Department of Civil Engineering
Katihar Engineering College, Katihar

Subject: Design of Concrete Structure - I
Topic: Column
Lecture: 02 & 03
Instructor: Prof. RASHID MUSTAFA

Design of Lateral Ties:

1. Diameter

 (a) $\frac{\phi_{main}}{4}$
 (b) 6 mm
 } Maximum Value

Where ϕ_{main} = Diameter of main reinforcement (Larger diameter)

2. Spacing

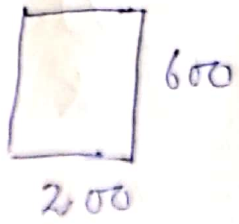
 (i) Least Lateral Dimension
 (ii) 16 ϕ_{main}
 (iii) 300 mm
 } Whichever is less.

When ϕ_{main} = Smallest diameter of main reinforcement.

Example: If 4 # 32 mm diameter, 2 # 20 mm diameter } Main reinforcement

Diameter = $\frac{32}{4}$ or 6 mm } Whichever is max
8 mm diameter bar is provided.

Spacing :



(i) 200 mm

(ii) 16 ϕ main

16 × 20 = 320 mm

(iii) 300 mm

} Min^m value

Spacing = 200 mm.

⇒ Design of Circular column

(a) Circular column with separate Lateral ties

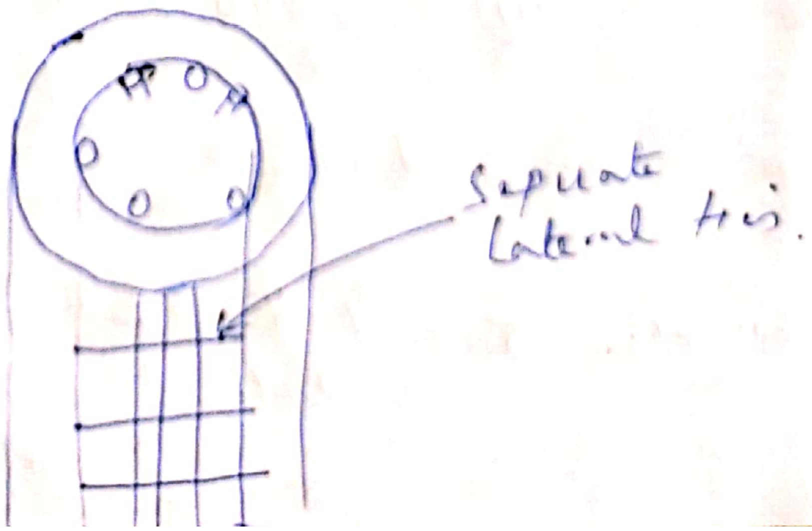
