절점	A_c/n (mm ²)	d_{vc} (mm)	Q_{vc} (mm ³)	I_v (mm ⁴)	V_r (N)	S_r (N/mm)	n	$\sum Z_r$ (N)	소요 간격 d_o	배치 간격	비고	
55	396,000.0	510.2	2.020E+08	5.802E+11	1.477E+06	514.5	8	3.700E+05	719.2mm	125.0mm	0.K	A1
56	216,000.0	681.1	1.471E+08	4.428E+11	1.258E+06	418.0	8	3.700E+05	885.2mm	250.0mm	0.K	
57	216,000.0	681.1	1.471E+08	4.428E+11	1.172E+06	389.4	8	3.700E+05	950.3mm	450.0mm	0.K	
58	216,000.0	681.1	1.471E+08	4.428E+11	1.101E+06	365.7	8	3.700E+05	1011.7mm	450.0mm	0.K	
59	216,000.0	681.1	1.471E+08	4.428E+11	1.050E+06	348.7	8	3.700E+05	1060.9mm	450.0mm	0.K	
60	216,000.0	874.7	1.889E+08	6.254E+11	1.009E+06	305.0	8	3.700E+05	1213.3mm	450.0mm	0.K	
61	216,000.0	874.7	1.889E+08	6.254E+11	9.860E+05	297.9	8	3.700E+05	1242.2mm	450.0mm	0.K	
62	216,000.0	855.8	1.849E+08	6.307E+11	9.787E+05	286.9	8	3.700E+05	1289.7mm	450.0mm	0.K	
63	216,000.0	855.8	1.849E+08	6.307E+11	9.851E+05	288.7	8	3.700E+05	1281.4mm	450.0mm	0.K	
64	216,000.0	959.3	2.072E+08	7.431E+11	1.005E+06	280.3	8	3.700E+05	1319.9mm	450.0mm	0.K	
65	216,000.0	959.3	2.072E+08	7.431E+11	1.039E+06	289.8	8	3.700E+05	1276.9mm	450.0mm	0.K	
66	216,000.0	886.5	1.915E+08	6.585E+11	1.092E+06	317.4	8	3.700E+05	1165.7mm	450.0mm	0.K	
67	216,000.0	814.9	1.760E+08	5.542E+11	1.156E+06	367.1	8	3.700E+05	1007.8mm	450.0mm	0.K	
68	216,000.0	980.4	2.118E+08	7.232E+11	1.231E+06	360.6	8	3.700E+05	1026.2mm	450.0mm	0.K	
69	216,000.0	980.4	2.118E+08	7.232E+11	1.321E+06	386.8	8	3.700E+05	956.5mm	400.0mm	0.K	
70	216,000.0	991.5	2.142E+08	8.904E+11	1.425E+06	342.7	8	3.700E+05	1079.7mm	400.0mm	0.K	
71	216,000.0	1,609.6	3.477E+08	1.616E+12	1.683E+06	361.9	8	3.700E+05	1022.4mm	400.0mm	0.K	
72	216,000.0	1,754.6	3.790E+08	2.161E+12	1.765E+06	309.5	8	3.700E+05	1195.3mm	400.0mm	0.K	P1
73	216,000.0	1,754.6	3.790E+08	2.161E+12	1.561E+06	273.7	8	3.700E+05	1352.0mm	400.0mm	0.K	
74	216,000.0	1,615.9	3.490E+08	1.675E+12	1.452E+06	302.6	8	3.700E+05	1222.7mm	400.0mm	0.K	
75	216,000.0	1,527.8	3.300E+08	1.198E+12	1.370E+06	377.4	8	3.700E+05	980.3mm	400.0mm	0.K	
76	216,000.0	902.6	1.950E+08	6.165E+11	1.286E+06	406.6	8	3.700E+05	909.9mm	450.0mm	0.K	
77	216,000.0	629.9	1.360E+08	3.572E+11	1.211E+06	461.3	8	3.700E+05	802.1mm	450.0mm	0.K	
78	216,000.0	629.9	1.360E+08	3.572E+11	1.148E+06	437.4	8	3.700E+05	845.9mm	450.0mm	0.K	
79	216,000.0	629.9	1.360E+08	3.572E+11	1.099E+06	418.8	8	3.700E+05	883.5mm	450.0mm	0.K	
80	216,000.0	546.8	1.181E+08	2.995E+11	1.069E+06	421.4	8	3.700E+05	877.9mm	450.0mm	0.K	
