Department of Civil Engineering
Katihar Engineering College, Katihar

Subject: Design of Concrete Structure - I
Topic: Design of Column
Lecture: 05
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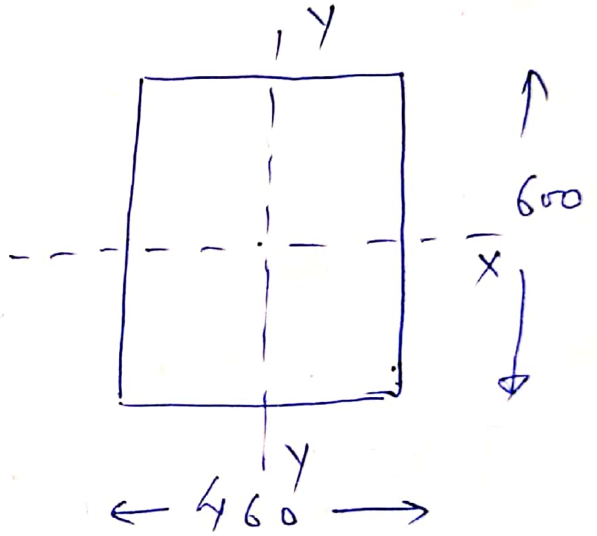
P-1. Design a RCC column of size 460 X 600 mm having effective length 3.6 m is to be designed using LSM to support an axial load of 2500 kN (Service Load). Use M20 Concrete and Fe 415 steel.



B = 460 mm
D = 600 mm

(i) Column contains axial load.

P = 2500 kN
Pu = 1.5 X 2500
= 3750 kN

(ii) Slenderness ratio (λ) = Effective length / Least lateral Dimension of column

= 3.6 X 1000 / 460 = 7.8 < 12

Column is short

(3) Minm eccentricity (e_{min})

About X–X axis

$$e_{min\,x-x} = \frac{L_{ex}}{500} + \frac{D}{30} \quad \text{or } 20\text{ mm} \quad \text{whichever is more}$$

$$= \frac{3600}{500} + \frac{600}{30} \text{ or } 20 \text{ mm}$$

$$= 27.2 \text{ or } 20 \text{ mm}$$

Maxm value

$$= 27.2 \text{ mm}$$

$$0.05D = 0.05 \times 600 = 30 \text{ mm}$$

$$e_{min\,x-x} < 0.05D \quad \text{ok}$$

(4) about Y–Y axis

$$e_{min\,y-y} = \frac{L_y}{500} + \frac{B}{30} \quad \text{or } 20\text{ mm} \quad \text{whichever is more}$$

$$= \frac{3600}{500} + \frac{460}{30} \quad \text{or } 20\text{ mm} \quad \text{whichever is more}$$

$$= 22.53 \text{ mm}$$

$$0.05B = 0.05 \times 460 = 23 \text{ mm}$$

$e_{min\,y-y} < 0.05B$

Load Carrying Capacity for an axially loaded short column

$P_u = 0.4 f_{ck} A_c + 0.67 f_y A_{sc}$

$3750 \times 10^3 = 0.4 \times 20 \times (A_g - A_{sc}) + 0.67 \times 415 A_{sc}$

$3750 \times 10^3 = 0.4 \times 20 [460 \times 600 - A_{sc}] + 0.67 \times 415 A_{sc}$

$A_{sc} = 5710.05\ mm^2$

Provide 25 mm diameter bar

No of bars $= \frac{5710.05}{\frac{\pi}{4} \times 25^2} = 11.63 \simeq 12$

Provide 12 # 25 mm ϕ

Design of stirrups

Diameter.

(I) $\frac{\phi_{main}}{4}$ } whichever is more
(II) 6 mm

Spacing

(I) Least lateral dimension } whichever is less.
(II) 16 ϕ_{main}
(III) 300 mm

Diameter

(i) $\frac{\phi_{main}}{4} = \frac{25}{4} = 6.25\ mm$

6 mm

Provide 8 mm diameter.

(2) Spacing of Lateral ties

(i) LLD = 460 mm

(ii) 16 ϕ_{main} = 16 × 25 = 400 mm } which is less

(iii) 300 mm

Provide spacing = 300 mm

Provide 8 mm ϕ @ 300 mm c/c

⇒ Design of circular column with helical reinforcement

A/c to IS 456 : 2000 ℄ 39.4.

Load carrying capacity of column is increased by 5%.

If $e_{min} \leq 0.05D$

$$P_u = 1.05\left[0.4 f_{ck} A_c + 0.67 f_y A_{sc}\right]$$

For helical Reinforcement

$$0.36 \frac{f_{ck}}{f_y}\left(\frac{A_g}{A_c} - 1\right) \leq \frac{V_h}{V_c}$$

Q-2. Design a circular column with helical reinforcement subjected to working load of 1500 kN.
Diameter of column = 450 mm
Unsupported length of column = 3.5 m.
A column is effectively held in position but not restrained against rotation.
Use LSM & M25 Concrete / Fe415 steel.

