

MEMBER NAME : Z-T1

1. General Information

- (1) Design Code : NSR-10
(2) Code Unit : N, mm

2. Material

- (1) F'_c : 28.00MPa
(2) F_y : 420MPa

3. Section

- (1) Section Size
 • Depth : 450mm
 • Cover : 75.00mm
 (2) Column Section
 • Shape of Column : Rectangle
 • Section : 300x500mm

4. Rebar

- (1) Direction Y
 • Layer 1 : #4@100 ($A_s = 1,290\text{mm}^2$)
 (2) Direction X
 • Layer 1 : #4@100 ($A_s = 1,290\text{mm}^2$)

5. Foundation

- (1) Foundation Size
 • L_x : 1.000m
 • L_y : 2.200m
 • No. of pile : 2- $\phi 400$
 • Space of pile : 1,200mm
 • $q_{a,comp.}$: 132kN/EA
 • $q_{a,tens.}$: 0.000kN/EA

6. Design Load

- (1) Service Load
 • P_s : 162kN
 • M_{sx} : 24.03kN·m
 • M_{sy} : 2.256kN·m
 (2) Factored Load
 • P_u : 198kN
 • M_{ux} : 30.89kN·m
 • M_{uy} : 16.77kN·m
 (3) Surcharge Load
 • Surface Load : 0.000KPa
 • Weight Density : 18.00kN/m³
 • Soil Height : 0.150m
 (4) Self weight is considered.

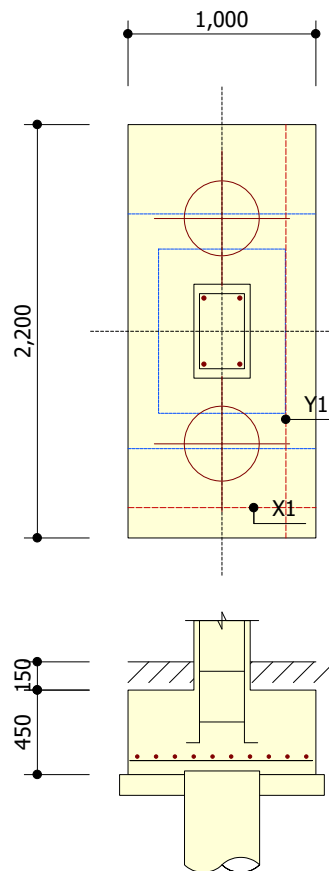
7. Calculation Summary

- (1) Overturning Moment (Service Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	2.256	14.21	0.159	M_{sy} / M_{rx}
Direction Y (kN·m)	24.03	31.26	0.769	M_{sx} / M_{ry}

- (2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
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Direction X (kN·m)	16.77	17.05	0.984	M_{uy} / M_{rx}
Direction Y (kN·m)	30.89	37.51	0.824	M_{ux} / M_{ry}

(3) Pile Bearing (Compression)

Category	Value	Criteria	Ratio	Note
Compression (kN)	112	132	0.854	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	138	774	0.179	

(4) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	547	0.000	$\phi = 0.750$
Direction Y (kN)	66.61	240	0.277	$\phi = 0.750$

(5) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	209	1,225	0.171	$\phi = 0.750$

(6) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	48.46	168	0.288	$\phi = 0.900$
Direction X, M_{uy} (kN·m)	0.000	174	0.000	$\phi = 0.900$

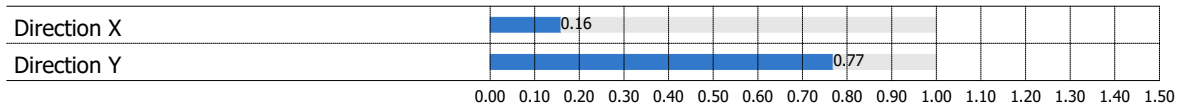
(7) Rebar Space

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (mm)	100	159	0.628	$A_{s,req} = 810\text{mm}^2$
Direction X, M_{uy} (mm)	100	159	0.628	

