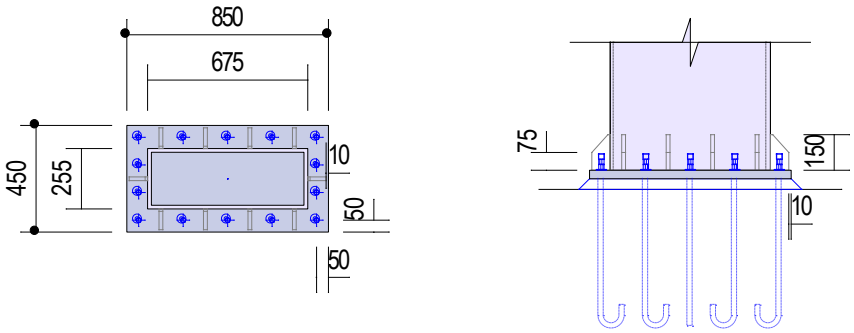
■ MEMBER NAME : BP01

1. General Information

(1) Design Code : AISC-LRFD10M
(2) Code Unit : N, mm

2. Material

(1) Base Plate : A36 (F_y = 248MPa, E_s = 199,948MPa)
(2) Rib / Wing : A36
(3) Anchor Bolt : A193-B7
(4) Concrete : 28.00MPa



3. Section

(1) Column : B-255x675x15.9x15.6
(2) Base Plate : 850x450x36.00t (Rectangle)
(3) Anchor Bolt : 14-7/8 (Pos.(x) : 50.00mm, Pos.(y) : 50.00mm)
(4) Rib Plate : 150x16.00t (No(x) : 4EA, No(y) : 1EA)

4. Design Forces

No	CHK	Name	P_u (kN)	M_{ux} (kN·m)	M_{uy} (kN·m)	V_{ux} (kN)	V_{uy} (kN)
-	-	LCB13	187	-260	-106	77.97	-82.29
1	Yes	LCB1	173	0.0407	-61.38	69.26	0.000
2	Yes	LCB2	250	0.125	-90.33	101	-0.0408
3	Yes	LCB3	221	0.000	-92.41	85.81	0.000
4	Yes	LCB4	212	1.504	-76.22	85.54	-0.443
5	Yes	LCB5	202	0.178	-59.97	85.20	-0.0530
6	Yes	LCB6	211	-1.321	-76.15	85.46	0.382
7	Yes	LCB7	244	78.93	-11.46	89.99	24.87
8	Yes	LCB8	235	-76.93	-18.02	85.91	-24.44
9	Yes	LCB9	236	260	-46.82	93.04	82.23
10	Yes	LCB10	220	260	-83.69	91.57	82.08
11	Yes	LCB11	179	-78.75	-141	81.02	-24.93
12	Yes	LCB12	189	77.11	-134	85.10	24.38
13	Yes	LCB13	187	-260	-106	77.97	-82.29
14	Yes	LCB14	204	-259	-68.68	79.44	-82.14
15	Yes	LCB15	120	-0.0600	-55.68	44.83	0.000

