

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

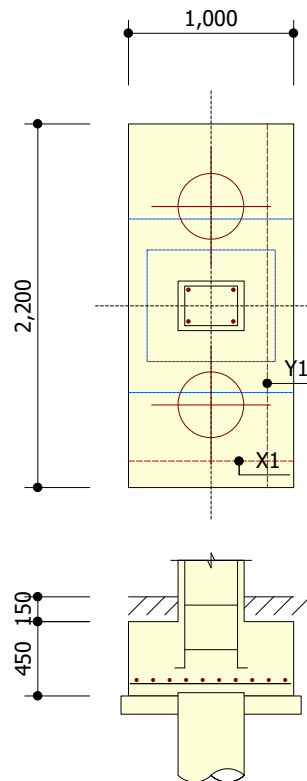
- (1) Section Size
 • Depth : 450mm
 • Cover : 75.00mm
 (2) Column Section
 • Shape of Column : Rectangle
 • Section : 400x300mm

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 : 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 (by Load Combinations)

No.	CHK	Name	P_s (kN)	M_{sx} (kN·m)	M_{sy} (kN·m)	Description
-	-	21	152	-25.60	1.863	
1	Yes	1	126	-4.805	-1.863	
2	Yes	2	148	-6.865	-1.863	
3	Yes	3	126	-4.609	-1.177	
4	Yes	4	126	-5.001	-2.550	
5	Yes	5	127	-6.669	-2.256	
6	Yes	6	125	-2.844	-1.569	
7	Yes	7	143	-6.178	-1.373	
8	Yes	8	143	-6.472	-2.354	
9	Yes	9	144	-7.845	-2.059	
10	Yes	10	142	-4.903	-1.667	
11	Yes	11	75.61	-2.648	-0.490	
12	Yes	12	75.71	-3.040	-1.863	
13	Yes	13	76.49	-4.805	-1.471	
14	Yes	14	74.82	-0.981	-0.883	
15	Yes	15	127	-3.727	19.91	
16	Yes	16	125	-5.786	-23.73	
17	Yes	17	138	-30.20	3.040	

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18	Yes	18	114	20.69	-6.865	
19	Yes	19	144	-5.590	14.61	
20	Yes	20	142	-7.159	-18.34	
21	Yes	21	152	-25.60	1.863	
22	Yes	22	134	12.94	-5.590	
23	Yes	23	76.79	-1.765	20.59	
24	Yes	24	74.53	-3.923	-22.95	
25	Yes	25	87.28	-28.34	3.825	
26	Yes	26	64.04	22.56	-6.080	

(2) Factored Load

- P_u : 172kN
- M_{ux} : 33.15kN·m
- M_{uy} : 4.609kN·m

(3) Surcharge Load

- Surface Load : 0.000KPa
- Weight Density : 18.04kN/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)	1.863	14.21	0.131	M_{sy} / M_{rx}
Direction Y (kN·m)	-25.60	31.27	0.818	M_{sx} / M_{ry}

(2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	4.609	17.06	0.270	M_{uy} / M_{rx}
Direction Y (kN·m)	33.15	37.53	0.883	M_{ux} / M_{ry}

(3) Pile Bearing (Compression)

Category	Value	Criteria	Ratio	Note
Compression (kN)	108	132	0.824	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	127	774	0.164	

(4) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	547	0.000	$\phi = 0.750$
Direction Y (kN)	100	240	0.417	$\phi = 0.750$

(5) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	193	1,177	0.164	$\phi = 0.750$

(6) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	57.20	168	0.340	$\phi = 0.900$
Direction X, M_{uy} (kN·m)	0.000	174	0.000	$\phi = 0.900$

(7) Rebar Space

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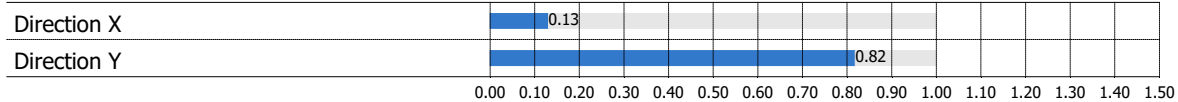
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Direction Y, M_{ux} (mm)	100	159	0.628	$A_{s,req} = 810\text{mm}^2$
Direction X, M_{uy} (mm)	100	159	0.628	

8. Check overturning moment (Service Load)

Calculation Summary (Overturning Moment (Service Load))

Category	Value	Criteria	Ratio	Note
Direction X ($\text{kN}\cdot\text{m}$)	1.863	14.21	0.131	M_{sy} / M_{rx}
Direction Y ($\text{kN}\cdot\text{m}$)	-25.60	31.27	0.818	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	22.48	1.000	0.500	1.100	11.24	24.72
Self Weight of Soil	5.955	1.000	0.500	1.100	2.977	6.550
Surcharge Load	0.000	1.000	0.500	1.100	-	-
Resistance Moment	-	-	-	-	14.21	31.27

