CE-601 SDD (RCC-I)

<u>Unit IV – Columns & Footings</u>

<u>Topic :– RCC Columns</u>

Column or strut is a compression member, the effective length of which exceeds three times the least lateral dimension.

i.e. $l_e > 3b$

if $l_e < 3b$ it is not a column
 it is a pedestal

$D \geq b$ but $D \not> 4b$ else it is a wall

X–X is major axis, Y–Y is minor axis

<u>Classification :</u> Ⓐ Based on slenderness ratio $\left(= \frac{\text{eff. length}}{\text{lateral dimension}}\right)$

① Short Column → $\dfrac{l_{ex}}{D} < 12$ & $\dfrac{l_{ey}}{b} < 12$

→ failure is compression failure by crushing. Full crushing strength utilized.

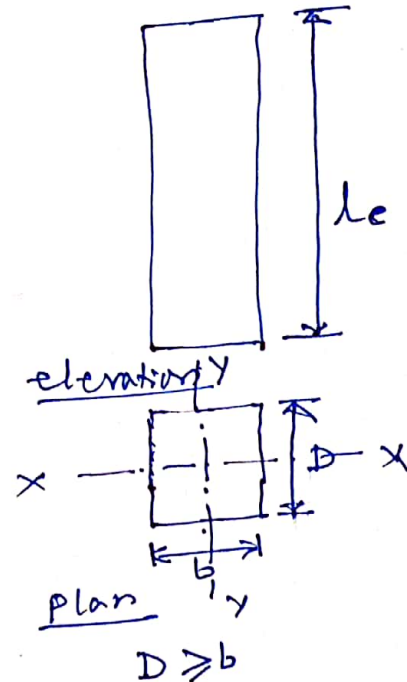② Long Column → $\dfrac{l_{ex}}{D} \geqslant 12$ <u>OR</u> $\dfrac{l_{ey}}{b} \geqslant 12$ <u>or both</u>

→ Column fail by buckling before full crushing strength developed

Max. slenderness ratio $\not> 60$

Ⓑ <u>Classification based on Column Shapes :–</u> Square, rectangular, circular, polygon, L-shaped, T-shaped etc.
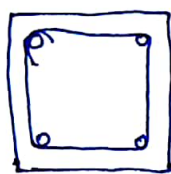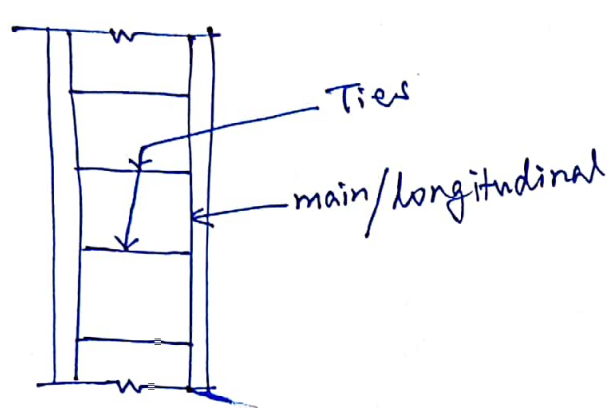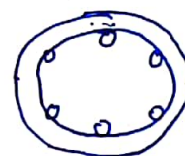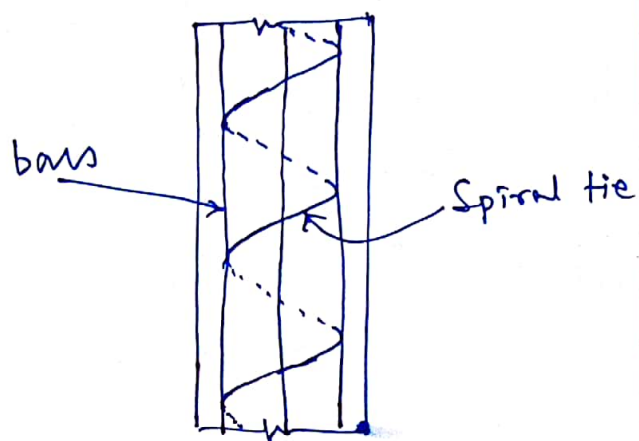
elevation
plan
$D \geq b$

~~Another~~

© Classification based on lateral support of main ~~ba~~ bars
  ① Tied Column — lateral ties are used
  ② Spiral Column — Spiral or helical ties are used.

Tied Column   Spiral Column

— A column may be subjected to;
  ① Axial load only
  ② Axial load & uniaxial bending
  ③ Axial load & biaxial bending

— Design approach differs in all three cases.