81	216,000.0	546.8	1.181E+08	2.995E+11	1.056E+06	416.4	8	3.700E+05	888.6mm	450.0mm	0.K	
82	216,000.0	546.8	1.181E+08	2.995E+11	1.061E+06	418.5	8	3.700E+05	884.0mm	450.0mm	0.K	
83	216,000.0	546.8	1.181E+08	2.995E+11	1.085E+06	427.9	8	3.700E+05	864.7mm	450.0mm	0.K	
84	216,000.0	629.9	1.360E+08	3.572E+11	1.127E+06	429.3	8	3.700E+05	861.9mm	450.0mm	0.K	
85	216,000.0	629.9	1.360E+08	3.572E+11	1.183E+06	450.6	8	3.700E+05	821.1mm	450.0mm	0.K	
86	216,000.0	629.9	1.360E+08	3.572E+11	1.251E+06	476.6	8	3.700E+05	776.3mm	450.0mm	0.K	
87	216,000.0	902.6	1.950E+08	6.165E+11	1.332E+06	421.1	8	3.700E+05	878.7mm	450.0mm	0.K	
88	216,000.0	1,527.8	3.300E+08	1.198E+12	1.413E+06	389.1	8	3.700E+05	950.9mm	400.0mm	0.K	
89	216,000.0	1,615.9	3.490E+08	1.675E+12	1.521E+06	317.0	8	3.700E+05	1167.2mm	400.0mm	0.K	
90	216,000.0	1,754.6	3.790E+08	2.161E+12	1.785E+06	313.0	8	3.700E+05	1182.2mm	400.0mm	0.K	
91	216,000.0	1,754.6	3.790E+08	2.161E+12	1.794E+06	314.6	8	3.700E+05	1175.9mm	400.0mm	0.K	P2
92	216,000.0	1,609.6	3.477E+08	1.616E+12	1.522E+06	327.2	8	3.700E+05	1130.6mm	400.0mm	0.K	
93	216,000.0	991.5	2.142E+08	8.904E+11	1.386E+06	333.4	8	3.700E+05	1109.7mm	400.0mm	0.K	
94	216,000.0	980.4	2.118E+08	7.232E+11	1.284E+06	375.9	8	3.700E+05	984.2mm	400.0mm	0.K	
95	216,000.0	980.4	2.118E+08	7.232E+11	1.196E+06	350.3	8	3.700E+05	1056.2mm	450.0mm	0.K	
96	216,000.0	814.9	1.760E+08	5.542E+11	1.123E+06	356.6	8	3.700E+05	1037.6mm	450.0mm	0.K	
97	216,000.0	886.5	1.915E+08	6.585E+11	1.063E+06	309.0	8	3.700E+05	1197.4mm	450.0mm	0.K	
98	216,000.0	959.3	2.072E+08	7.431E+11	1.021E+06	284.7	8	3.700E+05	1299.6mm	450.0mm	0.K	
99	216,000.0	959.3	2.072E+08	7.431E+11	9.935E+05	277.0	8	3.700E+05	1335.6mm	450.0mm	0.K	
100	216,000.0	855.8	1.849E+08	6.307E+11	9.797E+05	287.2	8	3.700E+05	1288.4mm	450.0mm	0.K	
101	216,000.0	855.8	1.849E+08	6.307E+11	9.799E+05	287.2	8	3.700E+05	1288.1mm	450.0mm	0.K	
102	216,000.0	874.7	1.889E+08	6.254E+11	9.970E+05	301.2	8	3.700E+05	1228.4mm	450.0mm	0.K	
103	216,000.0	874.7	1.889E+08	6.254E+11	1.030E+06	311.1	8	3.700E+05	1189.2mm	450.0mm	0.K	
104	216,000.0	681.1	1.471E+08	4.428E+11	1.072E+06	356.3	8	3.700E+05	1038.3mm	450.0mm	0.K	
105	216,000.0	681.1	1.471E+08	4.428E+11	1.136E+06	377.4	8	3.700E+05	980.3mm	450.0mm	0.K	
106	216,000.0	681.1	1.471E+08	4.428E+11	1.199E+06	398.4	8	3.700E+05	928.8mm	450.0mm	0.K	
107	216,000.0	681.1	1.471E+08	4.428E+11	1.344E+06	446.5	8	3.700E+05	828.7mm	250.0mm	0.K	
108	396,000.0	510.2	2.020E+08	4.428E+11	1.414E+06	645.2	8	3.700E+05	573.4mm	125.0mm	0.K	A2

