

UNIT IV DESIGN OF COLUMNS

Determine the reinforcement to be provided in a circular column with the following data:

Diameter of column 500 mm

Grade of concrete M20

Factored moment 125 kN.m

Characteristic strength 250 N/mm²

Factored load 1600 kN

Lateral reinforcement:

(a) Hoop reinforcement

(b) Helical reinforcement

(Assume moment due to minimum eccentricity to be less than the actual moment).

Assuming 25 mm bars with 40 mm cover,

$$d' = 40 + 12.5 = 52.5 \text{ mm}$$

$$d'/D = 52.5/500 = 0.105$$

Charts for $d'/D = 0.10$ will be used.

Let $b=D$

(a) Column with hoop reinforcement

$$\frac{P_u}{f_{ck} D^2} = \frac{1600 \times 10^3}{20 \times 500^2} = 0.32$$

$$\frac{M_u}{f_{ck} D^3} = \frac{125 \times 10^6}{20 \times 500^3} = 0.05$$

Referring to Chart 52, for $f_y = 250 \text{ N/mm}^2$

$$\frac{P}{f_{ck}} = 0.87$$

Percentage of reinforcement, $p = 0.87 \times 20 = 1.74 \%$

$$A_s = \frac{1.74}{100} \times \frac{\pi \times 500^2}{4} = 3416 \text{ mm}^2$$

(b) Column with Helical Reinforcement

According to 38.4 of the Code, the strength of a compression member with helical reinforcement is 1.05 times the strength of a similar member with lateral ties. Therefore, the, given load and moment should be divided by 1.05 before referring to the chart.

$$\frac{P_u}{f_{ck} D^2} = \frac{1600 \times 10^3}{1.05 \times 20 \times 500^2} = 0.31$$

$$\frac{M_u}{f_{ck} D^3} = \frac{125 \times 10^6}{1.05 \times 20 \times 500^3} = 0.048$$

Hence, From Chart 52, for $f_y = 250 \text{ N/mm}^2$,

$$\frac{P}{f_{ck}} = 0.078$$

$$p = 0.078 \times 20 = 1.56 \%$$

$$A_s = \frac{1.56}{100} \times \frac{\pi \times 500^2}{4} = 3063 \text{ mm}^2$$

According to 38.4.1 of the Code the ratio of the volume of helical reinforcement to the volume of the core shall not be less than

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

where A_g is the gross area of the section and A_c is the area of the core measured to the outside diameter of the helix. Assuming 8 mm dia bars for the helix

$$\text{Core diameter} = 500 - 2(40 - 8) = 436 \text{ mm}$$

$$\frac{A_g}{A_c} = \frac{500}{436} = 1.147$$

$$0.36 \left(\frac{A_g}{A_c} - 1 \right) \times \frac{f_{ck}}{f_y} = 0.36 \left(\frac{500}{436} - 1 \right) \times \frac{20}{250} = 0.0091$$

Volume of helical reinforcement / Volume of core

$$A_{sh} \pi \times 428 / (\pi / 4 \times 436^2) s_h$$

$$\Rightarrow 0.9 \frac{A_{sh}}{s_h}$$

where, A_{sh} is the area of the bar forming the helix and s_h is the pitch of the helix. In order to satisfy the code requirement,

$$0.09 A_{sh} / s_h = 0.0091$$

For 8 mm dia bar,

$$s_h = 0.09 \times 50 / 0.0091 = 49.7 \text{ mm.}$$

Thus provide 48 mm pitch

