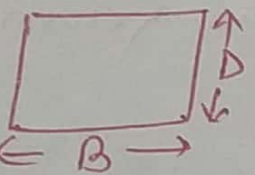
A structural element subjected predominantly to compressive force with or without bending moment is termed as "compression member". When a compression member is vertical is called a "column" and when inclined or horizontal, it is termed as "strut".

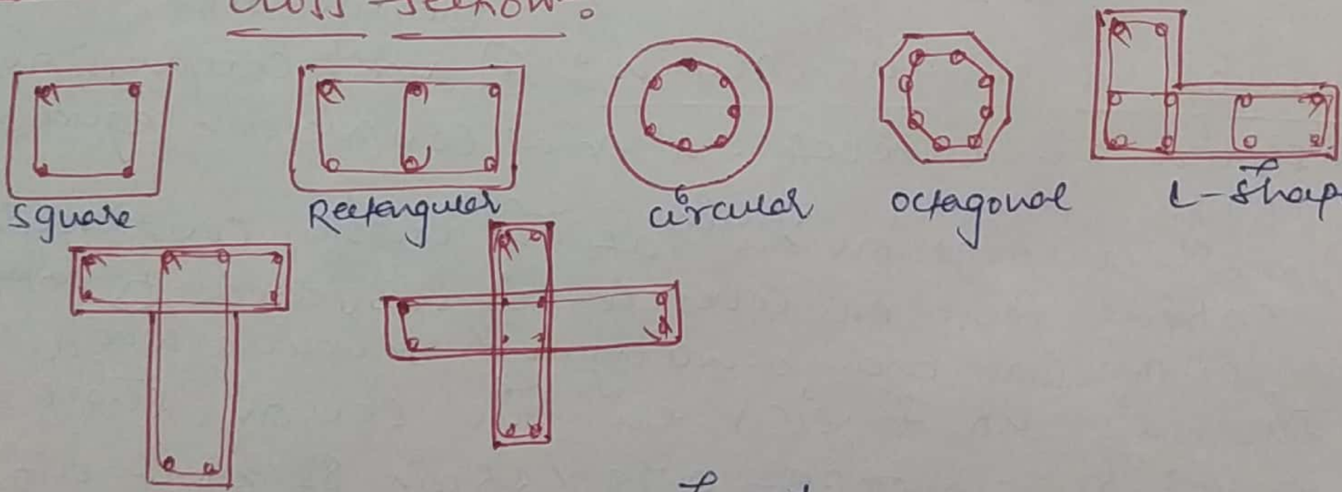
Column or strut in a compression member the effective length of is exceeded 3 times least lateral dimensions.



$l_{eff.} > 3(B \text{ or } D)$

↓ Effective length

Types of column :- ① On the Basis of shape of cross-section :-



② On the Basis of slenderness ratio

① Short column

$$S.R. = \frac{l_{eff.}}{\text{least lateral dim.}}$$

$$S.R. = \frac{l_{eff.}}{B \text{ or } D} < 12$$

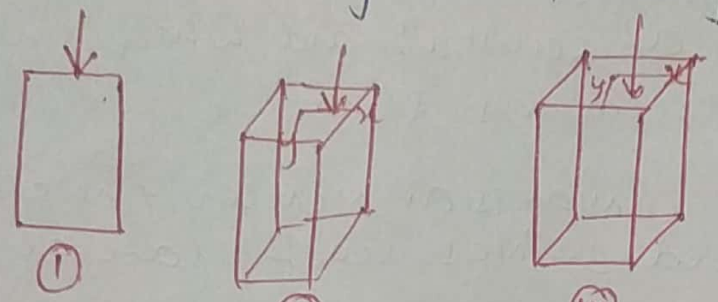
$l_{eff.}$ = Eff. length
S.R. = slenderness ratio.

② Long column

of $S.R. \geq 12$ then known as a long column

(3) On the Basis of Types of Loading

I. Axially loaded column
II. Uniaxially eccentrically loaded column
III. Biaxially eccentrically loaded column



(I) (II) (III)

4. On the Basis of pattern of Lateral Reinforcement

I Tied column
II Spiral column
III Composite column
IV In filled column

→ all the assumption of discuss for the beam valid for a column also.

