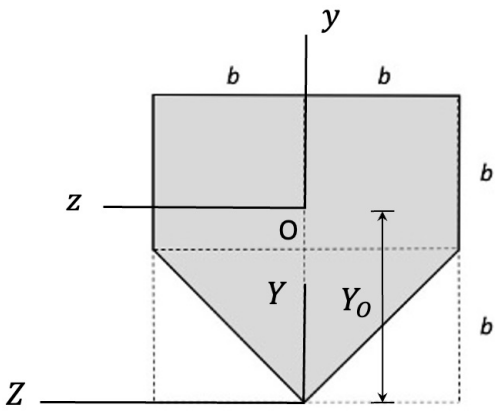
SOLUTION

ME 323: Mechanics of Materials ***Homework Set H15***

Summer 2023 ***Assigned/Due: June 28/July 2***

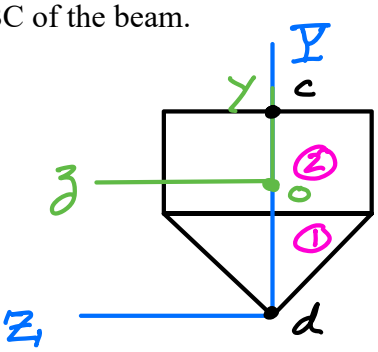
Consider the shear force/bending moment diagrams for the beam shown below. The beam has a cross-section as shown to the right, with $b = 0.2$ ft.

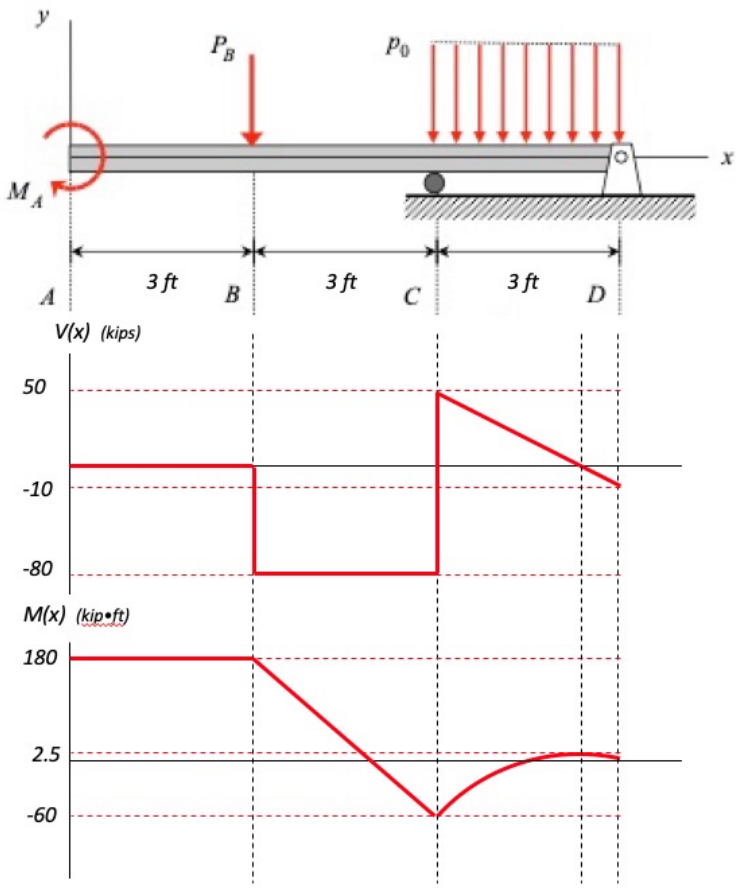


a) Determine the location Y_O of the centroid O of the beam cross-section and the second area moment I_O about the neutral axis, z.

b) Determine the maximum magnitude normal stress along section AB of the beam.

c) Determine the shear stress at the neutral axis along section BC of the beam.





(a) Let O be the centroid of the beam cross-section.

$$\bar{Y}_O = \frac{A_1\bar{Y}_1 + A_2\bar{Y}_2}{A_1 + A_2}$$

w/ $A_1 = \frac{1}{2}(2b)(b) = b^2$

$A_2 = (2b)(b) = 2b^2$

$\bar{Y}_1 = \frac{2}{3}b$

$\bar{Y}_2 = b + \frac{b}{2} = \frac{3b}{2}$

$$\therefore \bar{Y}_O = \frac{(b^2)(\frac{2}{3}b) + (2b^2)(\frac{3b}{2})}{b^2 + 2b^2} = \frac{11}{9}b$$

$I_O = I_{1O} + I_{2O}$

w/ $I_{1O} = \frac{1}{36}(2b)b^3 + \frac{1}{2}(2b)(b)\left[\frac{11}{9}b - \frac{2}{3}b\right]^2$; P.A.T.

$= \frac{59}{162}b^4$

$I_{2O} = \frac{1}{12}(2b)b^3 + (2b)(b)\left[\frac{3}{2}b - \frac{11}{9}b\right]^2$; P.A.T.

$= \frac{52}{162}b^4$

$\therefore \quad I_O = I_{1O} + I_{2O} = \frac{37}{54} b^4$

(b) $\quad M = 180 \text{ kip-ft}$

$$\sigma_d = - \frac{M y_d}{I_O}$$

w/ $y_d = -y_O = -\frac{11}{9} b$

$$I_O = \frac{37}{54} b^4$$

$\therefore$ $$\sigma_d = \frac{M\left(\frac{11}{9} b\right)}{\frac{37}{54} b^4} = \frac{66}{37} \frac{M}{b^3}$$