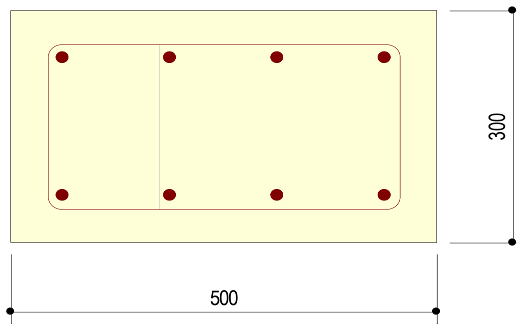
PEDESTAL IPE 240

1. General Information

(1) Design Code : ACI318M-14
(2) Unit System : N, mm

2. Material

(1) F'_c : 28.00MPa
(2) F_y : 413MPa
(3) F_{ys} : 413MPa



3. Section

(1) Section Size : 500 x 300mm
(2) L_x : 1.000m
(3) L_y : 1.000m
(4) K_x : 1.000
(5) K_y : 1.000
(6) Splicing Limit : 50%
(7) Frame Type : Braced Frame

4. Forces

(1) P_u : 11.20kN
(2) M_{ux} : 6.500kN·m
(3) M_{uy} : 2.800kN·m
(4) V_{ux} : 2.100kN
(5) V_{uy} : 1.700kN
(6) P_{ux} : 11.10kN
(7) P_{uy} : 11.10kN

5. Factors

(1) C_{mx} : 0.600
(2) C_{my} : 0.600
(3) β_{dns} : 0.600

6. Rebar

(1) Main Bar

- Layer-1 : 8 - 2 - #5 (C_c = 61.00mm, A_s = 1,600mm²)
- Layer-2 : -
- Layer-3 : -
- Layer-4 : -
- $A_{s.total}$: 1,600mm²

(2) Hoop Bar

- End : #3@100
- Middle : #3@100

(3) Tie Bar

- Apply Tie Bar to Shear Check : Yes
- Tie Bar : #3 (F_y = 414MPa)

7. Check Slenderness Ratio

(1) Calculate radii of gyration

- $r_x = 0.3D = 90.00\text{mm}$
- $r_y = 0.3B = 150\text{mm}$

(2) Calculate slenderness ratio

- $\dfrac{M_{1x}}{M_{2x}} = 0.000$
- $\dfrac{M_{1y}}{M_{2y}} = 0.000$
- $\dfrac{k_x\, l_{ux}}{r_x} = 11.11 < \min\left(34 + 12\dfrac{M_{1x}}{M_{2x}}, 40.0\right) = 34.00 \rightarrow$ Not Slender
- $\dfrac{k_y\, l_{uy}}{r_y} = 6.667 < \min\left(34 + 12\dfrac{M_{1y}}{M_{2y}}, 40.0\right) = 34.00 \rightarrow$ Not Slender

8. Check Magnified Moment

(1) Calculate moment magnification factor

- $\delta_{ns.x} = 1.000$
- $\delta_{ns.y} = 1.000$

9. Check Minimum Moment

(1) Calculate minimum eccentricity

- $e_{min.x} = 15 + 0.03D = 24.00\text{mm}$
- $e_{min.y} = 15 + 0.03B = 30.00\text{mm}$

(2) Calculate minimum moment

- $M_{min.x} = P_u\, e_{min.x} = 0.269\text{kN·m}$
- $M_{min.y} = P_u\, e_{min.y} = 0.336\text{kN·m}$

10. Check Design Moment

(1) Calculate design moment

- $M_{c.x} = M_{ux} = 6.500\text{kN·m}$
- $M_{c.y} = M_{uy} = 2.800\text{kN·m}$
- $M_c = 7.077\text{kN·m}$

11. Check Design Parameter

(1) Calculate rebar ratio

- A_g = **¡Error!** = 1,600mm²
- ρ_{min} = 0.0100, ρ_{max} = 0.0800, ρ = 0.0107
- $\rho_{min} < \rho < \rho_{max}$ → O.K

(2) Calculate eccentricity

- $e_x = M_{c.y} / P_u$ = 250mm
- $e_y = M_{c.x} / P_u$ = 580mm
- $e = M_c / P_u$ = 632mm
- Rotation angle of neutral axis = 6.555°

(3) Calculate concentric axial load capacity

- $P_0 = 0.85f'_c (A_g - A_{st}) + f_y A_{st}$ = 4,193kN
- $P_{0.max} = 0.80P_0$ = 3,354kN
- $P_t = f_y A_{st}$ = -661kN

12. Check Moment Capacity (Balanced axis)

(1) Calculate capacity of compression stress block

- β_1 = 0.850
- c = 170mm, $a = \beta_1 \cdot c$ = 145mm
- A_{com} = 58,498mm²
- c_{cx} = 20.46mm, c_{cy} = 90.33mm
- $C_c = 0.85 \cdot f'_c \cdot A_{com}$ = 1,392kN
- $M_{nx} = C_c \cdot c_{cy}$ = 126kN·m
- $M_{ny} = C_c \cdot c_{cx}$ = 28.49kN·m

