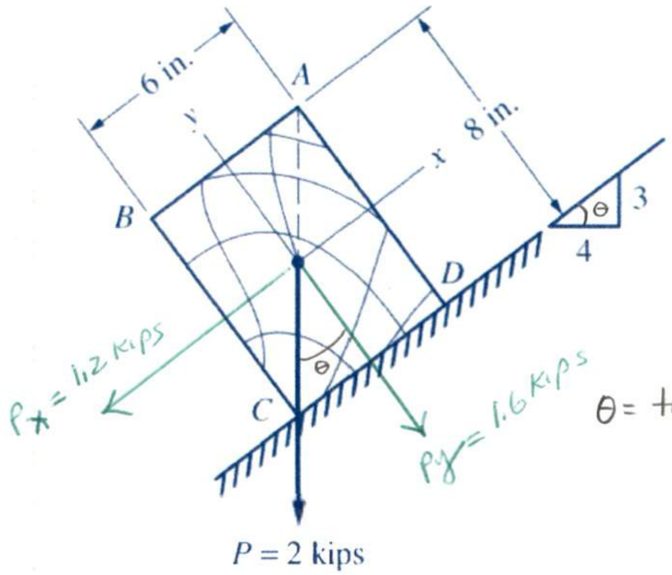
18-8

The 10-ft-long, simply supported timber beam of full-size, 6-in. x 8-in. section is supported in such a way that the vertical concentrated load P = 2 kips applied at the centroid of the midspan passes through the diagonal AC, as shown. Find the normal stresses at points A, B, C, and D in the midspan due to the load.

Solution.



$P_x = 2\text{ Kips} \sin 37° = 1.2\text{ Kips}$

$P_y = 2\text{ Kips} \cos 37° = 1.6\text{ Kips}$

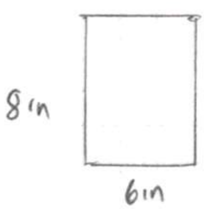
$\theta = \tan^{-1}\frac{3}{4} = 37°$

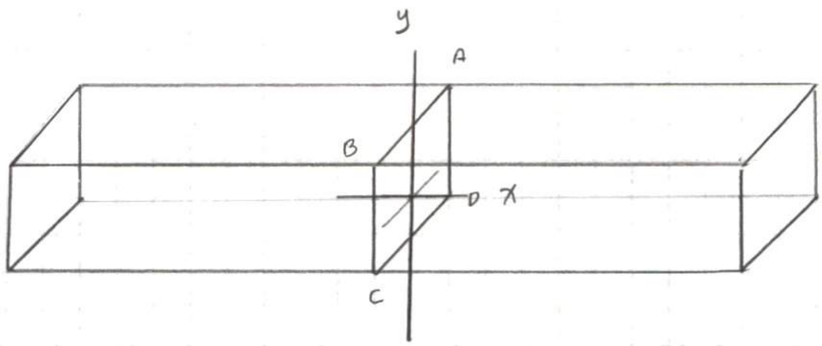
From Table 13-1, case 1

$$M_{MAX} = \frac{PL}{4} \quad \text{(at midspan)}$$

$$M_x = \frac{P_y L}{4} = \frac{1.6\text{ kips}(10\text{ ft})}{4} = 4\text{ kip}\cdot\text{ft}\left(\frac{12\text{ in}}{\text{ft}}\right) = 48\text{ kip}\cdot\text{in}$$

$$M_y = \frac{P_x L}{4} = \frac{1.2\text{ kip}(10\text{ ft})}{4} = 3\text{ kip}\cdot\text{ft}\left(\frac{12\text{ in}}{\text{ft}}\right) = 36\text{ kip}\cdot\text{in}$$





6 in x 8 in Rectangular Beam

Bending About the x-axis

CD (T)

AB (C)

Bending about the y-axis

BC (T)

AD (C)

For Rectangular Section

$$S_x = \frac{bh^2}{6} = \frac{6\text{ in}(8\text{ in})^2}{6} = 64\text{ in}^3$$

$$S_y = \frac{8\text{ in}(6\text{ in})^2}{6} = 48\text{ in}^3$$

$$\sigma_A = \frac{-M_x}{S_x} - \frac{M_y}{S_y} = \frac{-48 \text{ kip}\cdot\text{in}}{64 \text{ in}^3} - \frac{36 \text{ kip}\cdot\text{in}}{48 \text{ in}^3}$$

$$= -0.75 \text{ ksi} - 0.75 \text{ ksi} = -1.5 \text{ ksi (C)}$$

$$\sigma_B = \frac{-M_x}{S_x} + \frac{M_y}{y} = -0.75 \text{ ksi} + 0.75 \text{ ksi} = 0$$

$$\sigma_C = \frac{M_x}{S_x} + \frac{M_y}{S_y} = 0.75 \text{ ksi} + 0.75 \text{ ksi} = +1.5 \text{ ksi (T)}$$

$$\sigma_D = \frac{M_x}{S_x} - \frac{M_y}{S_y} = 0.75 \text{ ksi} - 0.75 \text{ ksi} = 0$$