RCC Structure – Column

Case Example – Uniaxial Bending:

Analyze a 350 mm x 450 mm column both end pinned with unsupported length 3.2 m subjected to design axial load of 1200 kN, and Moment 250 kNm in one direction. Consider concrete grade M20, Fe415 grade 25 mm diameter 10 longitudinal steel bars with clear cover 40 mm.

Analysis:

Data:

Characteristic strength of concrete f_{ck} = 20 N/mm^2 = 20e3 kN/m^2

Yield strength of steel fy = 415 N/mm^2 = 415e3 kN/m^2

Column cross section area = 350mmx450 mm

Unsupported length = 3.2 m

Steel area As = 0.25π*25^2*10 = 4909 mm^2

Concrete area Ac = 350x450 – As

Percent steel pt = As*100/(375x375) = 3.12%

A. Design Load:

(i) Axial load = 1200 kN

(ii) Moment-X = 250 kNm

B. Effective cover (d'):

Clear cover (40 mm) + bar diameter (25mm)/2 = 52.5 mm

Major Axis depth ratio = d'/D = 52.5/450 = 0.117

C. Slenderness ratio (Clause 25.1.2 IS: 456)

(i) Effective length (Table 25 IS 456 Case 3) 3.2 m

(ii) Slenderness ratio Le/D = 3.2/0.350 = 9.14 < 12 (short column)

E. Minimum Eccentricity (Clause 39.2 IS: 456)

(i) Eccentricity ε_{min} = Le/500 + D/30 = (3200/500) + (350/30) = 19.73

(ii) Eccentricity ε = Mu/Pu = (250e6)/(1200e3) = 208.36 mm

(iii) Eccentricity ε > ε_{min} Design for moment

F. Design for Axial and uniaxial Bending (Clause 39.3 IS: 456)

(i) A. Axial load Pu = 0.4 f_{ck}*Ac + 0.67fy*As = 0.4*20e3*(375^2 – 4909)/1e6 + 0.67*415e3*4909/1e6 = 1085.73+1364.94 = 2451 kN

(ii) Pu > 1200 kN (Load applied).

(iii) B. Use P-M interaction curve for (d'/D) = 0.116 or close

a. X-parameter = Mu_x/(f_{ck}bD^2) = 250e6/(20*350*450^2) = 0.176

b. Y-parameter = Pu/(f_{ck}bD) = 1200*e3/(20*350*450) = 0.381

c. Check the (pt/f_{ck}) curve and its value (≈0.14) at intersection of X-Y

d. Actual pt/f_{ck} =3.12/20 = 0.156 which is > recommended value 0.14.

G. Tie-bar diameter and spacing (Clause 26.5.3.2 IS: 456)

(i) Tie bar diameter cannot be less than $\phi/4 = 25/4 = 6.25$ mm

(ii) $\therefore$ Use 8 mm diameter for the Tie-bar.

(iii) Tie-bar spacing

a. Equal to dimension of the column (350 mm)
b. $16 \times \phi = 16*25 = 400$ mm
c. Minimum 300 mm

(iv) $\therefore$ Tie bar spacing = 300 mm

H. Material Estimates

(i) Concrete volume: $0.35*0.45*3.2 = 0.504$ m^3

(ii) Cement quantity: M20 Volume of cement 1:5.5 = $0.504*1440/5.5 = 132$ kg

(iii) Steel quantity: ϕ-25 mm x 32 m length; ϕ 8 mm x 18 m length $\approx$ 132 kg

Add necessary allowances for wastage, shrinkage etc. to the above estimates.