RCC Structure – Column

Case Example – Axial Load:
Analyze a 375 mm x 375 mm column both ends pinned with unsupported length of 3.5 m subjected to a characteristic axial of 1500 kN. 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 = 375mmx375 mm
Unsupported length = 3.5 m
Steel area As = $0.25\pi*25^2*10$ = 4909 mm^2
Concrete area Ac = 375x375 – As
Percent steel = As*100/(375x375) = 3.49%

A. Design Load:
- (i) Characteristic load = 1500 kN
- (ii) Load factor = 1.5
- (iii) Design load = 1500*1.5 = 2250 kN (As shown for the Design load)

B. Effective cover (d'):
Clear cover (40 mm) + bar diameter (25mm)/2 = 52.5 mm
Major Axis depth ratio = d'/D = 52.5/375 = 0.14

C. Slenderness ratio (Clause 25.1.2 IS: 456)
- (i) Effective length (Table 25 IS 456 Case 3) 3.5 m
- (ii) Slenderness ratio Le/D = 3.5/0.375 = 9.33 < 12 (short column)

E. Minimum Eccentricity (Clause 39.2 IS: 456)
- (i) Eccentricity ε = Le/500 + D/30 = (3500/500) + (375/30) = 19.5

F. Design Load Capacity (Clause 39.3 IS: 456)
- (i) 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 > 2250 kN (Load applied).
- (iii) Hence design is safe.

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 (375 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: $0.3.5*0.375*0.375 = 0.492$ m^3

(ii) Cement quantity: M20 Volume of cement 1:5.5 = $0.492*1440/5.5 = 129$ kg

(iii) Steel quantity: ϕ-25 mm x 35 m length; ϕ 8 mm x 18 m length $\approx$ 143 kg

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