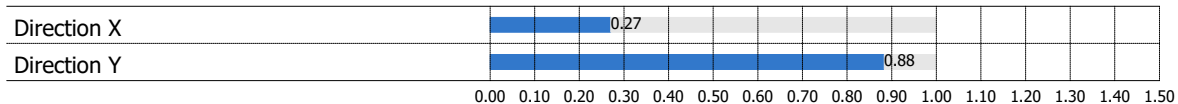
(2) Check overturning moment

Direction X (M_{sy})			Direction Y (M_{sx})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
1.863kN·m	14.21kN·m	0.131	-25.60kN·m	31.27kN·m	0.818

9. Check overturning moment (Factored Load)

Calculation Summary (Overturning Moment (Factored Load))

Category	Value	Criteria	Ratio	Note
Direction X ($\text{kN}\cdot\text{m}$)	4.609	17.06	0.270	M_{uy} / M_{rx}
Direction Y ($\text{kN}\cdot\text{m}$)	33.15	37.53	0.883	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	22.48	1.200	0.500	1.100	13.49	29.67
Self Weight of Soil	5.955	1.200	0.500	1.100	3.573	7.860
Surcharge Load	0.000	1.800	0.500	1.100	-	-
Resistance Moment	-	-	-	-	17.06	37.53

(2) Check overturning moment

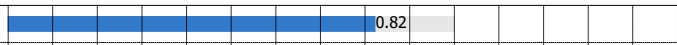
Direction X (M_{uy})			Direction Y (M_{ux})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
4.609kN·m	17.06kN·m	0.270	33.15kN·m	37.53kN·m	0.883

10. Check Pile Capacity

Calculation Summary (Pile Bearing (Compression))

Category	Value	Criteria	Ratio	Note
Compression (kN)	108	132	0.824	

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Tension (kN)	0.000	0.000	0.000					
Pile Punching (kN)	127	774	0.164					
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)	ϕV _{c,INT} (kN)	ϕV _{c,EDG} (kN)	ϕV _{c,COR} (kN)	ϕV _c (kN)	V _u / ϕV _c
01	0.000	600	127	1,166	1,066	774	774	0.164
02	0.000	-600	71.87	1,166	1,066	774	774	0.0928

- V_u , V_c : Pile Punching

(1) Calculate actual pile stress (kN)

- q_{s,max} = 108kN/EA
- q_{s,max} / q_a = 0.824 → 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} = 127kN/EA
- q_{u,min} = 71.87kN/EA

11. Check Shear

Calculation Summary (One Way Shear)

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	547	0.000	ø = 0.750
Direction Y (kN)	100	240	0.417	ø = 0.750

Direction X	0.00																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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(1) Calculate one-way shear (Direction X)

- V_u = 0.000kN
- $\phi = 0.750$
- $\phi V_c = 547$ kN
- V_u / $\phi V_c = 0.000$ → O.K

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

- V_u = 100kN
- $\phi = 0.750$
- $\phi V_c = 240$ kN
- V_u / $\phi V_c = 0.417$ → O.K

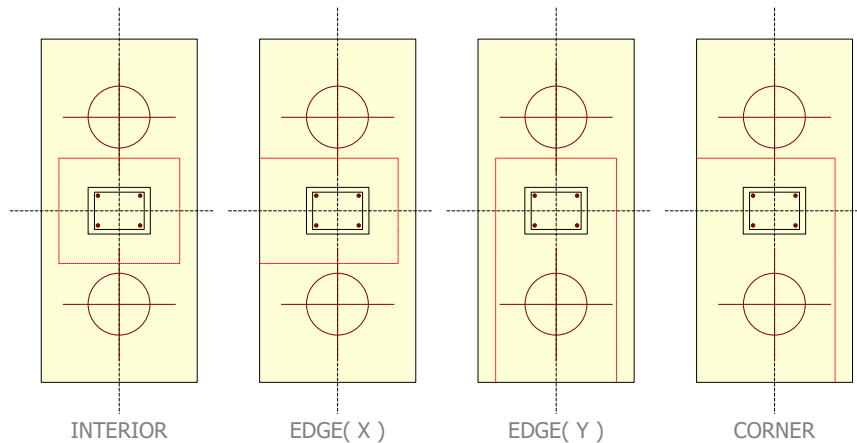
(3) Calculate two-way shear

Calculation Summary (Two Way Shear)

Category			Value	Criteria	Ratio	Note		
Two Way Shear (kN)			193	1,177	0.164	$\phi = 0.750$		
Two Way Shear			<div><div></div><div>0.16</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)	ϕV_c (kN)	Ratio
Interior	2,875	2,383	3,318	1,850	1,850	193	1,388	0.139
Edge(X)	2,437	2,021	2,580	1,569	1,569	193	1,177	0.164
Edge(Y)	3,637	3,016	2,968	2,341	2,341	65.57	1,756	0.0373

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Corner	2,319	1,922	1,945	1,493	1,493	65.57	1,119	0.0586
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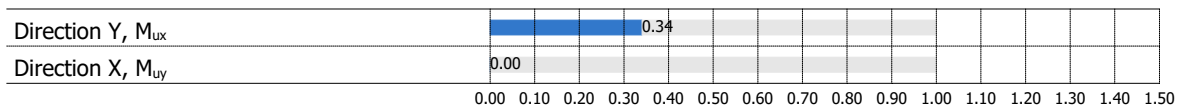


