

Bresler reciprocal method :-

All points are located in shaded area (safe zone)

$$P_o = 6878.4 \text{ Kn}$$

$$\frac{1}{P_n} = \frac{1}{P_{nx}} + \frac{1}{P_{ny}} - \frac{1}{P_{no}} = \frac{1}{4600} + \frac{1}{3000} - \frac{1}{6878.4} = 4.0534 \times 10^{-3} \text{ 1/Kn}$$

$$P_n = 2467.05 \text{ Kn} \Rightarrow \phi P_n = 0.65 \times 2467.05 = 1603.58 \text{ Kn} > P_u$$

ok the column is safe

$$f'_c = 25 \text{ MPa} \quad , \quad f_y = 420 \text{ Mpa} \quad , \quad L = 5500 \quad , \quad P_u = 1200 \text{ Kn}$$

$$K = 0.9 \quad , \quad M_1 = 140 \text{ Kn.m} \quad , \quad M_2 = 180 \text{ Kn.m}$$

Single curvature

$$\frac{0.9 * 5500}{0.3 * 500} \leq 34 - 12 \left(\frac{140}{180} \right) \Rightarrow 33 \not\leq 24.667$$

\Rightarrow slender column(Long column)

$$C_m = 0.6 + 0.4 \left(\frac{140}{180} \right) \geq 0.4$$

$$C_m = 0.911$$

$$I_g = \frac{b * h^3}{12} = \frac{500 * 500^3}{12} = 5.2083 \times 10^9 \text{ mm}^4$$

$$E_c = 4700 \sqrt{f'_c} = 4700 \sqrt{25} = 23500 \text{ Mpa}$$

$$\beta_d = 0.75$$

$$EI = \frac{0.4 * E_c * I_g}{1 + \beta_d} = \frac{0.4 * 23500 * 5.2083 \times 10^9}{1 + 0.75} = 2.798 \times 10^{13} \text{ N.mm}^2$$

$$P_c = \frac{\pi^2 EI}{(KL_u)^2} = \frac{\pi^2 (2.798 \times 10^{13})}{(0.9 * 5500)^2} * 10^{-3} = 11257.384 \text{ Kn}$$

$$M_{2_{\min}} = p_u * (15 + 0.03h) = 1200 * (15 + 0.03 * 500) 10^{-3} = 36 \text{ Kn.m}$$

$$M_2 = \max(M_2, M_{2_{\min}}) = 180 \text{ Kn.m}$$

$$\delta_{ns} = \frac{C_m}{1 - \frac{P_u}{0.75 * P_c}} \geq 1 \Rightarrow \frac{0.911}{1 - \frac{1200}{0.75 * 11257.384}} = 1.0621$$