— General Design considerations for columns are given in IS 456:2000 § 25 p.41 & 42

— Structural design (LSM) of columns is given in IS 456:2000 § 39 p.70 to p.72

— All columns (except short axially loaded columns when $e_{min} \not> 0.05$ times lateral dimension) are to be designed for min. eccentricity

$$e_{min} = \left(\frac{l}{500} + \frac{lateral\ dimension}{30} \right) \not< 20\ mm$$

where,

$l =$ unsupported length of column

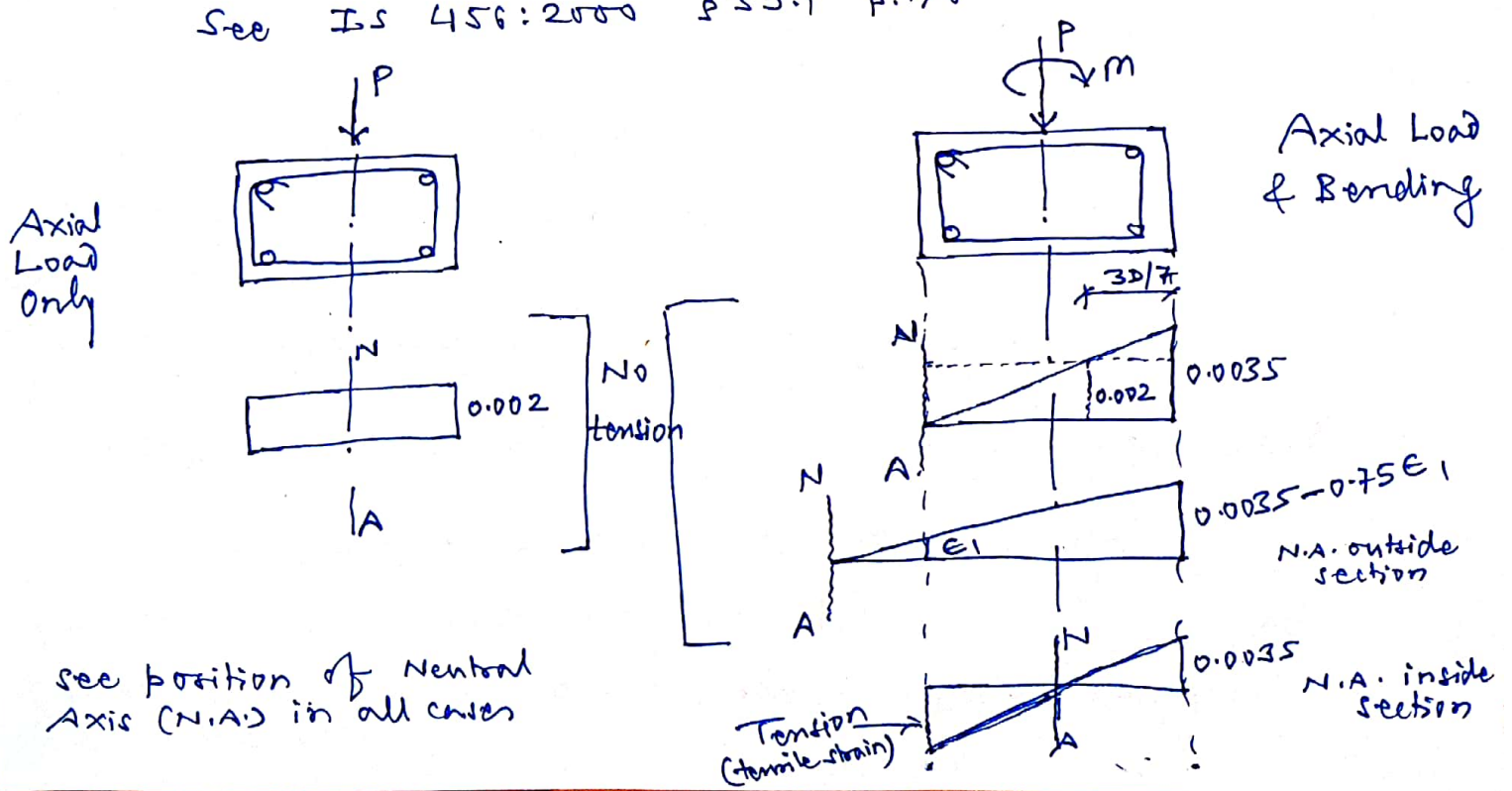$=$ length of columns between supports/restraints

or as specified in IS 456:2000 § 25.1.3/p.42 for special conditions.