8. Check overturning moment (Service Load)

Calculation Summary (Overturning Moment (Service Load))

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	2.256	14.21	0.159	M_{sy} / M_{rx}
Direction Y (kN·m)	24.03	31.26	0.769	M_{sx} / M_{ry}



(1) Calculate resistance Moment

Items	Weight (kN)	Factor	L_x (m)	L_y (m)	R_x (kN·m)	R_y (kN·m)
Self Weight of Concrete	22.48	1.000	0.500	1.100	11.24	24.72
Self Weight of Soil	5.940	1.000	0.500	1.100	2.970	6.534
Surcharge Load	0.000	1.000	0.500	1.100	-	-
Resistance Moment	-	-	-	-	14.21	31.26

(2) Check overturning moment

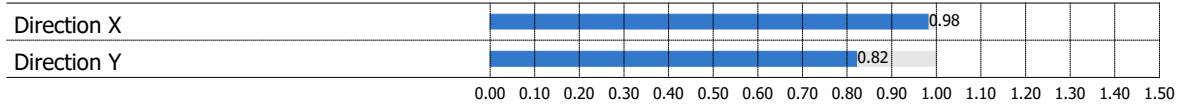
Direction X (M_{sy})			Direction Y (M_{sx})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
2.256kN·m	14.21kN·m	0.159	24.03kN·m	31.26kN·m	0.769

9. Check overturning moment (Factored Load)

Calculation Summary (Overturning Moment (Factored Load))

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Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	16.77	17.05	0.984	M_{uy} / M_{rx}
Direction Y (kN·m)	30.89	37.51	0.824	M_{ux} / M_{ry}



(1) Calculate resistance Moment

Items	Weight (kN)	Factor	L_x (m)	L_y (m)	R_x (kN·m)	R_y (kN·m)
Self Weight of Concrete	22.48	1.200	0.500	1.100	13.49	29.67
Self Weight of Soil	5.940	1.200	0.500	1.100	3.564	7.841
Surcharge Load	0.000	1.800	0.500	1.100	-	-
Resistance Moment	-	-	-	-	17.05	37.51

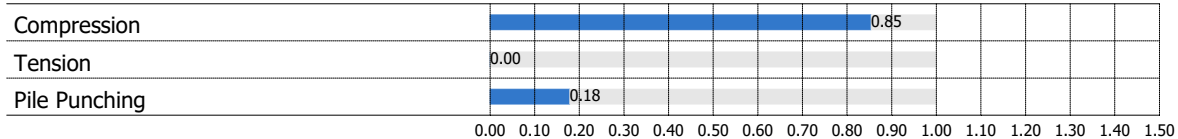
(2) Check overturning moment

Direction X (M_{uy})			Direction Y (M_{ux})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
16.77kN·m	17.05kN·m	0.984	30.89kN·m	37.51kN·m	0.824

10. Check Pile Capacity

Calculation Summary (Pile Bearing (Compression))

Category	Value	Criteria	Ratio	Note
Compression (kN)	112	132	0.854	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	138	774	0.179	



Index	X (mm)	Y (mm)	V_u (kN)	$\phi V_{c,INT}$ (kN)	$\phi V_{c,EDG}$ (kN)	$\phi V_{c,COR}$ (kN)	ϕV_c (kN)	$V_u / \phi V_c$
01	0.000	600	138	1,166	1,066	774	774	0.179
02	0.000	-600	86.99	1,166	1,066	774	774	0.112

- V_u , V_c : Pile Punching

(1) Calculate actual pile stress (kN)

- $q_{s,max} = 112\text{kN/EA}$
- $q_{s,max} / q_a = 0.854 \rightarrow \text{O.K}$
- $q_{s,min} = 0.000\text{kN/EA}$
- $q_{s,min} / q_a = 0.000 \rightarrow \text{O.K}$