- $\phi = 0.750$
- $d = 369\text{mm}$
- $V_{c1} = 0.17 \left(1 + \frac{2}{\beta} \right) \sqrt{f_c} b_0 d$
- $V_{c2} = 0.083 \left(\frac{a_s d}{b_0} + 2 \right) \sqrt{f_c} b_0 d$
- $V_{c3} = 0.33 \sqrt{f_c} b_0 d$
- $V_c = \min(V_{c1}, V_{c2}, V_{c3})$
- $V_u = 193\text{kN}$
- $V_u / \phi V_c = 0.164 \rightarrow \text{O.K}$

12. Check Moment Capacity

Calculation Summary (Moment Capacity)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	57.20	168	0.340	$\phi = 0.900$
Direction X, M_{uy} (kN·m)	0.000	174	0.000	$\phi = 0.900$



(1) Calculate moment capacity (Direction X)

- $\phi = 0.900$
- $M_{uy} = 0.000\text{kN}\cdot\text{m}$ $\phi M_{ny} = 174\text{kN}\cdot\text{m}$
- $M_{uy} / \phi M_{ny} = 0.000 \rightarrow \text{O.K}$

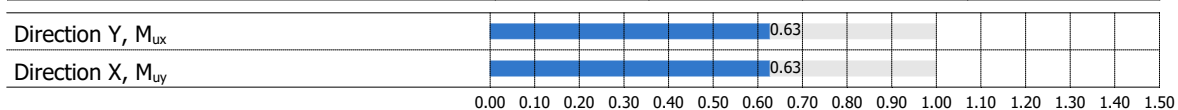
(2) Calculate moment capacity (Direction Y)

- $\phi = 0.900$
- $M_{ux} = 57.20\text{kN}\cdot\text{m}$ $\phi M_{nx} = 168\text{kN}\cdot\text{m}$
- $M_{ux} / \phi M_{nx} = 0.340 \rightarrow \text{O.K}$

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)
- $s_{\text{req.}} = 159\text{mm}$
- $s_x = 100\text{mm} < s_{\text{req.}} = 159\text{mm} \rightarrow \text{O.K}$

(3) Calculate minimum rebar space required (Direction X)

- $A_s = 129\text{mm}^2$ (#4@100)
- $s_{\text{req.}} = 159\text{mm}$
- $s_y = 100\text{mm} < s_{\text{req.}} = 159\text{mm} \rightarrow \text{O.K}$

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

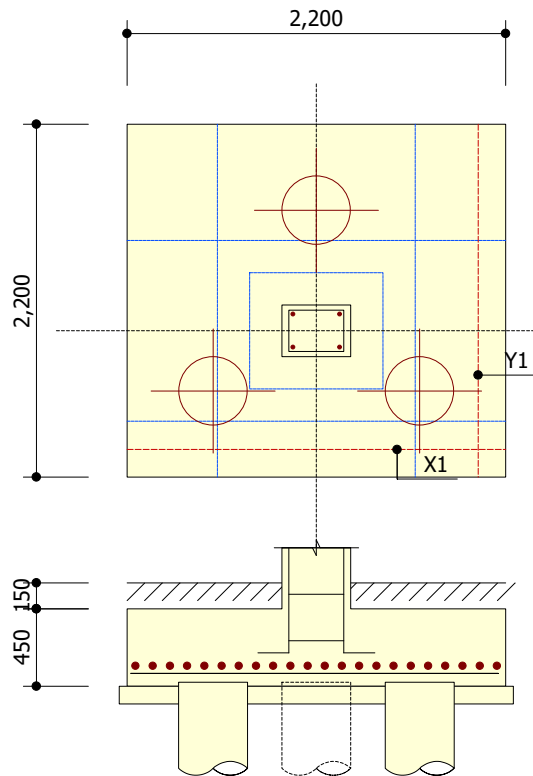
- (1) Section Size
 • Depth : 450mm
 • Cover : 75.00mm
 (2) Column Section
 • Shape of Column : Rectangle
 • Section : 400x300mm

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 : 3- ϕ 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
-	-	22	228	23.54	2.844	
1	Yes	1	199	0.883	1.765	
2	Yes	2	239	1.471	3.138	
3	Yes	3	199	1.177	2.550	
4	Yes	4	199	0.686	0.981	
5	Yes	5	199	-1.275	1.765	
6	Yes	6	199	3.138	1.765	
7	Yes	7	229	1.569	3.432	
8	Yes	8	229	1.177	2.256	
9	Yes	9	229	-0.294	2.844	
10	Yes	10	229	3.040	2.844	
11	Yes	11	119	0.785	1.863	
12	Yes	12	119	0.294	0.294	
13	Yes	13	119	-1.667	1.079	
14	Yes	14	119	2.746	1.079	
15	Yes	15	200	2.157	23.05	
16	Yes	16	198	-0.294	-19.42	
17	Yes	17	201	-28.24	1.667	