7) 전단연결재의 극한강도검토

(도.설.해 3.9.5.10)

■ 전단연결재의 극한강도

$$V_u = 0.4 \cdot d^2 \cdot \sqrt{f_{ck} \cdot E_c}$$

$$= 0.4 \times 25.0^2 \times \sqrt{27.0 \times 28,693.4}$$

$$= 220,045.7 \text{ N} > A_{sc} f_u = \pi/4 \cdot d^2 \cdot f_u = 490.9 \times 410.0 = 201,258.3 \text{ N}$$

여기서, V_u : 전단연결재의 극한강도 (N) 단, $V_u \leq A_{sc} f_u$
 d : 전단연결재의 지름 (mm)
 f_{ck} : 콘크리트의 28일 압축강도 (MPa)
 A_{sc} : 전단연결재의 단면적 (mm²)
 f_u : 전단연결재의 인장강도 (MPa)

■ 최대 정모멘트부의 슬래브에 작용하는 힘

※ 최대 정모멘트부의 슬래브에 작용하는 힘은 다음 두 식의 값 중 작은 값을 취한다.

여기서, A_s : 덮개판을 포함하는 강재 단면의 총면적(mm²)
 $P_1 = A_s \cdot f_y$ f_y : 사용된 강재의 최소 공칭항복응력(MPa) [345.0 MPa]
 f_{ck} : 콘크리트의 28일 압축강도(MPa)
 $P_2 = 0.85 \cdot f_{ck} \cdot b \cdot t_s$ b : 슬래브의 유효폭(mm)
 t_s : 콘크리트 슬래브의 두께(mm) [240.0 mm]

■ 최대 부모멘트부의 슬래브에 작용하는 힘

여기서, A_r : 내부지점부 유효 슬래브 폭 내에 설치된 종방향 철근의 총단면적(mm²)
 $P_3 = A_r \cdot f_y^r$ f_y^r : 철근의 최소 항복응력(MPa) [400.0 MPa]

■ 전단연결재 필요개수

여기서, N_1 : 최대 정모멘트부와 인접한 교대 지점부 사이의 전단연결재 개수
 $N_1 = P / (\Phi V_u)$ P : 슬래브에 작용하는 힘 P_1 또는 P_2 중 작은 값(N)
 Φ : 감소계수 [0.85]
 $N_2 = (P + P_3) / (\Phi V_u)$ N_2 : 최대 정모멘트부와 인접한 최대부모멘트부 사이의 전단연결재 개수

※ 구간별 전단연결재 필요개수 및 설치개수 검토

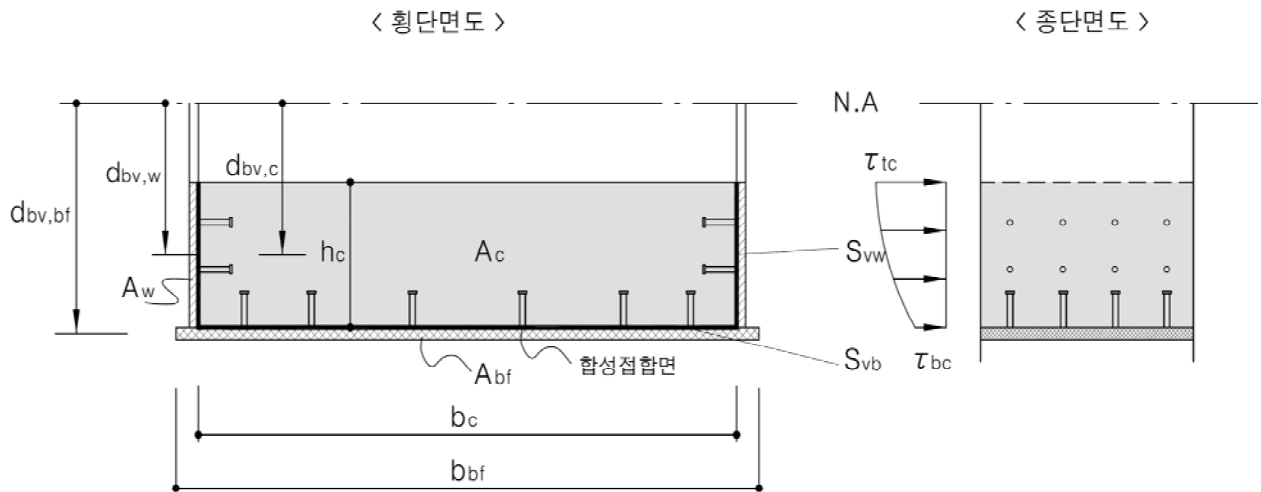
위 치 (절점번호)	b (mm)	A_s (mm ²)	A_r (mm ²)	P_1 (N)	P_2 (N)	P_3 (N)	필요개수		설치 개수	비고
							N_1	N_2		
1 ~ 9	6,300.0	207,400.0	0.0	7.155E+07	3.470E+07	0.000E+00	203	-	624	0.K
9 ~ 18	6,300.0	207,400.0	51,075.4	7.155E+07	3.470E+07	2.043E+07	-	322	624	0.K
18 ~ 27	6,300.0	106,600.0	51,075.4	3.678E+07	3.470E+07	2.043E+07	-	322	618	0.K
27 ~ 37	6,300.0	106,600.0	51,075.4	3.678E+07	3.470E+07	2.043E+07	-	322	678	0.K
37 ~ 46	6,300.0	207,400.0	51,075.4	7.155E+07	3.470E+07	2.043E+07	-	322	624	0.K
46 ~ 54	6,300.0	207,400.0	0.0	7.155E+07	3.470E+07	0.000E+00	203	-	618	0.K
55 ~ 62	6,300.0	207,400.0	0.0	7.155E+07	3.470E+07	0.000E+00	203	-	564	0.K
62 ~ 72	6,300.0	207,400.0	51,075.4	7.155E+07	3.470E+07	2.043E+07	-	322	684	0.K
72 ~ 81	6,300.0	106,600.0	51,075.4	3.678E+07	3.470E+07	2.043E+07	-	322	618	0.K
81 ~ 91	6,300.0	106,600.0	51,075.4	3.678E+07	3.470E+07	2.043E+07	-	322	678	0.K
91 ~ 100	6,300.0	207,400.0	51,075.4	7.155E+07	3.470E+07	2.043E+07	-	322	624	0.K
100 ~ 108	6,300.0	207,400.0	0.0	7.155E+07	3.470E+07	0.000E+00	203	-	618	0.K

※ b , A_s , A_r 값은 구간내에서 가장 큰 값을 사용합니다.