(2) Calculate capacity of rebar

i	d_s (mm)	ε_s	f_s (MPa)	A_s (mm²)	F_s (kN)	d_y (mm)	M_{nx} (kN)	d_x (mm)	M_{ny} (kN)
1	288	-0.002065	-413	200	-82.60	-89.00	7.351	-189	15.61
2	111	0.001050	210	200	41.99	89.00	3.738	-189	-7.937
3	96.33	0.001303	261	200	52.13	89.00	4.639	-63.00	-3.284
4	81.95	0.001557	311	200	62.26	89.00	5.541	63.00	3.923
5	67.56	0.001810	362	200	72.40	89.00	6.443	189	13.68
6	244	-0.001305	-261	200	-52.20	-89.00	4.646	189	-9.866
7	259	-0.001558	-312	200	-62.33	-89.00	5.548	63.00	-3.927
8	273	-0.001812	-362	200	-72.47	-89.00	6.449	-63.00	4.565

- $\sum F_s$ = -40.82kN
- $\sum M_{nx}$ = 44.36kN·m
- $\sum M_{ny}$ = 12.77kN·m

(3) Calculate nominal capacity for neutral axis

- $P_b = C_c + P_s$ = 1,351kN
- $M_{nx} = M_{nx.conc} + M_{nx.bar}$ = 170kN·m
- $M_{ny} = M_{ny.conc} + M_{ny.bar}$ = 41.25kN·m
- $M_n = \sqrt{(M_{nx})^2 + (M_{ny})^2}$ = 175kN·m

13. Check Moment Capacity (Neutral axis)

(1) Calculate capacity of compression stress block

- $c = 84.44mm$, $a = \beta_1 \cdot c = 71.78mm$
- $A_{com} = 21,762mm^2$
- $c_{cx} = 55.00mm$, $c_{cy} = 125mm$
- $C_c = 0.85 \cdot f_{ck} \cdot A_{com} = 518kN$
- $M_{nx} = C_c \cdot c_{cy} = 64.78kN{\cdot}m$
- $M_{ny} = C_c \cdot c_{cx} = 28.49kN{\cdot}m$

(2) Calculate capacity of rebar

i	d_s (mm)	ε_s	f_s (MPa)	A_s (mm²)	F_s (kN)	d_y (mm)	M_{nx} (kN)	d_x (mm)	M_{ny} (kN)
1	288	-0.007216	-413	200	-82.60	-89.00	7.351	-189	15.61
2	111	-0.000933	-187	200	-37.33	89.00	-3.322	-189	7.055
3	96.33	-0.000422	-84.45	200	-16.89	89.00	-1.503	-63.00	1.064
4	81.95	0.000089	17.74	200	3.548	89.00	0.316	63.00	0.224
5	67.56	0.000600	120	200	23.99	89.00	2.135	189	4.533
6	244	-0.005683	-413	200	-82.60	-89.00	7.351	189	-15.61
7	259	-0.006194	-413	200	-82.60	-89.00	7.351	63.00	-5.204
8	273	-0.006705	-413	200	-82.60	-89.00	7.351	-63.00	5.204

- $\sum F_s = -357kN$
- $\sum M_{nx} = 27.03kN{\cdot}m$
- $\sum M_{ny} = 12.88kN{\cdot}m$