$$\therefore \delta_{ns} = 1.0621$$

$$M_c = \delta_{ns} * M_2 = 1.0621 * 180 = 191.17 \text{ Kn.m}$$

This point (1200, 191.17) is located in safe zone ... OK the column is safe

Problem:2**1)**

$$W_u = 1.4(2 + 0.2 * 24) + 1.7(3) = 14.62 \text{ Kn/m}^2$$

1) Exterior panel

$$L_n = 6 - \frac{0.3}{2} - \frac{0.3}{2} = 5.7 \text{ m}$$

$$h_{min} = \frac{L_n}{30} = \frac{5700}{30} = 190 \text{ mm}$$

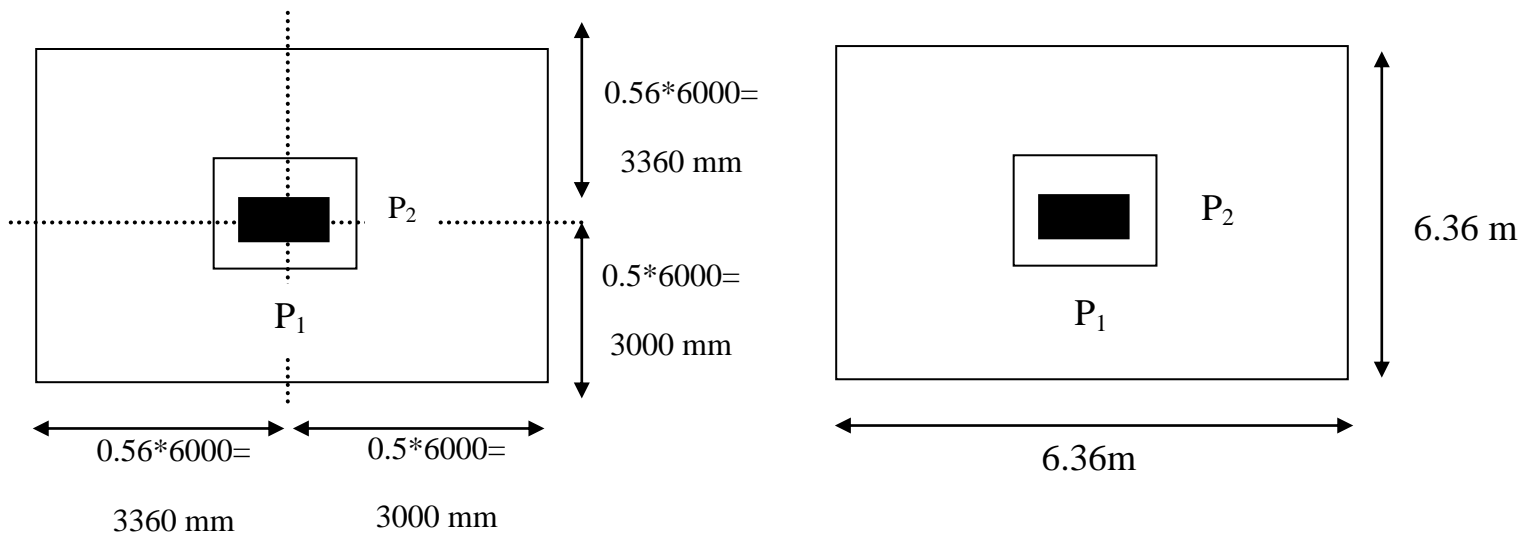
2) Interior panel

$$L_n = 6 - \frac{0.3}{2} - \frac{0.3}{2} = 5.7 \text{ m}$$

$$h_{min} = \frac{L_n}{33} = \frac{5700}{33} = 172.73 \text{ mm}$$

$$h_{min} = \text{Max}(190, 172.73) = 190 \text{ mm}$$

$$h > h_{min} \rightarrow \text{ok}$$

2)

$$P_1 = C_1 + d_{ave} = 300 + 168 = 468 \text{ mm}$$

$$P_2 = C_2 + d_{ave} = 300 + 168 = 468 \text{ mm}$$

$$V_u = W_u (A_o - A_c) = 14.62 (6.36 * 6.36 - 0.468 * 0.468) = 588.17 \text{ KN}$$

$$b_o = \text{length of critical perimeter} = 2 * (P_1 + P_2) = 2 * (468 + 468) = 1872 \text{ mm.}$$

$$\beta_c = \text{column length ratio } \left(\frac{\text{long side}}{\text{short side}} \right) = \frac{300}{300} = 1$$

$$\alpha_s = 40$$

$$V_c = \text{Min} \left\{ \begin{array}{l} \left(1 + \frac{2}{1} \right) \frac{\sqrt{25}}{6} * 1872 * 168 \times 10^{-3} = 786.24 \text{ Kn} \\ \left(2 + \frac{40 * 168}{1872} \right) \frac{\sqrt{25}}{12} * 1872 * 168 \times 10^{-3} = 732.48 \text{ KN} \\ \frac{\sqrt{25}}{3} * 1872 * 168 \times 10^{-3} = 524.16 \text{ Kn} \end{array} \right\}$$

$$= 524.16 \text{ KN}$$

$$\phi V_c = 0.75 * 524.16 = 393.12 \text{ Kn} < 588.17 \text{ Kn} \therefore \text{two way shear is not ok}$$

3)

	Span B ₂ -B ₃		
L₁ (m)	6		
L₂ (m)	6		
L_n (m)	5.7		
$M_o = W_s L_2 \frac{L_n^2}{8}$ (KN.m)	356.25		
L_{min} (m)	6		
CS width (m) = 0.5 L_{min}	3		
Moment coefficients	0.65	0.35	0.65
-ve and +ve moments	231.56	124.69	231.56
CS moment (%)	75	60	75
CS moments (kN.m)	173.67	74.81	173.67
MS moment (%)	25	40	25
MS moments (kN.m)	57.89	49.88	57.89

4)

$$b = 3000 \text{ mm} , \quad M_u = 200 \text{ kn.m}$$

$$d = 200 - 20 - \frac{12}{2} = 174 \text{ mm} , \quad R_n = \frac{200/0.9}{3000 * 174^2} * 10^6 = 2.447 \text{ Mpa}$$

$$m = \frac{420}{0.85 * 25} = 19.765 ,$$

$$\rho = \frac{1}{19.765} \left(1 - \sqrt{1 - \frac{2 * 2.447 * 19.765}{420}} \right) = 0.00621$$

$$A_s = 0.00621 * 3000 * 174 = 3239.48 \text{ mm}^2 ,$$

$$A_{s \min} = 0.0018 * 3000 * 200 = 1080 \text{ mm}^2$$

$$S_{\max} = \min \left(\frac{113.04}{3239.48} * 3000 = 104.68 \text{ mm}, 300 \text{ mm}, 2 * 200 = 400 \right) \\ = 104.68 \text{ mm}$$

for flexural → use Ø12@100 mm

5)

$$I_b = 9.56 \times 10^9 \text{ mm}^4$$

$$I_s = \frac{b * h^3}{12} = \frac{6000 * 150^3}{12} = 1.6875 \times 10^9 \text{ mm}^4$$

$$\alpha = \frac{I_b}{I_s} = \frac{9.56 \times 10^9}{1.6875 \times 10^9} = 5.67$$

6)

$$\alpha = 2.5$$

$$\beta = \frac{6000 - 300}{6000 - 300} = 1$$

$$h_{min} = \frac{L_n \left(0.8 + \frac{f_y}{1500} \right)}{36 + 9\beta}$$

$$h_{min} = \frac{5700 \left(0.8 + \frac{420}{1500} \right)}{36 + 9(1)} = 160.8 \text{ mm}$$

$$h = 150 < h_{min} \quad \text{not ok}$$