Design of Short Columns:

$\O P_n = \O 0.8[0.85f_c'(A_g - A_{st}) + f_y A_{st}]$ $\rightarrow Design\ Axial\ Strength\ of\ columns\ SBC - 18, 22.4.2$

$A_g = \frac{P_u}{0.4(f_c' + f_y\rho)}$ $\rightarrow initial\ trial\ section\ size$

$A_g = \frac{P_u}{0.6f_c'}$ $\rightarrow initial\ trial\ section\ size$

$d_{s\,min} = \begin{cases} 10\ mm & if\ d_b < 32\ mm \\ 12\ mm & if\ d_b \geq 32\ mm \end{cases}$ $\rightarrow Minimum\ TieS\ ize\ SBC - 18, 25.7.2.2$

$s_{max} = min \begin{cases} 16d_b \\ 48d_s \\ smallest\ dimension \end{cases}$ $\rightarrow maximum\ Vertical\ spacing\ of\ tiesSBC - 18, 25.7.2.1$

$e = \frac{M_n}{P_n}$ $\rightarrow distance\ of\ applied\ force\ from\ column\ centroid$

$K_n = \frac{P_n}{f_c' A_g}$ $\rightarrow normalizing\ P_n$

$R_n = \frac{P_n e}{f_c' A_g h}$ $\rightarrow normalizing\ M_n$

$\gamma h = h - 2 \times effective\ cover$ $\rightarrow distance\ between\ bars\ centroids\ on\ oppsite\ sides$

$\gamma = \frac{\gamma h}{h}$ $\rightarrow distance\ between\ bars\ centroids\ on\ oppsite\ sides\ divided\ by\ h$

Design the section and reinforcement of a short square tied column to support an axial service dead load of 620 kN, and a service axial live load of 220 kN, Assuming ρ = 2%. Calculate the number of 20 mm diameter steel bars required. Use f'_c = 28 MPa, f_y = 420 MPa.

1- Find ultimate load on column:

$$P_u = 1.4DL + 1.7LL = 1.4 \times 620 + 1.7 \times 220 = 1242\ kN$$

2- Find initial trial size:

$$A_g = \frac{P_u}{0.4\left(f_c' + f_y\rho\right)} = \frac{1242 \times 10^3}{0.4(28 + 420 \times 0.02)} = 85302.2\ mm^2$$

Alternatively:

$$A_g = \frac{P_u}{0.6f_c'} = \frac{1242 \times 10^3}{0.6 \times 28} = 73928.5\ mm^2$$

$$h = \sqrt{A_g} = \sqrt{85302.2} = 292.07\ mm$$

use 300 mm × 300 mm ➔ A_g = 90000 mm^2

3- Determine long reinforcement:

$$A_{st} = \rho A_g = 0.02 \times 90000 = 1800\ mm^2$$

$$A_b = \pi\frac{d_b^2}{4} = 314\ mm^2$$

$$\#\ bars = \frac{1800}{314} = 5.7$$

use 6Ø20

$$A_{st\ prov} = 1884 mm^2$$

4- Determine tie reinforcement:

$$d_s = 10\ mm \qquad because\ d_b < 32\ mm$$

$$s_{max} = \begin{cases} 16d_b & = 320\ mm \\ 48d_s & = 480\ mm \\ smallest\ dimension\ of\ column & = 300\ mm \end{cases}$$

use Ø10 @ 300 mm

5- Check the maximum load capacity, $ØP_n > P_u$:

$$ØP_n = Ø0.8\left[0.85f_c'\left(A_g - A_{st}\right) + f_y A_{st}\right]$$

$$ØP_n = 0.65 \times 0.8 \times [0.85 \times 28 \times (90000 - 1884) + 420 \times 1884] = 1502\ kN$$