MEMBER NAME : Z-T2

18	Yes	18	197	30.11	1.863	
19	Yes	19	230	2.256	18.93	
20	Yes	20	229	0.490	-13.24	
21	Yes	21	230	-20.79	2.746	
22	Yes	22	228	23.54	2.844	
23	Yes	23	120	1.765	22.36	
24	Yes	24	118	-0.588	-20.20	
25	Yes	25	121	-28.64	0.981	
26	Yes	26	118	29.81	1.177	

(2) Factored Load (by Load Combinations)

No.	CHK	Name	P _u (kN)	M _{ux} (kN·m)	M _{uy} (kN·m)	Description
-	-	27	245	43.44	11.67	
1	Yes	1	279	1.275	2.550	
2	Yes	2	303	2.059	4.315	
3	Yes	3	259	1.373	2.844	
4	Yes	4	259	1.765	4.119	
5	Yes	5	259	0.981	1.471	
6	Yes	6	259	-2.256	2.844	
7	Yes	7	259	5.099	2.844	
8	Yes	8	259	-1.079	3.825	
9	Yes	9	259	3.923	1.863	
10	Yes	10	303	2.256	5.001	
11	Yes	11	303	1.863	3.628	
12	Yes	12	303	0.196	4.315	
13	Yes	13	303	3.923	4.315	
14	Yes	14	303	0.785	4.805	
15	Yes	15	303	3.334	3.825	
16	Yes	16	179	1.177	2.942	
17	Yes	17	179	0.490	0.294	
18	Yes	18	179	-2.844	1.667	
19	Yes	19	179	4.511	1.569	
20	Yes	20	249	-9.611	32.75	
21	Yes	21	245	12.06	-27.85	
22	Yes	22	247	15.49	32.75	
23	Yes	23	246	-13.04	-27.95	
24	Yes	24	249	-40.01	11.38	
25	Yes	25	244	42.46	-6.570	
26	Yes	26	249	-40.99	-6.767	
27	Yes	27	245	43.44	11.67	
28	Yes	28	181	-10.00	31.87	
29	Yes	29	177	11.67	-28.73	
30	Yes	30	180	15.10	31.97	
31	Yes	31	178	-13.44	-28.73	
32	Yes	32	182	-40.40	10.59	
33	Yes	33	176	42.07	-7.355	
34	Yes	34	181	-41.38	-7.551	
35	Yes	35	177	43.05	10.79	

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(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)	2.844	64.08	0.0444	M _{sy} / M _{rx}
Direction Y (kN·m)	23.54	59.71	0.394	M _{sx} / M _{ry}

(2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	11.67	76.89	0.152	M _{uy} / M _{rx}
Direction Y (kN·m)	43.44	71.65	0.606	M _{ux} / M _{ry}

(3) Pile Bearing (Compression)

Category	Value	Criteria	Ratio	Note
Compression (kN)	114	131	0.865	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	141	1,064	0.133	

(4) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	53.37	510	0.105	ø = 0.750
Direction Y (kN)	141	528	0.267	ø = 0.750

(5) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	294	1,388	0.212	ø = 0.750

(6) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M _{ux} (kN·m)	35.37	168	0.210	ø = 0.900
Direction X, M _{uy} (kN·m)	17.39	174	0.0998	ø = 0.900

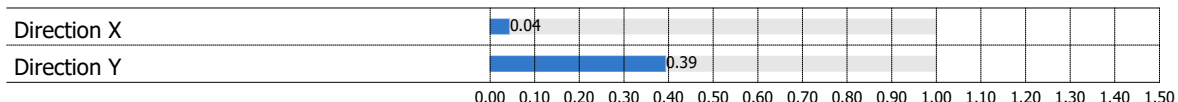
(7) Rebar Space

Category	Value	Criteria	Ratio	Note
Direction Y, M _{ux} (mm)	100	159	0.628	A _{s,req} = 810mm 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)	2.844	64.08	0.0444	M _{sy} / M _{rx}
Direction Y (kN·m)	23.54	59.71	0.394	M _{sx} / M _{ry}



(1) Calculate resistance Moment

MEMBER NAME : Z-T2

Items	Weight (kN)	Factor	L _x (m)	L _y (m)	R _x (kN·m)	R _y (kN·m)
Self Weight of Concrete	46.07	1.000	1.100	1.025	50.68	47.23
Self Weight of Soil	12.18	1.000	1.100	1.025	13.39	12.48
Surcharge Load	0.000	1.000	1.100	1.025	-	-
Resistance Moment	-	-	-	-	64.08	59.71

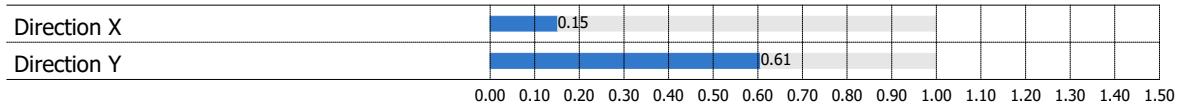
(2) Check overturning moment

Direction X (M _{sy})			Direction Y (M _{sx})		
M _a	M _R	M _a / M _R	M _a	M _R	M _a / M _R
2.844kN·m	64.08kN·m	0.0444	23.54kN·m	59.71kN·m	0.394

9. Check overturning moment (Factored Load)

Calculation Summary (Overturning Moment (Factored Load))

