

Design a simply supported rectangular concrete beam with tension steel only to carry a service dead load of 1.35 k/ft and a service live load of 1.9 k/ft.

The dead load does not include self weight. The span is 18 ft. Assume #4 stirrups. Use $f'_c = 4 \text{ ksi}$; $60 \text{ ksi} = f_y$

① Assume self wt = 300 #/ft

② Calculate factored load & moment

$$W_u = 1.2 W_{DL} + 1.6 W_{LL} = 1.2 [1.35 + 0.3] + 1.6 [1.9] \\ = 5.02 \text{ #/ft}$$

$$M_u = \frac{w l^2}{8} = \frac{(5.02 \text{ #/ft})(18)^2}{8} = 203.31 \text{ ft-k}$$

③ $e_{bal} = 0.0285$

$$e_{max} = 0.75(0.0285) = 0.0214$$

$$e = \frac{1}{2} e_{max} = 0.0107 \leftarrow \text{using this}$$

④ from Tbl A.13

$$\frac{M_u}{\phi b d^2} = 581.2 \Rightarrow b d^2 = \frac{(203.31)(12)(1000)}{0.9(581.2)}$$

$$b d^2 = 4664.14$$

⑤ Select section (Guess)

$$12 \times 19.7 \Rightarrow d \approx 20 \text{ try } 12 \times 22 (d \approx 20)$$

$$14 \times 21.6 \Rightarrow d \approx 22$$