$ØP_n$= 1502 > P_u =1242 kN ➔ design is safe for axial load

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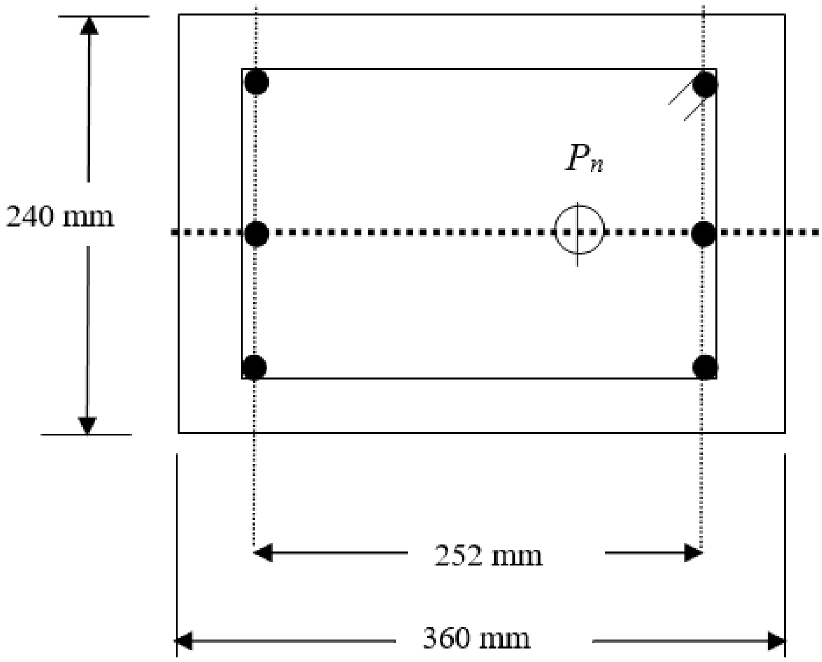
Short rectangular tied column of size 360×240 mm^2 was designed to support an ultimate load of 950 kN and an ultimate moment of 120 kN.m. Using the interaction diagram attached, and assuming the steel reinforcement is placed adjacent to two opposite ends of the section as shown in the Figure, Calculate the number of 25 mm diameter steel bars required. Use f'_c = 28 MPa, f_y = 420 MPa.



1- Find nominal loads on column:

$$P_n = \frac{P_u}{\emptyset} = \frac{950}{0.65} = 1461.5\ kN$$

$$M_n = \frac{M_u}{\emptyset} = \frac{120}{0.65} = 164.62\ kN.m$$

2- Find, e, K_n, R_n, and γh:

