MEMBER NAME : Z-T1

1. General Information

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

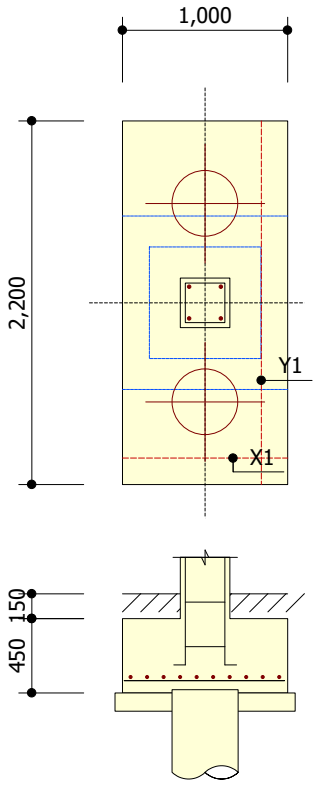
2. Material

(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 : 300x300mm



4. Rebar

(1) Direction Y
- Layer 1 : #4@100 (A_s = 1,290mm²)

(2) Direction X
- Layer 1 : #4@100 (A_s = 1,290mm²)

5. Foundation

(1) Foundation Size
- L_x : 1.000m
- L_y : 2.200m
- No. of pile : 2-ø400
- 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
-	-	22	159	23.24	0.0981	
1	Yes	1	130	1.765	-3.236	
2	Yes	2	161	3.923	-5.590	
3	Yes	3	129	1.863	-0.981	
4	Yes	4	131	1.569	-5.492	
5	Yes	5	129	-1.079	-3.825	
6	Yes	6	131	4.511	-2.648	
7	Yes	7	153	3.432	-3.334	
8	Yes	8	154	3.236	-6.669	
9	Yes	9	153	1.275	-5.492	
10	Yes	10	154	5.492	-4.511	
11	Yes	11	77.28	1.177	0.294	
12	Yes	12	78.75	0.883	-4.217	
13	Yes	13	77.18	-1.765	-2.550	
14	Yes	14	78.85	3.825	-1.373	
15	Yes	15	123	3.236	18.24	
16	Yes	16	137	0.294	-24.71	
17	Yes	17	123	-24.52	-10.00	

18	Yes	18	137	27.95	3.530	
19	Yes	19	148	4.511	11.28	
20	Yes	20	158	2.256	-21.28	
21	Yes	21	148	-16.48	-10.10	
22	Yes	22	159	23.24	0.0981	
23	Yes	23	71.29	2.550	19.52	
24	Yes	24	84.63	-0.490	-23.44	
25	Yes	25	70.71	-25.20	-8.728	
26	Yes	26	85.32	27.26	4.805	

(2) Factored Load

- P_u : 175kN
- M_{ux} : 34.42kN·m
- M_{uy} : 3.923kN·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)	0.0981	14.21	0.00690	M_{sy} / M_{rx}
Direction Y (kN·m)	23.24	31.26	0.744	M_{sx} / M_{ry}

(2) Overturning Moment (Factored Load)

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	3.923	17.05	0.230	M_{uy} / M_{rx}
Direction Y (kN·m)	34.42	37.51	0.918	M_{ux} / M_{ry}

(3) Pile Bearing (Compression)

Category	Value	Criteria	Ratio	Note
Compression (kN)	110	132	0.836	
Tension (kN)	0.000	0.000	0.000	
Pile Punching (kN)	130	774	0.168	

(4) One Way Shear

Category	Value	Criteria	Ratio	Note
Direction X (kN)	0.000	547	0.000	ø = 0.750
Direction Y (kN)	102	240	0.426	ø = 0.750

(5) Two Way Shear

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	197	1,128	0.175	ø = 0.750

(6) Moment Capacity

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	58.45	168	0.348	ø = 0.900
Direction X, M_{uy} (kN·m)	0.000	174	0.000	ø = 0.900

(7) Rebar Space

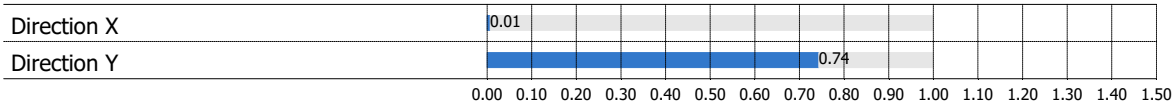
Category	Value	Criteria	Ratio	Note

Direction Y, M_{ux} (mm)	100	159	0.628	$A_{s.req}$ = 810mm²
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)	0.0981	14.21	0.00690	M_{sy} / M_{rx}
Direction Y (kN·m)	23.24	31.26	0.744	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