16	Yes	LCB16	111	1.438	-39.50	44.57	-0.422
17	Yes	LCB17	102	0.112	-23.24	44.22	-0.0324
18	Yes	LCB18	111	-1.386	-39.43	44.49	0.403
19	Yes	LCB19	144	78.87	25.27	49.01	24.89
20	Yes	LCB20	134	-77.00	18.71	44.93	-24.42
21	Yes	LCB21	136	260	-10.10	52.06	82.25
22	Yes	LCB22	119	260	-46.96	50.59	82.10
23	Yes	LCB23	78.27	-78.81	-104	40.04	-24.91
24	Yes	LCB24	88.13	77.05	-97.63	44.12	24.40
25	Yes	LCB25	86.26	-260	-68.83	36.99	-82.27
26	Yes	LCB26	103	-259	-31.96	38.46	-82.12
27	Yes	LCB27	123	0.0291	-43.85	49.47	0.000
28	Yes	LCB28	187	0.0855	-67.42	75.61	-0.0282
29	Yes	LCB29	129	-0.0226	-53.58	49.66	0.000
30	Yes	LCB30	123	0.876	-43.87	49.50	-0.258
31	Yes	LCB31	118	0.0808	-34.11	49.29	-0.0244
32	Yes	LCB32	123	-0.818	-43.82	49.45	0.237
33	Yes	LCB33	146	55.22	1.464	52.61	17.42
34	Yes	LCB34	139	-53.89	-3.127	49.76	-17.10
35	Yes	LCB35	141	182	-23.29	54.75	57.57
36	Yes	LCB36	129	182	-49.10	53.72	57.47
37	Yes	LCB37	100	-55.16	-89.16	46.34	-17.44
38	Yes	LCB38	107	53.95	-84.57	49.19	17.08
39	Yes	LCB39	106	-182	-64.40	44.20	-57.59
40	Yes	LCB40	118	-182	-38.59	45.23	-57.49
41	Yes	LCB41	175	0.0326	-68.82	69.21	0.000
42	Yes	LCB42	171	0.707	-61.54	69.09	-0.210
43	Yes	LCB43	167	0.110	-54.23	68.94	-0.0340
44	Yes	LCB44	171	-0.564	-61.51	69.06	0.162
45	Yes	LCB45	188	41.46	-27.54	71.43	13.05
46	Yes	LCB46	183	-40.37	-30.99	69.29	-12.84
47	Yes	LCB47	184	137	-46.11	73.03	43.16
48	Yes	LCB48	175	136	-65.46	72.26	43.09
49	Yes	LCB49	154	-41.32	-95.51	66.72	-13.10
50	Yes	LCB50	159	40.51	-92.06	68.86	12.79
51	Yes	LCB51	158	-136	-76.94	65.12	-43.21
52	Yes	LCB52	167	-136	-57.59	65.89	-43.13
53	Yes	LCB53	79.53	-0.0343	-36.04	29.87	0.000
54	Yes	LCB54	74.09	0.865	-26.33	29.71	-0.254
55	Yes	LCB55	68.54	0.0692	-16.58	29.50	-0.0201
56	Yes	LCB56	73.98	-0.830	-26.29	29.66	0.241
57	Yes	LCB57	96.98	55.21	19.00	32.82	17.42
58	Yes	LCB58	90.08	-53.90	14.41	29.97	-17.09
59	Yes	LCB59	91.39	182	-5.751	34.96	57.58
60	Yes	LCB60	79.69	182	-31.56	33.93	57.47
61	Yes	LCB61	51.09	-55.17	-71.62	26.55	-17.44
62	Yes	LCB62	57.99	53.93	-67.03	29.40	17.08
63	Yes	LCB63	56.68	-182	-46.86	24.41	-57.59
64	Yes	LCB64	68.38	-182	-21.06	25.44	-57.49

5. Check bearing stress of base plate

(1) Bearing Stress

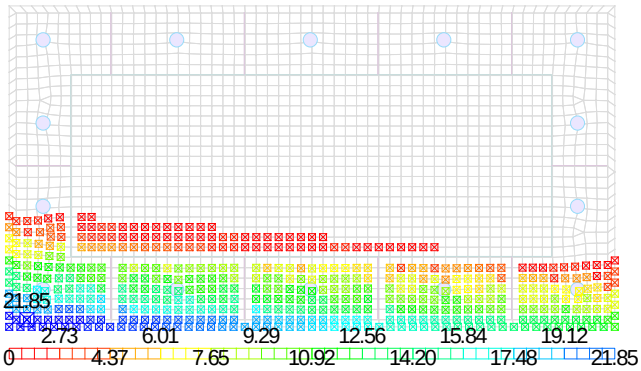
- f_{max} = 22.04N (Area = 1.000mm²)
- f_{min} = 0.0149N (Area = 1.000mm²)
- σ_{max} = 22.04MPa
- σ_{min} = 0.0149MPa

(2) Calculate Bearing Stress of Concrete

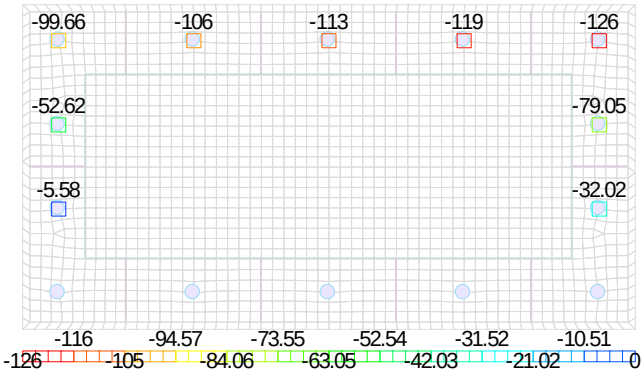
- Φ = 0.650
- A_1 = 382,500mm², A_2 = 1,530,000mm²
- $F_n = 0.85 f_{ck} \sqrt{A_2 / A_1} = 47.60$MPa
- ϕF_n = 30.94MPa

(3) Calculate ratio

- $\sigma_{max} / \phi F_n = 0.712 < 1.000 \rightarrow$ O.K



6. Check tension stress of anchor bolt



(1) Tension Forces

- $T_{u.max}$ = -126kN
- $T_{u.min}$ = -5.581kN

(2) Check Tensile Strength

- $\Phi = 0.750$
- $F_{nt} = 646MPa$
- $A_b = 388mm^2$
- $R_{nt} = F_{nt} \times A_b = 251kN$
- $\phi R_{nt} = 188kN$

