REFERENCES	CALCULATIONS	RESULTS

Code: ENV 1992-1-1 :1991

MEMBER #1 (SECTION POSITION 0.0 mm) COLUMN DESIGN REPORT

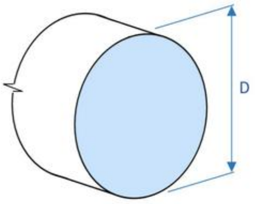
Project details

YourLOGOHere

Project Name:
Project ID:
Company:
Designer:
Client:
Project Notes:
Project Units: Metric

General member design information

Dimentions:



Diameter $D = 457.2\ \mathrm{mm}$
Member length $= 2250\ \mathrm{mm}$

Material properties:
Concrete strength $f_{ck} = 25\ \mathrm{MPa}$
Steel strength of longitudinal rebar $f_{yk} = 500\ \mathrm{MPa}$
Steel strength of shear rebar $f_{ywk} = 500\ \mathrm{MPa}$
Limiting crack width $\omega_{max} = 0.3\ \mathrm{mm}$

Design Factors and Settings:
Partial safety factor for concrete $\gamma_c = 1.50$
Partial safety factor for rebar $\gamma_s = 1.15$
Long term and unfavorable effects for concrete $\alpha_{cc} = 0.85$

Load Combinations

Ultimate Limit State:
LC 1: ULS: 1. D (N = 26.73 kN, Mz = -0.28 kN-m, My = 0.27 kN-m)
LC 2: ULS: 2. D + L (N = 23.22 kN, Mz = -6.56 kN-m, My = 0.50 kN-m)
LC 3: ULS: 3. D + (S or Lr or R) (N = 26.73 kN, Mz = -0.28 kN-m, My = 0.27 kN-m)
LC 4: ULS: 4. D + 0.75L + 0.75(S or Lr or R) (N = 24.10 kN, Mz = -4.99 kN-m, My = 0.44 kN-m)
LC 5: ULS: 5a. D + 0.6W (N = 26.73 kN, Mz = -0.28 kN-m, My = 0.27 kN-m)
LC 6: ULS: 5b. D + 0.7E (N = 26.73 kN, Mz = -0.28 kN-m, My = 0.27 kN-m)
LC 7: ULS: 6a. D + 0.75L + 0.75(0.6)W + 0.75(S or Lr or R) (N = 24.10 kN, Mz = -4.99 kN-m, My = 0.44 kN-m)
LC 8: ULS: 6b. D + 0.75L + 0.75(0.7)E + 0.75S (N = 24.10 kN, Mz = -4.99 kN-m, My = 0.44 kN-m)
LC 9: ULS: 7. 0.6D + 0.6W (N = 16.04 kN, Mz = -0.17 kN-m, My = 0.16 kN-m)
LC 10: ULS: 8. 0.6D + 0.7E (N = 16.04 kN, Mz = -0.17 kN-m, My = 0.16 kN-m)

Serviceabiity Limit State:
LC 1: LC-1 (N = 26.73 kN, Mz = -0.28 kN-m, My = 0.27 kN-m)

DL - Dead Load
LL - Live Load
WL - Wind Load
LrL - Roof Live Load
RL - Rain Load
SL - Snow Load
EL - Earthquake Load

Detailing and strength check status of column section based on all load combinations

LC #	P (kN)	Mz (kN-m)	My (kN-m)	Vy (kN)	Vz (kN)	Ratio	Status
1	26.73	-0.44	-0.54	0.00	0.31	0.42	OK
2	23.22	-6.69	0.63	3.34	0.44	0.42	OK
3	26.73	-0.44	-0.54	0.00	0.31	0.42	OK
4	24.10	-5.13	0.58	2.50	0.41	0.42	OK
5	26.73	-0.44	-0.54	0.00	0.31	0.42	OK
6	26.73	-0.44	-0.54	0.00	0.31	0.42	OK
7	24.10	-5.13	0.58	2.50	0.41	0.42	OK
8	24.10	-5.13	0.58	2.50	0.41	0.42	OK
9	16.04	-0.26	-0.33	0.00	0.19	0.42	OK
10	16.04	-0.26	-0.33	0.00	0.19	0.42	OK

Detailed report based on load combination: 10

Detailing of Members

DETAILING RULES FOR COLUMN (LONGITUDINAL REINFORCEMENT)

Section input data:
Design strength of rebar $f_{yd} = f_{yk}/\gamma_s = 500/1.15 = 434.78\ \text{MPa}$
Mean width of tension zone $b_t = 457.2\ \text{mm}$
Section concrete area $A_c = 164173.22\ \text{mm}^2$
Longitudinal rebar area $A_{st} = 785.40\ \text{mm}^2$
Given axial force $N_{ed} = 16.04\ \text{kN}$

9.5.2(2), 9.5.2(3)

1. Calculation of maximum allowed longitudinal reinforcement (9.5.2(2), 9.5.2(3))

$$f_{ck} = 25\ \text{MPa} \leq 50\ \text{MPa}$$

$$f_{ctm} = 0.3 \cdot f_{ck}^{2/3} = 0.3 \cdot 25^{2/3} = 2.56\ \text{MPa}$$

$$A_{s,max} = 0.04 \cdot A_c = 0.04 \cdot 164173.22322758927 = 6566.93\ \text{mm}^2$$

9.2.1.1(1)

9.2.1.1(1)

