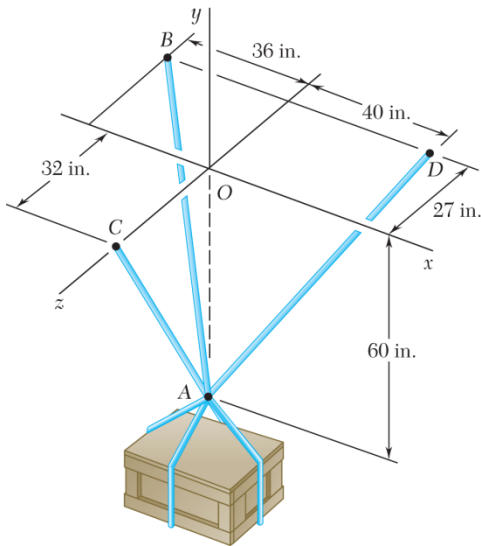


PROBLEM 2.106

A 1600-lb crate is supported by three cables as shown. Determine the tension in each cable.



SOLUTION

The forces applied at A are:

$$\mathbf{T}_{AB}, \mathbf{T}_{AC}, \mathbf{T}_{AD} \text{ and } \mathbf{W}$$

where $\mathbf{P} = P\mathbf{j}$. To express the other forces in terms of the unit vectors $\mathbf{i}, \mathbf{j}, \mathbf{k}$, we write

$$\overline{AB} = -(36 \text{ in.})\mathbf{i} + (60 \text{ in.})\mathbf{j} - (27 \text{ in.})\mathbf{k}$$

$$AB = 75 \text{ in.}$$

$$\overline{AC} = (60 \text{ in.})\mathbf{j} + (32 \text{ in.})\mathbf{k}$$

$$AC = 68 \text{ in.}$$

$$\overline{AD} = (40 \text{ in.})\mathbf{i} + (60 \text{ in.})\mathbf{j} - (27 \text{ in.})\mathbf{k}$$

$$AD = 77 \text{ in.}$$

and

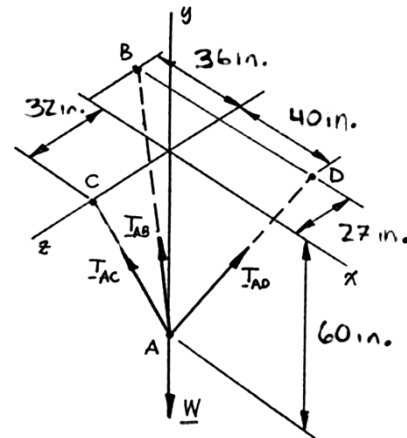
$$\begin{aligned} \mathbf{T}_{AB} &= T_{AB} \lambda_{AB} = T_{AB} \frac{\overline{AB}}{AB} \\ &= (-0.48\mathbf{i} + 0.8\mathbf{j} - 0.36\mathbf{k})T_{AB} \end{aligned}$$

$$\begin{aligned} \mathbf{T}_{AC} &= T_{AC} \lambda_{AC} = T_{AC} \frac{\overline{AC}}{AC} \\ &= (0.88235\mathbf{j} + 0.47059\mathbf{k})T_{AC} \end{aligned}$$

$$\begin{aligned} \mathbf{T}_{AD} &= T_{AD} \lambda_{AD} = T_{AD} \frac{\overline{AD}}{AD} \\ &= (0.51948\mathbf{i} + 0.77922\mathbf{j} - 0.35065\mathbf{k})T_{AD} \end{aligned}$$

Equilibrium Condition with $\mathbf{W} = -W\mathbf{j}$

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



PROBLEM 2.106 (Continued)

Substituting the expressions obtained for \mathbf{T}_{AB} , \mathbf{T}_{AC} , and \mathbf{T}_{AD} and factoring \mathbf{i} , \mathbf{j} , and \mathbf{k} :

$$\begin{aligned} &(-0.48T_{AB} + 0.51948T_{AD})\mathbf{i} + (0.8T_{AB} + 0.88235T_{AC} + 0.77922T_{AD} - W)\mathbf{j} \\ &+ (-0.36T_{AB} + 0.47059T_{AC} - 0.35065T_{AD})\mathbf{k} = 0 \end{aligned}$$

Equating to zero the coefficients of \mathbf{i} , \mathbf{j} , \mathbf{k} :

$$-0.48T_{AB} + 0.51948T_{AD} = 0 \quad (1)$$

$$0.8T_{AB} + 0.88235T_{AC} + 0.77922T_{AD} - W = 0 \quad (2)$$

$$-0.36T_{AB} + 0.47059T_{AC} - 0.35065T_{AD} = 0 \quad (3)$$

Substituting $W = 1600$ lb in Equations (1), (2), and (3) above, and solving the resulting set of equations using conventional algorithms gives,

$$T_{AB} = 571 \text{ lb} \quad \blacktriangleleft$$

$$T_{AC} = 830 \text{ lb} \quad \blacktriangleleft$$

$$T_{AD} = 528 \text{ lb} \quad \blacktriangleleft$$