Problem 1:

1)

$$A_g = b * b \ , \quad A_s = 8 * \frac{\pi d_b^2}{4}$$

$$P_n = -A_s * f_y \quad \Rightarrow \quad -1277.25 * 10^3 = -\left(8 * \frac{\pi d_b^2}{4}\right) * 420$$

$$d_b = \sqrt{\frac{(-1277.25 * 10^3) * 4}{8 * 420 * \pi}} = 22\, mm$$

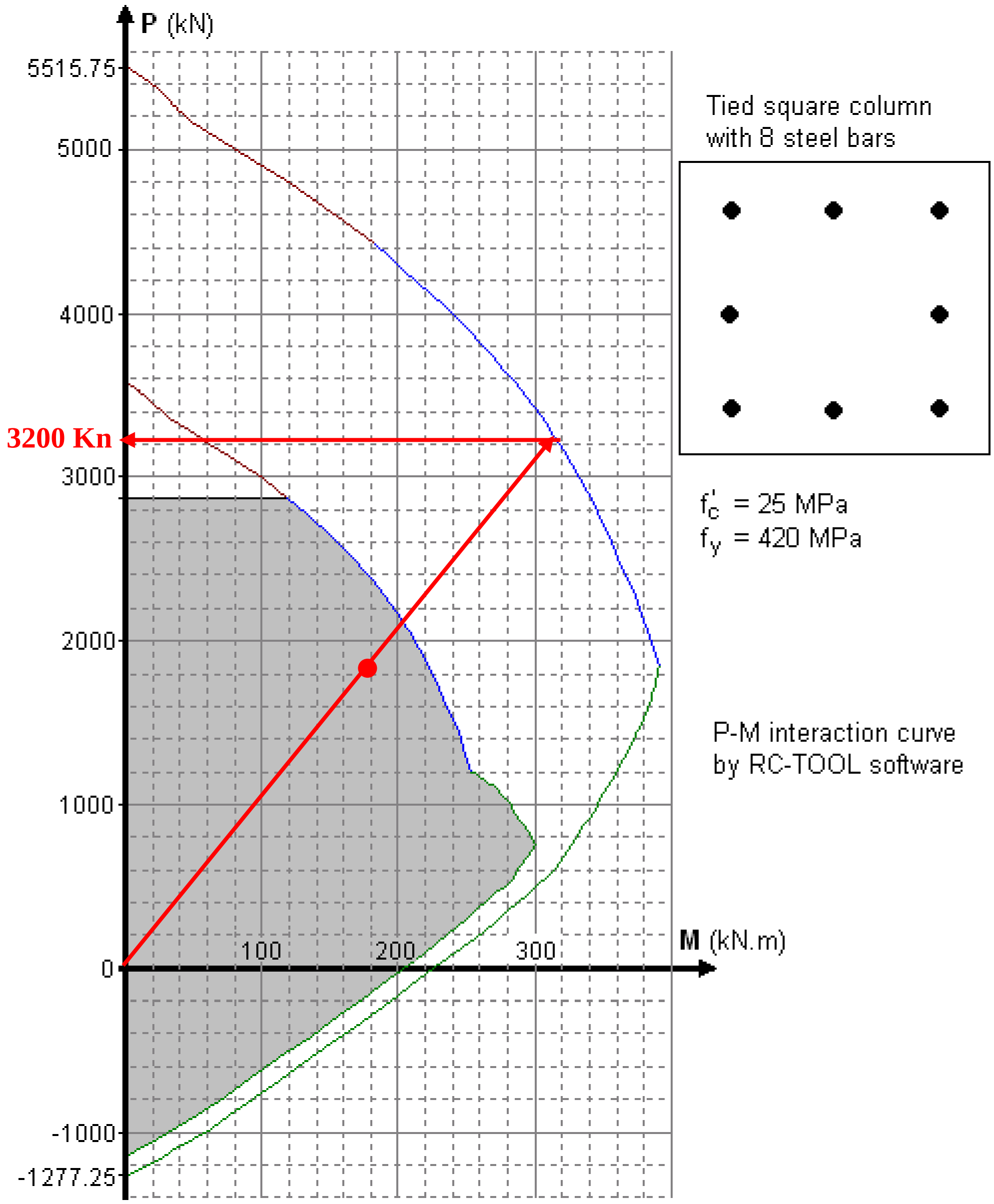
$$A_s = 8 * \frac{\pi * 22^2}{4} = 3039.52\, mm^2$$