2. Calculation of minimum allowed longitudinal reinforcement (9.2.1.1(1))

$$A_{s,min1} = 0.1 \cdot \frac{N_{ed}}{f_{yd}} = 0.1 \cdot \frac{16040.29}{434.78} = 3.69\ \text{mm}^2$$

$$A_{s,min2} = 0.002 \cdot A_c = 0.002 \cdot 164173.22 = 328.35\ \text{mm}^2$$

$$A_{s,min} = max\left[A_{s,min1}, A_{s,min2}\right] = 328.35\ \text{mm}^2$$

3. Check of allowed longitudinal reinforcement

$$A_{st} = 785.40\ \text{mm}^2 \leq A_{s,max} = 6566.93\ \text{mm}^2\ \text{(Ratio: 0.120)}$$

$$A_{st} = 785.40\ \text{mm}^2 \geq A_{s,min} = 328.35\ \text{mm}^2\ \text{(Ratio: 0.418)}$$

STATUS OK!
Ratio: 0.120

STATUS OK!
Ratio: 0.418

Slenderness of column braced against sidesway

Section input data:
Effective Length factor $K_z = 1.00$
Effective Length factor $K_y = 1.00$
Unsupported length of the column $l = 2250.00\ \text{mm}$
Section axial load based on current load combination $N_{ed} = 16.04\ \text{kN}$
Section flexure about major axis based on current load combination $M_{edz} = -0.17\ \text{kN-m}$
Section flexure about minor axis based on current load combination $M_{edy} = 0.16\ \text{kN-m}$

Top column section moment about major axis $M_{edz,top} = -0.17$ kN-m
Top column section moment about minor axis $M_{edy,top} = 0.16$ kN-m
Bottom column section moment about major axis $M_{edz,bot} = -0.16$ kN-m
Bottom column section moment about minor axis $M_{edy,bot} = -0.24$ kN-m
Design compressive strength of concrete $f_{cd} = \alpha_{cc} \cdot f_{ck}/\gamma_c = 0.85 \cdot 25/1.5 = 14.17$ MPa
Design strength of rebar $f_{yd} = f_{yk}/\gamma_s = 500/1.15 = 434.78$ MPa
Section concrete area $A_c = 164173.22\ \mathrm{mm}^2$
Longitudinal rebar area $A_{st} = 785.40\ \mathrm{mm}^2$

Second-order moment about major axis Z

5.8.2, 5.8.3.1

1. Check if the column is long

$$e_i = \frac{l}{400} = \frac{2250}{400} = 5.63\ \mathrm{mm}$$

$$N_{ed} \cdot e_i = 16.04 \cdot 5.63 \cdot 0.001 = 0.09\ \text{kN-m}$$

$$M_{01} = min\,\{|M_{top}|, |M_{bot}|\} + N_{ed} \cdot e_i = 0.16 + 0.09 = 0.25\ \text{kN-m}$$

$$M_{02} = max\,\{|M_{top}|, |M_{bot}|\} + N_{ed} \cdot e_i = 0.17 + 0.09 = 0.26\ \text{kN-m}$$

$$\text{Radius of gyration } r_z = 0.25 \cdot D = 0.25 \cdot 457.2 = 114.30\ \mathrm{mm}$$

$$\omega = (\frac{A_{st} \cdot f_{yd}}{A_c \cdot f_{cd}}) = (\frac{785.40 \cdot 434.78}{164173.22 \cdot 14.17}) = 0.15$$

$$A = 0.7$$

$$B = \sqrt{1 + 2 \cdot \omega} = \sqrt{1 + 2 \cdot 0.15} = 1.14$$

$$C = 1.7 - \frac{M_{01}}{M_{02}} = 1.7 - \frac{0.25}{0.26} = 0.73$$

$$n = \frac{N_{Ed}}{A_c \cdot f_{cd}} = \frac{16.04 \cdot 1000}{164173.22 \cdot 14.17} = 0.01$$

$$\lambda_{lim} = \frac{20 \cdot A \cdot B \cdot C}{\sqrt{n}} = \frac{20 \cdot 0.70 \cdot 1.14 \cdot 0.73}{\sqrt{0.01}} = 140.19$$

$$\frac{K_y \cdot l}{r_z} = \frac{1 \cdot 2250}{114.30} = 19.69 \leq \lambda_{lim} = 140.19$$

Column is short. Second-order moment can be ignored.

$$0.6 \cdot M_{02} + 0.4 \cdot M_{01} = 0.6 \cdot 0.26 + 0.4 \cdot 0.25 = 0.26\ \text{kN-m} \geq 0.4 \cdot M_{02} = 0.4 \cdot 0.26 = 0.10\ \text{kN-m}$$

$$M_{0ed} = 0.26\ \text{kN-m}$$

$$M_{ed} = max\,\{M_{02}, M_{0ed} + M_2, M_{01} - 0.5 \cdot M_2\} =$$

$$= max\,\{0.26, 0.26, |0.25|\} = 0.26\ \text{kN-m}$$

Second-order moment about minor axis Y

5.8.2, 5.8.3.1

1. Check if the column is long

$$e_i = \frac{l}{400} = \frac{2250}{400} = 5.63\ \mathrm{mm}$$

$$N_{ed} \cdot e_i = 16.0402870896 \cdot 5.63 \cdot 0.001 = 0.09\ \text{kN-m}$$

$$M_{01} = min\,\{|M_{top}|, |M_{bot}|\} + N_{ed} \cdot e_i = -0.16 + 0.09 = -0.07\ \text{kN-m}$$

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