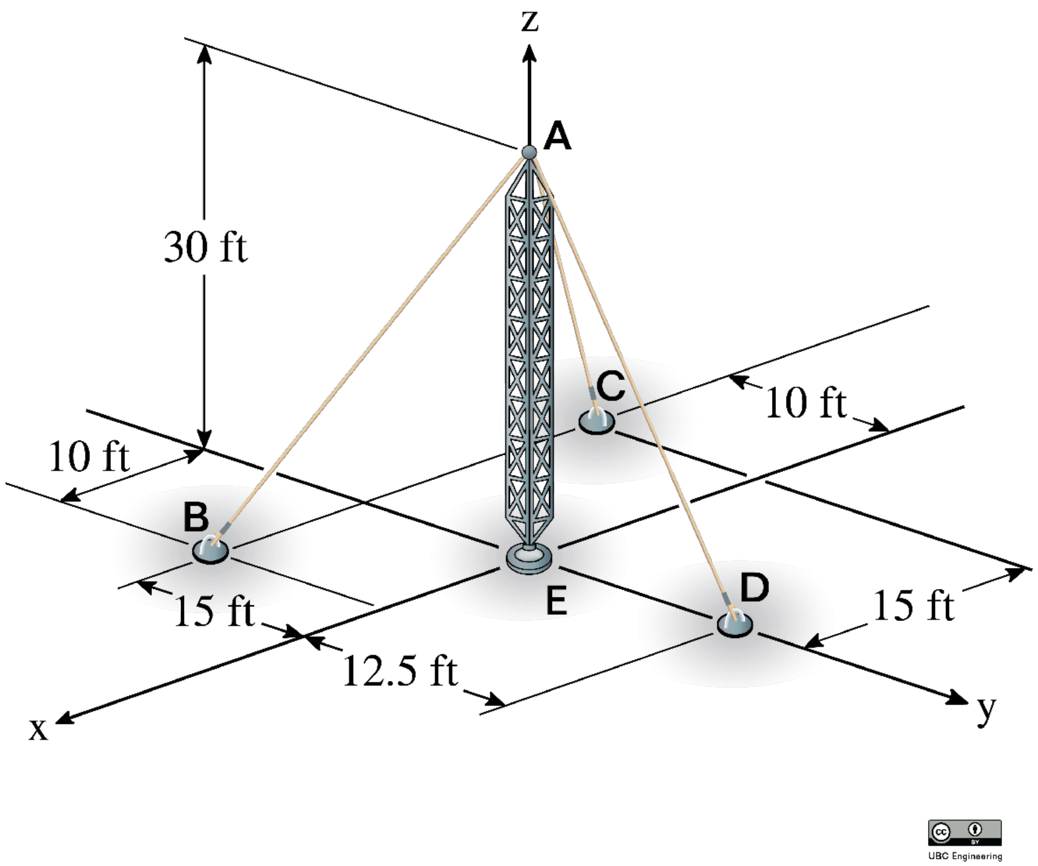
21-S-3.4-RP-01



Three ropes are attached to a tower as shown above. In order for the tower to remain upright, the ropes must exert forces such that there is static equilibrium. If the tension in the rope AD is F_{AD}, find the forces exerted by the AB and AC ropes.

Find the unit vectors in the direction of $\overrightarrow{AB}$, $\overrightarrow{AC}$, and $\overrightarrow{AD}$. Enter your answers as vectors.

$$\hat{AB} = \frac{\overrightarrow{AB}}{||\overrightarrow{AB}||} = \frac{<10, -15, -30>}{35} = \frac{1}{7} <2, -3, -6>$$

$$\hat{AC} = \frac{\overrightarrow{AC}}{||\overrightarrow{AC}||} = \frac{<-15, -10, -30>}{35} = \frac{1}{7} <-3, -2, -6>$$

$$\hat{AD} = \frac{\overrightarrow{AD}}{||\overrightarrow{AD}||} = \frac{<0, 12.5, -30>}{32.5} = \frac{1}{13} <0, 5, -12>$$

Find the cartesian force components of the rope AD. **Use - to distinguish direction**

$$\overrightarrow{F_{AD}} = F_{AD}\,\hat{AD}$$

$$F_{ADx} = 0 \text{ lbs}$$

$$F_{ADy} = \frac{5}{13}(F_{AD}) \text{ lbs}$$

$$F_{ADz} = \frac{-12}{13}(F_{AD}) \text{ lbs}$$

Find the tensions in the other ropes.

$$\Sigma F_x = 0 \rightarrow \frac{2}{7}F_{AB} - \frac{3}{7}F_{AC} = 0 \rightarrow F_{AB} = \frac{3}{2}F_{AC}$$

$$\Sigma F_y = 0 \rightarrow \frac{5}{13}F_{AD} - \frac{3}{7}F_{AB} - \frac{2}{7}F_{AC} = 0$$

$$\rightarrow \frac{35}{13}F_{AD} = (\frac{9}{2} + 2)F_{AC}$$

$$\rightarrow F_{AC} = \frac{70}{169}F_{AD}$$

$$\rightarrow F_{AB} = \frac{105}{169}F_{AD}$$