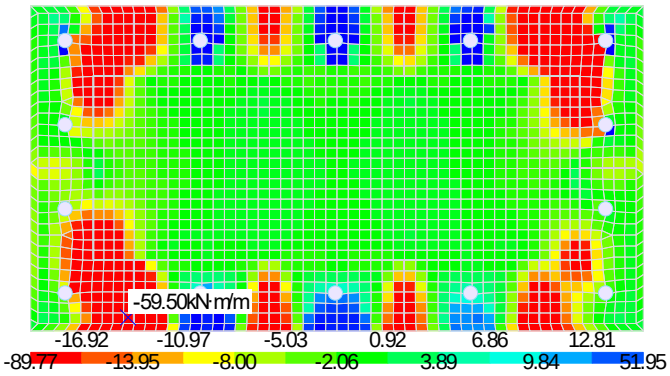
(3) Calculate ratio

- $T_{u.max} / \phi R_{nt} = 0.670 < 1.000 \rightarrow O.K$

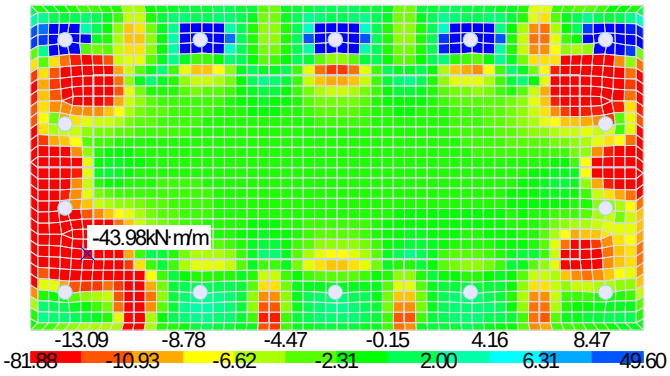
7. Check base plate

(1) Moment Diagram (Element Force. Nodal Average is not Applied.)

- Moment Diagram (Mxx)

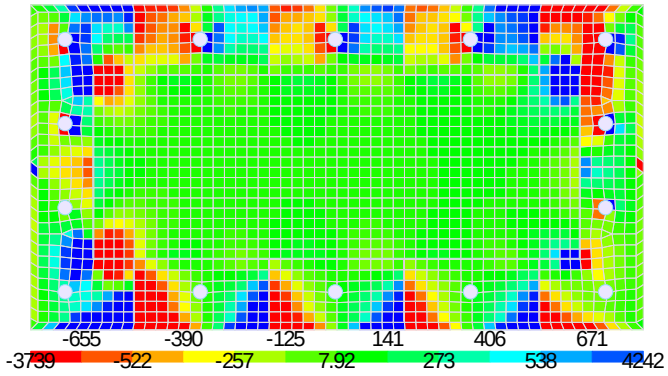


- Moment Diagram (Myy)

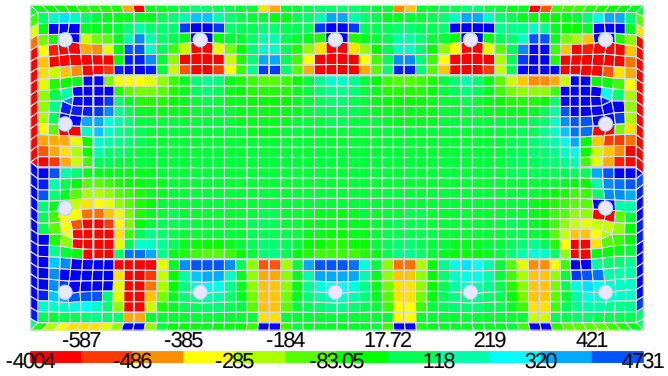


(2) Shear Force Diagram

- Shear Force Diagram (Vxx)



- Shear Force Diagram (Vyy)



(3) Design Moment (Use Average)

- M_{ux} = -59.50kN·m/m
- M_{uy} = -43.98kN·m/m
- M_u = max(M_{ux} , M_{uy}) = -59.50kN·m/m

(4) Calculate moment strength

- Φ = 0.900
- $Z_{bp} = (t_{bp})^2 / 4 = 324\ mm^3/mm$
- $M_n = F_y \times Z_{bp}$ = 80.42kN·m/m
- øM_n = 72.38kN·m/m

