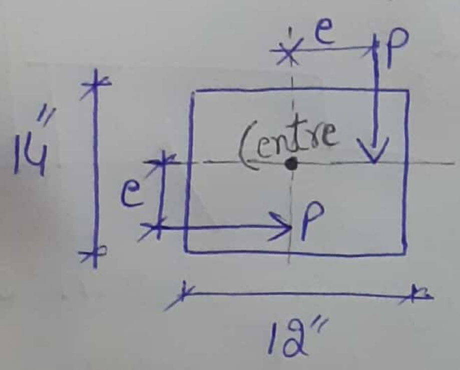
Lecture-03 ; Final Term ; Page-01

21-05-2020

Column: "It is an axially loaded compression member".

Classification of Column according to:

1 → Loading. → Concentrically loaded Column
→ Eccentrically loaded Column.



where; P = load (compression)
e = eccentricity.

2 → Lateral Reinforcement → Tied Column
→ Spiral Column.

Function of Ties: 1- It will hold the longitudinal Reinforcement in Position while Providing Concrete
2- It Prevents buckling of longitudinal Reinforcement.
3- It contains concrete.

3 → Material → Steel
→ R.C Column
→ Composite (I section embedded in the middle of R.C Column.)

4- Modes of failure → Short Column (Crushing)
→ Long/Slender Column (Buckling)

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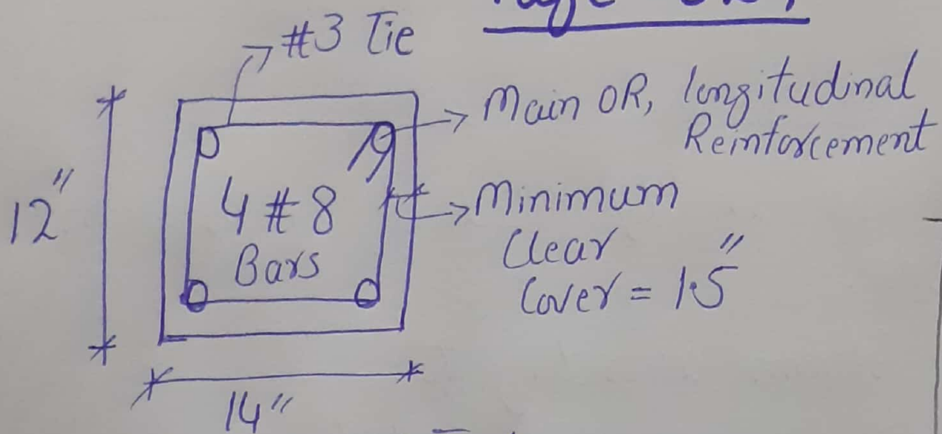


Fig: X-Section of Tied Column.

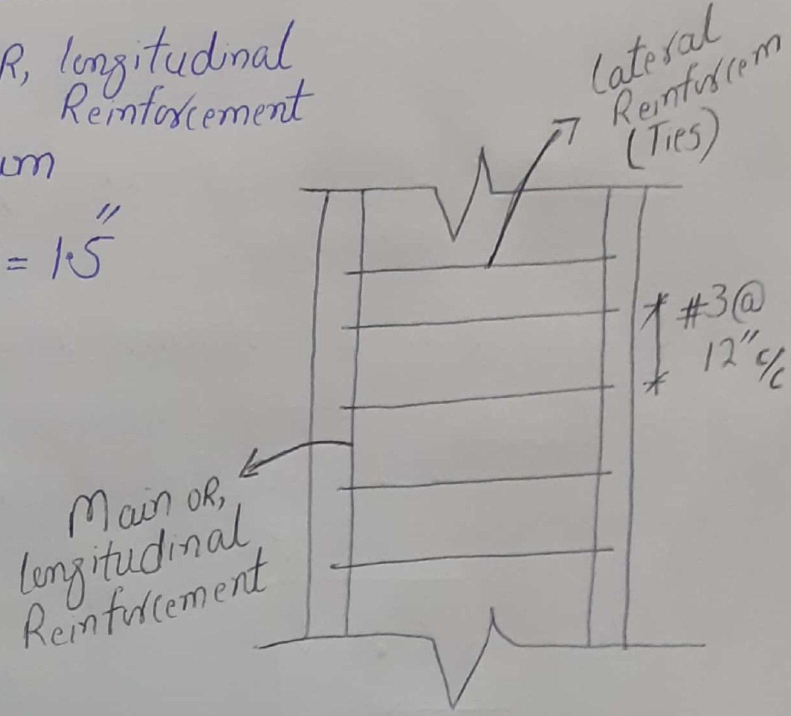


Fig: long-Section of Tied Column.