For long column

(i) Load Carrying Capacity

$$P = C_r(\sigma_{sc} \cdot A_{sc} + \sigma_{cc} \cdot A_c)$$

where C_r = Reduction Coefficient

$$C_r = 1.25 - \frac{L_{eff}}{48D}$$



(ii) Design of lateral ties

Diameter

(a) $\frac{\phi_{main}}{4}$ } Whichever is more

(b) 6 mm

(II) Spacing

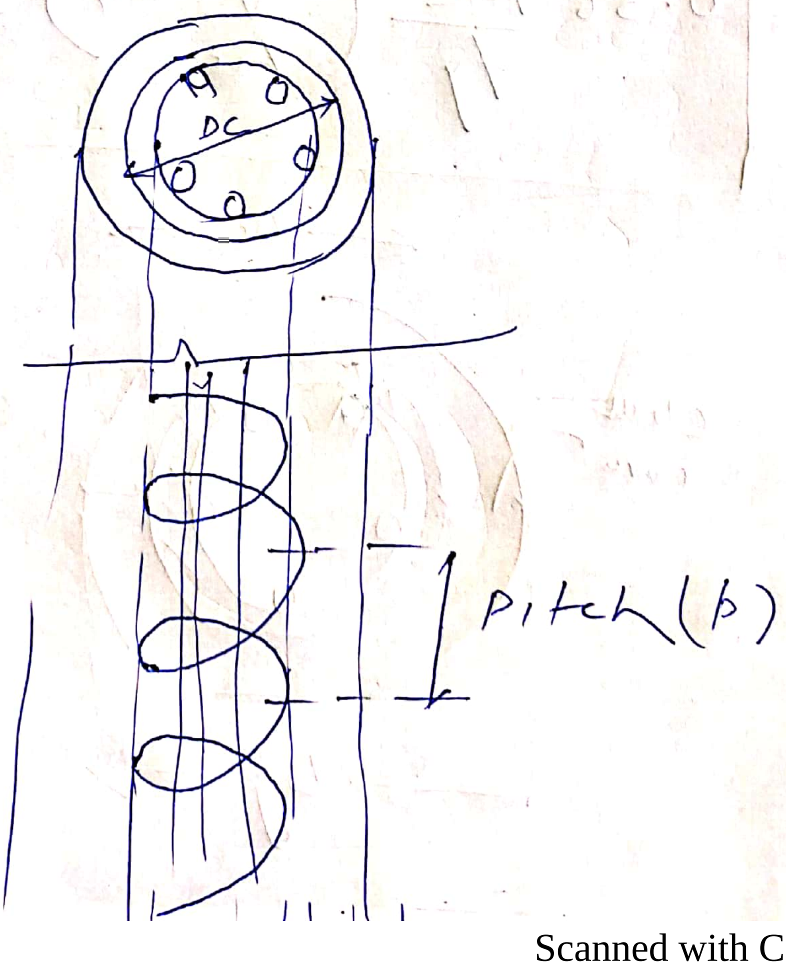
(a) Least lateral Dimension } Whichever is less.

(b) $16\ \phi_{main}$

(c) 300 mm

(2) Circular column with helical reinforcement

A/c to IS 456 : 2000, Load Carrying capacity is increased by 5%.



Load Carrying capacity of a long column

$$P = 1.05 \times C_r (\sigma_{sc} A_{sc} + \sigma_{cc} \cdot A_c)$$

$$P = 1.05\left(1.25 - \frac{L_{eff}}{48 D_c}\right)(\sigma_{sc} A_{sc} + \sigma_{cc} A_c)$$

↳ Circular long column with helical reinforcement

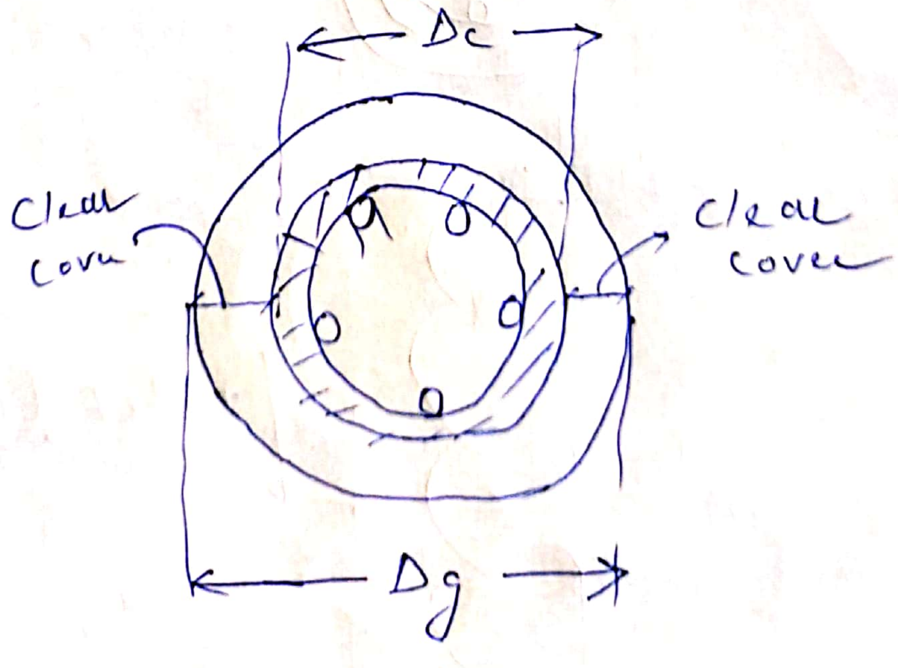
For short column with helical reinforcement

