Q1)

$$super\ imposed = 2\ Kn/m^2\ \ ,LL = 3\ Kn/m^2, h = 185\ mm$$

a)

$$h_{min} = \frac{l}{24} = \frac{4000}{24} = 166.67\ mm$$

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

b)

$$DL = (0.185 * 24) + 2 = 6.44\ \ kn/m^2$$

$$LL = 3\ kn/m^2$$

$$Wu = 1.4(6.44) + 1.7(3) = 14.116\ Kn/m^2$$

c)

$$M_u + = \frac{1}{14} * 14.116 * 3.7^2 = 13.803\ kn.m$$

$$M_u - = \frac{1}{9} * 14.116 * 3.7^2 = 21.47\ kn.m$$

d)

$$M_u = 20\ \ kn.m \quad ,Assume\ \ d_b = 12$$

$$d = 185 - 20 - \frac{12}{2} = 159mm\ , \qquad R_n = \frac{20/0.9}{1000 * 159^2} * 10^6 = 0.879\ Mpa$$

$$m = \frac{420}{0.85 * 25} = 19.765\ , \qquad \rho = \frac{1}{19.765}\left(1 - \sqrt{1 - \frac{2 * 0.879\ \ * 19.765}{420}}\right) = 0.00214$$

$$A_s = 0.00214 * 1000 * 159 = 340\ mm^2\ , \qquad A_{s\ min} = 0.0018 * 1000 * 185 = 333\ mm^2$$

$$S_{max} = \min\left(\frac{113.04}{340} * 1000 = 332.5mm\ ,300mm, 2 * 185 = 370\right) = 300\ mm$$

$$for\ flexural\ \rightarrow use\ \emptyset 12@300\ mm$$

$$A_{s\ shrinkage} = 0.0018 * 1000 * 185 = 333\ mm^2$$

$$S_{max} = \min\left(\frac{113.04}{333} * 1000 = 339.45\ mm, 300mm, 4 * 185 = 740\right) = 300mm$$

$$for\ shrinkage \rightarrow use\ Ø12@300\ mm$$

d)

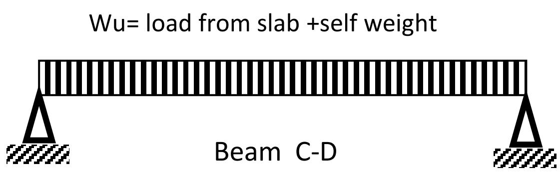
$$C_v = 1.15\ , \qquad V_u = \frac{1.15 * 14.116 * 3.7}{2} = 30.03\ kn$$

$$d = 185 - 20 - \frac{12}{2} = 159\ mm$$

$$ØV_c = 0.75 * \frac{\sqrt{25}}{6} * 1000 * 159 * 10^{-3} = 99.375\ kn$$

$$ØV_c > V_u \rightarrow ok$$

f)



$$Wu\ \ slab = 14.116\ kn/m^2$$

$$Wu\ beam(B - E) = 14.116 * \left(\frac{4}{2} + \frac{4}{2}\right) + 1.4 * (0.415 * 0.3 * 24) = 60.65\ kn/m$$

g)

Force transfer from beam (B-E) to (D-F):-

$$P_{(D-F)} = 60.65 * \left(\frac{8.1 - 0.3}{2}\right) = 236.535\ kn/m$$

Q2)

$$super\ imposed = 2\,Kn/m^2\ \ ,LL = 3\,Kn/m^2, h = 190\ mm$$

$$Wu = 1.4(2 + 0.19 * 24) + 1.7(3) = 14.284\ \ Kn/m^2$$

	Span B_1-B_2		
L_1 (m)	5		
L_2 (m)	5		
L_n (m)	4.7		
$\boldsymbol{M_o = W_s L_2 \frac{L_n^2}{8}\ \ (KN.m)}$	197.21		
L_{min} (m)	6		
CS width (m) =0.5 L_{min}	3		
Moment coefficients	0.26	0.52	0.7
-ve and +ve moments	51.27	102.55	138.05
CS moment (%)	100	60	75
CS moments (kN.m)	51.27	61.53	103.54

Q2)

a)

$$A_{s1} = 628\,mm^2\ \ ,\qquad A_{s2} = 628\,mm^2$$

$$A_g = 90 * 10^3\ mm^2\ \ ,\ A_{st} = 1256\,mm^2$$

$\mathbf{I - At\ point\ \ \varepsilon_t = 0.006}$

$$d_1 = 60mm\ \ ,\ \ ,\ d_3 = 240\ mm$$

$$C = \frac{0.003}{0.003 + \varepsilon_t} * d_3$$

$$C = \frac{0.003}{0.003 + 0{,}006} * 240 = 80\ mm$$

$$\varepsilon_i = \frac{d_i - C}{C} * 0.003$$

$$\varepsilon_1 = \frac{60 - 80}{80} * 0.003 = -0.00075$$

$$\varepsilon_2 = \frac{240-80}{80} * 0.003 * 0.003 = 0.006$$

$$f_{si} = \varepsilon_i * E = \qquad -420 < \quad f_{si} < 420$$

$$f_{s1} = -0.00075 * 200{,}000 = -150$$

$$f_{s2} = 0.006 * 200{,}000 = 1200 > 420 \Rightarrow use\ \ 420\ Mpa$$

$$a_b = \beta * C$$

$$a_b = 0.85 * 80 = 68\ mm$$

$$a_b > d_i \quad \rightarrow compression\ zone \quad , \quad a_b < d_i \quad \rightarrow tension\ zone$$

