

(a)  $\theta = 0$

Bar BD:

$$\begin{cases} \sum F_x = 0: & B_x + D_x + E_x = 0 & (1) \\ \sum F_y = 0: & -B_y + E_y = 0 & (2) \\ \sum M_D = 0: & E_y \left(\frac{L}{2} \frac{\sqrt{3}}{2}\right) - E_x \left(\frac{L}{2} \cdot \frac{1}{2}\right) - B_y \left(L \frac{\sqrt{3}}{2}\right) - B_x \left(L \frac{1}{2}\right) = 0 & (3) \end{cases}$$

Bar AC:

$$\begin{cases} \sum F_x = 0: & A_x + C_x - E_x = 0 & (4) \\ \sum F_y = 0: & A_y + C_y - E_y = 0 & (5) \\ \sum M_A = 0: & -E_y \left(\frac{L}{2} \frac{\sqrt{3}}{2}\right) - E_x \left(\frac{L}{2} \cdot \frac{1}{2}\right) + C_y \left(L \frac{\sqrt{3}}{2}\right) + C_x \left(L \frac{1}{2}\right) = 0 & (6) \end{cases}$$

Bar BC:

$$\begin{cases} \sum F_x = 0: & -B_x - C_x + P = 0 & (7) \\ \sum F_y = 0: & B_y - C_y = 0 & (8) \\ \sum M_F = 0: & B_x \left(\frac{L}{4}\right) - C_x \left(\frac{L}{4}\right) = 0 & (9) \end{cases}$$

Solve the above nine equations to obtain

$$\begin{cases} A_x = -P/2 & C_x = P/2 \\ A_y = 0 & C_y = -0.577P \\ B_x = P/2 & D_x = -P/2 \\ B_y = -0.577P & E_x = 0, E_y = -0.577P \end{cases}$$

(b)  $\theta = 30^\circ$ . All equations remain the same except (7)  $\neq$  (8):

$$-B_x - C_x + P \frac{\sqrt{3}}{2} = 0 \quad (7)$$

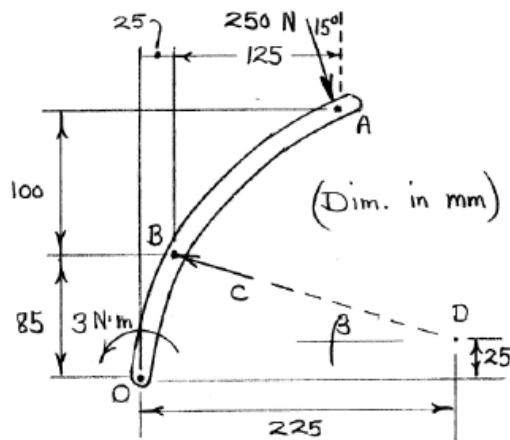
$$B_y - C_y + P/2 = 0 \quad (8)$$

Resolve:

$$\begin{cases} A_x = 0.433P & C_x = 0.433P \\ A_y = -P/2 & C_y = -P/2 \\ B_x = 0.433P & D_x = -1.299P \\ B_y = -P & E_x = 0.866P \quad E_y = -P \end{cases}$$

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$$\beta = \tan^{-1} \frac{60}{200} = 16.70^\circ$$



$$\sum M_O = 0: 3000 - 250 \cos 15^\circ (150) - 250 \sin 15^\circ (185) + C \cos \beta (85) + C \sin \beta (25) = 0$$

$$C = 510 \text{ N}$$

$$C = pA: 510 = p \left( \frac{\pi 45^2}{4} \right)$$

$$p = 0.321 \frac{\text{N}}{\text{mm}^2} \text{ or } 321\,000 \text{ Pa}$$

(gauge pressure)

4/117 | Frame as a whole:

$$\theta = \tan^{-1} \frac{5 \sin 50^\circ}{7 + 5 \cos 50^\circ} = 20.6^\circ$$

$$d = 7 \sin 20.6^\circ = 2.46 \text{ ft}$$

$$\beta + 20.6^\circ = 50^\circ, \beta = 29.4^\circ$$

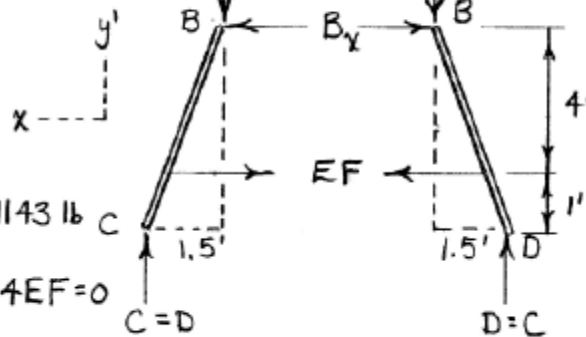
$$\sum M_x = 0: (5 \cos 50^\circ)(1200) - 2.46T = 0, T = 1569 \text{ lb}$$

$$\sum F_{(C-D)-B} = 0: R - 1200 \cos 40^\circ - 1569 \cos 29.4^\circ = 0$$

$$R = 2290 \text{ lb}$$

$$\frac{2290}{2} = 1143 \text{ lb}$$

Plane of frame:



$$\sum F_{y'} = 0: C = D = 1143 \text{ lb}$$

$$\sum M_B = 0: 1143(1.5) - 4EF = 0$$

$$EF = 429 \text{ lb}$$