$$P_o = \left[0.85\, f_c^{`}\left(A_g - A_{st}\right) + \ f_y * A_{st}\ \right]$$

$$5515.75 * 10^3 = \left[0.85 * 25 * \left(A_g - 3039.52\right) + \ 420 * 3039.52\ \right]$$

$$A_g = \frac{4303741.4}{21.25} = 202529.007\, mm^2$$

$$b = \sqrt{202529.007} = 450\, mm$$



Bresler reciprocal method :-

All points are located in shaded area (safe zone)

$$P_o = 5515.75\ Kn$$

$$\frac{1}{P_n} = \frac{1}{P_{nx}} + \frac{1}{P_{ny}} - \frac{1}{P_{no}} = \frac{1}{3200} + \frac{1}{3200} - \frac{1}{5515.75} = 4.437 * 10^{-4}\ \ 1/Kn$$

$$P_n = 2253.77\ Kn \Rightarrow \quad \emptyset P_n = 0.65 * 2253.77 = 1464.95\ Kn < P_u$$

The column is not safe

3)

$$f_c' = 25\ \text{MPa} \quad , \quad 350x350 \quad , \quad L = 4700 \quad , \quad P_u = 1800\ \text{Kn}$$

$$K = 1 \quad , \quad M_1 = 80\ \text{Kn.m} \quad , \quad M_2 = 180\ \text{Kn.m}$$

Clockwise moment →Double curvature

$$\frac{1 * 4700}{0.3 * 350} \leq 34 - 12\left(\frac{80}{-180}\right) \Rightarrow 44.762 \nleq 39.33$$

$$\Rightarrow \text{slender column(Long column)}$$

$$C_m = 0.6 + 0.4\left(\frac{80}{-180}\right) \geq 0.4$$

$$C_m = 0.422$$

$$I_g = \frac{b * h^3}{12} = \frac{350 * 350^3}{12} = 1.2505X10^9 mm^4$$

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

$$\beta_d = 0.6$$

$$EI = \frac{0.4 * E_c * I_g}{1 + \beta_d} = \frac{0.4 * 23500 * 1.2505X10^9}{1 + 0.6} = 7.3468X10^{12} N.mm^2$$

$$P_c = \frac{\pi^2 EI}{(kL_u)^2} = \frac{\pi^2(7.3468X10^{12})}{(1 * 4700)^2} * 10^{-3} = 3279.1583\ Kn$$