Assumptions in the column:- (I) Max^m compression strain in concrete in axial compression equal to .002.

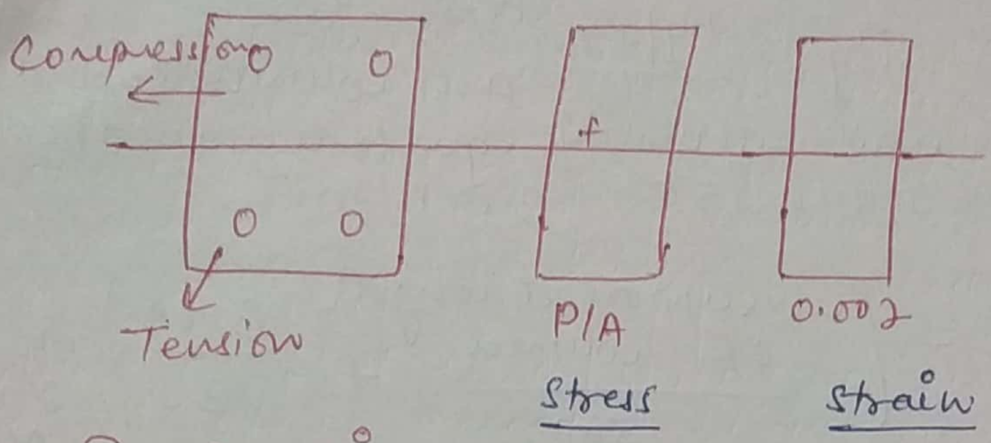
(II) Max^m compression strain in at the higher compressed extreme fibre in concrete is subjected to axial compression and bending and bending when there is no tension in the section shall be equal to = 0.0035 − 0.75 × strain of least at least compressed extreme fibre.

Functions of the longitudional Reinforcement and transverse reinforcement:-

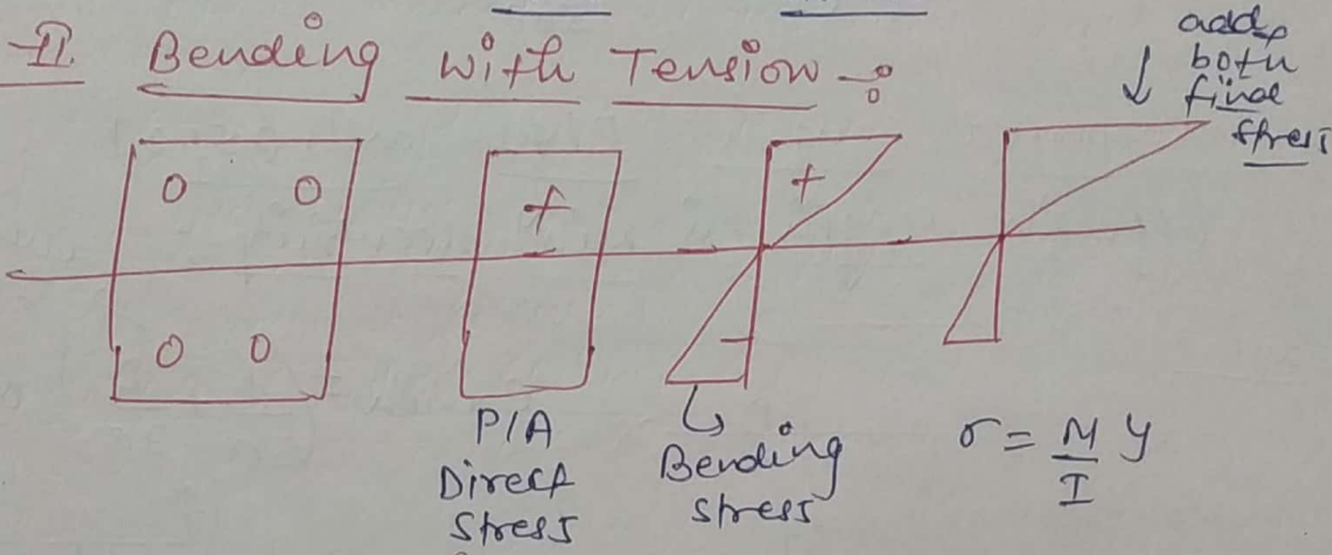
→ Longitudional rein. to shear the vertical compress. load, there by the over all size of the column
→ To prevent sudden brittle failure

