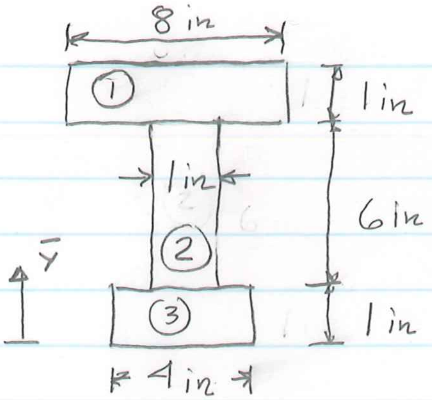
4.8



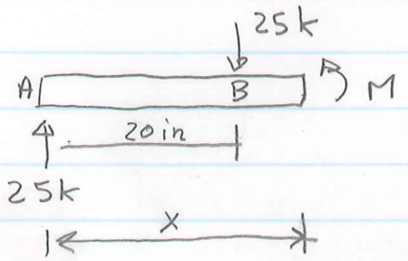
i	A_i	$\bar{y}_i$	$A_i \bar{y}_i$
1	$8\ in^2$	$7.5\ in$	$60\ in^3$
2	$6\ in^2$	$4\ in$	$24\ in^3$
3	$4\ in^2$	$0.5\ in$	$2\ in^2$

$$\bar{Y}_c = \frac{\Sigma A_i \bar{Y}_i}{\Sigma A_i} = \frac{86\ in^3}{18\ in^2} = 4.778\ in$$

location of neutral axis

$$I = \frac{1}{12}(8in)(1in)^3 + A_1 \cdot (\bar{Y}_1 - \bar{Y}_c)^2 + \frac{1}{12}(1in)(6in)^3 + A_2 \cdot (\bar{Y}_2 - \bar{Y}_c)^2 + \frac{1}{12}(4in)(in)^3 + A_3 \cdot (\bar{Y}_3 - \bar{Y}_c)^2 = 155.11\ in^4$$

about neutral axis



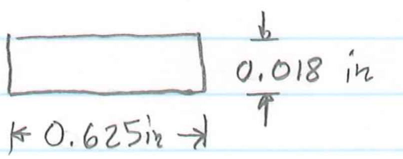
$$\Sigma M_{cut} = 0$$

$$-25k \cdot X + 25k \cdot (x - 20in) + M = 0$$

$M = 500$ in-kips between B and C

$$\boxed{\begin{aligned} \sigma_{top} &= M \cdot (8in - Y_c)/I = 10.39\ ksi \quad (\text{max compression}) \\ \sigma_{bot} &= M \cdot Y_c / I = 15.40\ ksi \quad (\text{max tension}) \end{aligned}}$$

4.21



$$I = \frac{1}{12}(0.625in)(0.018in)^3 = 3.0375 \times 10^{-7}\ in^4$$

$E = 29 \times 10^6$ psi, $\rho = 4$ in

$$M = \frac{EI}{\rho} = 2.2022\ in\text{-}lb$$

$$\boxed{\sigma_{max} = M \cdot 0.009in / I = 65.25\ ksi \quad (\text{ten \& comp})}$$

(Answer actually does not depend on I.)

4.51 Assume neutral axis is in the top wide part.
From class notes, a is the depth to the neutral axis

$b\,a^2/2 - (d-a)\,n\,A_s = 0$

$b = 30\text{ in}$, $d = 21.5\text{ in}$, $n = 30/3.75 = 8$

$A_s = 4 \cdot \pi\,(0.5\text{in})^2 = 3.14159\text{ in}^2$

Solve for a: $a = 5.2224\text{ in.}$ The assumption about the neutral is not correct. So, recalculate:

$b\,a^2/2 - (30\text{in} - 12\text{in})\,(a - 5\text{in})^2/2 - (d-a)\,n\,A_s = 0$

Solve for a: $a = 5.2249\text{ in}$ (close to previous value since it was just below the wide part).

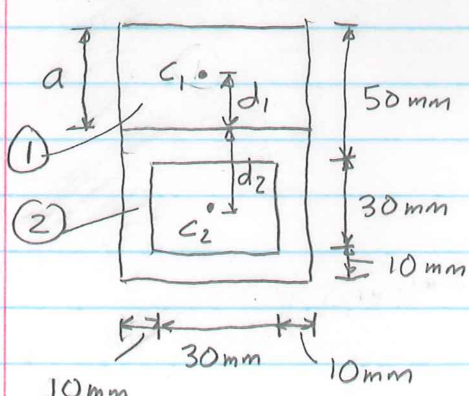
$I = \frac{1}{3} b a^3 + n A_s (d-a)^2 = 8083.5\text{ in}^4$ ← This formula is close enough.

$M = 1800\text{ in-kips}$

$\boxed{\sigma_{c,max} = Ma/I = 1.16\text{ ksi comp}}$

$\boxed{\sigma_s = n \cdot M(d-a)/I = 29.00\text{ ksi ten}}$

4.81



$A_1 = 50\text{mm} \cdot a$

$A_2 = 50\text{mm} \cdot (90\text{mm} - a) - 900\text{ mm}^2$

$A_1 = A_2 \Rightarrow a = 36\text{ mm}$

$A_1 = 1800\text{ mm}^2 = A_2$

$d_1 = 18\text{ mm}$

$d_2 = (50\text{mm} \cdot 54\text{mm} \cdot 27\text{mm} - 900\text{mm}^2 \cdot 29\text{mm}) / A_2$

$= 26\text{ mm}$

$Z = A\,d/2$ where $A = A_1 + A_2 = 3600\text{mm}^2$

$d = d_1 + d_2 = 44\text{mm}$

$Z = 79{,}200\text{ mm}^3$

$M_p = \sigma_Y \cdot Z$ where $\sigma_Y = 240\text{ MPa}$

$M_p = 19.0\text{ kN-m}$