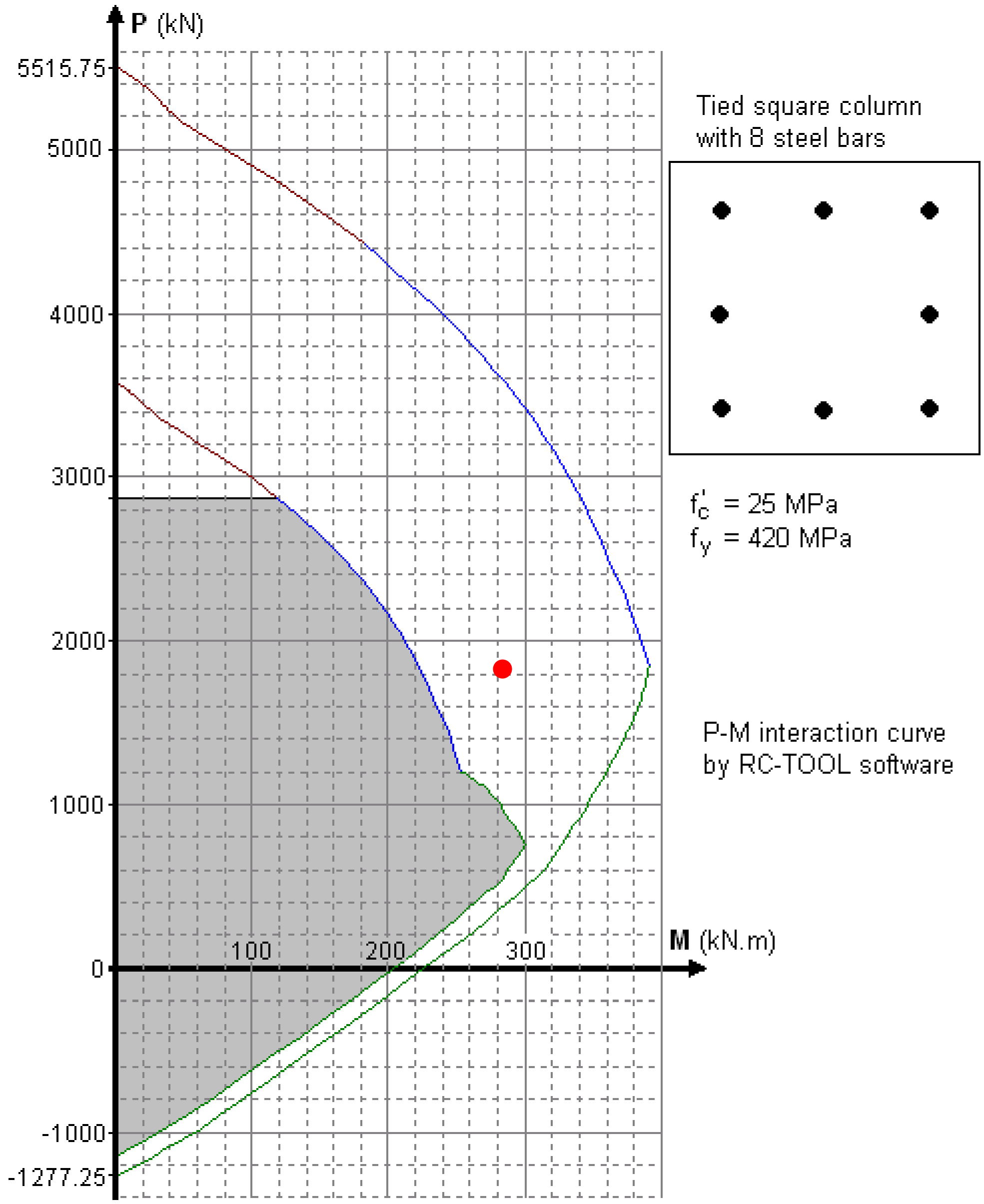
$$M_{2_{min}} = p_u * (15 + 0.03h) = 1800 * (15 + 0.03 * 350)10^{-3} = 45.9\ Kn.m$$

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

$$\delta_{ns} = \frac{C_m}{1 - \frac{P_u}{0.75 * P_c}} \geq 1 \Rightarrow \frac{0.422}{1 - \frac{1800}{0.75 * 3279.1583}} = 1.575$$

$$\therefore \delta_{ns} = 1.575$$

$$M_c = \delta_{ns} * M_2 = 1.575 * 180 = 283.5\ Kn.m$$



This point (1800, 283.5) is located in unsafe zone … OK the column is not safe

Problem 2:

1)

$$Wu = 1.4(2.5 + 0.2 * 24) + 1.7(2.5) = 14.47\ Kn/m^2$$

1) Exterior panel

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

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

2) Interior panel

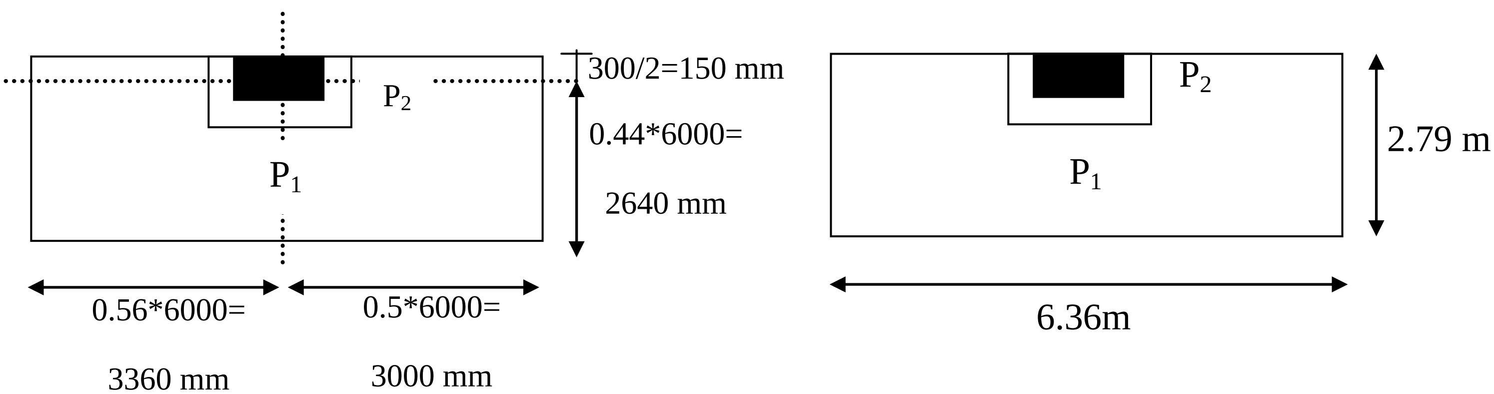
$$L_n = 6 - \frac{0.3}{2} - \frac{0.3}{2} = 5.7\ m$$

