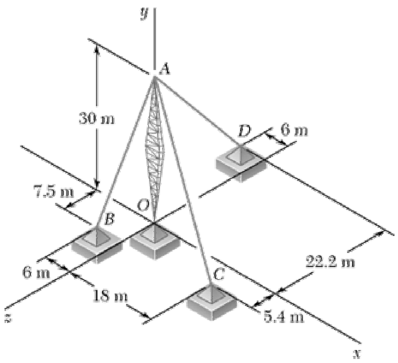
PROBLEM 2.112



A transmission tower is held by three guy wires attached to a pin at *A* and anchored by bolts at *B*, *C*, and *D*. If the tension in wire *AC* is 2.6 kN, determine the vertical force **P** exerted by the tower on the pin at *A*.

SOLUTION

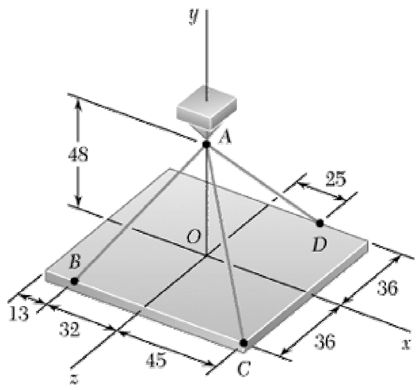
Based on the results of Problem 2.111, particularly Equations (1), (2) and (3), we substitute $T_{AC} = 2.6$ kN and solve the three resulting linear equations using conventional tools for solving Linear Algebraic Equations (MATLAB or Maple, for example), to obtain

$$T_{AB} = 4.77 \text{ kN}$$

$$T_{AD} = 2.61 \text{ kN}$$

$$\mathbf{P} = 8.81 \text{ kN} \uparrow \blacktriangleleft$$

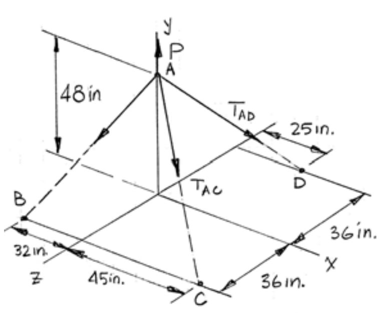
PROBLEM 2.113



Dimensions in inches

A rectangular plate is supported by three cables as shown. Knowing that the tension in cable AC is 15 lb, determine the weight of the plate.

SOLUTION



The (vector) force in each cable can be written as the product of the (scalar) force and the unit vector along the cable. That is, with

$$\overrightarrow{AB} = (32\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} + (36\text{ in.})\mathbf{k}$$

$$AB = \sqrt{(-32\text{ in.})^2 + (-48\text{ in.})^2 + (36\text{ in.})^2} = 68\text{ in.}$$

$$\mathbf{T}_{AB} = T\boldsymbol{\lambda}_{AB} = T_{AB}\frac{\overrightarrow{AB}}{AB} = \frac{T_{AB}}{68\text{ in.}}\left[-(32\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} + (36\text{ in.})\mathbf{k}\right]$$

$$\mathbf{T}_{AB} = T_{AB}(-0.4706\mathbf{i} - 0.7059\mathbf{j} + 0.5294\mathbf{k})$$

and
$$\overrightarrow{AC} = (45\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} + (36\text{ in.})\mathbf{k}$$

$$AC = \sqrt{(45\text{ in.})^2 + (-48\text{ in.})^2 + (36\text{ in.})^2} = 75\text{ in.}$$

$$\mathbf{T}_{AC} = T\boldsymbol{\lambda}_{AC} = T_{AC}\frac{\overrightarrow{AC}}{AC} = \frac{T_{AC}}{75\text{ in.}}\left[(45\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} + (36\text{ in.})\mathbf{k}\right]$$

$$\mathbf{T}_{AC} = T_{AC}(0.60\mathbf{i} - 0.64\mathbf{j} + 0.48\mathbf{k})$$

Finally,
$$\overrightarrow{AD} = (25\text{ in.})\mathbf{i} - (48\text{ in.})\mathbf{j} - (36\text{ in.})\mathbf{k}$$

$$AD = \sqrt{(25\text{ in.})^2 + (-48\text{ in.})^2 + (-36\text{ in.})^2} = 65\text{ in.}$$

PROBLEM 2.113 CONTINUED

$$\mathbf{T}_{AD} = T\boldsymbol{\lambda}_{AD} = T_{AD}\frac{\overrightarrow{AD}}{AD} = \frac{T_{AD}}{65 \text{ in.}}\left[(25 \text{ in.})\mathbf{i} - (48 \text{ in.})\mathbf{j} - (36 \text{ in.})\mathbf{k}\right]$$

$$\mathbf{T}_{AD} = T_{AD}(0.3846\mathbf{i} - 0.7385\mathbf{j} - 0.5538\mathbf{k})$$

With $\mathbf{W} = W\mathbf{j}$, at A we have:

$$\Sigma\mathbf{F} = 0: \quad \mathbf{T}_{AB} + \mathbf{T}_{AC} + \mathbf{T}_{AD} + W\mathbf{j} = 0$$