$$P = 1.05 (\sigma_{sc} \cdot A_{sc} + \sigma_{cc} \cdot A_c)$$

where D_c → Diameter of core.

⇒ Design of helical reinforcement.

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



(1) Gross Area (A_g)

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

where $D_g = D =$ Gross diameter.

(2) Core Diameter (D_c)

$D_c \rightarrow$ outside to outside of helical reinforcement

$$D_c = D_g - 2 \times \text{clear cover}$$

clear cover = 40 mm

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

V_c = Volume of core for unit length

$$V_c = (A_c \times 1000) \text{ mm}^3$$

$V_h \rightarrow$ Volume of helical reinforcement for unit length of column

$$= \begin{pmatrix} \text{No of} \\ \text{turns} \end{pmatrix} \times \begin{pmatrix} \text{length of} \\ \text{one unit} \end{pmatrix} \times \begin{pmatrix} \text{Cross} \\ \text{section} \\ \text{Area} \end{pmatrix}$$

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

$p \rightarrow$ pitch

$\pi D_h \rightarrow$ length of reinforcement in one turn

$D_h \rightarrow$ Diameter of helix

$= (D_c - \phi_h)$

pitch can be found by the formula given by IS 456: 2000

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

A/c to IS 456: 2000 (cl. 26.5.3.2(c) page 49)

pitch (p)

① $p \not> 75\,mm$ } whichever is more

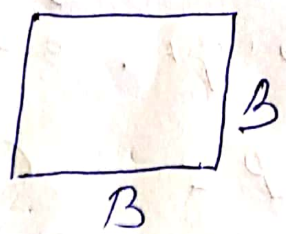
② $p \not> \frac{D_c}{6}$

③ $p \not< 25\,mm$

④ $p \not< 3\phi_h$

Q-1. Design a column (square) for an axial load of 3000 kN, unsupported length of column is 12 m. The column is held in position & restrained against rotation at one end, other end is held in position but not restrained against rotation.
Use M25 concrete & Fe 415 steel.
Use WSM & take Area of steel is 1% of Gross Area

Area of steel (p) = 1%.



$$A_{sc} = 0.01\,A_g$$

$$A_{sc} = 0.01\,B^2$$

$$A_c = A_g - A_{sc}$$

$$= A_g - 0.01B^2$$

$$= B^2 - 0.01B^2$$

$$= 0.99\,B^2$$

$$\sigma_{cc} = 6\ N/mm^2$$

$$\sigma_{sc} = 190\ N/mm^2$$

Load Carrying Capacity (P)

$$P = A_{sc}\,\sigma_{sc} + \sigma_{cc} \cdot A_c$$

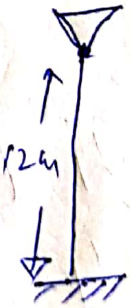
Assume Column is Short

$$3000 \times 10^3 = 0.01B^2 \times 190 + 6 \times 0.99B^2$$

$$B = 618.59\ mm$$

$$\simeq 620\ mm$$

Effective length (L_{eff})



$$L_{eff} = 0.80L$$

$$L_{eff} = 0.80 \times 12 = 9.6\ m$$

Slenderness ratio (λ) $= \dfrac{L_{eff}}{L.L.D} = \dfrac{9.6 \times 1000}{620} = 15.48 > 12$

long column. (Assumption is wrong)

Design a long column.