Soln

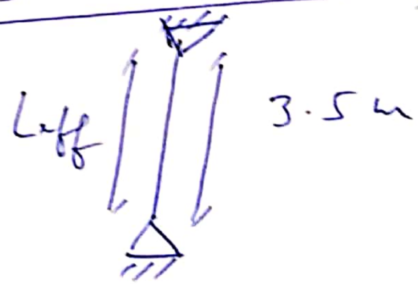
(i) Axial load (P) = 1500 kN

factored load (P_u) = 1.5 × 1500

= 2250 kN

(ii) Slenderness ratio (λ)

L_{eff} = 3.5m



$$\lambda = \frac{L_{eff}}{D} = \frac{3.5 \times 1000}{450}$$

= 7.78 mm < 12 (ok)
short column.

(iii) Minm eccentricity (e_{min})

$$e_{min} = \frac{L}{500} + \frac{D}{30}$$ } whichever is max
or 20mm

$e_{min} = \frac{3500}{500} + \frac{450}{30}$ } whichever is more
or 20 mm

$e_{min} = 22$ mm

$0.05D = 0.05 \times 450 = 22.5$ mm

$e_{min} < 0.05D$

$P_u = 0.4 f_{ck} A_c + 0.67 f_y A_{sc}$

Since we have to design for helical reinforcement.

$P_u = 1.05[0.4 f_{ck} A_c + 0.67 f_y A_{sc}]$

$2250 \times 10^3 = 1.05[0.4 \times 25 \times [A_g - A_{sc}] + 0.67 f_y A_{sc}]$

$2250 \times 10^3 = 1.05[0.4 \times 25 [\frac{\pi}{4} \times 450^2 - A_{sc}] + 0.67 \times 415 \times A_{sc}$

$A_{sc} = 2061 \text{ mm}^2$

Provide 16 mm ϕ

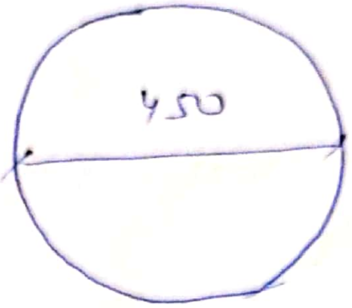
No of bars $= \frac{2061}{\frac{\pi}{4} \times 16^2} = 10.25$

Provide 11 Nos.

Design of helical reinforcement.

$$0.36 \frac{f_{ck}}{f_y}\left(\frac{A_g}{A_c}-1\right) \le \frac{V_h}{V_c}$$

(a) $D_g = 450$ mm



$A_g = \frac{\pi}{4} \times D_g^2$

$= \frac{\pi}{4} \times 450^2$

$= 159043$ mm^2

(b) Diameter of Core (D_c)

$D_c = D_g - 2 \times$ clear cover

$= 450 - 2 \times 40 = 370$ mm

$A_c = \frac{\pi}{4} \times D_c^2 = \frac{\pi}{4} \times 370^2$

$= 107521$ mm^2

$V_c =$ Volume of core

$= 1000 \times A_c$

$= 1000 \times 107521$

$= 107521000$ mm^3

Let D_h be the Diameter of helix

$D_h = D_c - \phi_h$

$= 370 - 8$

$= 362$ mm

$$V_h = \left(\frac{1000}{p}\right) \times \pi D_h \times \frac{\pi}{4} \times \phi_h^2$$

$$= \left(\frac{1000}{p}\right) \times \pi \times 362 \times \frac{\pi}{4} \times 8^2$$

$$V_h = \frac{57164749}{p}$$

$$0.36 \frac{f_{ck}}{f_y} \left(\frac{A_g}{A_c} - 1\right) \leq \frac{V_h}{V_c}$$

$$0.36 \times \frac{25}{415} \left[\frac{159043}{107521} - 1\right] \leq \frac{57164749}{p \times 107521000}$$

$$0.01 \leq \frac{0.532}{p}$$

$$p \leq 53 \text{ mm}$$

Provide pitch = 50 mm

Provide 10 mm diameter

$$p = 53 \times \frac{10^2}{8^2} = 82.8 \text{ mm}$$

pitch:
(1) $p \ngtr 75$ mm
(2) $p \ngtr \frac{D_c}{6} = \frac{370}{6} = 68.8$ ok
(3) $p \nless 25$ mm ok
(4) $p \nless 3\phi_h = 3 \times 8 = 24$ mm

Provide 8 mm ϕ @ 50 mm c/c