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	11.67	76.89	0.152	M _{uy} / M _{rx}
Direction Y (kN·m)	43.44	71.65	0.606	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	46.07	1.200	1.100	1.025	60.82	56.67
Self Weight of Soil	12.18	1.200	1.100	1.025	16.07	14.98
Surcharge Load	0.000	1.800	1.100	1.025	-	-
Resistance Moment	-	-	-	-	76.89	71.65

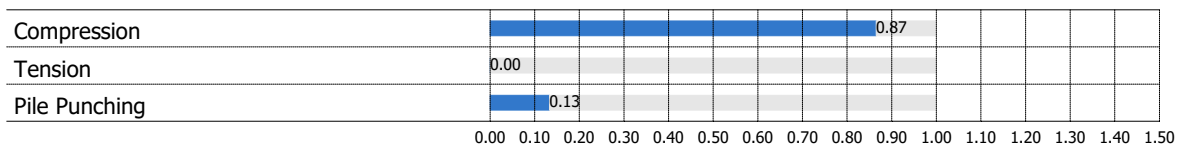
(2) Check overturning moment

Direction X (M _{uy})			Direction Y (M _{ux})		
M _a	M _R	M _a / M _R	M _a	M _R	M _a / M _R
11.67kN·m	76.89kN·m	0.152	43.44kN·m	71.65kN·m	0.606

10. Check Pile Capacity

Calculation Summary (Pile Bearing (Compression))

Category	Value	Criteria	Ratio	Note
Compression (kN)	114	131	0.865	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	141	1,064	0.133	



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	0.000	700	141	1,166	1,066	1,064	1,064	0.133
02	-600	-350	69.67	1,166	1,066	774	774	0.0900
03	600	-350	89.12	1,166	1,066	774	774	0.115

- V_u , V_c : Pile Punching

(1) Calculate actual pile stress (kN)

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- $q_{s,max} = 114\text{kN/EA}$
- $q_{s,max} / q_a = 0.865 \rightarrow \text{O.K}$
- $q_{s,min} = 0.000\text{kN/EA}$
- $q_{s,min} / q_a = 0.000 \rightarrow \text{O.K}$

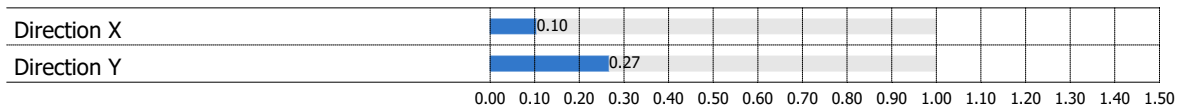
(2) Calculate factored pile stress (kN)

- $q_{u,max} = 141\text{kN/EA}$
- $q_{u,min} = 69.67\text{kN/EA}$

11. Check Shear

Calculation Summary (One Way Shear)

Category	Value	Criteria	Ratio	Note
Direction X (kN)	53.37	510	0.105	$\phi = 0.750$
Direction Y (kN)	141	528	0.267	$\phi = 0.750$



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

- $V_u = 53.37\text{kN}$
- $\phi = 0.750$
- $\phi V_c = 510\text{kN}$
- $V_u / \phi V_c = 0.105 \rightarrow \text{O.K}$

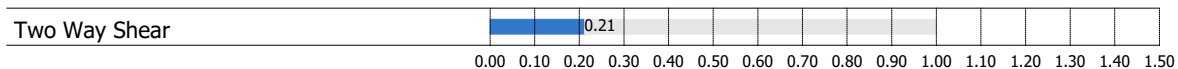
(2) Calculate one-way shear (Direction Y)

- $V_u = 141\text{kN}$
- $\phi = 0.750$
- $\phi V_c = 528\text{kN}$
- $V_u / \phi V_c = 0.267 \rightarrow \text{O.K}$

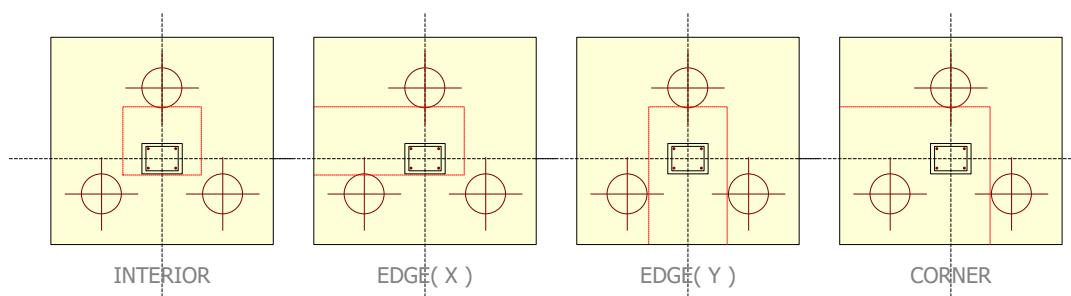
(3) Calculate two-way shear

Calculation Summary (Two Way Shear)

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	294	1,388	0.212	$\phi = 0.750$



