A-solid slab design:

a)

$$h_{min} = \frac{l}{24} = \frac{3500}{24} = 145.83\ mm$$

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

b)

$$DL = own\ weight + superimposed$$

$$DL = (0.18 * 25) + 2 = 6.5\ \ kn/m^2$$

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

$$Wu = 1.4DL + 1.7LL$$

$$M_u + = \frac{1}{14} * 14.2 * 3.2^2 = 10.386\ kn.m$$

$$M_u - = \frac{1}{9} * 14.2 * 3.2^2 = 16.156\ kn.m$$

c)

$$M_u = 25\ \ kn.m \quad , Assume\ \ d_b = 12$$

$$d = 180 - 20 - \frac{12}{2} = 154mm\ , \qquad R_n = \frac{25/0.9}{1000 * 154^2} * 10^6 = 1.1713\ Mpa$$

$$m = \frac{420}{0.85 * 25} = 19.765\ , \qquad \rho = \frac{1}{19.765}\left(1 - \sqrt{1 - \frac{2 * 1.1713 * 19.765}{420}}\ \right) = 0.00287$$

$$A_s = 0.00287 * 1000 * 154 = 441.98\ mm^2\ , \qquad A_{s\ min} = 0.0018 * 1000 * 180 = 324\ mm^2$$

$$S_{max} = \min\left(\frac{113.04}{449.98} * 1000 = 255.76\ mm\ ,300mm, 2 * 180 = 360\right) = 255.76mm$$

$$for\ flexural \rightarrow use\ \emptyset 12@250\ mm$$

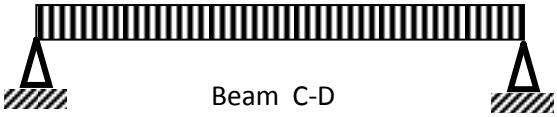
$$A_{s\ shrinkage} = 0.0018 * 1000 * 180 = 324\ mm^2$$

$$S_{max} = \min\left(\frac{113.04}{324} * 1000 = 348.89mm, 300mm, 4 * 180 = 720\right) = 300mm$$

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

d)

Wu= load from slab +self weight

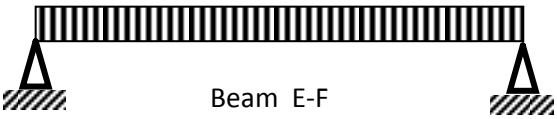


$$Wu \;\; slab = 14.2 \;\; kn/m^2$$

$$Wu\ beam(C-D) = 14.2 * \left(\frac{3.5}{2} + \frac{3.5}{2}\right) + 1.4 * (0.42 * 0.3 * 25) = 54.11 \;\; kn/m$$

e)

Wu= load from slab +self weight + weight of wall

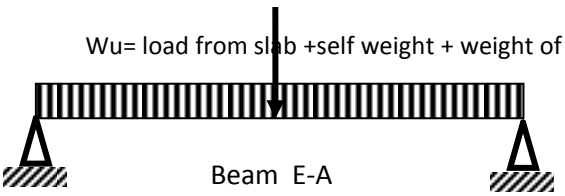


$$Wu\ beam(E-F) = 14.2 * \left(\frac{3.5}{2} + 0.15\right) + 1.4 * [(0.42 * 0.3 * 25) + (3 * 0.2 * 15)] = 43.99 \;\; kn/m$$

$$Axial\ load\ on\ column(\boldsymbol{E}) from \;\; beam\ (E-F) = 43.99 * \frac{7.5}{2} = 164.9625\ Kn$$

Pu= load from beam C-D

Wu= load from slab +self weight + weight of wall



$$Wu\ beam(E-A) = 1.4 * (0.42 * 0.3 * 25) = 4.41\ kn/m$$

$$Pu\ beam(E-A) = 54.11 * \frac{7.2}{2} = 194.796\ Kn$$

$$Axial\ load\ on\ column(\boldsymbol{E}) from \;\; beam\ (E-A) = \left[4.41 * \frac{7.5}{2}\right] + \left[194.796 * \frac{1}{2}\right] = 113.9355\ Kn$$

$$Self\ weight\ of\ column\ E = 1.4 * 0.3 * 0.3 * 25 * 3 = 9.45\ Kn$$

$$\boldsymbol{Total\ axial\ load\ on\ column\ E} =$$

$$No.of\ story * \ (Axial\ load\ from\ beam\ (E-F) + Axial\ load\ from\ beam\ (E-A) + self\ weight\ of\ column\ E\ )$$

$$\boldsymbol{Total\ axial\ load\ on\ column\ E} = \mathbf{3} * (\mathbf{164.9625} + \mathbf{113.9355} + \mathbf{9.45}) = \mathbf{865.044\ Kn}$$