$$F_{si} = \ f_{si} * A_{si} * 10^{-3} \ \rightarrow Tension\ \ Zone$$

$$F_{si} = (f_{si} + 0.85 * f_c`) * A_{si} * 10^{-3} \ \rightarrow Compression\ \ Zone$$

$$F_{s1} = (-150 + 0.85 * 25) * 628 * 10^{-3} = -80.855\ Kn$$

$$F_{s2} = 420 * 628 * 10^{-3} = 263.76Kn$$

$$C_c = 0.85 * f_c` * b * \beta * c * 10^{-3}$$

$$C_c = 0.85 * 25 * 300 * 0.85 * 80 * 10^{-3} = 433.5\ Kn$$

$$P_n = C_c - \Sigma F_s$$

$$P_n = 433.5 - (-80.55 + 263.76) = 250.595\ Kn$$

$$M_n = C_c\left[\frac{h}{2} - \frac{a}{2}\right] + F_{s1}\left[d_1 - \frac{h}{2}\right] + F_{s2}\left[d_2 - \frac{h}{2}\right] + F_{s3}\left[d_3 - \frac{h}{2}\right] * 10^{-3}$$

$$M_n = 433.5\left[\frac{300}{2} - \frac{68}{2}\right] - 80.855\ \left[60 - \frac{300}{2}\right] + 236.76\left[240 - \frac{300}{2}\right] * 10^{-3} = 78.87\ Kn.m$$

$$\emptyset P_n = 0.9 * 250.595 = 225.536\ Kn$$

$$\emptyset M_n = 0.9 * 78.87 \ = 70.98Kn.m$$

<u>II – at point $C = 150\ mm$</u>

$$d_1 = 60\ mm \quad , \quad , \quad d_3 = 240\ mm$$

$$\varepsilon_i = \frac{d_i - C}{C} * 0.003$$

$$\varepsilon_i = \frac{d_i - C}{C} * 0.003$$

$$\varepsilon_1 = \frac{60-150}{150} * 0.003 = -0.0018$$

$$\varepsilon_2 = \frac{240-150}{150} * 0.003 = 0.0018$$

$$f_{si} = \varepsilon_i * E = \qquad -420 < \quad f_{si} < 420$$

$$f_{s1} = -0.0018 * 200{,}000 = -360$$

$$f_{s2} = 0.0018 * 200{,}000 = 360$$

$$a_b = \beta * C$$

$$a_b = 0.85 * 150 = 127.5\, mm$$

$$a_b > d_i \quad \to compression\ zone \quad , \quad a_b < d_i \quad \to tension\ zone$$

$$F_{si} = \ f_{si} * A_{si} * 10^{-3} \ \to Tension\ \ Zone$$

$$F_{si} = (f_{si} + 0.85 * f_c`) * A_{si} * 10^{-3} \ \to Compression\ \ Zone$$

$$F_{s1} = (-360 + 0.85 * 25) * 628 * 10^{-3} = -212.735\, Kn$$

$$F_{s2} = 360 * 628 * 10^{-3} = 226.08 Kn$$

$$C_c = 0.85 * f_c` * b * \beta * c * 10^{-3}$$

$$C_c = 0.85 * 25 * 300 * 0.85 * 150 * 10^{-3} = 812.813 Kn$$

$$P_n = C_c - \Sigma F_s$$

$$P_n = 812.813 - (-212.735 + 226.08) = 799.468\, Kn$$

$$M_n = C_c\left[\frac{h}{2} - \frac{a}{2}\right] + F_{s1}\left[d_1 - \frac{h}{2}\right] + F_{s2}\left[d_2 - \frac{h}{2}\right] + F_{s3}\left[d_3 - \frac{h}{2}\right] * 10^{-3}$$

$$M_n = 812.813\left[\frac{300}{2} - \frac{127.5}{2}\right] - 212.74\left[60 - \frac{300}{2}\right] + 226.08\left[240 - \frac{300}{2}\right] * 10^{-3} = 109.6\, Kn.m$$