10.2 하부슬래브 전단연결재

1) 단일합성후 고정하중에 의한 수평전단력

(도.설 3.9.5.7~9)



① 수평전단력 산정 기본식

$$\bullet S_v = V \cdot Q_v / I_v \text{ (N/mm)}, \quad \bullet Q_v = A \cdot d_v / n \text{ (mm}^3\text{)}$$

여기서, S_v : 수평전단력 (N/mm)

I_v : 단일합성 중립축에서의 단면2차모멘트(mm⁴)

V : 단일합성후 작용하중에 의한 수직전단력(N)

Q_v : 단일합성단면 중립축에 대한 접합면 기준 단면1차모멘트(mm³)

d_v : 단일합성단면 중립축에서 접합면 외측 단면의 도심까지의 거리(mm)

② 하부플랜지와 콘크리트 최하단과의 접합면 수평전단력 산정

$$\bullet S_{vb} = V_{d1} \cdot Q_{v,bf} / I_v \text{ (N/mm)}$$

여기서, V_{d1} : 단일합성후 상부바닥판 자중에 의한 수직전단력(N)

$Q_{v,bf}$: 하부플랜지의 단일합성단면 중립축에 대한 단면1차모멘트(mm³)

$$= A_{bf} \cdot d_{bv,bf}$$

$d_{bv,bf}$: 하부플랜지 도심에서 단일합성단면 중립축까지의 거리(mm)

③ 복부하단부와 콘크리트 접합면 수평전단력 산정

$$\bullet S_{vw} = 2 \cdot (\tau_{tc} + \tau_{bc}) \cdot h_c / 2$$

여기서, τ_{tc} : 복부측 접합면 최상단의 전단응력(MPa)

$$= V_{d1} \cdot (Q_{v,c} + Q_{v,bf} + Q_{v,w}) / (b_c \cdot I_v)$$

τ_{bc} : 복부측 접합면 최하단의 전단응력(Mpa)

$$= V_{d1} \cdot Q_{v,bf} / (b_c \cdot I_v)$$

$Q_{v,c}$: 하부콘크리트의 단일합성단면 중립축에 대한 단면1차모멘트(mm³)

$$= A_c / n \cdot d_{bv,c}$$

$Q_{v,bf}$: 하부플랜지의 단일합성단면 중립축에 대한 단면1차모멘트(mm³)

$$= A_{bf} \cdot d_{bv,bf}$$

$Q_{v,w}$: 양측 복부의 단일합성단면 중립축에 대한 단면1차모멘트(mm³)

$$= 2 \cdot A_w \cdot d_{bv,w}$$

$d_{bv,c}$: 하부콘크리트 도심에서 단일합성단면 중립축까지의 거리(mm)

$d_{bv,bf}$: 하부플랜지 도심에서 단일합성단면 중립축까지의 거리(mm)

$d_{bv,w}$: 복부 도심에서 단일합성단면 중립축까지의 거리(mm)

④ 위치별 전단응력 산정

절점	단 면	A _c / n (mm ²)	A _{bf} (mm ²)	A _w (mm ²)	d _{bv,c} (mm)	d _{bv,bf} (mm)	d _{bv,w} (mm)	τ _{tc} (MPa)	τ _{bc} (MPa)	비 고
16	단면9	140,571	57,200	13,120	814	1,030	814	0.27026	0.08652	
17	단면10	168,000	57,200	15,680	934	1,190	934	0.29530	0.08389	
18	단면11	205,714	72,800	21,600	1,107	1,421	1,107	0.25814	0.07521	
19	단면12	181,714	57,200	16,960	957	1,233	957	0.24685	0.06679	
20	단면13	161,143	57,200	15,040	874	1,120	874	0.23703	0.06964	
21	단면14	132,000	57,200	12,320	736	939	736	0.21978	0.07384	