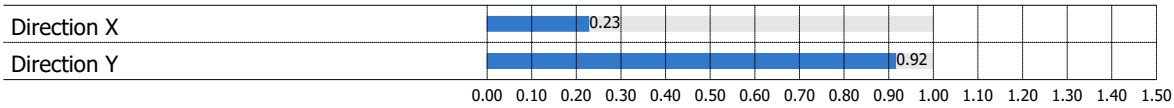
(2) Check overturning moment

Direction X (M_{sy})			Direction Y (M_{sx})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
0.0981kN·m	14.21kN·m	0.00690	23.24kN·m	31.26kN·m	0.744

9. Check overturning moment (Factored Load)

Calculation Summary (Overturning Moment (Factored Load))

Category	Value	Criteria	Ratio	Note
Direction X (kN·m)	3.923	17.05	0.230	M_{uy} / M_{rx}
Direction Y (kN·m)	34.42	37.51	0.918	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

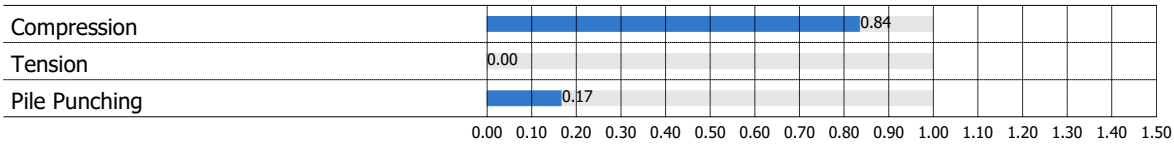
Direction X (M_{uy})			Direction Y (M_{ux})		
M_a	M_R	M_a / M_R	M_a	M_R	M_a / M_R
3.923kN·m	17.05kN·m	0.230	34.42kN·m	37.51kN·m	0.918

10. Check Pile Capacity

Calculation Summary (Pile Bearing (Compression))

Category	Value	Criteria	Ratio	Note
Compression (kN)	110	132	0.836	

Tension (kN)	0.000	0.000	0.000
Pile Punching (kN)	130	774	0.168



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	130	1,166	1,066	774	774	0.168
02	0.000	-600	72.52	1,166	1,066	774	774	0.0937

- V_u , V_c : Pile Punching

(1) Calculate actual pile stress (kN)

- $q_{s,max}$ = 110kN/EA
- **$q_{s,max} / q_a$ = 0.836 → O.K**
- $q_{s,min}$ = 0.000kN/EA
- **$q_{s,min} / q_a$ = 0.000 → O.K**

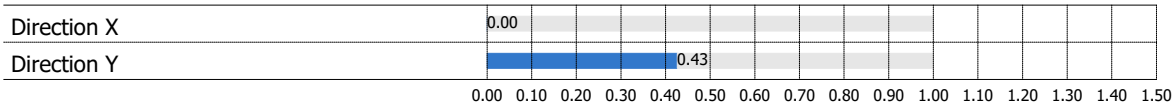
(2) Calculate factored pile stress (kN)

- $q_{u,max}$ = 130kN/EA
- $q_{u,min}$ = 72.52kN/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)	102	240	0.426	ø = 0.750



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

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

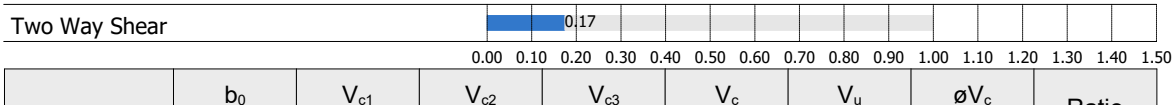
(2) Calculate one-way shear (Direction Y)