$P = C_r (\sigma_{sc} A_{sc} + \sigma_{cc} A_c)$

$C_r = 1.25 - \frac{L_{eff}}{48B}$

$3000 \times 10^3 = \left(1.25 - \frac{9600}{48B}\right)\left(190 \times 0.01 B^2 + 0.99 B^2 \times 6\right)$

$B = 639.04$ mm

$B = 640$ mm

Compute $\lambda = \frac{L_{eff}}{L.L.D} = \frac{9600}{640} = 15 > 12$ OK

<u>Area of steel</u> $= 1\%$ of A_g

$= 0.01 \times 640^2$

$= 4096$ mm^2

Provide 4 # 32 mm ϕ = 3216
4 # 20 mm ϕ = 1256

4472 mm^2

Design of lateral Ties

(I) Diameter

(a) $\frac{\phi main}{4}$ } whichever is more

(b) 6 mm

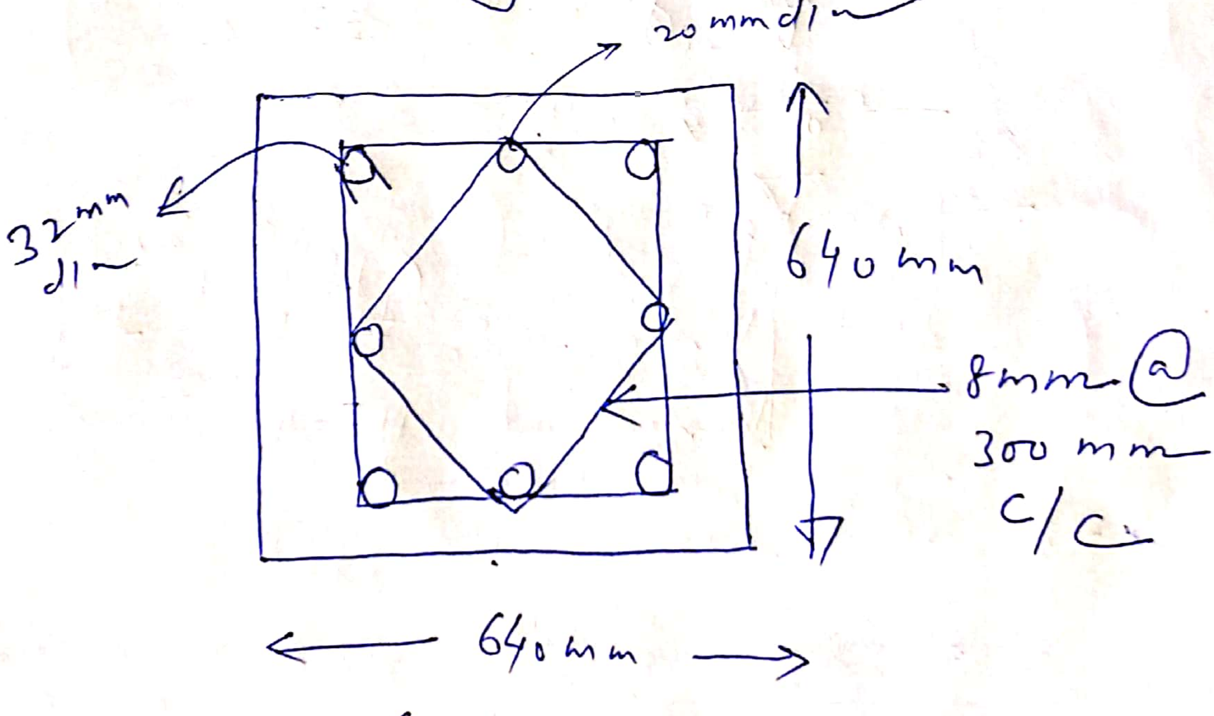
$\frac{32}{4}$ or 6 mm
whichever is more

Dia of lateral Tie = 8 mm

(II) Spacing

(a) LLD = 640 mm
(b) 16 ϕmain = 16×20 = 320 mm } which is less
(c) 300 mm

Provide spacing = 300 mm c/c



Square column.

<Happy Learning>

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