$$e = \frac{M_n}{P_n} = \frac{164.62}{1461.5} = 0.12632\ m = 126.32\ mm$$

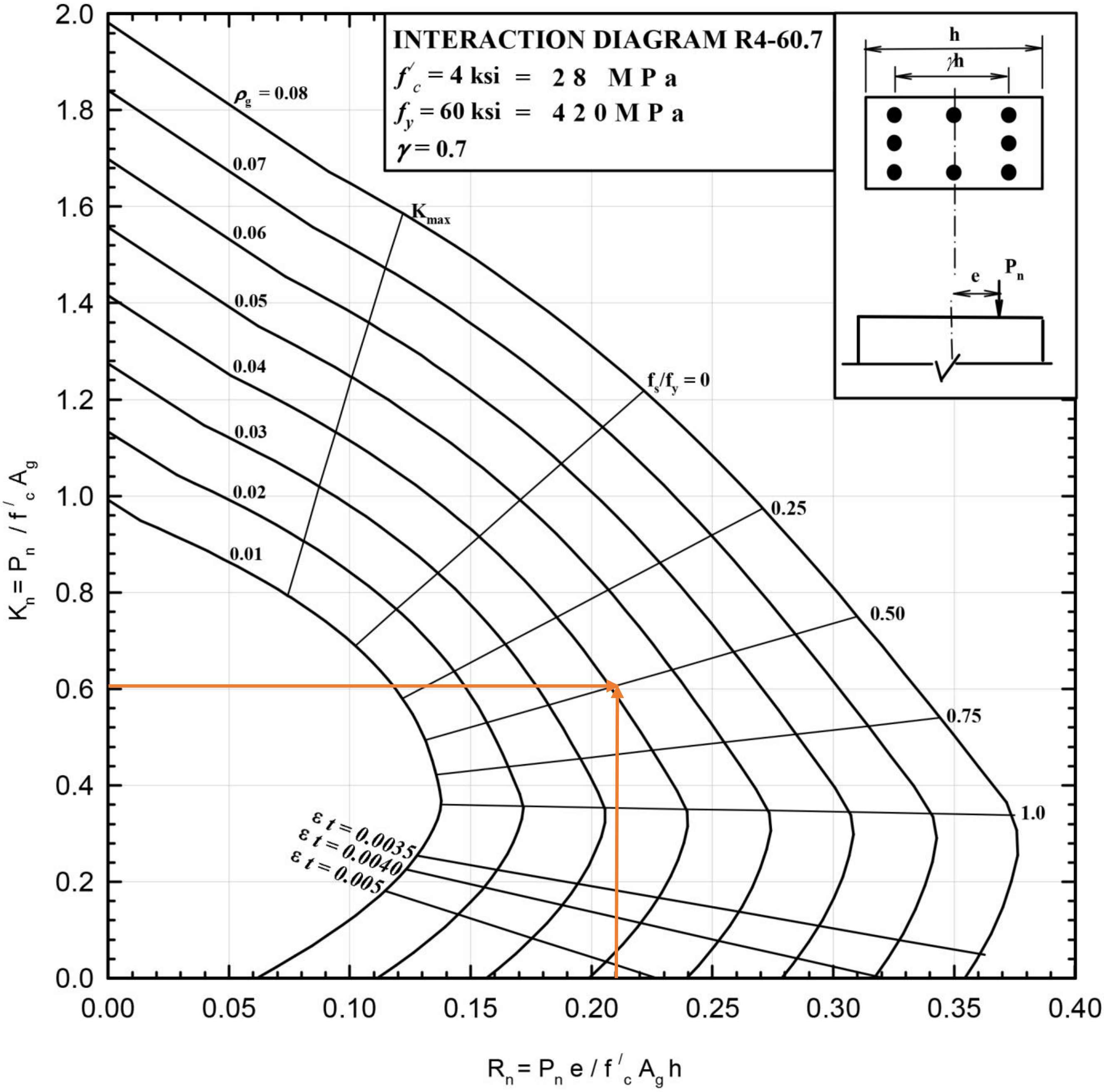
$$K_n = \frac{P_n}{f_c' A_g} = \frac{1461.5}{28 \times (360 \times 240)} = 0.604$$

$$R_n = \frac{P_n e}{f_c' A_g h} = \frac{1461.5 \times 126.32}{28 \times (360 \times 240) \times 360} = 0.212$$

$$\gamma = \frac{\gamma h}{h} = \frac{252}{360} = 0.7$$

3- use interaction diagram:

COLUMNS 3.2.2 - Nominal load-moment strength interaction diagram, R4-60.7



ρ = 0.04 and compression controlled, Ø = 0.65

$$A_{st} = \rho A_g = 0.03 \times 240 \times 360 = 3456\ mm^2$$

$$A_b = \pi \frac{d_b^2}{4} = 491\ mm^2$$

$$\#\ bars = \frac{2592}{491} = 7.03$$

use 8Ø25

$$A_{st\ prov} = 3928 mm^2$$

4- Determine tie reinforcement:

$$d_s = 10\ mm \qquad because\ d_b < 32\ mm$$

$$s_{max} = \begin{cases} 16d_b & = 400\ mm \\ 48d_s & = 480\ mm \\ smallest\ dimension\ of\ column & = 240\ mm \end{cases}$$

use Ø10 @ 200 mm

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