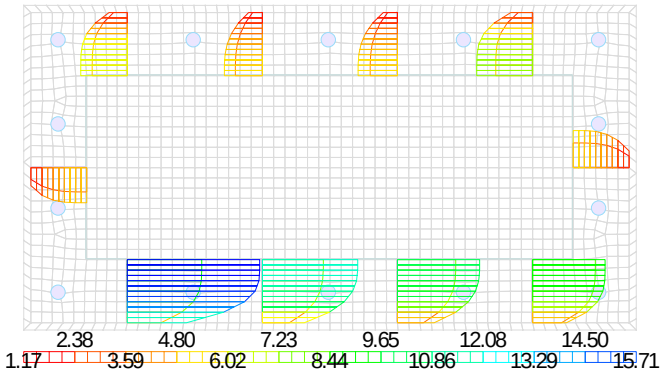
(5) Calculate ratio

- $M_u / øM_n = 0.822 < 1.000$ → O.K

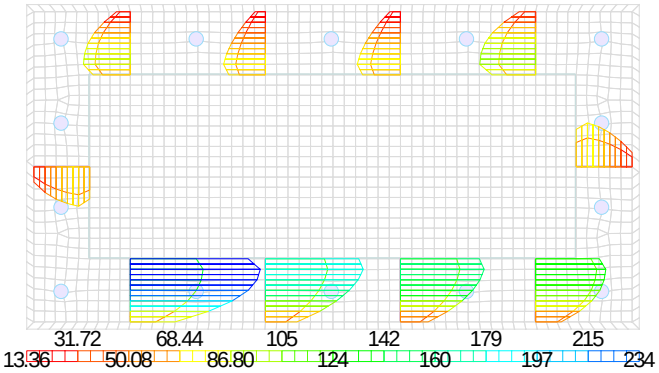
8. Force Diagram (Rib Plate)

(1) Force Diagram

- Moment Diagram



- Shear Force Diagram



9. Check rib plate (Moment Strength)

(1) Design Forces

- M_u = 15.71kN·m

(2) Calculate nominal flexural strength for Yielding (Y)

- $M_p = F_y Z_x$ = 22.34kN·m
- $M_y = F_y S_x$ = 14.89kN·m
- M_{n1} = min(M_p , 1.6M_y) = 22.34kN·m

(3) Calculate nominal flexural strength for Lateral-torsional buckling (LTB)

- $L_b{}^2 = 51.27 < \frac{0.08E_s}{F_y}$ → Lateral-torsional buckling is not applied

(4) Calculate flexural strength about major axis

- $M_{nx} = M_{n1} = 22.34kN·m$
- Resistance factor for flexure : ø = 0.900
- $øM_{nx} = 20.11kN·m$
- $M_{ux} / øM_{nx} = 0.781 < 1.000$ → O.K

10. Check rib plate (Shear Strength)

(1) Design Forces

- $V_u = 234kN$

(2) Calculate the web plate buckling coefficient (k_v)

- $k_v = 5.000$ (for stiffened webs)

(3) Calculate the web shear coefficient (C_v)

- for webs of all other doubly/singly symmetric shapes and channels
- $h / t_w = 0.000 < 1.10 \sqrt{k_v E_s / F_y} = 69.81$
- $C_v = 1.000$

(4) Calculate shear strength in local-y direction

- $A_w = 2{,}400mm^2$
- $V_{ny} = 0.6 F_y A_w C_v = 357kN$
- Resistance factor for shear : ø = 0.900
- $øV_{ny} = 322kN$
- $V_{uy} / øV_{ny} = 0.726 < 1.000$ → O.K

11. Check anchor bolt (Cast-In-Place)

(1) Design Force

- Number of Anchor Bolt = 14EA
- $T_{u.max} = -126kN$
- $V_u = 113kN$
- $V_{u1} = 8.097kN$

(2) Check Shear Strength

- Φ = 0.750
- $A_b = 388mm^2$
- $F_{nv} = 388MPa$
- $R_{nv} = F_{nv} \times A_b = 151kN$
- $øR_{nv} = 113kN$
- $V_{u1} / øR_{nv} = 0.072 < 1.000$ → O.K

(3) Check Tensile Strength

- Φ = 0.750
- $A_b = 388mm^2$
- $F_{nt} = 646MPa$
- $f_v = V_{u1} / A_b = 20.87MPa$
- $F_{nt}' = 1.3F_{nt} - \frac{F_{nt}}{øF_{nv}} f_v \le F_{nt}$
- $F_{nt}' = 646MPa$
- $R_{nt} = F_{nt}' \times A_b = 251kN$
- $øR_{nt} = 188kN$
- $T_{u.max} / øR_{nt} = 0.670 < 1.000$ → O.K

12. Check Development Length of Anchor Bolt

(1) Check Development Length (Hooked Bar)

- Φ = 0.750
- $L_{anc} = 622mm$

- $T_{anc} = \phi F_{anc} A_{anc} = 188kN$
- $L_{h1} = (T_{anc} / 2) / (0.70 f_{ck} d_{anc}) = 216mm$
- $L_{h2} = 17 d_{anc} = 378mm$
- $L_{req} = L_{h1} + L_{h2} = 594mm$
- $L_{req} / L_{anc} = 0.954 < 1.000 \rightarrow$ O.K