(2) Calculate factored pile stress (kN)

- $q_{u,max} = 138\text{kN/EA}$
- $q_{u,min} = 86.99\text{kN/EA}$

11. Check Shear

Calculation Summary (One Way Shear)

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	547	0.000	$\phi = 0.750$
Direction Y (kN)	66.61	240	0.277	$\phi = 0.750$



- (2) Calculate one-way shear (Direction Y)

- (3) Calculate two-way shear

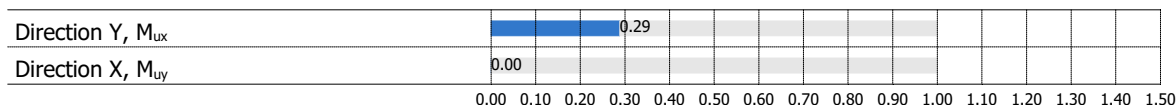
-	b ₀ (mm)	V _{c1} (kN)	V _{c2} (kN)	V _{c3} (kN)	V _c (kN)	V _u (kN)	øV _c (kN)	Ratio
Interior	3,075	2,243	3,383	1,979	1,979	209	1,484	0.141
Edge(X)	2,537	1,851	2,612	1,633	1,633	209	1,225	0.171
Edge(Y)	3,737	2,727	3,001	2,406	2,406	76.25	1,804	0.0423
Corner	2,369	1,728	1,961	1,525	1,525	76.25	1,144	0.0667



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Direction Y, M_{lux} (kN·m)	48.46	168	0.288	$\varnothing = 0.900$
Direction X, M_{luy} (kN·m)	0.000	174	0.000	$\varnothing = 0.900$

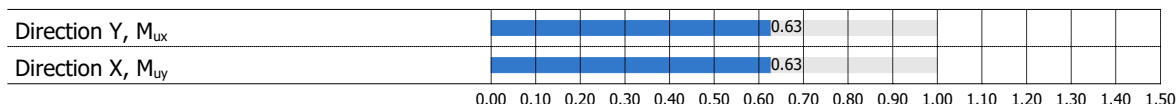


- (1) Calculate moment capacity (Direction X)
 - $\phi = 0.900$
 - $M_{uy} = 0.000 \text{ kN}\cdot\text{m}$ $\phi M_{ny} = 174 \text{ kN}\cdot\text{m}$
 - $M_{uy} / \phi M_{ny} = 0.000 \rightarrow \text{O.K}$
- (2) Calculate moment capacity (Direction Y)
 - $\phi = 0.900$
 - $M_{ux} = 48.46 \text{ kN}\cdot\text{m}$ $\phi M_{nx} = 168 \text{ kN}\cdot\text{m}$
 - $M_{ux} / \phi M_{nx} = 0.288 \rightarrow \text{O.K}$

13. Check Rebar

Calculation Summary (Rebar Space)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{lux} (mm)	100	159	0.628	$A_{ts,req} = 810\text{mm}^2$
Direction X, M_{luy} (mm)	100	159	0.628	



- (1) Calculate minimum rebar area required
 - $A_{s,min} = 0.00180D = 810\text{mm}^2$
- (2) Calculate minimum rebar space required (Direction Y)
 - $A_s = 129\text{mm}^2$ (#4@100)
 - $s_{req.} = 159\text{mm}$
 - **$s_x = 100\text{mm} < s_{req.} = 159\text{mm} \rightarrow \text{O.K}$**
- (3) Calculate minimum rebar space required (Direction X)
 - $A_s = 129\text{mm}^2$ (#4@100)
 - $s_{req.} = 159\text{mm}$
 - **$s_y = 100\text{mm} < s_{req.} = 159\text{mm} \rightarrow \text{O.K}$**