절점	단 면	Q _{v,c} (mm ³)	Q _{v,bf} (mm ³)	Q _{v,w} (mm ³)	I _v (mm ⁴)	V _{d1} (kN)	S _{vw,d1} (N/mm)	S _{vb,d1} (N/mm)	ΣS _{v,d1} (N/mm)	비 고
16	단면9	1.14.E+08	5.89.E+07	1.07.E+07	5.48.E+11	1,932.69	146.3	207.7	353.9	
17	단면10	1.57.E+08	6.81.E+07	1.46.E+07	7.53.E+11	2,227.69	185.8	201.3	387.1	
18	단면11	2.28.E+08	1.03.E+08	2.39.E+07	1.19.E+12	2,071.28	200.0	180.5	380.5	
19	단면12	1.74.E+08	7.05.E+07	1.62.E+07	8.14.E+11	1,850.65	166.2	160.3	326.5	
20	단면13	1.41.E+08	6.41.E+07	1.31.E+07	6.21.E+11	1,620.76	144.1	167.1	311.3	
21	단면14	9.71.E+07	5.37.E+07	9.06.E+06	4.16.E+11	1,371.45	113.0	177.2	290.3	

2) 이종합성후 고정하중 및 활하중에 의한 수평 전단력

※ "1) 단일합성후 고정하중에 의한 수평전단력"과 수평전단력 산정방식은 동일하나, 단면강성과 하중이 변화 됨.

V_{d2}: 이종합성후 2차고정하중(DL3)에 의한 수직전단력, V_a: 이종합성후 활하중(LL+SET)에 의한 수평전단력

절점	단 면	A _c / n (mm ²)	A _{bf} (mm ²)	A _w (mm ²)	d _{bv,c} (mm)	d _{bv,bf} (mm)	d _{bv,w} (mm)	τ _{tc} (MPa)	τ _{bc} (MPa)	비 고
16	단면9	140,571	57,200	13,120	995	1,211	995	0.29386	0.09162	
17	단면10	168,000	57,200	15,680	1,088	1,344	1,088	0.49269	0.13688	
18	단면11	205,714	72,800	21,600	1,227	1,541	1,227	0.47006	0.13483	
19	단면12	181,714	57,200	16,960	1,101	1,377	1,101	0.43318	0.11468	
20	단면13	161,143	57,200	15,040	1,013	1,259	1,013	0.41253	0.11860	
21	단면14	132,000	57,200	12,320	893	1,097	893	0.38410	0.12574	

절점	단 면	Q _{v,c} (mm ³)	Q _{v,bf} (mm ³)	Q _{v,w} (mm ³)	I _v (mm ⁴)	V _{d2} (kN)	V _a (kN)	S _{vw,d2+a} (N/mm)	S _{vb,d2+a} (N/mm)	ΣS _{v,d2+a} (N/mm)
16	단면9	1.40.E+08	6.92.E+07	1.30.E+07	7.05.E+11	872.19	1,365.24	158.0	219.9	377.9
17	단면10	1.83.E+08	7.69.E+07	1.71.E+07	9.06.E+11	2,227.69	1,644.52	308.5	328.5	637.0
18	단면11	2.52.E+08	1.12.E+08	2.65.E+07	1.34.E+12	2,071.28	1,793.04	362.9	323.6	686.5
19	단면12	2.00.E+08	7.88.E+07	1.87.E+07	9.62.E+11	1,850.65	1,512.45	290.4	275.2	565.6
20	단면13	1.63.E+08	7.20.E+07	1.52.E+07	7.40.E+11	1,620.76	1,304.20	249.6	284.6	534.3
21	단면14	1.18.E+08	6.27.E+07	1.10.E+07	5.25.E+11	1,371.45	1,155.55	196.3	301.8	498.1

3) 건조수축 및 온도차에 의한 지점부 수평전단력

① 전단력의 분포길이 산정 :

(도.설 3.9.5.3)

- 하부콘크리트 폭 : 2.4 m

∴ 전단분포폭은 하부콘크리트 폭으로 함. $a = 2.40 \text{ m}$

② 건조수축에 의한 수평전단력 :

(도.설.편 p506-173)

(강교설계의 기초 p.262, 건설도서)

n_2 : 21

I_s : 강재 단면2차모멘트, mm^4

A_c : 하부콘크리트 단면적, mm^2

I_c : 하부콘크리트 단면2차모멘트, mm^4

A_s : 강재 단면적, mm^2

E_s : 205,000 MPa (강재의 탄성계수)

d : 강재도심과 하부콘크리트 중심간 거리, mm ϵ_s : 0.00027 (콘크리트의 건조수축에 의한 최종수축율)

$$P_2 = E_s \cdot \epsilon_s \cdot A_c / n_2 \text{ (N)}$$

$$F_2 = \frac{1}{1 + \frac{A_c}{n_2 \cdot A_s} + \frac{A_c \cdot d^2}{I_c + n_2 \cdot I_s}}$$

$$N_{cs} = P_2 \cdot F_2 = \text{N}$$

$$S_s = 2 \cdot N_{cs} / a = \text{N/mm}$$

- 각위치별 건조수축에 의한 수평전단력 :