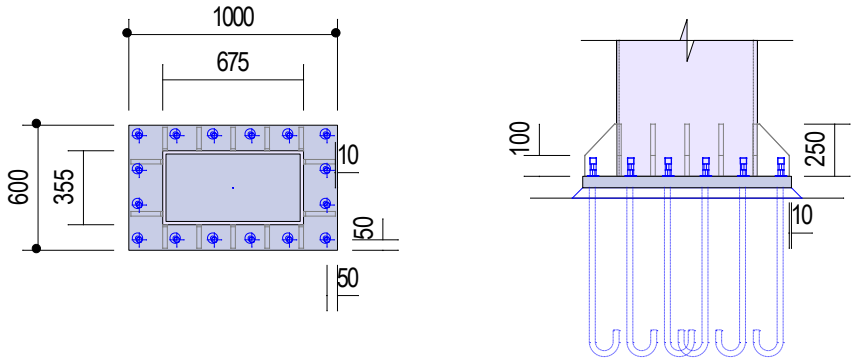
■ MEMBER NAME : BP02

1. General Information

(1) Design Code : AISC-LRFD10M
(2) Code Unit : N, mm

2. Material

(1) Base Plate : A36 (F_y = 248MPa, E_s = 199,948MPa)
(2) Rib / Wing : A36
(3) Anchor Bolt : A193-B7
(4) Concrete : 28.00MPa



3. Section

(1) Column : B-355x675x15.9x15.6
(2) Base Plate : 1,000x600x55.00t (Rectangle)
(3) Anchor Bolt : 16-1-1/8 (Pos.(x) : 50.00mm, Pos.(y) : 50.00mm)
(4) Rib Plate : 250x22.00t (No(x) : 5EA, No(y) : 2EA)

4. Design Forces

No	CHK	Name	P_u (kN)	M_{ux} (kN·m)	M_{uy} (kN·m)	V_{ux} (kN)	V_{uy} (kN)
-	-	LCB10	342	811	-225	121	235
1	Yes	LCB1	278	0.000	-147	99.03	0.000
2	Yes	LCB2	420	0.000	-228	150	0.000
3	Yes	LCB3	365	0.000	-227	122	0.000
4	Yes	LCB4	352	4.221	-190	126	-1.182
5	Yes	LCB5	338	0.000	-152	129	0.000
6	Yes	LCB6	352	-4.221	-190	126	1.182
7	Yes	LCB7	385	243	-71.83	141	70.43
8	Yes	LCB8	385	-243	-71.83	141	-70.43
9	Yes	LCB9	362	811	-154	130	235
10	Yes	LCB10	342	811	-225	121	235
11	Yes	LCB11	319	-243	-307	111	-70.43
12	Yes	LCB12	319	243	-307	111	70.43
13	Yes	LCB13	342	-811	-225	121	-235
14	Yes	LCB14	362	-811	-154	130	-235

15	Yes	LCB15	193	0.000	-133	60.37	0.000
16	Yes	LCB16	179	4.221	-94.76	63.66	-1.182
17	Yes	LCB17	165	0.000	-56.96	66.95	0.000
18	Yes	LCB18	179	-4.221	-94.76	63.66	1.182
19	Yes	LCB19	212	243	23.02	78.55	70.43
20	Yes	LCB20	212	-243	23.02	78.55	-70.43
21	Yes	LCB21	189	811	-59.42	68.13	235
22	Yes	LCB22	169	811	-130	59.19	235
23	Yes	LCB23	146	-243	-213	48.77	-70.43
24	Yes	LCB24	146	243	-213	48.77	70.43
25	Yes	LCB25	169	-811	-130	59.19	-235
26	Yes	LCB26	189	-811	-59.42	68.13	-235
27	Yes	LCB27	199	0.000	-105	70.73	0.000
28	Yes	LCB28	312	0.000	-169	112	0.000
29	Yes	LCB29	207	0.000	-128	68.76	0.000
30	Yes	LCB30	199	2.532	-105	70.73	-0.709
31	Yes	LCB31	191	0.000	-82.61	72.71	0.000
32	Yes	LCB32	199	-2.532	-105	70.73	0.709
33	Yes	LCB33	222	170	-22.84	81.16	49.30
34	Yes	LCB34	222	-170	-22.84	81.16	-49.30
35	Yes	LCB35	206	567	-80.55	73.86	164
36	Yes	LCB36	192	567	-130	67.61	164
37	Yes	LCB37	176	-170	-188	60.31	-49.30
38	Yes	LCB38	176	170	-188	60.31	49.30
39	Yes	LCB39	192	-567	-130	67.61	-164
40	Yes	LCB40	206	-567	-80.55	73.86	-164
41	Yes	LCB41	290	0.000	-170	99.93	0.000
42	Yes	LCB42	284	1.899	-153	101	-0.532
43	Yes	LCB43	278	0.000	-136	103	0.000
44	Yes	LCB44	284	-1.899	-153	101	0.532
45	Yes	LCB45	301	128	-90.90	109	36.97
46	Yes	LCB46	301	-128	-90.90	109	-36.97
47	Yes	LCB47	289	426	-134	104	123
48	Yes	LCB48	279	426	-171	99.07	123
49	Yes	LCB49	266	-128	-215	93.59	-36.97
50	Yes	LCB50	266	128	-215	93.59	36.97
51	Yes	LCB51	279	-426	-171	99.07	-123
52	Yes	LCB52	289	-426	-134	104	-123
53	Yes	LCB53	127	0.000	-85.85	40.47	0.000
54	Yes	LCB54	119	2.532	-63.17	42.44	-0.709
55	Yes	LCB55	111	0.000	-40.49	44.41	0.000
56	Yes	LCB56	119	-2.532	-63.17	42.44	0.709
57	Yes	LCB57	143	170	19.27	52.87	49.30
58	Yes	LCB58	143	-170	19.27	52.87	-49.30
59	Yes	LCB59	126	567	-38.44	45.57	164
60	Yes	LCB60	112	567	-87.90	39.31	164
61	Yes	LCB61	96.06	-170	-146	32.02	-49.30
62	Yes	LCB62	96.06	170	-146	32.02	49.30
63	Yes	LCB63	112	-567	-87.90	39.31	-164
64	Yes	LCB64	126	-567	-38.44	45.57	-164