-	b_0 (mm)	V_{c1} (kN)	V_{c2} (kN)	V_{c3} (kN)	V_c (kN)	V_u (kN)	ϕV_c (kN)	Ratio
Interior	2,875	2,383	3,318	1,850	1,850	294	1,388	0.212
Edge(X)	3,637	3,016	2,968	2,341	2,341	254	1,756	0.145
Edge(Y)	3,487	2,891	2,920	2,245	2,245	294	1,684	0.175
Corner	2,844	2,358	2,115	1,831	1,831	205	1,373	0.149



- 6

MEMBER NAME : Z-T3

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

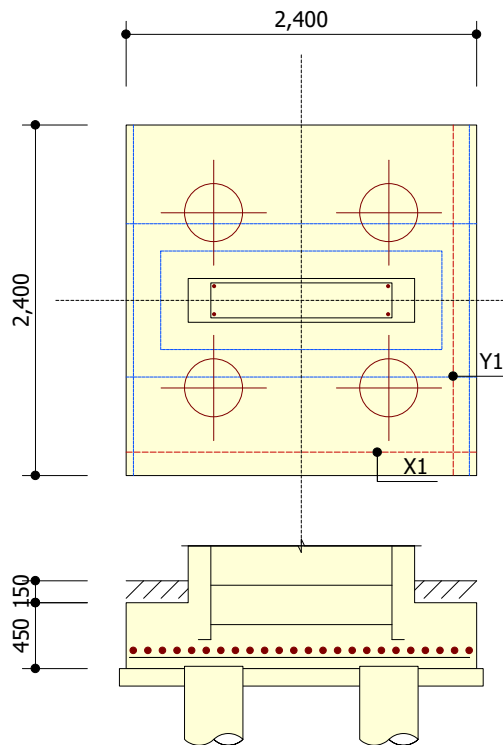
- (1) Section Size
 • Depth : 450mm
 • Cover : 75.00mm
 (2) Column Section
 • Shape of Column : Rectangle
 • Section : 1,550x300mm

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 : 2.400m
 • L_y : 2.400m
 • No. of pile : 4- ϕ 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	319	-28.24	9.807	
1	Yes	1	277	-1.961	11.57	
2	Yes	2	331	-4.707	14.02	
3	Yes	3	276	-1.667	12.45	
4	Yes	4	278	-2.354	10.59	
5	Yes	5	276	-4.119	11.77	
6	Yes	6	277	0.0981	11.28	
7	Yes	7	317	-3.727	14.02	
8	Yes	8	319	-4.315	12.65	
9	Yes	9	317	-5.590	13.53	
10	Yes	10	318	-2.452	13.14	
11	Yes	11	165	-0.883	7.845	
12	Yes	12	167	-1.569	5.982	
13	Yes	13	166	-3.334	7.159	
14	Yes	14	167	0.883	6.669	
15	Yes	15	251	0.000	32.75	
16	Yes	16	303	-3.923	-9.709	
17	Yes	17	279	-33.93	6.767	

MEMBER NAME : Z-T3

18	Yes	18	275	30.01	16.28	
19	Yes	19	298	-2.550	29.42	
20	Yes	20	337	-5.492	-2.746	
21	Yes	21	319	-28.24	9.807	
22	Yes	22	316	20.20	16.97	
23	Yes	23	140	0.785	28.15	
24	Yes	24	192	-3.138	-14.32	
25	Yes	25	168	-33.15	2.157	
26	Yes	26	164	30.79	11.67	

(2) Factored Load (by Load Combinations)

No.	CHK	Name	P _u (kN)	M _{ux} (kN·m)	M _{uy} (kN·m)	Description
-	-	26	357	-49.43	-1.569	
1	Yes	1	387	-2.844	16.18	
2	Yes	2	420	-6.669	17.75	
3	Yes	3	359	-3.727	15.10	
4	Yes	4	358	-3.138	16.57	
5	Yes	5	361	-4.315	13.53	
6	Yes	6	359	-7.257	15.49	
7	Yes	7	360	-0.196	14.61	
8	Yes	8	357	-5.884	16.57	
9	Yes	9	361	-1.569	13.63	
10	Yes	10	419	-6.374	18.53	
11	Yes	11	421	-6.963	16.97	
12	Yes	12	419	-8.434	18.04	
13	Yes	13	420	-4.903	17.55	
14	Yes	14	419	-7.747	18.53	
15	Yes	15	421	-5.590	17.06	
16	Yes	16	247	-1.177	11.87	
17	Yes	17	251	-2.452	8.826	
18	Yes	18	248	-5.296	10.79	
19	Yes	19	250	1.667	9.905	
20	Yes	20	307	-13.83	42.66	
21	Yes	21	379	7.943	-14.02	
22	Yes	22	305	13.53	46.68	
23	Yes	23	381	-19.42	-18.04	
24	Yes	24	335	-47.76	16.67	
25	Yes	25	351	41.87	11.96	
26	Yes	26	357	-49.43	-1.569	
27	Yes	27	329	43.54	30.20	
28	Yes	28	213	-12.65	38.74	
29	Yes	29	285	9.120	-17.95	
30	Yes	30	211	14.71	42.76	
31	Yes	31	287	-18.34	-21.97	
32	Yes	32	241	-46.58	12.75	
33	Yes	33	257	43.05	8.041	
34	Yes	34	263	-48.35	-5.492	
35	Yes	35	235	44.72	26.28	