→ Transverse reinforcement to prevent buckling of longitudional reinforcement.
→ to hold the longitudional reinforcement in position at the time of concreting.

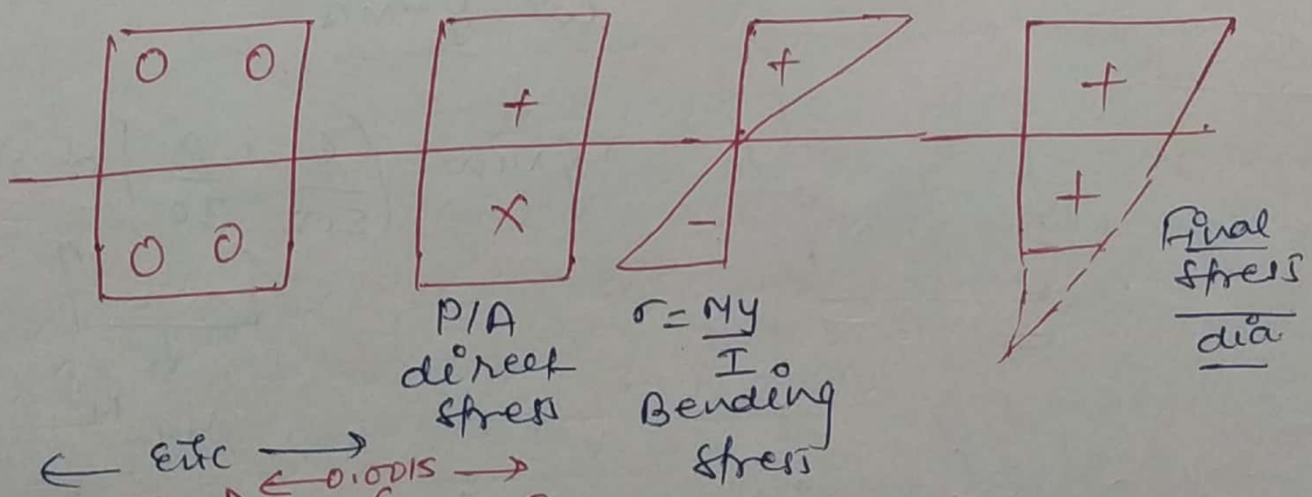
Case - I Axial compression :

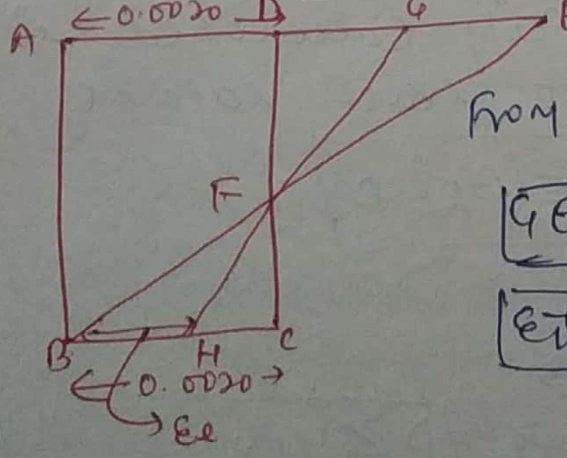


Case - II. Bending with Tension :



Case - III. No Tension : (whole column compression)





From sim^l triangle

$$GE = 0.75\,\epsilon_e$$

$$\epsilon_{tc} = 0.0035 - 0.75\,\epsilon_e$$

Design of column:

☆ Min^m eccentricity :- Pg/42 Art (25.4)