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

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

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

2)



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

$$P_2 = C_2 + \frac{d_{ave}}{2} = 300 + \frac{168}{2} = 384\ mm$$

$V_u = W_u(A_o - A_c) = 14.47(6.36 * 2.79 - 0.468 * 0.384) = 254.16\ KN$

b_o=length of critical perimeter= (P_1+2* P_2)= (468+ 2*384)=1236 mm.

β_c=column length ratio ($\frac{long\ side}{short\ side}$) = $\frac{300}{300} = 1$

α_s = 30

$$V_c = \text{Min}\left\{\begin{array}{c} \left(1+\frac{2}{1}\right)\frac{\sqrt{25}}{6} * 1236 * 168\ \text{x}10^{-3} = 519.12\ \text{Kn} \\ \left(2+\frac{30*168}{1236}\right)\frac{\sqrt{25}}{12} * 1320 * 168\ \text{x}10^{-3} = 525.84\text{KN} \\ \frac{\sqrt{25}}{3} * 1236 * 168\text{x}10^{-3} = 346.08\ \text{Kn} \end{array}\right\}$$
$$= 346.08\ \text{KN}$$

$$\varphi V_c = 0.75 * 346.08 = 259.56\ Kn > 254.16 Kn\ \therefore two\ way\ shear\ is\ ok$$

3)

	Span B_1-B_2		
L_1 (m)	6		
L_2 (m)	6		
L_n (m)	5.7		
$\boldsymbol{M_o = W_s L_2 \frac{L_n^2}{8}}$ $(\boldsymbol{KN.m})$	352.59		
L_{min} (m)	6		
CS width (m) =0.5 L_{min}	3		
Moment coefficients	0.26	0.52	0.7
-ve and +ve moments	91.68	183.34	246.82
CS moment (%)	100	60	75
CS moments (kN.m)	91.68	110.01	185.11
MS moment (%)	0	40	25
MS moments (kN.m)	0	73.34	61.71

4)

$b = 3000\ mm \quad , \quad M_u = 180\ kn.m$

$d = 174\ mm \ , \qquad R_n = \dfrac{180/0.9}{3000 * 174^2} * 10^6 = 2.20\ Mpa$

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

$$\rho = \frac{1}{19.765}\left(1 - \sqrt{1 - \frac{2 * 2.20 * 19.765}{420}}\right) = 0.00555$$

$A_s = 0.00555 * 3000 * 174 = 2895.45\ mm^2$,

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

$S_{max} = \min\left(\dfrac{113.04}{2895.4} * 3000 = 117.12\ mm, 300mm, 2 * 200 = 400\right)$
$= 117.12mm$

$$for\ flexural\ \rightarrow use\ \emptyset 12@115\ mm$$

5)

$$0.2 < \alpha = 1.9 < 2$$

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

$$h_{min} = \frac{L_n\left(0.8 + \frac{f_y}{1500}\right)}{36 + 9\beta(\alpha_m - 0.2)}$$

$$h_{min} = \frac{5700\left(0.8 + \frac{420}{1500}\right)}{36 + 5 * 1(1.9 - 0.2)} = 138.34\ mm$$

$h = 145 > h_{min}$ thickness is ok