MEMBER NAME : Z-T3

(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)	9.807	89.28	0.110	M _{sy} / M _{rx}
Direction Y (kN·m)	-28.24	89.28	0.316	M _{sx} / M _{ry}

(2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	-1.569	107	0.0146	M _{uy} / M _{rx}
Direction Y (kN·m)	-49.43	107	0.461	M _{ux} / M _{ry}

(3) Pile Bearing (Compression)

Category	Value	Criteria	Ratio	Note
Compression (kN)	110	131	0.839	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	128	871	0.147	

(4) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	597	0.000	ø = 0.750
Direction Y (kN)	201	576	0.348	ø = 0.750

(5) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	412	1,721	0.239	ø = 0.750

(6) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M _{ux} (kN·m)	47.79	168	0.284	ø = 0.900
Direction X, M _{uy} (kN·m)	0.000	174	0.000	ø = 0.900

(7) Rebar Space

Category	Value	Criteria	Ratio	Note
Direction Y, M _{ux} (mm)	100	159	0.628	A _{s,req} = 810mm 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)	9.807	89.28	0.110	M _{sy} / M _{rx}
Direction Y (kN·m)	-28.24	89.28	0.316	M _{sx} / M _{ry}

Direction X	0.11																		
Direction Y	0.32																		

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 resistance Moment

MEMBER NAME : Z-T3

Items	Weight (kN)	Factor	L _x (m)	L _y (m)	R _x (kN·m)	R _y (kN·m)
Self Weight of Concrete	58.84	1.000	1.200	1.200	70.61	70.61
Self Weight of Soil	15.55	1.000	1.200	1.200	18.66	18.66
Surcharge Load	0.000	1.000	1.200	1.200	-	-
Resistance Moment	-	-	-	-	89.28	89.28

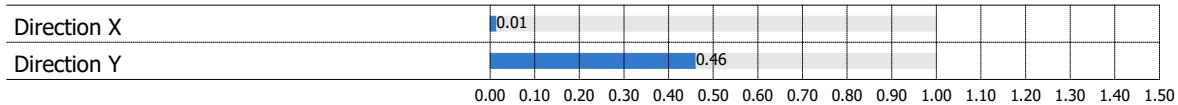
(2) Check overturning moment

Direction X (M _{sy})			Direction Y (M _{sx})		
M _a	M _R	M _a / M _R	M _a	M _R	M _a / M _R
9.807kN·m	89.28kN·m	0.110	-28.24kN·m	89.28kN·m	0.316

9. Check overturning moment (Factored Load)

Calculation Summary (Overturning Moment (Factored Load))

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	-1.569	107	0.0146	M _{uy} / M _{rx}
Direction Y (kN·m)	-49.43	107	0.461	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	58.84	1.200	1.200	1.200	84.74	84.74
Self Weight of Soil	15.55	1.200	1.200	1.200	22.39	22.39
Surcharge Load	0.000	1.800	1.200	1.200	-	-
Resistance Moment	-	-	-	-	107	107

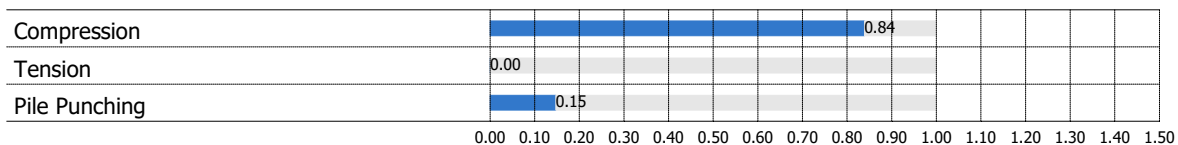
(2) Check overturning moment

Direction X (M _{uy})			Direction Y (M _{ux})		
M _a	M _R	M _a / M _R	M _a	M _R	M _a / M _R
-1.569kN·m	107kN·m	0.0146	-49.43kN·m	107kN·m	0.461

10. Check Pile Capacity

Calculation Summary (Pile Bearing (Compression))

Category	Value	Criteria	Ratio	Note
Compression (kN)	110	131	0.839	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	128	871	0.147	



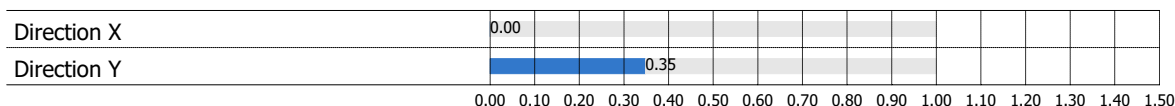
Index	X (mm)	Y (mm)	V _u (kN)	ϕV _{c,INT} (kN)	ϕV _{c,EDG} (kN)	ϕV _{c,COR} (kN)	ϕV _c (kN)	V _u / ϕV _c
01	-600	600	86.90	1,166	1,162	871	871	0.0998
02	600	600	85.60	1,166	1,162	871	871	0.0983
03	-600	-600	128	1,166	1,162	871	871	0.147
04	600	-600	127	1,166	1,162	871	871	0.146