5. Check bearing stress of base plate

(1) Bearing Stress

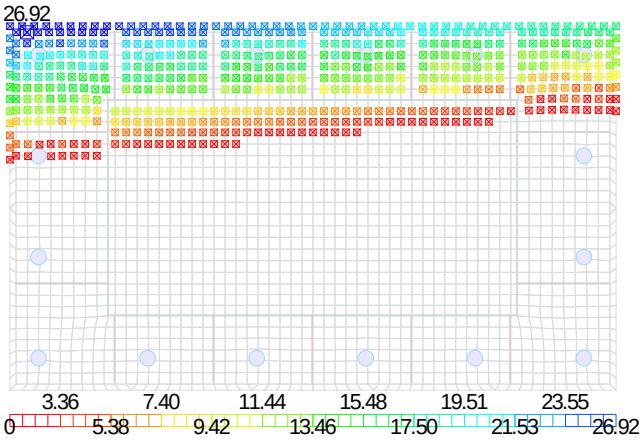
- f_{max} = 27.13N (Area = 1.000mm²)
- f_{min} = 0.0279N (Area = 1.000mm²)
- σ_{max} = 27.13MPa
- σ_{min} = 0.0279MPa

(2) Calculate Bearing Stress of Concrete

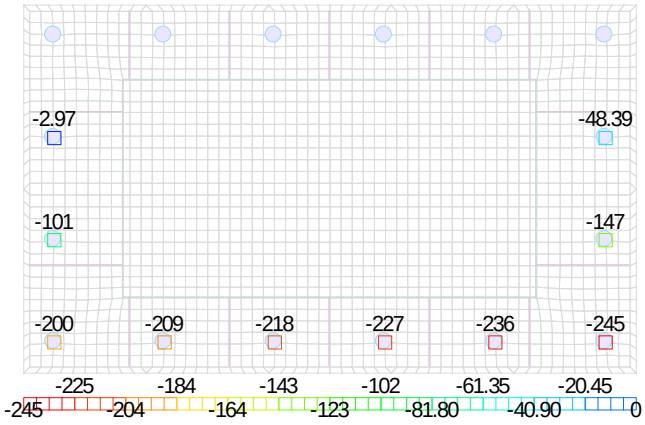
- Φ = 0.650
- A_1 = 600,000mm², A_2 = 2,400,000mm²
- F_n = 0.85 f_{ck} $\sqrt{A_2 / A_1}$ = 47.60MPa
- øF_n = 30.94MPa

(3) Calculate ratio

- σ_{max} / øF_n = 0.877 < 1.000 → O.K



6. Check tension stress of anchor bolt



(1) Tension Forces

- $T_{u.max}$ = -245kN
- $T_{u.min}$ = -2.968kN

(2) Check Tensile Strength

- $\Phi = 0.750$
- $F_{nt} = 646MPa$
- $A_b = 641mm^2$
- $R_{nt} = F_{nt} \times A_b = 415kN$
- $\phi R_{nt} = 311kN$