MEMBER NAME : Z-T2

1. General Information

- (1) Design Code : NSR-10
(2) Code Unit : N, mm

2. Material

- (1) F'_c : 28.00MPa
(2) F_y : 420MPa

3. Section

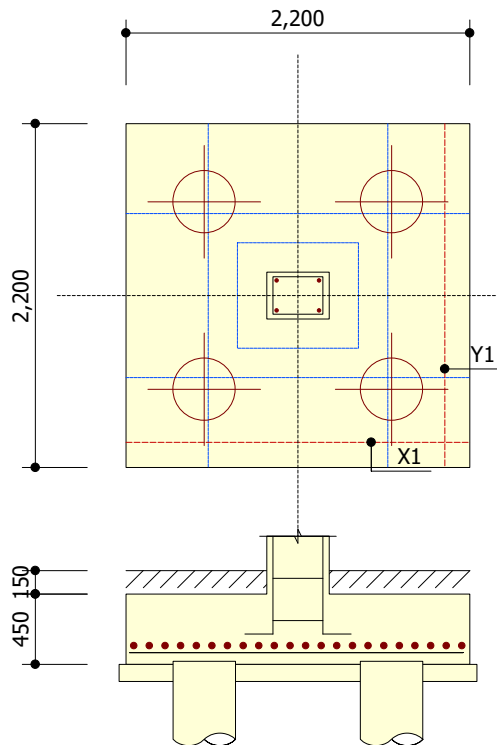
- (1) Section Size
 • Depth : 450mm
 • Cover : 75.00mm
 (2) Column Section
 • Shape of Column : Rectangle
 • Section : 400x300mm

4. Rebar

- (1) Direction Y
 • Layer 1 : #4@100 ($A_s = 1,290\text{mm}^2$)
 (2) Direction X
 • Layer 1 : #4@100 ($A_s = 1,290\text{mm}^2$)

5. Foundation

- (1) Foundation Size
 • L_x : 2.200m
 • L_y : 2.200m
 • No. of pile : 4- $\phi 400$
 • Space of pile : 1,200mm
 • $q_{a,comp.}$: 131kN/EA
 • $q_{a,tens.}$: 0.000kN/EA



6. Design Load

(1) Service Load (by Load Combinations)

No.	CHK	Name	P_s (kN)	M_{sx} (kN·m)	M_{sy} (kN·m)	Description
-	-	21	324	-66.78	3.825	
1	Yes	1	291	-30.60	2.746	
2	Yes	2	346	-31.48	3.236	
3	Yes	3	291	-30.60	4.021	
4	Yes	4	291	-30.69	1.373	
5	Yes	5	290	-35.99	2.844	
6	Yes	6	292	-25.30	2.648	
7	Yes	7	332	-31.19	4.119	
8	Yes	8	332	-31.28	2.157	
9	Yes	9	331	-35.30	3.236	
10	Yes	10	333	-27.16	3.040	
11	Yes	11	175	-18.34	2.942	
12	Yes	12	174	-18.44	0.294	
13	Yes	13	173	-23.73	1.765	
14	Yes	14	176	-13.04	1.471	
15	Yes	15	294	-27.95	43.74	
16	Yes	16	288	-33.34	-38.25	
17	Yes	17	280	-77.57	3.727	

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18	Yes	18	301	16.28	1.765	
19	Yes	19	335	-29.22	34.13	
20	Yes	20	330	-33.24	-27.95	
21	Yes	21	324	-66.78	3.825	
22	Yes	22	340	4.315	2.354	
23	Yes	23	178	-15.69	42.66	
24	Yes	24	172	-21.08	-39.32	
25	Yes	25	164	-65.31	2.648	
26	Yes	26	185	28.54	0.686	

(2) Factored Load

- P_u : 344kN
- M_{ux} : 75.71kN·m
- M_{uy} : 12.75kN·m

(3) Surcharge Load

- Surface Load : 0.000KPa
- Weight Density : 18.00kN/m³
- Soil Height : 0.150m

(4) Self weight is considered.

