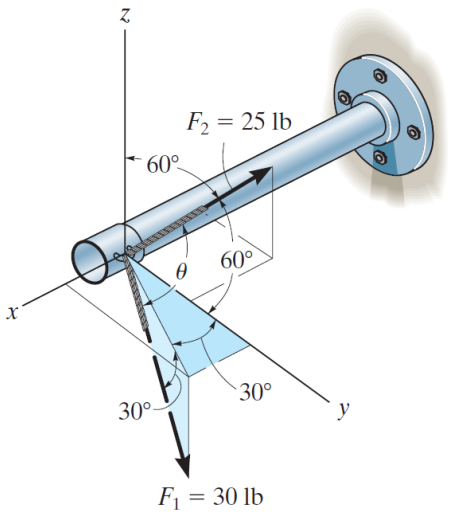
Problem 2-120

Two cables exert forces on the pipe. Determine the magnitude of the projected component of $\mathbf{F}_1$ along the line of action of $\mathbf{F}_2$.



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Solution

Begin by finding the angle α that $\mathbf{F}_2$ makes with the positive x-axis ($90° < \alpha < 180°$).

$$\cos^2\alpha + \cos^2 60° + \cos^2 60° = 1 \quad \rightarrow \quad \alpha = \{\cancel{45°}, 135°\}$$

Write each of the forces in component form.

$$\mathbf{F}_1 = 30\,\langle \cos 30° \sin 30°, \cos 30° \cos 30°, -\sin 30° \rangle \text{ lb}$$

$$\mathbf{F}_2 = 25\,\langle \cos 135°, \cos 60°, \cos 60° \rangle \text{ lb}$$

Take the dot product of $\mathbf{F}_1$ with a unit vector in the direction of $\mathbf{F}_2$ to obtain the desired projection.

$$\begin{aligned}\mathbf{F}_1 \cdot \frac{\mathbf{F}_2}{|\mathbf{F}_2|} &= 30\,\langle \cos 30° \sin 30°, \cos 30° \cos 30°, -\sin 30° \rangle \cdot \langle \cos 135°, \cos 60°, \cos 60° \rangle \text{ lb} \\ &= 30(\cos 30° \sin 30° \cos 135° + \cos 30° \cos 30° \cos 60° - \sin 30° \cos 60°) \text{ lb} \\ &\approx -5.44 \text{ lb}\end{aligned}$$

Therefore, the magnitude of the projected component of $\mathbf{F}_1$ along the line of action of $\mathbf{F}_2$ is

$$\left|\mathbf{F}_1 \cdot \frac{\mathbf{F}_2}{|\mathbf{F}_2|}\right| \approx 5.44 \text{ lb}.$$