$$\emptyset P_n = 0.65 * 799.468 = 519.654\, Kn$$

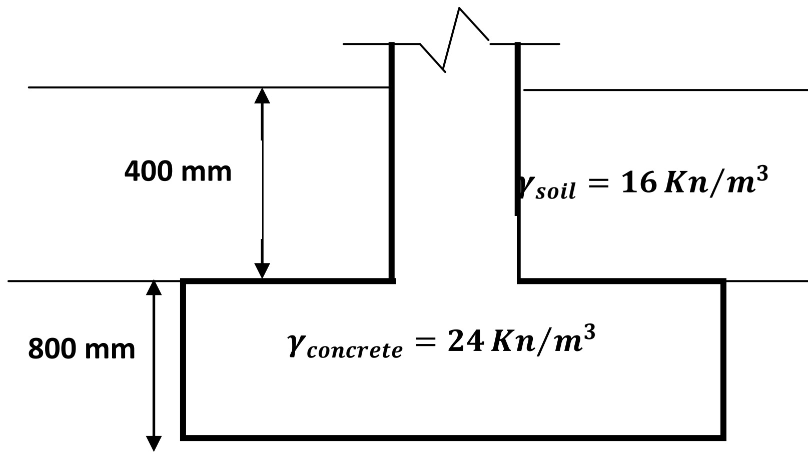
$$\emptyset M_n = 0.65 * 109.6 = 71.24\, Kn.m$$

b)

$f_c' = 25\ \text{MPa}$, 300x300 , $L = 3000$, $K = 1$, $M_1 = = M_2 = 100\ \text{Kn.m}$

Double curvature

$$\frac{1 * 3000}{0.3 * 300} \leq 34 - 12\left(\frac{100}{-100}\right) \Rightarrow 33.33 \leq 46 \Rightarrow \text{short column}$$



Q3)

$q_{all} = 280\ \text{Kn/m}^2$, 400x400

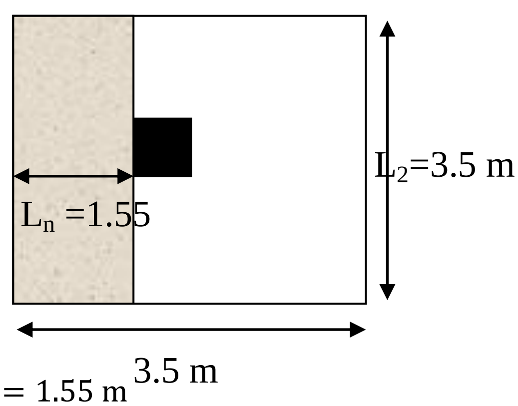
$P_{dead} = 1500\ \text{Kn}$, $P_{live} = 1300\ \text{Kn}$

a)

$q_{net} = 280 - \{0.4 * 16 + 0.8 * 24\} = 254.4\ \text{Kn/m}^2$

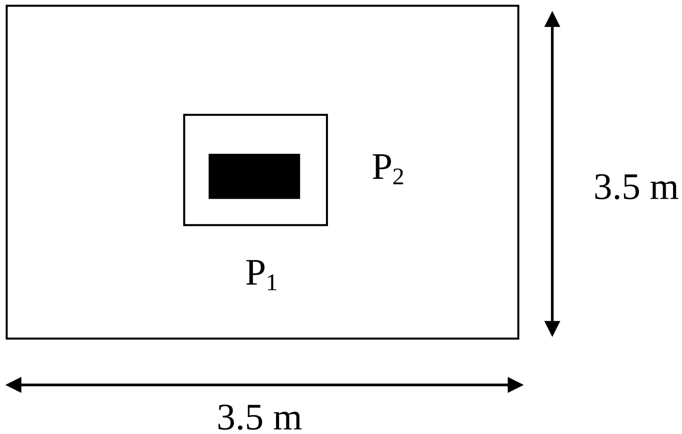
Minimum Area of footing $= \frac{1500+1300}{254.4} = 11.006\ m^2$

b)



$$q_{ult} = \frac{1.4 * 1500 + 1.7 * 1300}{12.25} = 351.84\ \text{Kn/m}^2 \quad , L_n = \frac{3.5 - 0.4}{2} = 1.55\ \text{m}$$

$$M_u = \frac{q_{ult} * L_2 * L_n^2}{2} = \frac{351.84 * 3.5 * 1.55^2}{2} = 1479.27\ Kn.m$$



$P_1 = C_1 + d_{ave} = 400 + 710 = 1110\ mm$

$P_2 = C_2 + d_{ave} = 400 + 710 = 1110\ mm$

$V_u = W_u(A_o - A_c) = 351.84\ (3.5 * 3.5 - 1.11 * 1.11) = 3876.54\ KN$

b_o=length of critical perimeter= 2*(P_1+ P_2)= 2*(1110+ 1110)=4440 mm.

β_c=column length ratio ($\frac{long\ \ side}{short\ side}$) = $\frac{400}{400} = 1$

$\alpha_s = 40$

$$V_c = \text{Min}\left\{\begin{array}{c} \left(1+\frac{2}{1}\right)\frac{\sqrt{25}}{6} * 4440 * 710\ \text{x}10^{-3} = 7881\ \text{Kn} \\ \left(2+\frac{40 * 710}{4440}\right)\frac{\sqrt{25}}{12} * 4440 * 710\ \text{x}10^{-3} = 11028.67\text{KN} \\ \frac{\sqrt{25}}{3} * 4440 * 710\text{x}10^{-3} = 5254\ \text{Kn} \end{array}\right\} = 5254\ \text{KN}$$

$$\varphi V_c = 0.75 * 5254 = 3940.5\ Kn > 3876.54\ Kn\ \therefore\ \text{ok}$$