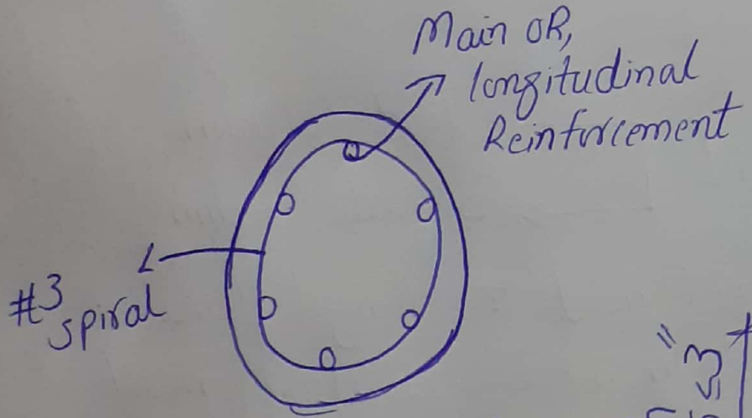


Fig: X-Section of Spiral Column

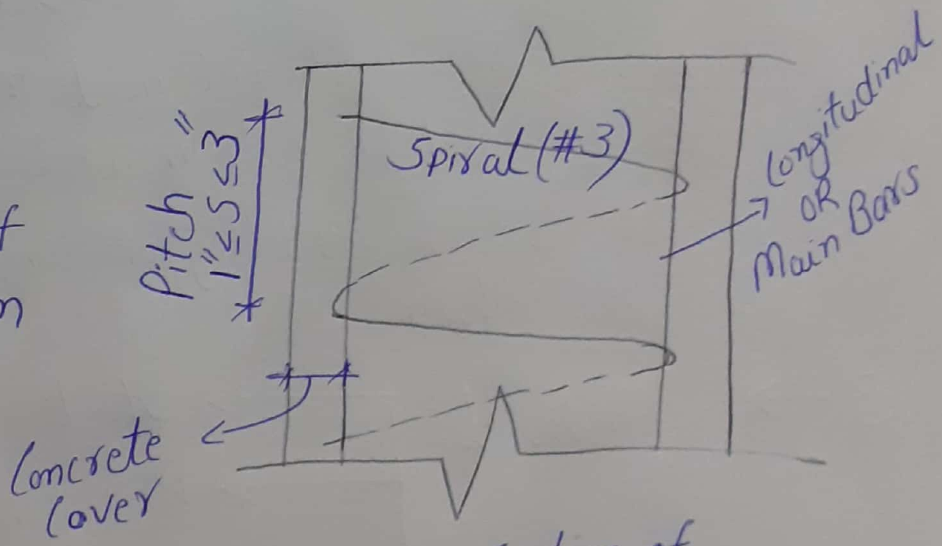


Fig: long-Section of Spiral Column.

=> Min. Number of Main bars in Tied Column = 04

=> Min. Number of Main bars in Spiral Column = 06

=> Area of Steel for Main bars/Longitudinal bars

$= A_s = (1\% \text{ to } 8\%) \text{ of } A_g$

Scanned with CamScanner

Design of Lateral Ties:

1- If Longitudinal bar use is from #4 to #10
=> Use Minimum #3 Ties

2- If Longitudinal bar use is #11, #14, #18.
=> Use Minimum #4 Ties.

Spacing OR, Centre to Centre distance b/w Ties:

1- 16 * diameter of longitudinal bar
2- 48 * diameter of Tie bar
3- Least Column dimension.

=> Select the least value.