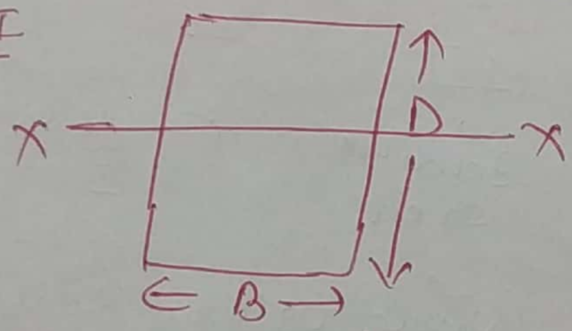
design for min^m eccentricity : All column should be equal to unsupported length of column / 500 + B or D/30.

$$\text{min}^m \text{ eccentricity} = \left[\frac{\text{unsupported length of column}}{500} + \frac{B \text{ or } D}{30}\right] \text{ or } 20\text{ mm}$$

Unsupported length :- P/42 art. (25.1.3.)

Effective length in min^m eccentricity :-

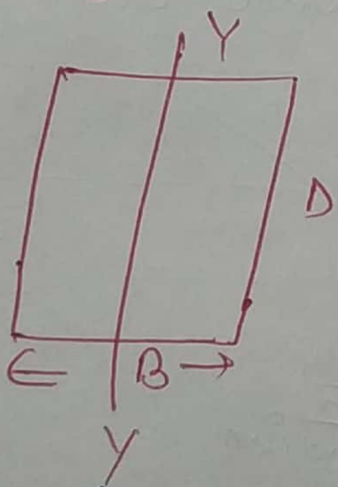
Case-I cut in x-axis



$$e_{x\,min} = \left(\frac{l}{500} + \frac{D}{300}\right) \text{ or } 20\text{mm}$$

Max

Case-II cut y-axis



$$e_{y\,min} = \left(\frac{l}{500} + \frac{B}{30}\right) \text{ or } 20\text{mm}$$

Max^m.

NOTE-(I) When min^m. eccentricity calculated is less then 0.05 times least lateral dimension.

$$e_{min} \leq 0.05(B \text{ or } D)$$

NOTE (II) $e_{min} = 20\text{ mm}$

$$20 \leq 0.05 \times B$$

$$B \geq 400 \text{ or } D \geq 400$$

NOTE-III minm. size of short column = 400MM (5)

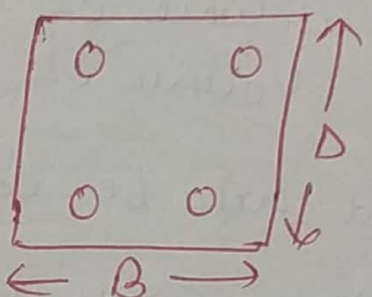
Design steps for short column:- (Pg/71)

M.M.9. When short axialy for loaded column load carrying capacity of the column,

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

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

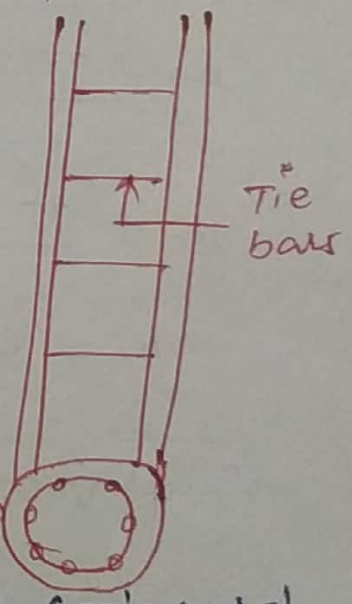
↓ Total area ↓ area of steel in compression



A_c = area of concrete
A = Total area
A_{sc} = area of steel in compression

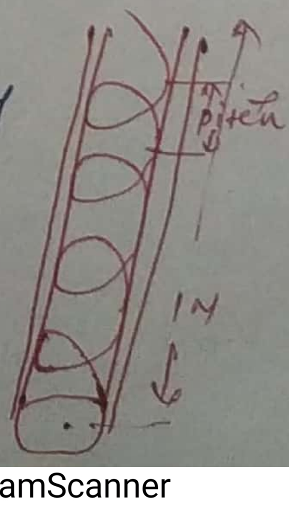
Circular column -: A) Type No. I of seperate Tie bars are used