절점	단 면	A_c (mm^2)	A_s (mm^2)	d (mm)	I_s (mm^4)	I_c (mm^4)	P_2 (N)	F_2	N_{cs} (N)	S_s (N/mm)	비고
16	단면9	984,000	179,840	1,344	2.64.E+11	1.38.E+10	2.594E+06	0.633	1.64E+06	1367.3	경계부
17	단면10	1,176,000	244,992	1,567	5.15.E+11	2.35.E+10	3.100E+06	0.669	2.07E+06	0.0	
18	단면11	1,440,000	330,480	1,780	8.18.E+11	4.32.E+10	3.795E+06	0.679	2.58E+06	2148.2	교각부
19	단면12	1,272,000	256,656	1,623	5.47.E+11	2.98.E+10	3.353E+06	0.655	2.20E+06	0.0	
20	단면13	1,128,000	189,088	1,449	2.84.E+11	2.08.E+10	2.973E+06	0.595	1.77E+06	0.0	
21	단면14	924,000	180,256	1,197	2.30.E+11	1.14.E+10	2.435E+06	0.659	1.60E+06	1337.0	경계부

※ "경계부"는 단일합성과의 경계 단부 임.

③ 온도차에 의한 수평전단력 :

$n = 7$

I_s : 강재 단면2차모멘트, mm^4

A_c : 하부콘크리트 단면적, mm^2

I_c : 하부콘크리트 단면2차모멘트, mm^4

A_s : 강재 단면적, mm^2

$$P_1 = E_s \cdot \alpha \cdot \Delta t \cdot A_c / n \text{ (N)}$$

d : 강재도심과 바닥판 중심간 거리, mm

$E_s = 205,000 \text{ MPa}$ (강재의 탄성계수)

$\alpha = 0.000012$ (강재 및 콘크리트의 선팽창계수)

$\Delta t = 5 \text{ } ^\circ\text{C}$ (바닥판 콘크리트와 강재와의 온도차)

※ 하부콘크리트는 강박스 내부에 위치하여

온도영향이 미미하므로 $5 \text{ } ^\circ\text{C}$ 만을 고려함.

$$F_1 = \frac{1}{1 + \frac{A_c}{n \cdot A_s} + \frac{A_c \cdot d^2}{I_c + n \cdot I_s}}$$

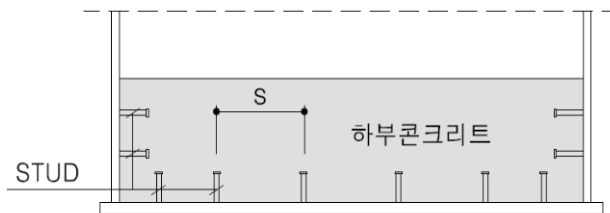
$$N_{cs} = P_1 \cdot F_1 = N$$

$$St = 2 \cdot N_{cs} / a = N/mm$$

- 각위치별 온도차에 의한 수평전단력 :

절점	단 면	A_c (mm^2)	A_s (mm^2)	d (mm)	I_s (mm^4)	I_c (mm^4)	P_1 (N)	F_1	N_{cs} (N)	St (N/mm)	비고
16	단면9	984,000	179,840	1,344	2.64.E+11	1.38.E+10	1.729E+06	0.365	6.32E+05	526.4	경계부
17	단면10	1,176,000	244,992	1,567	5.15.E+11	2.35.E+10	2.066E+06	0.403	8.33E+05	0.0	
18	단면11	1,440,000	330,480	1,780	8.18.E+11	4.32.E+10	2.530E+06	0.414	1.05E+06	873.8	교각부
19	단면12	1,272,000	256,656	1,623	5.47.E+11	2.98.E+10	2.235E+06	0.388	8.67E+05	0.0	
20	단면13	1,128,000	189,088	1,449	2.84.E+11	2.08.E+10	1.982E+06	0.330	6.54E+05	0.0	
21	단면14	924,000	180,256	1,197	2.30.E+11	1.14.E+10	1.624E+06	0.392	6.37E+05	530.6	경계부

4) STUD의 배치 간격



$H = 150 \text{ mm}$ (h : stud 의 전높이)

$d = 25 \text{ mm}$ (d : stud 의 직경)

① STUD의 허용전단력 :

(도.설 3.9.5.6)

$$H / d = 150 / 25 = 6.000 > 5.5 \text{ 이므로}$$

$$Q_a = 9.5 \cdot d^2 \cdot \sqrt{f_{ck}} = 9.5 \times (25)^2 \times \sqrt{40} = 37,552 \text{ N/본}$$

- 단일합성 경계부 : $Q_a' = n(\text{횡방향 스테드 갯수}) \times Q_a(\text{본당허용전단력}) = 12 \times 37,552 = 450,624 \text{ N}$

- 일반부 : $Q_a' = n(\text{횡방향 스테드 갯수}) \times Q_a(\text{본당허용전단력}) = 10 \times 37,552 = 375,520 \text{ N}$

- 교각부 : $Q_a' = n(\text{횡방향 스테드 갯수}) \times Q_a(\text{본당허용전단력}) = 14 \times 37,552 = 525,728 \text{ N}$