Formula to find Design load for Column:

1- Tied Column:

$$P_d = \phi * 0.80 * [0.85 * f'_c * (A_g - A_s) + A_s * f_y]$$

where; $\phi = 0.65$, f'_c = Concrete Compression strength

A_g = Gross Area of Concrete, A_s = Area of Steel

f_y = Yield Strength.

2- Spiral Column:

$$P_d = \phi * 0.85 * [0.85 * f'_c * (A_g - A_s) + A_s * f_y]$$

where; $\phi = 0.70$

Note: $P_d \geq P_u$

Pb-01: Design a square tied column to support an axial dead load of 400 kips and a live load of 240 kips. Use $f'_c = 5$ ksi and $f_y = 60$ ksi and use steel ratio of about 5%. Also design the necessary Ties.

Sol: $P_d = \phi * 0.80 * [0.85 * f'_c * (A_g - A_s) + A_s * f_y]$

First find design load;

$P_d = 1.2 * D.L + 1.6 * L.L = 1.2 * 400 + 1.6 * 240$

$P_d = 864$ kips.

As, it is given in the question that;

$A_s = 5\%$ of $A_g = 0.05 * A_g$.

So;

$864 = 0.65 * 0.80 * [0.85 * 5 * (A_g - 0.05 * A_g) + 0.05 * A_g * 60]$

$A_g = 236.01 \text{ in}^2$.

Since, it is a square tied column.

So, $A_g = b * b = 236.01$

$b^2 = 236.01 \Rightarrow b = 15.36'' \approx 16''$.

Let $b = 16''$

Now $A_g = b * b = 16 * 16 = 256 \text{ in}^2$.

$864 = 0.65 * 0.80 * [0.85 * 5 * (256 - A_s) + A_s * 60]$

$A_s = 10.13 \text{ in}^2$

Next step is to find number of bars;

Let try #10 bar having $A_b = 1.27 \, in^2$.

$$\text{No. of bars} = \frac{A_s}{A_b} = \frac{10.13}{1.27} = 7.98 \approx 8 \text{ \#10 bars}$$

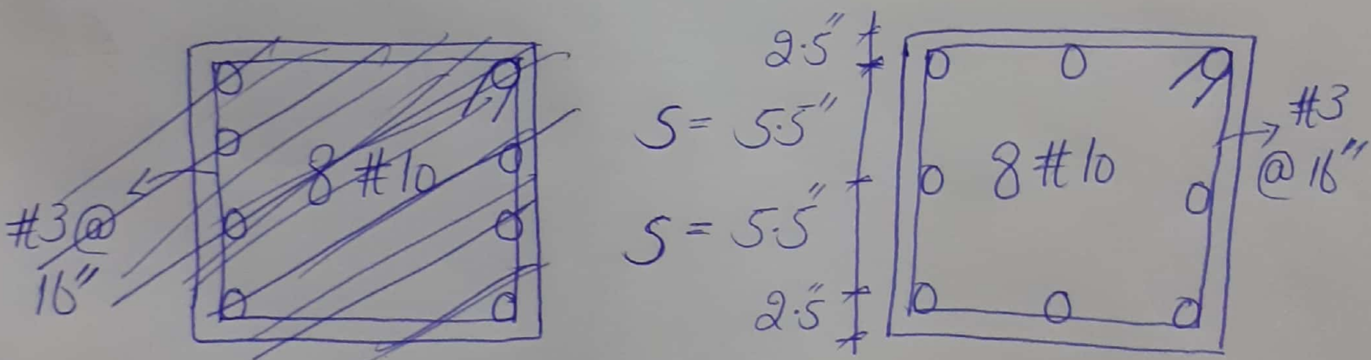
Design of Ties: 1- 16 * dia of longitudinal bar

$$16 * \frac{10}{8} = 20''$$

2- 48 * diameter of Tie bar $= 48 * \frac{3}{8} = 18''$

3- Least Column dimension = 16"

⇒ c/c distance b/w Ties = 16".



If $S > 6''$, then More ties will be Provided.

⇒ Check for additional Ties

$S = 5.5 - \frac{10}{8} = 4.25'' < 6''$, therefore no additional ties are required.

Note: S = Clear / Face to face distance b/w two Main bars.