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



Type No. II with helical reinforcement (Tiebars) as a helical of helical reinforcement is used then load carrying capacity of column is ↑ by 5%.

$$P_u = 1.05 (0.4 f_{ck} A_c + 0.67 f_y A_{sc})$$



For helical reinforcement spacing should be such that following criteria should be satisfied

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

Pg/71 Art. 39.4.

V_h = volume of helical reinforcement
V_c = volume of core

$\frac{V_h}{V_c}$ should not be less than $0.36\left(\frac{A_g}{A_c}-1\right)\frac{f_{ck}}{f_y}$

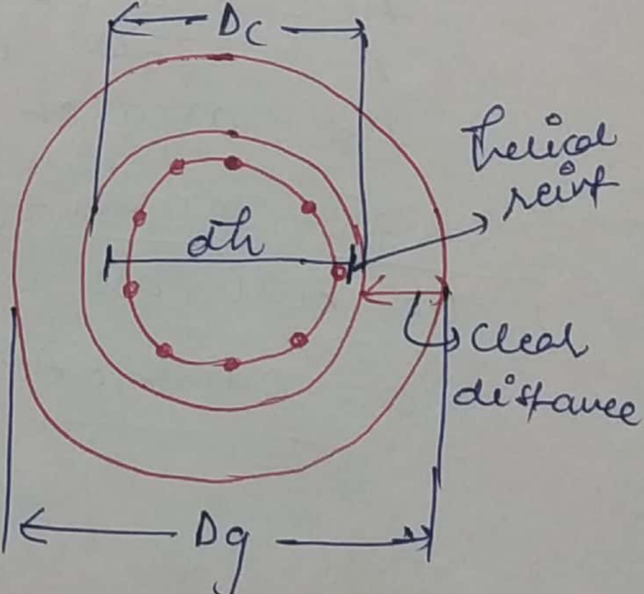
A_g = gross area
A_c = core area

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

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

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

D_c = core dia.



V_c = volume per unit length of column

$V_c = A_c \times 1000$ mm^3 when let the length of the column is 1m.

V_h = volume of helical reinforcement in one unit length of column (say 1m.)

V_h = no. of turns × length of one turn × X-sectional area of helical reinforcement.

⇒ ϕ_h = dia. of helical reinforcement

⇒ no. of turns = $\frac{1000}{P}$ ↓ when length 1M

P → pitch

$$d_h = d_c - \frac{\phi_h}{2} - \frac{\phi_h}{2} = d_c - \phi_h$$

length of one turn = $\pi d_h = 2\pi \frac{d_h}{2}$ → radius

so $\left\{ V_h = \frac{1000}{P} \times \pi d_h \times \frac{\pi}{4} \phi_h^2 \right\}$

$\left\{ V_c = A_c \times 1000 \right\}$

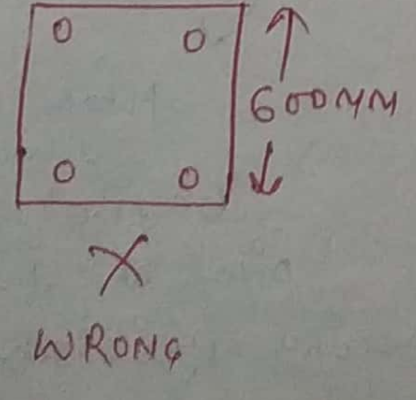
Some IS recommendation: - pg/48 min % of steel = 0.8% of Gross area