- V_u = 102kN
- ø = 0.750
- ϕV_c = 240kN
- **$V_u / \phi V_c$ = 0.426 → O.K**

(3) Calculate two-way shear

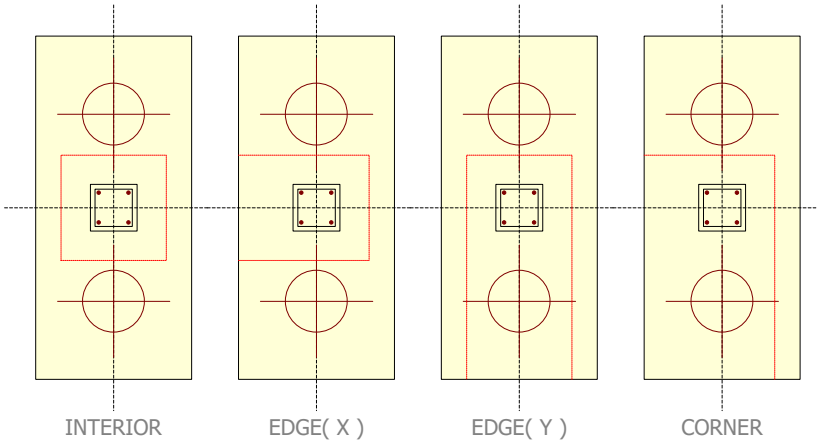
Calculation Summary (Two Way Shear)

Category	Value	Criteria	Ratio	Note
Two Way Shear (kN)	197	1,128	0.175	ø = 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	2,675	2,661	3,254	1,722	1,722	197	1,291	0.153
Edge(X)	2,337	2,325	2,547	1,505	1,505	197	1,128	0.175
Edge(Y)	3,537	3,519	2,936	2,277	2,277	67.04	1,708	0.0393

Corner	2,269	2,257	1,928	1,460	1,460	67.04	1,095	0.0612

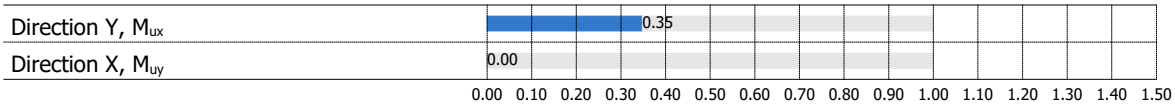


- ø = 0.750
- d = 369mm
- $V_{c1} = 0.17 \left(1 + \frac{2}{\beta} \right) \sqrt{f'_c}\ b_0\ d$
- $V_{c2} = 0.083 \left(\frac{a_s\ d}{b_0} + 2 \right) \sqrt{f'_c}\ b_0\ d$
- $V_{c3} = 0.33 \sqrt{f'_c}\ b_0\ d$
- $V_c = \min(V_{c1}, V_{c2}, V_{c3})$
- V_u = 197kN
- **V_u / øV_c = 0.175 → O.K**

12. Check Moment Capacity

Calculation Summary (Moment Capacity)

Category	Value	Criteria	Ratio	Note
Direction Y, M_{ux} (kN·m)	58.45	168	0.348	ø = 0.900
Direction X, M_{uy} (kN·m)	0.000	174	0.000	ø = 0.900



(1) Calculate moment capacity (Direction X)

- ø = 0.900
- M_{uy} = 0.000kN·m øM_{ny} = 174kN·m
- **M_{uy} / øM_{ny} = 0.000 → O.K**

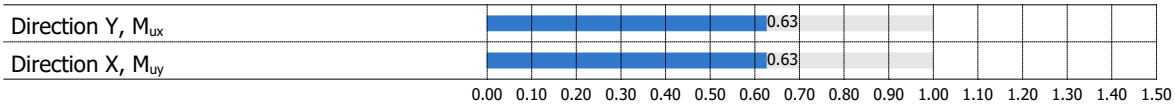
(2) Calculate moment capacity (Direction Y)

- ø = 0.900
- M_{ux} = 58.45kN·m øM_{nx} = 168kN·m
- **M_{ux} / øM_{nx} = 0.348 → 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	



(1) Calculate minimum rebar area required

- $A_{s,min}$ = 0.00180D = 810mm²

(2) Calculate minimum rebar space required (Direction Y)

- A_s = 129mm² (#4@100)
- $s_{req.}$ = 159mm
- **s_x = 100mm < $s_{req.}$ = 159mm → O.K**

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

- A_s = 129mm² (#4@100)
- $s_{req.}$ = 159mm
- **s_y = 100mm < $s_{req.}$ = 159mm → O.K**