7. Calculation Summary

(1) Overturning Moment (Service Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	3.825	68.77	0.0556	M_{sy} / M_{rx}
Direction Y (kN·m)	-66.78	68.77	0.971	M_{sx} / M_{ry}

(2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	12.75	82.52	0.154	M_{uy} / M_{rx}
Direction Y (kN·m)	75.71	82.52	0.917	M_{ux} / M_{ry}

(3) Pile Bearing (Compression)

Category	Value	Criteria	Ratio	Note
Compression (kN)	123	131	0.934	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	138	774	0.178	

(4) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	127	547	0.232	$\phi = 0.750$
Direction Y (kN)	209	528	0.395	$\phi = 0.750$

(5) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	397	1,388	0.286	$\phi = 0.750$

(6) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	54.15	168	0.322	$\phi = 0.900$
Direction X, M_{uy} (kN·m)	38.59	174	0.221	$\phi = 0.900$

(7) Rebar Space

Category	Value	Criteria	Ratio	Note
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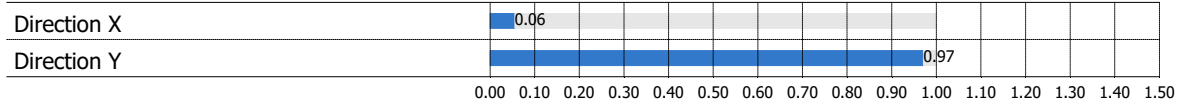
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Direction Y, M_{ux} (mm)	100	159	0.628	$A_{s,req} = 810\text{mm}^2$
Direction X, M_{uy} (mm)	100	159	0.628	

8. Check overturning moment (Service Load)

Calculation Summary (Overturning Moment (Service Load))

Category	Value	Criteria	Ratio	Note
Direction X ($\text{kN}\cdot\text{m}$)	3.825	68.77	0.0556	M_{sy} / M_{rx}
Direction Y ($\text{kN}\cdot\text{m}$)	-66.78	68.77	0.971	M_{sx} / M_{ry}



(1) Calculate resistance Moment

Items	Weight (kN)	Factor	L_x (m)	L_y (m)	R_x ($\text{kN}\cdot\text{m}$)	R_y ($\text{kN}\cdot\text{m}$)
Self Weight of Concrete	49.45	1.000	1.100	1.100	54.39	54.39
Self Weight of Soil	13.07	1.000	1.100	1.100	14.37	14.37
Surcharge Load	0.000	1.000	1.100	1.100	-	-
Resistance Moment	-	-	-	-	68.77	68.77

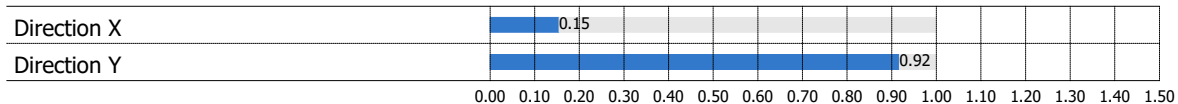
(2) Check overturning moment

Direction X (M_{sy})			Direction Y (M_{sx})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
3.825kN·m	68.77kN·m	0.0556	-66.78kN·m	68.77kN·m	0.971

9. Check overturning moment (Factored Load)

Calculation Summary (Overturning Moment (Factored Load))

Category	Value	Criteria	Ratio	Note
Direction X ($\text{kN}\cdot\text{m}$)	12.75	82.52	0.154	M_{uy} / M_{rx}
Direction Y ($\text{kN}\cdot\text{m}$)	75.71	82.52	0.917	M_{ux} / M_{ry}



(1) Calculate resistance Moment

Items	Weight (kN)	Factor	L_x (m)	L_y (m)	R_x ($\text{kN}\cdot\text{m}$)	R_y ($\text{kN}\cdot\text{m}$)
Self Weight of Concrete	49.45	1.200	1.100	1.100	65.27	65.27
Self Weight of Soil	13.07	1.200	1.100	1.100	17.25	17.25
Surcharge Load	0.000	1.800	1.100	1.100	-	-
Resistance Moment	-	-	-	-	82.52	82.52