② STUD의 배치간격 :

$$d_o = Q_a' / S \quad (S : \text{수평전단력})$$

5) 하중조합에 따른 STUD 의 배치

절점	하 중 조 합 (N/mm)					소요간격	배치간격	비 고	
	Sv(고정하중+활하중)	Ss(건조수축)	St(온도차)	조합력(Sv+St)	조합력(Ss+St)	do=Qa' / S			
16	731.9	1,367.3	526.4	1,258.2	1,893.6	238 mm	150 mm	0.K	경계부
17	1,024.1	0.0	0.0	1,024.1	0.0	367 mm	150 mm	0.K	
18	1,067.0	2,148.2	873.8	1,940.9	3,022.0	174 mm	150 mm	0.K	교각부
19	892.1	0.0	0.0	892.1	0.0	421 mm	150 mm	0.K	
20	845.5	0.0	0.0	845.5	0.0	444 mm	150 mm	0.K	
21	788.3	1,337.0	530.6	1,318.9	1,867.5	241 mm	150 mm	0.K	경계부

① STUD 배치 간격 검토 : (도.설 3.9.5.4, 3.9.5.5)

- stud의 최대간격 검토

바닥판콘크리트 두께의 3배 ($3 \times 385 = 1155 \text{ mm}$) 이고, 600 mm 이하

⇒ 150 mm 이하 사용

0.K

- stud의 최소간격 검토

교축방향 : $5 \cdot d = 125 \text{ mm or } 100 \text{ mm} \Rightarrow 150 \text{ mm}$ 사용

0.K

교축직각방향 : $d + 30 = 55 \text{ mm} \Rightarrow 75 \text{ mm}$ 사용

0.K

플랜지연단 순간격 : $25 \text{ mm} \Rightarrow 100 - 25 / 2 = 87.5 \text{ mm}$ 사용

0.K

6) 전단연결재의 피로설계

(도.설 3.9.5.9)

① 수평전단력 범위 :

$$Sr = \frac{Vr \cdot Q}{I}$$

Sr : 설계대상 단면의 슬래브와 주거더 사이의 수평전단력 범위 (N/mm)

Vr : 충격을 포함하는 활하중에 대한 전단력의 범위 (N)

Q : 정모멘트부 ⇒ 합성단면의 중립축에 대한 접합면의 단면1차모멘트(mm^3)

부모멘트부 ⇒ 합성단면의 중립축에 대한 철근의 단면1차모멘트(mm^3)

I : 합성단면의 단면2차모멘트(mm^4) - 부모멘트부의 경우 철근 고려

② 허용수평전단력 범위 :

$$Zr = \beta \cdot d^2 \Rightarrow 55 \times 25.0^2 = 34375 \text{ N (DB 하중의 경우)}$$

$$\Rightarrow 74 \times 25.0^2 = 46250 \text{ N (DL 하중의 경우)}$$

Zr : 전단연결재의 허용수평전단력 범위 (N)

d : 25 mm (stud 의 지름)

β : 55 (하중 반복회수 : DB 하중 - 200만이상)

74 (하중 반복회수 : DL 하중 - 50만)

③ 피로를 고려한 전단연결재의 필요간격 :

$$do = \frac{\sum Zr}{Sr}$$

do : $\sum Zr = n \cdot Zr$

n : 한 단면에 설치된 전단연결재의 총 개수

④ 활하중 피로에 의한 전단연결재 간격 검토

- 단면특성

절점	단 면	A _c / n (mm ²)	A _{bf} (mm ²)	A _w (mm ²)	d _{bv,c} (mm)	d _{bv,bf} (mm)	d _{bv,w} (mm)	I _v (mm ⁴)	Q _{v,c} (mm ³)	Q _{v,bf} (mm ³)	Q _{v,w} (mm ³)
16	단면9	140,571	57,200	13,120	995	1,211	995	7.05.E+11	1.40.E+08	6.92.E+07	1.30.E+07
17	단면10	168,000	57,200	15,680	1,088	1,344	1,088	9.06.E+11	1.83.E+08	7.69.E+07	1.71.E+07
18	단면11	205,714	72,800	21,600	1,227	1,541	1,227	1.34.E+12	2.52.E+08	1.12.E+08	2.65.E+07
19	단면12	181,714	57,200	16,960	1,101	1,377	1,101	9.62.E+11	2.00.E+08	7.88.E+07	1.87.E+07
20	단면13	161,143	57,200	15,040	1,013	1,259	1,013	7.40.E+11	1.63.E+08	7.20.E+07	1.52.E+07
21	단면14	132,000	57,200	12,320	893	1,097	893	5.25.E+11	1.18.E+08	6.27.E+07	1.10.E+07