Equating the factors of **i**, **j**, and **k** to zero, we obtain the linear algebraic equations:

$$\mathbf{i}: \quad -0.4706T_{AB} + 0.60T_{AC} - 0.3846T_{AD} = 0 \qquad (1)$$

$$\mathbf{j}: \quad -0.7059T_{AB} - 0.64T_{AC} - 0.7385T_{AD} + W = 0 \qquad (2)$$

$$\mathbf{k}: \quad 0.5294T_{AB} + 0.48T_{AC} - 0.5538T_{AD} = 0 \qquad (3)$$

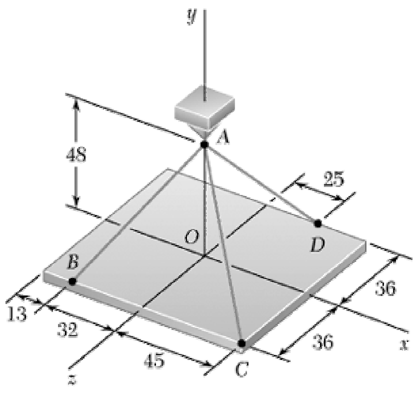
In Equations (1), (2) and (3), set $T_{AC} = 15$ lb, and, using conventional methods for solving Linear Algebraic Equations (MATLAB or Maple, for example), we obtain:

$$T_{AB} = 136.0 \text{ lb}$$

$$T_{AD} = 143.0 \text{ lb}$$

$$W = 211 \text{ lb} \blacktriangleleft$$

PROBLEM 2.114



A rectangular plate is supported by three cables as shown. Knowing that the tension in cable *AD* is 120 lb, determine the weight of the plate.

SOLUTION

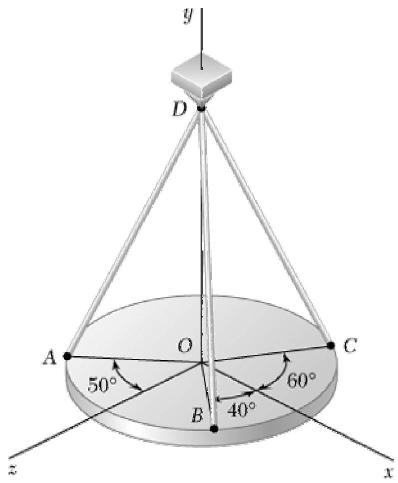
Based on the results of Problem 2.111, particularly Equations (1), (2) and (3), we substitute $T_{AD} = 120$ lb and solve the three resulting linear equations using conventional tools for solving Linear Algebraic Equations (MATLAB or Maple, for example), to obtain

$$T_{AC} = 12.59 \text{ lb}$$

$$T_{AB} = 114.1 \text{ lb}$$

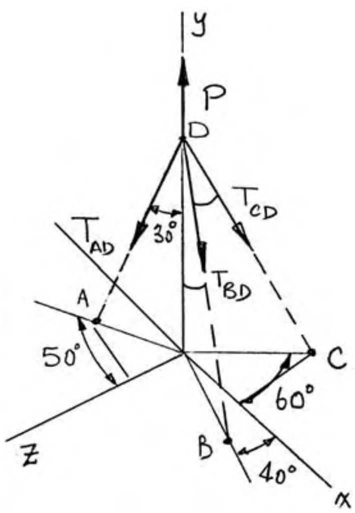
$W = 177.2$ lb ◀

PROBLEM 2.115



A horizontal circular plate having a mass of 28 kg is suspended as shown from three wires which are attached to a support D and form 30° angles with the vertical. Determine the tension in each wire.

SOLUTION



$$\Sigma F_x = 0: \quad -T_{AD}\sin 30°\sin 50° + T_{BD}\sin 30°\cos 40°$$

$$+ T_{CD}\sin 30°\cos 60° = 0$$

Dividing through by the factor $\sin 30°$ and evaluating the trigonometric functions gives

$$-0.7660T_{AD} + 0.7660T_{BD} + 0.50T_{CD} = 0 \qquad (1)$$

Similarly,

$$\Sigma F_z = 0: \quad T_{AD}\sin 30°\cos 50° + T_{BD}\sin 30°\sin 40°$$

$$- T_{CD}\sin 30°\sin 60° = 0$$

or $$0.6428T_{AD} + 0.6428T_{BD} - 0.8660T_{CD} = 0 \qquad (2)$$

From (1) $$T_{AD} = T_{BD} + 0.6527T_{CD}$$

Substituting this into (2):

$$T_{BD} = 0.3573T_{CD} \qquad (3)$$

Using T_{AD} from above:

$$T_{AD} = T_{CD} \qquad (4)$$

Now,

$$+\uparrow \Sigma F_y = 0: \quad -T_{AD}\cos 30° - T_{BD}\cos 30° - T_{CD}\cos 30°$$

$$+ (28\text{ kg})\left(9.81\text{ m/s}^2\right) = 0$$

or $$T_{AD} + T_{BD} + T_{CD} = 317.2\text{ N}$$

PROBLEM 2.115 CONTINUED

Using (3) and (4), above:

$$T_{CD} + 0.3573T_{CD} + T_{CD} = 317.2 \text{ N}$$

Then: $T_{AD} = 135.1 \text{ N}$ ◀

$T_{BD} = 46.9 \text{ N}$ ◀

$T_{CD} = 135.1 \text{ N}$ ◀