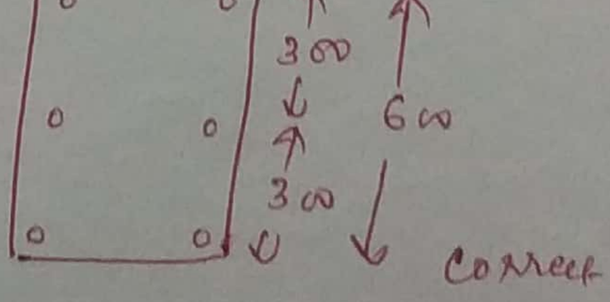
→ Max^m % of steel i) when bars arent lap = 6%.
ii) when bars are lap = 4% (of Gross area)

→ Min^m. dia. of bar = 12 MM

→ Min^m no. of bars → circular = 6 bars
Rectangular = 4 bars

→ Max^m spacing = 300 MM
of main bars (longitudional bars)





Transverse Reinforcement (Tie bars or Stirrups) :- ⑧

Pg/48

Diameter :-

1) $\frac{\phi_{main}}{4}$ or 6MM → max.

P/48

Spacing :- (distance b/w two bars)

1) Least lateral dimension (B or D)
II) $16 \times \phi_{main}$
III) 300MM.

→ min. of all

P/49. **Pitch of helical Reinforcement :-**

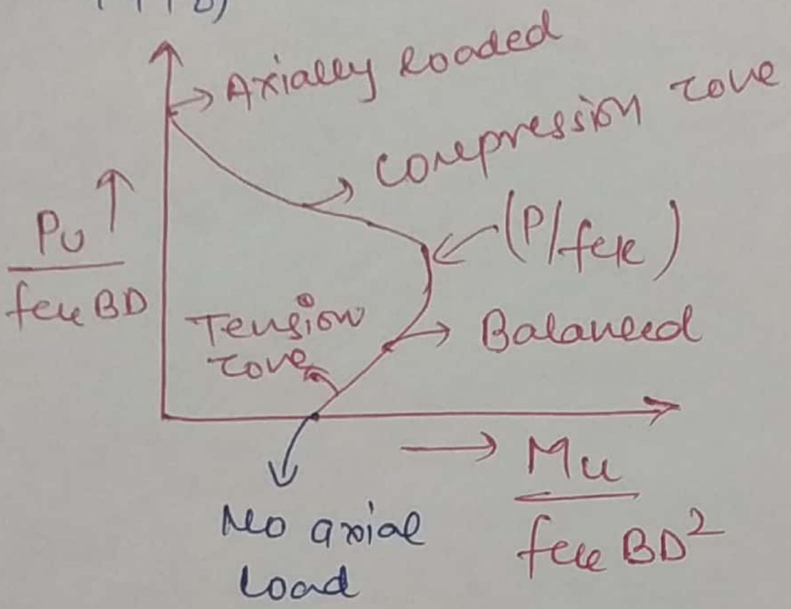
I) Not greater than 75 MM ($\ngtr 75MM$)
II) Not less than 25MM ($\nless 25MM$)
III) $\ngtr \frac{1}{6} \times D_c$
IV) $\nless 3\phi_h$

→ min. of all that would be the pitch of the helical Reinforcement

Design of column subjected to axial load and bending :-

1) P–M Interaction chart (special publication SP-16)

Book – (Design AIDS for Reinforce Concrete (IS 456-1978)



1) $M_u = 0$
→ axially loaded

11) $P_u = 0$
Pure bending

111) P_u & M_u Both are present

1) If a column is to design for a load P_u and moment M_u.

11) size of the column should be known (B×D)

111) chart given

Step-I Find out value of $P_u / f_{ck} \cdot B \cdot D = Y_{value}$

Step-II Find out value of $M_u / f_{ck} \cdot B \cdot D^2 = X_{value}$

Step-III As per value of X & Y from the interaction chart we can find $p/f_{ck} = k$.

Step-IV % of steel required $= p$ $(p = k \cdot f_{ck})$

Area of steel required $A_{st} = \dfrac{p \times Bd}{100}$

Step-V ultimate load carrying capacity of the column (P_{uz}) when (moment = 0) as per code IS : 456 2000 (pg|71)

$$P_{uz} = 0.45 f_{ck} \cdot A_c + 0.75 f_y \cdot A_{sc}$$