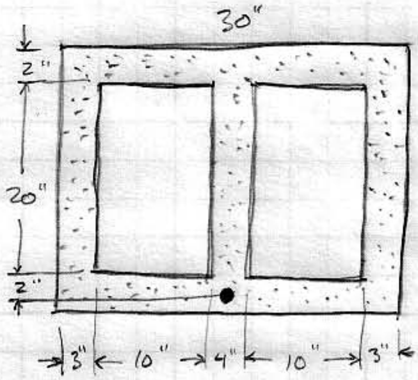
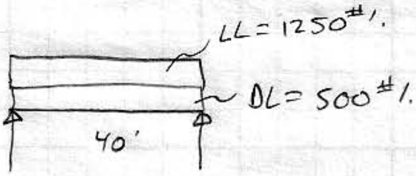
15-3 c.





$f'_c = 4.5$ ksi $\qquad \beta_1 = 0.825 \qquad f_y = 50$ ksi

Find: A_s

$U_{DL} = 1.4 \times 500^{\#/'} = 700^{\#/'}$

$U_{LL} = 1.7 \times 1250^{\#/'} = 2125^{\#/'}$ +

$U_{TL} = 2825^{\#/'} = 2.825^{k/'}$

$$M_u = \frac{w\ell^2}{8} = \frac{2.825^{k/'}(40')^2}{8} = 565^{k-'}$$

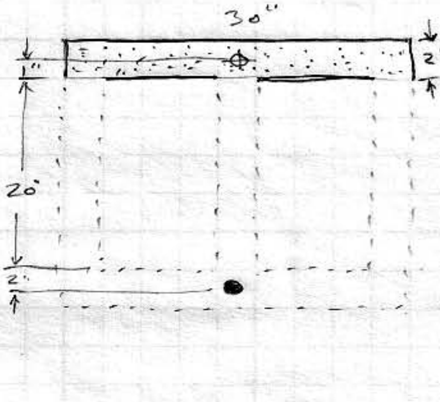
$$M_n = \frac{M_u}{\phi} = \frac{565^{k-'}}{0.9} = 627.8^{k-'}$$

Determine if compression block falls entirely within top slab:

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

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

$M_{nt} = 0.85\, f'_c A_{ct} z_t = 0.85\,(4.5 \text{ ksi})(60 \text{ in}^2)(23")$
$= 5278.5^{k-"} \times \, ^1/_{12"} = 440^{k-'}$



This is not sufficient to cover required moment capacity ($627.8^{k-'}$). Therefore the stress block extends into the webs.

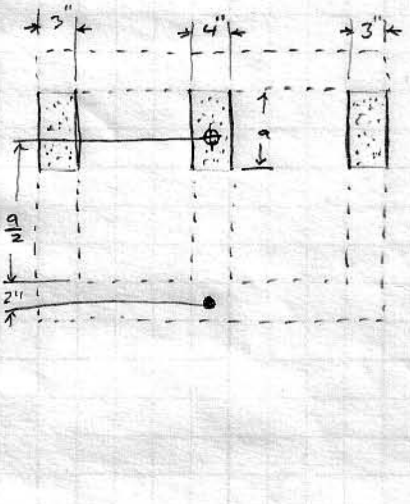
The moment capacity required by the webs is;

$M_{nw} = M_n - M_{nt} = 627.8^{k-'} - 440^{k-'} = 187.8^{k-'}$

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

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

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



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

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

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

15-3 c (cont.)

Solving the quadratic:

$$a = \frac{44 \pm \sqrt{44^2 - 4(117.8)}}{2} \qquad a = \underline{2.865''}, \ \cancel{41.135''}$$

not possible

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

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

$$M_{nw} = 0.85 f'_c A_c z = 0.85(4.5\ ksi)(28.65\ in^2)(20.57'')$$
$$= 2254^{k-''} = 187.8^{k-'}$$

✓

Find the area of steel required for each section:

Top slab:

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

web:

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

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

QED