(3) Calculate nominal capacity for neutral axis

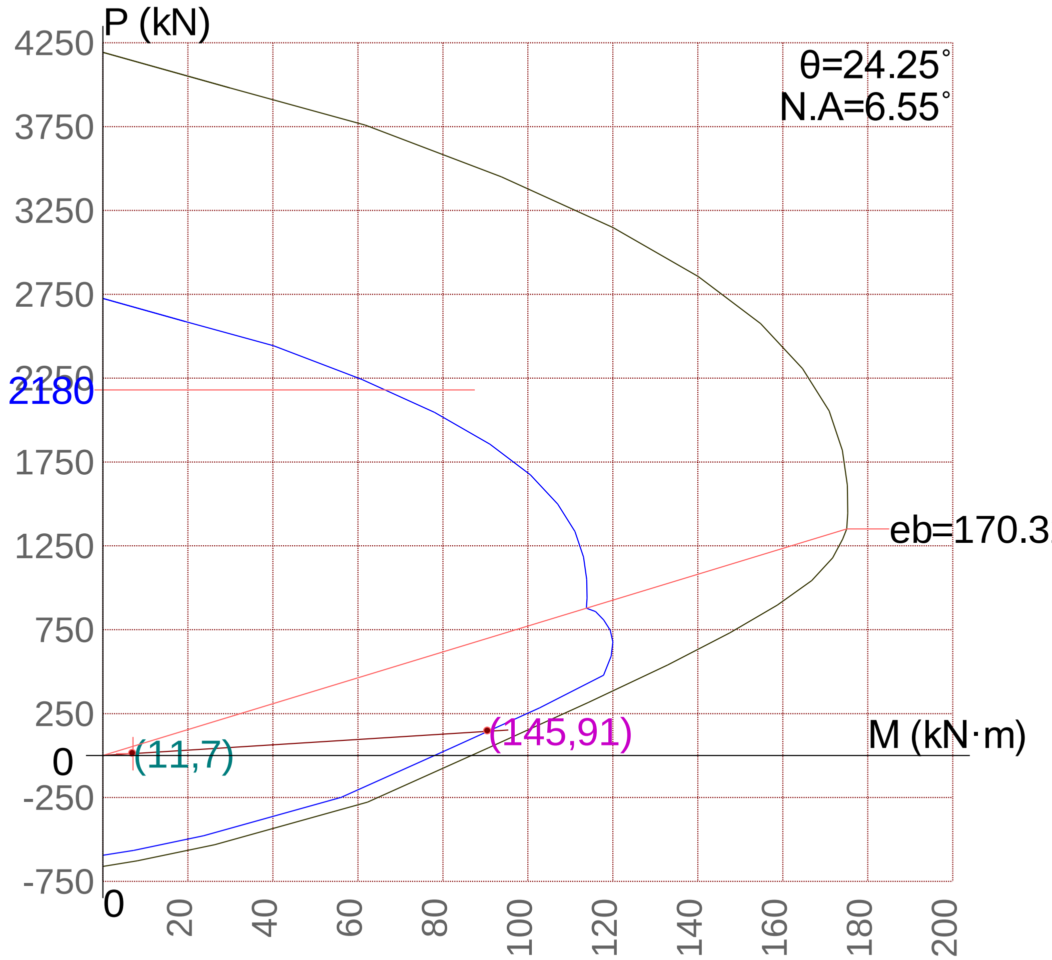
- $P_n = C_c + P_s = 161kN$
- $M_{nx} = M_{nx.conc} + M_{nx.bar} = 91.81kN{\cdot}m$
- $M_{ny} = M_{ny.conc} + M_{ny.bar} = 41.36kN{\cdot}m$
- $M_n = \sqrt{(M_{nx})^2 + (M_{ny})^2} = 101kN{\cdot}m$

(4) Calculate strength reduction factor

- $\varepsilon_{t.min} = 0.0021$, $\varepsilon_{t.max} = 0.0050$
- $\varepsilon_t = 0.007216$
- $\phi = 0.900$

(5) Calculate axial load and moment capacities

- $\phi P_n = 145kN$
- $\phi M_{nx} = 82.63kN{\cdot}m$
- $\phi M_{ny} = 37.23kN{\cdot}m$
- $\phi M_n = 90.63kN{\cdot}m$
- $M_{ux} / \phi M_{nx} = 0.0787 < 1.000 \rightarrow$ O.K
- $M_{uy} / \phi M_{ny} = 0.0752 < 1.000 \rightarrow$ O.K
- $P_u / \phi P_n = 0.0774 < 1.000 \rightarrow$ O.K
- $M_c / \phi M_n = 0.0781 < 1.000 \rightarrow$ O.K


P (kN)
4250
3750
3250
2750
2250
2180
1750
1250
750
250
0
-250
-750
θ=24.25°
N.A=6.55°
eb=170.32
(145,91)
(11,7)
M (kN·m)
0
20
40
60
80
100
120
140
160
180
200

14. Check Shear Capacity

(1) Calculate maximum space

- $\phi = 0.750$
- S_{max} = min($16D_{MainBar}$, $48D_{Stirrup}$, B, D) = 254mm

(2) Calculate Shear Strength (Direction X)

- $s = 100mm < s_{max} = 254mm$ → O.K
- $\phi V_c = \phi 0.17 \left(1+ \dfrac{N_u}{14A_g} \right) \sqrt{f'_c}\ b_w\ d = 89.32kN$
- $\phi V_s = \phi \dfrac{A_v\ f_{yt}\ d}{s} = 193kN$
- $\phi V_n = \phi V_c + \phi V_s = 282kN$
- $V_u / \phi V_n = 0.00744$ → O.K

(3) Calculate Shear Strength (Direction Y)

- $s = 100mm < s_{max} = 254mm$ → O.K
- $\phi V_c = \phi 0.17 \left(1+ \dfrac{N_u}{14A_g} \right) \sqrt{f'_c}\ b_w\ d = 81.05kN$
- $\phi V_s = \phi \dfrac{A_v\ f_{yt}\ d}{s} = 158kN$
- $\phi V_n = \phi V_c + \phi V_s = 239kN$
- $V_u / \phi V_n = 0.00712$ → O.K
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