B-joist slab design:

a)

$$h_{min} = \frac{l}{18.5} = \frac{3500}{18.5} = 189.19\ mm$$

$$h = 380\ mm > h_{min} \rightarrow ok$$

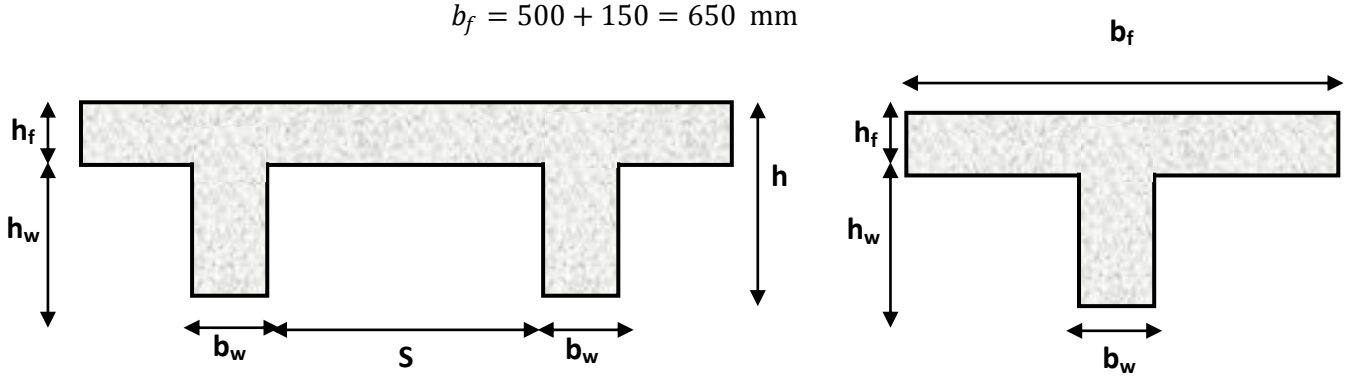
$$h_f \geq \left(50mm\ , \frac{500}{12} = 41{,}67\ mm\right) = 50\ mm \qquad h_f = 80\ mm \quad ok$$

$$h_w \not> (3.5 * 150 = 525mm) \qquad h_w = 300 \quad mm \quad ok$$

$$b_w \geq 100\ mm \qquad b_w = 150\ mm \quad ok$$

$$S \not> 800\ \text{mm} \qquad S = 500mm \quad ok$$

$$b_f = 500 + 150 = 650\ \text{mm}$$



b)

$$DL = own\ weight + superimposed$$

$$DL = (0.08 * 25) + 2 = 4\ \ kn/m^2$$

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

$$Wu = 1.4DL + 1.7LL$$

$$Wu = 1.4(4) + 1.7(3) = 10.7\ kn/m^2$$

Load on typical rip:

$$Wu_{/rip} = 10.7 * (0.65) + 1.4 * (0.3 * 0.15 * 25) = 8.53\ kn/m$$

C)

$$M_u+ = \frac{1}{14} * 8.53 * 3.2^2 = 6.239\ kn.m$$

$$M_u- = \frac{1}{9} * 8.53 * 3.2^2 = 9.705\ kn.m$$

d)

$$M_u - ve = 28\ kn.m \quad , \ , Assume\ d_b = 12$$

$$d = 380 - 20 - 8 - \frac{12}{2} = 346\ mm\ , \qquad R_n = \frac{28/0.9}{150 * 346^2} * 10^6 = 1.7325\ Mpa$$

$$m = \frac{420}{0.85 * 25} = 19.765\ , \qquad \rho = \frac{1}{19.765}\left(1 - \sqrt{1 - \frac{2 * 1.7325\ * 19.765}{420}}\ \right) = 0.00431$$

$$A_s = 0.00431 * 150 * 346 = 223.608\ mm^2\ , \qquad A_{s\,min} = max\begin{bmatrix} \frac{1.4}{420} * 150 * 346 \\ \frac{\sqrt{f_c}}{4 * 420} * 150 * 346 \end{bmatrix} = 173\ mm^2$$

$$n = \frac{A_s}{A_b} = \frac{223.608}{113.04} = 1.98 \approx 2$$

$$for\ flexural\ \rightarrow use\ \ 2\ \emptyset 12$$

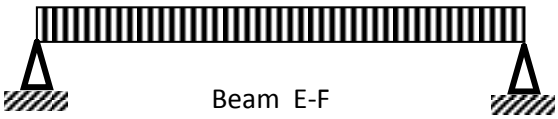
$$A_{s\ shrinkage}\ = 0.0018 * 1000 * 80 = 144\ mm^2$$

$$S_{max}\ = \min\left(\frac{113.04}{144} * 1000 = 785\ mm\ , 300mm, 4 * 80 = 320\right) = 300mm$$

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

e)

Wu= load from slab +self weight + weight of wall



Beam E-F

$$Wu\ beam(E-F) =$$

$$\frac{8.53}{0.65} * \left(\frac{3.5}{2} - 0.15\right) + 1.4 * [(0.6 * 0.3 * 25) + (0.3 * 2) + (3 * 0.2 * 15)] + 1.7 * (0.3 * 3)$$
$$= 42.267\ \ kn/m$$