Effective length of column le

The values are given in terms of l for different end conditions in Ann. 'E' IS456:2000/p.94

Basic assumptions in Lsm design of columns :-

See IS 456:2000 § 39.1 p.70

Axial Load Only

0.002

No tension

see position of Neutral Axis (N.A) in all cases

Axial Load & Bending

3D/7

0.0035

0.002

0.0035 — 0.75 ε₁

N.A. outside section

ε₁

0.0035

N.A. inside section

Tension (tensile strain)

Clean cover to main reinforcement in columns
(subjected to mild exposure) =

(i) $\not< 40$ mm.   (ii) $\not< \phi$ where ϕ = max. dia of main bar

(iii) 25 mm. for columns of minimum dimension
≤ 200 mm. & where $\phi \leq 12$ mm.

see   IS 456:2000   § 26.4.2.1 p. 46

Design of Short Columns under Axial Compression

§ 39.3 p.71 IS 456:2000

When $e_{min} \not> 0.05$ times lateral dimension,
the column may be designed using following
formula,

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

where,

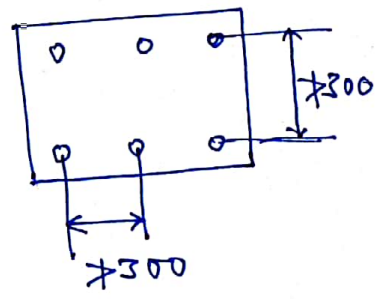P_u = Factored axial load

A_c = Area of concrete
  $= A_g - A_{sc}$ but may be taken $= A_g$ without
  much error, $A_g = b \times D$

A_{sc} = Area of steel in compression

Size of column & area of steel is calculated
using above formula. Dia & spacing of main
bars & tie bars (stirrups) are decided from following
considerations / requirements as per § 26.5.3 p. 48 & 49 of
the code.

A. Longitudinal (or main) reinforcement

① Longitudinal reinf. $\not< 0.8\%$ & $\not> 6\%$. ($\not> 4\%$ when lapped bars are used) of gross cross sectional area of column

② Min. % i.e. 0.8% shall be based on required / calculated gross area & not on actual gross area.

③ Minimum bars = 4 in rectangular column
= 6 in circular column.

④ Min. diameter $\not< 12$ mm.

⑤ spacing of longitudinal bars — measured along ~~periphery~~ periphery $\not> 300$ mm.

⑥ other requirements — read from code
:

B. Transverse (Lateral) reinforcement :-

① Min. dia $\not< \dfrac{\phi}{4}$ where, ϕ = dia. of largest longitudinal bar

$\not< 6$ mm.

② Pitch (spacing) $<$
- ⓘ b ---- b = least lateral dimension
- ⓘⓘ 16ϕ --- ϕ = Dia of smallest longitudinal bar
- ⓘⓘⓘ 300 mm.

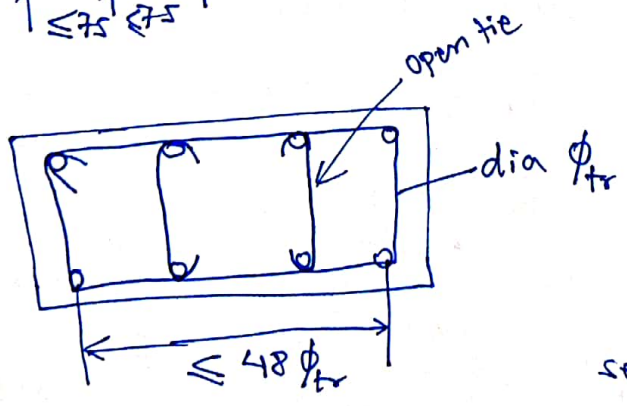In case of helical reinforcement — if inclination of helical reinf. is accounted for to carry additional load,

$$\text{pitch} \not> 75 \text{ mm.}$$
$$\not> \frac{\text{core dia. of column}}{6}$$
$$\not< 25 \text{ mm.}$$
$$\not< 3\phi_{tr} \quad --- \quad \phi_{tr} = \text{dia. of } \cancel{\text{lateral}} \text{ helical (transverse) reinf.}$$

If inclination of helical reinf. is not accounted for to carry additional load, provide pitch similar to normal ties.

For arrangement of transverse reinforcement refer § 26.5.3.2 (b) p.49 of IS 456:2000 & Figs 8,9,10 & 11 on p.50 of the code

longitudinal bars spaced not more than 75 mm, only alternate bar need to be tied in both direction

≤75 ≤75

open tie

— dia ϕ_{tr}

≤ 48 ϕ_{tr}

open ties may be used in such situation

see code for full details.