- DB24에 대한 전단연결재 간격 검토

절점	단 면	V _r (kN)	τ _{tc} (MPa)	τ _{bc} (MPa)	S _{vw,r} (N/mm)	S _{vb,r} (N/mm)	ΣS _r (N/mm)	횡갯수 n	ΣZ _r (N)	소요 간격 do(mm)	배치 간격 (mm)	비 고
16	단면9	712.72	0.09361	0.02918	50.3	70.0	120.4	12	4.125E+05	3426	150	O.K.
17	단면10	777.87	0.09897	0.02750	62.0	66.0	128.0	10	3.438E+05	2686	150	O.K.
18	단면11	888.03	0.10802	0.03098	83.4	74.4	157.8	14	4.813E+05	3050	150	O.K.
19	단면12	830.10	0.10692	0.02831	71.7	67.9	139.6	10	3.438E+05	2462	150	O.K.
20	단면13	775.12	0.10932	0.03143	66.2	75.4	141.6	10	3.438E+05	2428	150	O.K.
21	단면14	723.00	0.10989	0.03597	56.2	86.3	142.5	12	4.125E+05	2895	150	O.K.

- DL24에 대한 전단연결재 간격 검토

절점	단 면	V _r (kN)	τ _{tc} (MPa)	τ _{bc} (MPa)	S _{vw,r} (N/mm)	S _{vb,r} (N/mm)	ΣS _r (N/mm)	횡갯수 n	ΣZ _r (N)	소요 간격 do(mm)	배치 간격 (mm)	비 고
16	단면9	712.72	0.09361	0.02918	50.3	70.0	120.4	12	5.550E+05	4610	150	O.K.
17	단면10	777.87	0.09897	0.02750	62.0	66.0	128.0	10	4.625E+05	3614	150	O.K.
18	단면11	888.03	0.10802	0.03098	83.4	74.4	157.8	14	6.475E+05	4104	150	O.K.
19	단면12	830.10	0.10692	0.02831	71.7	67.9	139.6	10	4.625E+05	3313	150	O.K.
20	단면13	775.12	0.10932	0.03143	66.2	75.4	141.6	10	4.625E+05	3267	150	O.K.
21	단면14	723.00	0.10989	0.03597	56.2	86.3	142.5	12	5.550E+05	3895	150	O.K.

7) 전단연결재의 극한강도검토

(도.설 3.9.5.10)

① 전단연결재의 극한강도 :

$$\begin{aligned} V_u &= 0.4 d^2 \sqrt{f_{ck} \cdot E_c} \\ &= 0.4 \times 25^2 \times \sqrt{40 \times 30891} \\ &= 277899 \text{ N} > A_{sc} f_u \end{aligned}$$

V_u : 전단연결재의 극한강도 (N) 단, $V_u \leq A_{sc} f_u$

d : 전단연결재의 지름 (mm)

f_{ck} : 콘크리트의 28일 압축강도 (MPa)

$$\begin{aligned} A_{sc} f_u &= \pi/4 \times 25^2 \times 410 = 201258 \text{ N} \\ \Rightarrow V_u &= A_{sc} f_u = 201258.3 \text{ N} \end{aligned}$$

A_{sc} : 전단연결재의 단면적 (mm²)

f_u : 전단연결재의 인장강도 (MPa) (도.설 3.9.5.11)

② 최대 부모멘트부의 슬래브에 작용하는 힘 (P) : P_1, P_2 중 작은 값을 취한다.

$$P_1 = A_s \cdot f_y$$

A_s : 덮개판을 포함하는 강재 단면의 총면적 (mm²)

f_y : 사용된 강재의 공칭항복응력 380 (MPa)

f_{ck} : 콘크리트의 28일 압축강도 (MPa)

$$P_2 = 0.85 f_{ck} b t_s$$

b : 슬래브의 유효폭 (mm)

t_s : 콘크리트 슬래브의 두께 600 (mm) (최대두께)

③ 최대 정모멘트부의 슬래브에 작용하는 힘 :

$$P_3 = A_s' \cdot f_y'$$

A_s' : 지점부 유효슬래브 폭 내에 설치된 종방향 철근의 총면적 (mm²)

f_y' : 철근의 최소 항복응력 400 (MPa)

④ 전단연결재 필요개수 :

$$N_1 = \frac{P}{\Phi V_u}$$

N_1 : 최대 부모멘트부와 인접한 교각 지점부 사이의 전단연결재 필요개수

P : P_1, P_2 중 작은 값

$$N_2 = \frac{P + P_3}{\Phi V_u}$$

Φ : 감소계수 (0.85)

N_2 : 최대 부모멘트부와 인접한 최대정모멘트부 사이의 전단연결재 필요개수

⑤ 구간별 전단연결재 필요개수 및 설치개수 검토결과

위치 (절점)	b	ts	As	As'	P ₁	P ₂	P ₃	필요개수		설치개수	비고
	(mm)	(mm)	(mm ²)	(mm ²)	(N)	(N)	(N)	N ₁	N ₂		
16~18	2,400	600	330,480	0	125,582,400	48,960,000	0	286	-	792	O.K.
18~21	2,400	600	330,480	0	125,582,400	48,960,000	0	286	-	1200	O.K.