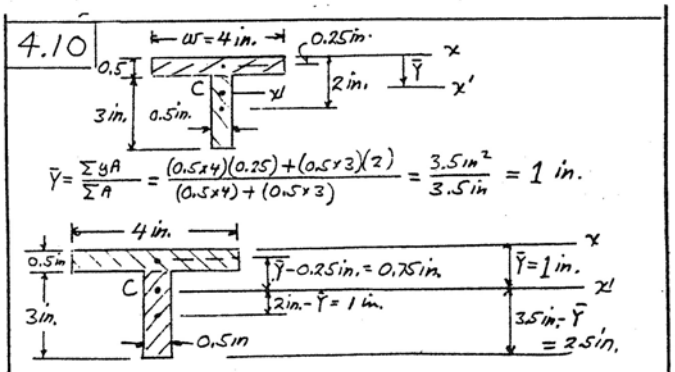
5B (after EXAM 1) Sol.

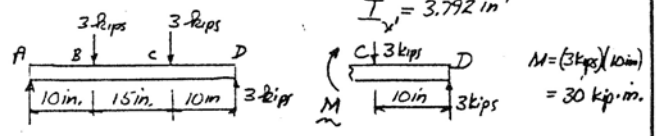
4.10



$$\bar{y} = \frac{\Sigma yA}{\Sigma A} = \frac{(0.5\times4)(0.25)+(0.5\times3)(2)}{(0.5\times4)+(0.5\times3)} = \frac{3.5\ in^2}{3.5\ in} = 1\ in.$$

$$I_{x'} = \Sigma\left(\frac{1}{12}bd^3 + Ad^2\right) = \frac{1}{12}(4)(0.5)^3 + (0.5\times4)(0.75)^2 + \frac{1}{12}(0.5)(3)^3 + (0.5\times3)(1)^2$$

$$I_{x'} = 3.792\ in^4$$



$M = (3\ kips)(10\ in) = 30\ kip\cdot in.$

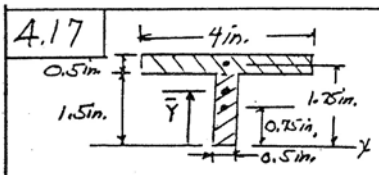
MAX TENSILE STRESS AT BOTTOM EDGE: $c = 2.5\ in.$

$$\sigma = \frac{Mc}{I_{x'}} = \frac{(30\ kip\cdot in.)(2.5\ in.)}{3.792\ in^4} \qquad \sigma = +19.78\ ksi$$ ◀

MAX COMPRESSIVE STRESS AT TOP EDGE: $c = 1\ in$

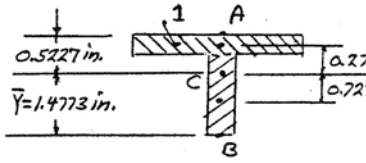
$$\sigma = \frac{Mc}{I_{x'}} = \frac{(30\ kip\cdot in.)(1\ in.)}{3.792\ in^4} \qquad \sigma = -7.91\ ksi$$ ◀

4.17



$$\bar{y} = \frac{\Sigma A\bar{y}}{\Sigma A} = \frac{(0.5\times4)(1.75)+(1.5\times0.5)(0.75)}{(0.5\times4)+(1.5\times0.5)}$$

$$\bar{y} = \frac{4.0625}{2.75} = 1.4773\ in.$$

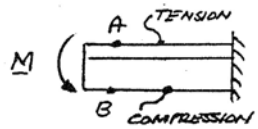


$$I_{x'} = \Sigma\left(\frac{1}{12}bh^3 + Ad^2\right)$$

① $I_{x'} = \left[\frac{1}{12}(4)(0.5)^3 + (4\times0.5)(0.2727)^2\right] = 0.1904\ in^4$

② $I_{x'} = \left[\frac{1}{12}(0.5)(1.5)^3 + (0.5\times1.5)(0.7273)^2\right] = 0.5373\ in^4$

Σ: $I_{x'} = 0.7277\ in^4$



ASSUME: $\sigma_A = +\sigma_{all} = +6\ ksi$

$$M = \sigma_A \frac{I_{x'}}{c} = (6\ ksi)\frac{0.7277\ in^4}{0.5227\ in} = 8.35\ kip\cdot in.$$ ◁

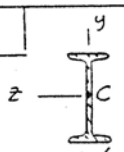
ASSUME: $\sigma_B = -\sigma_{all} = -15\ ksi$

$$M = \sigma_B \frac{I_{x'}}{c} = (15\ ksi)\frac{0.7277\ in^4}{1.4773\ in.} = 7.39\ kip\cdot in.$$ ◁

WE CHOOSE THE SMALLER M:

$M_{all} = 7.39\ kip\cdot in.$ ◀

4.21



$E = 29\times10^6\ psi$

S10×25.4 FROM APPENDIX C

$I_z = 124\ in^4$

$S_z = 24.7\ in^3$

$I_y = 6.79\ in^4$

$S_y = 2.91\ in^4$

(a) BEND ABOUT HORIZONTAL AXIS: $M_z = 75\ kip\cdot in.$

$$\sigma = \frac{M_z}{S_z} = \frac{75\ kip\cdot in.}{24.7\ in^3} \qquad \sigma = 3.04\ ksi$$ ◀

$$\frac{1}{\rho} = \frac{M_z}{EI_z} = \frac{75\ kip\cdot in.}{(29\times10^6\ psi)(124\ in^4)} = 20.857\times10^{-6}\ in^{-1}$$

$\rho = 47950\ in. = 3996\ ft$ $\qquad \rho = 4000\ ft$ ◀

(b) BEND ABOUT VERTICAL AXIS: $M_y = 75\ kip\cdot in$

$$\sigma = \frac{M_y}{S_y} = \frac{75\ kip\cdot in.}{2.91\ in^3} \qquad \sigma = 25.8\ ksi$$ ◀

$$\frac{1}{\rho} = \frac{M_y}{EI_y} = \frac{75\ kip\cdot in.}{(29\times10^6\ psi)(6.79\ in^4)} = 380.88\times10^{-6}\ in^{-1}$$

$\rho = 2625\ in. = 218.8\ ft$ $\qquad \rho = 219\ ft$ ◀