(2) Check overturning moment

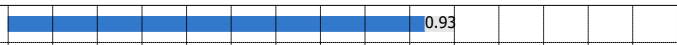
Direction X (M_{uy})			Direction Y (M_{ux})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
12.75kN·m	82.52kN·m	0.154	75.71kN·m	82.52kN·m	0.917

10. Check Pile Capacity

Calculation Summary (Pile Bearing (Compression))

Category	Value	Criteria	Ratio	Note
Compression (kN)	123	131	0.934	

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Tension (kN)	0.000	0.000	0.000					
Pile Punching (kN)	138	774	0.178					
Compression								
Tension								
Pile Punching								
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50								
Index	X (mm)	Y (mm)	V _u (kN)	øV _{c,INT} (kN)	øV _{c,EDG} (kN)	øV _{c,COR} (kN)	øV _c (kN)	V _u / øV _c
01	-600	600	127	1,166	1,066	774	774	0.164
02	600	600	138	1,166	1,066	774	774	0.178
03	-600	-600	63.96	1,166	1,066	774	774	0.0826
04	600	-600	74.58	1,166	1,066	774	774	0.0963

- V_u , V_c : Pile Punching

(1) Calculate actual pile stress (kN)

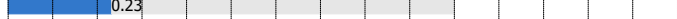
- q_{s,max} = 123kN/EA
- **q_{s,max} / q_a = 0.934 → O.K**
- q_{s,min} = 0.000kN/EA
- **q_{s,min} / q_a = 0.000 → O.K**

(2) Calculate factored pile stress (kN)

- q_{u,max} = 138kN/EA
- q_{u,min} = 63.96kN/EA

11. Check Shear

Calculation Summary (One Way Shear)

Category	Value	Criteria	Ratio	Note
Direction X (kN)	127	547	0.232	$\phi = 0.750$
Direction Y (kN)	209	528	0.395	$\phi = 0.750$
Direction X				
Direction Y				
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50				

(1) Calculate one-way shear (Direction X)

- V_u = 127kN
- ø = 0.750
- øV_c = 547kN
- **V_u / øV_c = 0.232 → O.K**

(2) Calculate one-way shear (Direction Y)

- V_u = 209kN
- ø = 0.750
- øV_c = 528kN
- **V_u / øV_c = 0.395 → O.K**

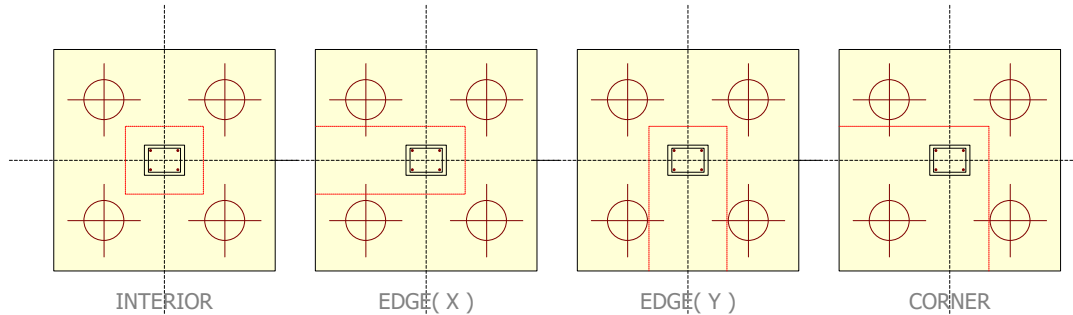
(3) Calculate two-way shear

Calculation Summary (Two Way Shear)