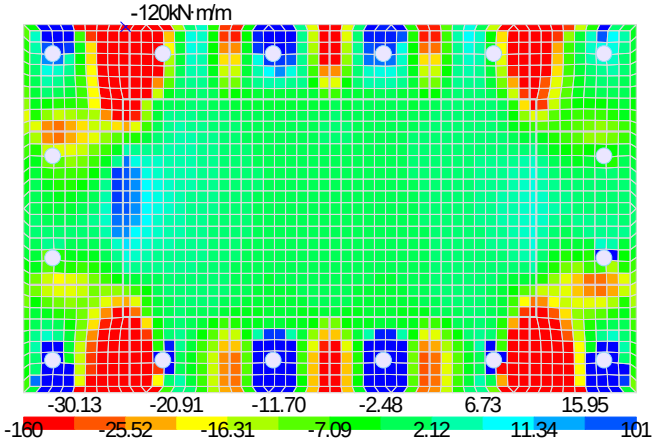
(3) Calculate ratio

- $T_{u.max} / \phi R_{nt} = 0.789 < 1.000 \rightarrow O.K$

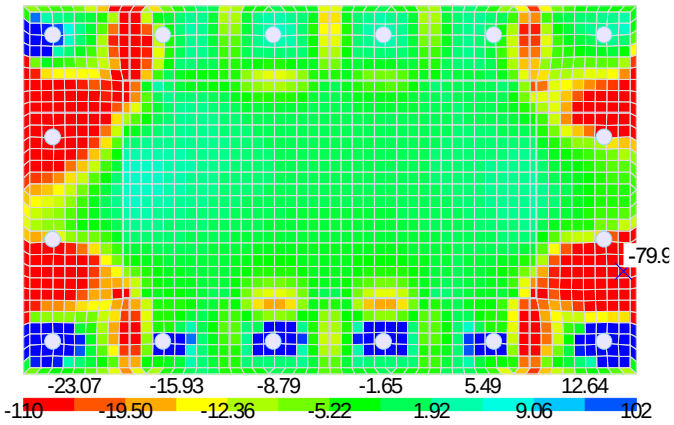
7. Check base plate

(1) Moment Diagram (Element Force. Nodal Average is not Applied.)

- Moment Diagram (Mxx)

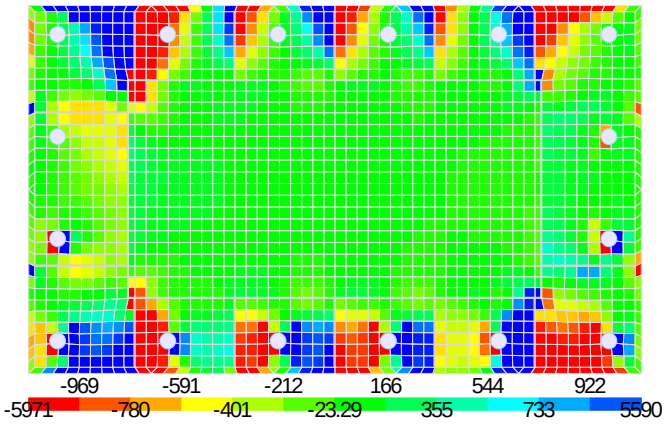


- Moment Diagram (Myy)

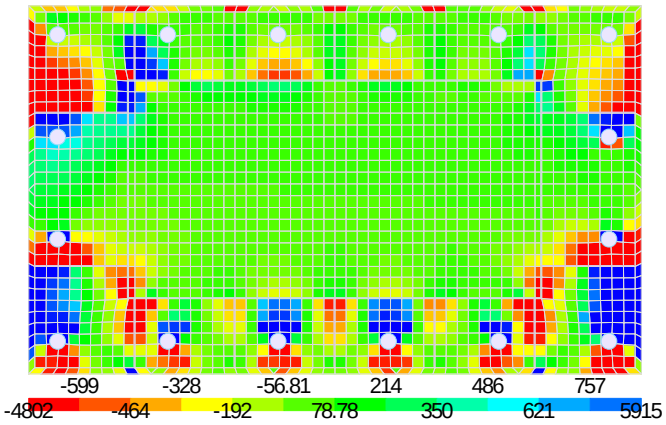


(2) Shear Force Diagram

- Shear Force Diagram (Vxx)



- Shear Force Diagram (Vyy)



(3) Design Moment (Use Average)

- M_{ux} = -120kN·m/m
- M_{uy} = -79.96kN·m/m
- M_u = max(M_{ux} , M_{uy}) = -120kN·m/m

(4) Calculate moment strength

- Φ = 0.900
- $Z_{bp} = (t_{bp})^2 / 4 = 756\ mm^3/mm$
- $M_n = F_y \times Z_{bp}$ = 188kN·m/m
- øM_n = 169kN·m/m

