

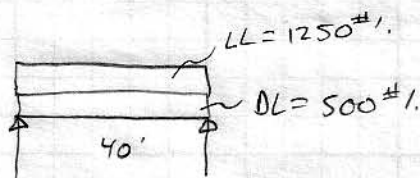
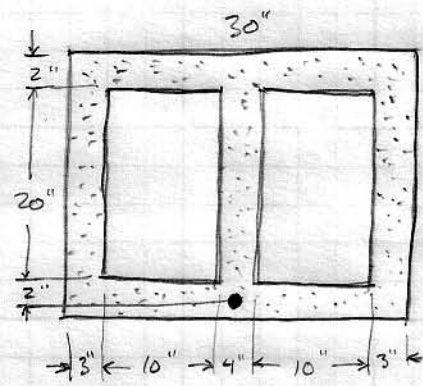
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15-3 c.



$f'_c = 4.5 \text{ ksi}$ $\beta_1 = 0.825$ $f_y = 50 \text{ ksi}$

Find: A_s

$$uDL = 1.4 \times 500 \text{ #/ft} = 700 \text{ #/ft}$$

$$uLL = 1.7 \times 1250 \text{ #/ft} = 2125 \text{ #/ft}$$

$$u+L = 2825 \text{ #/ft} = 2.825 \text{ k/ft}$$

$$M_u = \frac{wL^2}{8} = \frac{2.825 \text{ k/ft} (40 \text{ ft})^2}{8} = 565 \text{ k-ft}$$

$$M_n = \frac{M_u}{\phi} = \frac{565 \text{ k-ft}}{0.9} = 627.8 \text{ k-ft}$$

Determine if compression block falls entirely within top slab:

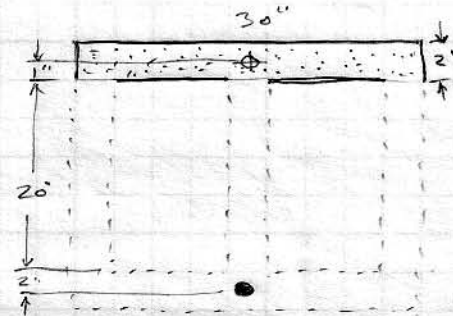
$$z_t = 2'' + 20'' + 1'' = 23''$$

$$A_{ct} = 2'' \times 30'' = 60 \text{ in}^2$$

$$M_{nt} = 0.85 f'_c A_{ct} z_t = 0.85 (4.5 \text{ ksi}) (60 \text{ in}^2) (23'')$$

$$= 5278.5 \text{ k-in} \times 1/12 = 440 \text{ k-ft}$$

This is not sufficient to cover required moment capacity (627.8 k-ft). Therefore the stress block extends into the webs.



The moment capacity required by the webs is:

$$M_{nw} = M_n - M_{nt} = 627.8 \text{ k-ft} - 440 \text{ k-ft} = 187.8 \text{ k-ft}$$

$$z_w = 2'' + (20'' - \frac{a}{2}) = 22'' - \frac{a}{2}$$

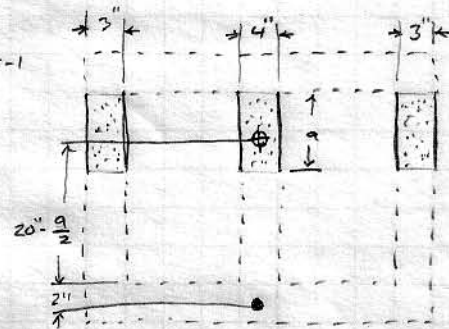
$$A_{cw} = (3'' + 4'' + 3'') a = 10a \text{ (in}^2)$$

$$M_{nw} = 0.85 f'_c A_{cw} z_w = 187.8 \text{ k-ft}$$

$$0.85 (4.5 \text{ ksi}) (10a \text{ in}^2) (22'' - \frac{a}{2}) = 187.8 \text{ k-ft} \times 12 \text{ in/ft}$$

$$22a - \frac{a^2}{2} = \frac{187.8 \times 12}{0.85 \times 4.5 \times 10} = 58.92 \text{ (in}^2)$$

$$a^2 - 44a + 117.8 = 0 \text{ (in}^2)$$



15-3 c (cont.)

Solving the quadratic:

$$a = \frac{44 \pm \sqrt{44^2 - 4(117.8)}}{2}$$

$$a = \underline{2.865''}, \quad \cancel{41.135''} \text{ not possible}$$

$$z_w = 22'' - \frac{a}{2} = 22'' - \frac{2.865''}{2} = 20.57''$$

$$A_{cw} = 10a (h/2) = 10 \times 2.865 (h/2) = 28.65 \text{ in}^2$$

$$M_{nw} = 0.85 f'_c A_c z = 0.85 (4.5 \text{ ksi}) (28.65 \text{ in}^2) (20.57'')$$

$$= 2254 \text{ k-in} = 187.8 \text{ k-ft} \quad \checkmark$$

Find the area of steel required for each section:

Top slab:

$$A_{st} = \frac{M_{nt}}{f_y z_t} = \frac{5278.5 \text{ k-in}}{50 \text{ ksi} \times 23''} = 4.59 \text{ in}^2$$

Web:

$$A_{sw} = \frac{M_{nw}}{f_y z_w} = \frac{2254 \text{ k-in}}{50 \text{ ksi} \times 20.57''} = 2.19 \text{ in}^2$$

$$A_s = A_{st} + A_{sw} = 4.59 \text{ in}^2 + 2.19 \text{ in}^2 = 6.78 \text{ in}^2$$

QED