Category			Value	Criteria	Ratio	Note		
Two Way Shear (kN)			397	1,388	0.286	ø = 0.750		
Two Way Shear			<div><div></div><div>0.29</div></div>					
			0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50					
-	b ₀ (mm)	V _{c1} (kN)	V _{c2} (kN)	V _{c3} (kN)	V _c (kN)	V _u (kN)	øV _c (kN)	Ratio
Interior	2,875	2,383	3,318	1,850	1,850	397	1,388	0.286

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Edge(X)	3,637	3,016	2,968	2,341	2,341	397	1,756	0.226
Edge(Y)	3,637	3,016	2,968	2,341	2,341	397	1,756	0.226
Corner	2,919	2,420	2,139	1,879	1,879	259	1,409	0.184

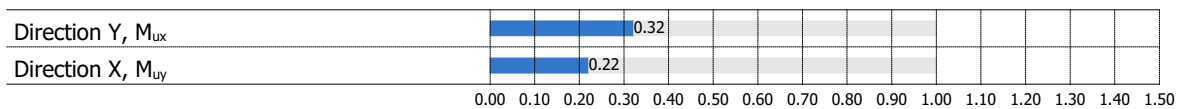


- $\phi = 0.750$
- $d = 369\text{mm}$
- $V_{c1} = 0.17 \left(1 + \frac{2}{\beta} \right) \sqrt{f'_c} b_0 d$
- $V_{c2} = 0.083 \left(\frac{a_s d}{b_0} + 2 \right) \sqrt{f'_c} b_0 d$
- $V_{c3} = 0.33 \sqrt{f'_c} b_0 d$
- $V_c = \min(V_{c1}, V_{c2}, V_{c3})$
- $V_u = 397\text{kN}$
- $V_u / \phi V_c = 0.286 \rightarrow \text{O.K}$

12. Check Moment Capacity

Calculation Summary (Moment Capacity)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	54.15	168	0.322	$\phi = 0.900$
Direction X, M_{uy} (kN·m)	38.59	174	0.221	$\phi = 0.900$



(1) Calculate moment capacity (Direction X)

- $\phi = 0.900$
- $M_{uy} = 38.59\text{kN}\cdot\text{m}$ $\phi M_{ny} = 174\text{kN}\cdot\text{m}$
- $M_{uy} / \phi M_{ny} = 0.221 \rightarrow \text{O.K}$

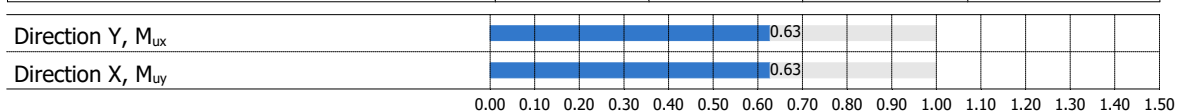
(2) Calculate moment capacity (Direction Y)

- $\phi = 0.900$
- $M_{ux} = 54.15\text{kN}\cdot\text{m}$ $\phi M_{nx} = 168\text{kN}\cdot\text{m}$
- $M_{ux} / \phi M_{nx} = 0.322 \rightarrow \text{O.K}$

13. Check Rebar

Calculation Summary (Rebar Space)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (mm)	100	159	0.628	$A_{s,req} = 810\text{mm}^2$
Direction X, M_{uy} (mm)	100	159	0.628	



- (1) Calculate minimum rebar area required
- $A_{s,min} = 0.00180D = 810\text{mm}^2$
- (2) Calculate minimum rebar space required (Direction Y)
- $A_s = 129\text{mm}^2$ (#4@100)
 - $s_{req.} = 159\text{mm}$
 - $s_x = 100\text{mm} < s_{req.} = 159\text{mm} \rightarrow \text{O.K}$
- (3) Calculate minimum rebar space required (Direction X)
- $A_s = 129\text{mm}^2$ (#4@100)
 - $s_{req.} = 159\text{mm}$
 - $s_y = 100\text{mm} < s_{req.} = 159\text{mm} \rightarrow \text{O.K}$