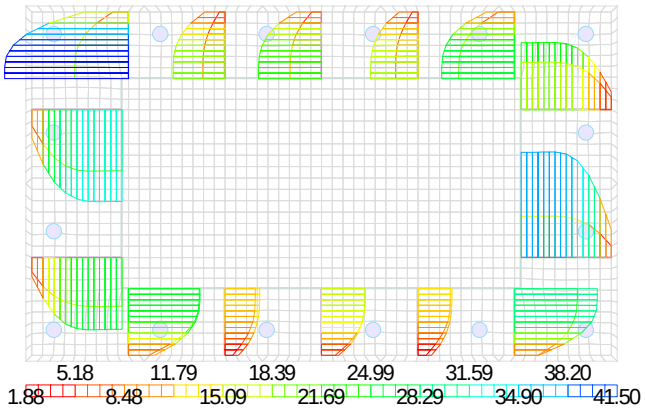
(5) Calculate ratio

- $M_u / øM_n = 0.709 < 1.000$ → O.K

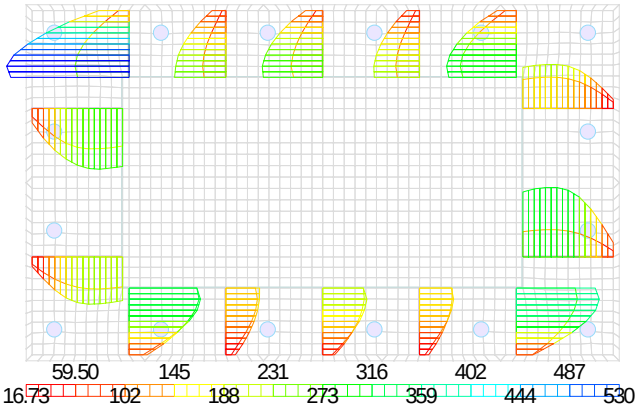
8. Force Diagram (Rib Plate)

(1) Force Diagram

- Moment Diagram



- Shear Force Diagram



9. Check rib plate (Moment Strength)

(1) Design Forces

- M_u = 41.50kN·m

(2) Calculate nominal flexural strength for Yielding (Y)

- $M_p = F_y Z_x$ = 85.32kN·m
- $M_y = F_y S_x$ = 56.88kN·m
- M_{n1} = min(M_p , 1.6M_y) = 85.32kN·m

(3) Calculate nominal flexural strength for Lateral-torsional buckling (LTB)

- $\frac{0.08\ E_s}{F_y} = 64.44 < \frac{L_b\ d}{t^2} = 78.77 < \frac{1.9\ E_s}{F_y} = 1{,}531$

- $M_n = C_b \left(1.52 - 0.274 \left(\frac{L_b\, d}{t^2} \right) \frac{F_y}{E_s} \right) M_y = 84.94\text{kN·m}$
- $M_{n2} = \min(M_n , M_p) = 84.94\text{kN·m}$

(4) Calculate flexural strength about major axis

- $M_{nx} = \min(M_{n1} , M_{n2}) = 84.94\text{kN·m}$
- Resistance factor for flexure : ø = 0.900
- $øM_{nx} = 76.44\text{kN·m}$
- $M_{ux} / øM_{nx} = 0.543 < 1.000$ → O.K

10. Check rib plate (Shear Strength)

(1) Design Forces

- $V_u = 530\text{kN}$

(2) Calculate the web plate buckling coefficient (k_v)

- $k_v = 5.000$ (for stiffened webs)

(3) Calculate the web shear coefficient (C_v)

- for webs of all other doubly/singly symmetric shapes and channels
- $h / t_w = 0.000 < 1.10 \sqrt{k_v E_s / F_y} = 69.81$
- $C_v = 1.000$

(4) Calculate shear strength in local-y direction

- $A_w = 5{,}500\text{mm}^2$
- $V_{ny} = 0.6 F_y A_w C_v = 819\text{kN}$
- Resistance factor for shear : ø = 0.900
- $øV_{ny} = 737\text{kN}$
- $V_{uy} / øV_{ny} = 0.719 < 1.000$ → O.K

11. Check anchor bolt (Cast-In-Place)

(1) Design Force

- Number of Anchor Bolt = 16EA
- $T_{u.max} = -245\text{kN}$
- $V_u = 264\text{kN}$
- $V_{u1} = 16.52\text{kN}$

(2) Check Shear Strength

- Φ = 0.750
- $A_b = 641\text{mm}^2$
- $F_{nv} = 388\text{MPa}$
- $R_{nv} = F_{nv} \times A_b = 249\text{kN}$
- $øR_{nv} = 187\text{kN}$
- $V_{u1} / øR_{nv} = 0.088 < 1.000$ → O.K

(3) Check Tensile Strength

- Φ = 0.750
- $A_b = 641\text{mm}^2$
- $F_{nt} = 646\text{MPa}$
- $f_v = V_{u1} / A_b = 25.75\text{MPa}$
- $F_{nt}' = 1.3F_{nt} - \frac{F_{nt}}{øF_{nv}} f_v \le F_{nt}$
- $F_{nt}' = 646\text{MPa}$
- $R_{nt} = F_{nt}' \times A_b = 415\text{kN}$
- $øR_{nt} = 311\text{kN}$
- $T_{u.max} / øR_{nt} = 0.789 < 1.000$ → O.K

12. Check Development Length of Anchor Bolt

(1) Check Development Length (Hooked Bar)

- $\Phi = 0.750$
- $L_{anc} = 800mm$
- $T_{anc} = \phi F_{anc} A_{anc} = 311kN$
- $L_{h1} = (T_{anc} / 2) / (0.70 f_{ck} d_{anc}) = 278mm$
- $L_{h2} = 17 d_{anc} = 486mm$
- $L_{req} = L_{h1} + L_{h2} = 763mm$
- $L_{req} / L_{anc} = 0.954 < 1.000 \rightarrow$ O.K