- V_u, V_c : Pile Punching
- (1) Calculate actual pile stress (kN)
 - $q_{s,max} = 110\text{kN/EA}$
 - $q_{s,max} / q_a = 0.839 \rightarrow \text{O.K}$
 - $q_{s,min} = 0.000\text{kN/EA}$
 - $q_{s,min} / q_a = 0.000 \rightarrow \text{O.K}$
 - (2) Calculate factored pile stress (kN)
 - $q_{u,max} = 128\text{kN/EA}$
 - $q_{u,min} = 85.60\text{kN/EA}$

11. Check Shear

Calculation Summary (One Way Shear)

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	597	0.000	ø = 0.750
Direction Y (kN)	201	576	0.348	ø = 0.750

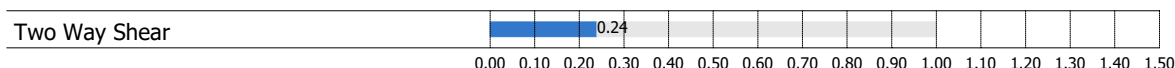


- (1) Calculate one-way shear (Direction X)
 - $V_u = 0.000\text{kN}$
 - $\phi = 0.750$
 - $\phi V_c = 597\text{kN}$
 - $V_u / \phi V_c = 0.000 \rightarrow \text{O.K}$
- (2) Calculate one-way shear (Direction Y)
 - $V_u = 201\text{kN}$
 - $\phi = 0.750$
 - $\phi V_c = 576\text{kN}$
 - $V_u / \phi V_c = 0.348 \rightarrow \text{O.K}$

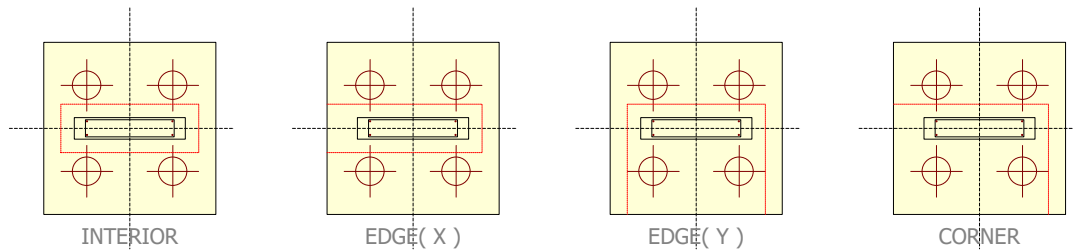
- (3) Calculate two-way shear

Calculation Summary (Two Way Shear)

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	412	1,721	0.239	$\phi = 0.750$



-	b ₀ (mm)	V _{c1} (kN)	V _{c2} (kN)	V _{c3} (kN)	V _c (kN)	V _u (kN)	øV _c (kN)	Ratio
Interior	5,175	2,380	4,063	3,331	2,380	412	1,785	0.231
Edge(X)	4,987	2,294	3,406	3,211	2,294	412	1,721	0.239
Edge(Y)	4,987	2,294	3,406	3,211	2,294	239	1,721	0.139
Corner	3,694	1,699	2,390	2,378	1,699	239	1,274	0.188



- $\phi = 0.750$
- $d = 369\text{mm}$
- $V_{c1} = 0.17 \left(1 + \frac{2}{\beta} \right) \sqrt{f'_c} b_0 d$
- $V_{c2} = 0.083 \left(\frac{a_s d}{b_0} + 2 \right) \sqrt{f'_c} b_0 d$
- $V_{c3} = 0.33 \sqrt{f'_c} b_0 d$
- $V_c = \min(V_{c1}, V_{c2}, V_{c3})$
- $V_u = 412\text{kN}$
- $V_u / \phi V_c = 0.239 \rightarrow \text{O.K}$

12. Check Moment Capacity

Calculation Summary (Moment Capacity)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	47.79	168	0.284	$\phi = 0.900$
Direction X, M_{uy} (kN·m)	0.000	174	0.000	$\phi = 0.900$

Direction Y, M_{ux}	<div><div></div></div> 0.28																
Direction X, M_{uy}	<div><div></div></div> 0.00																

(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)

- $\phi = 0.900$
- $M_{ux} = 47.79\text{kN}\cdot\text{m}$ $\phi M_{nx} = 168\text{kN}\cdot\text{m}$
- $M_{ux} / \phi M_{nx} = 0.284 \rightarrow \text{O.K}$

13. Check Rebar

Calculation Summary (Rebar Space)

Category	Value	Criteria	Ratio	Note
Direction Y, M _{ux} (mm)	100	159	0.628	A _{s,req} = 810mm²
Direction X, M _{uy} (mm)	100	159	0.628	

Direction Y, M _{ux}	<div><div></div></div>	0.63	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>
Direction X, M _{uy}	<div><div></div></div>	0.63	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></div></div>	<div><div></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

(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)
- $s_{req.} = 159\text{mm}$
- $s_y = 100\text{mm} < s_{req.} = 159\text{mm} \rightarrow \text{O.K}$