

[2.15절]

2.109 [ 공간에서 질점의 평형 ]

$$T_{AC} = 60 \text{ N}, \quad \mathbf{P} = -P \mathbf{j}, \quad \mathbf{W} = W \mathbf{j}$$

$$\mathbf{P} + \mathbf{W} = 0 \Rightarrow -P \mathbf{j} + W \mathbf{j} = 0 \Rightarrow W = P$$

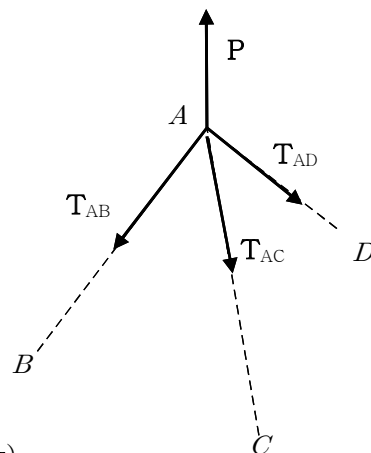
$$d_{AB} = \sqrt{(-320 \text{ mm})^2 + (-480 \text{ mm})^2 + (360 \text{ mm})^2}$$

$$= 680 \text{ mm}$$

$$\lambda_{AB} = \frac{1}{680}(-320 \mathbf{i} - 480 \mathbf{j} + 360 \mathbf{k})$$

$$= -0.4706 \mathbf{i} - 0.7059 \mathbf{j} + 0.5294 \mathbf{k}$$

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



$$d_{AC} = \sqrt{(450 \text{ mm})^2 + (-480 \text{ mm})^2 + (360 \text{ mm})^2} = 750 \text{ mm}$$

$$\lambda_{AC} = \frac{1}{750}(450 \mathbf{i} - 480 \mathbf{j} + 360 \mathbf{k}) = 0.6000 \mathbf{i} - 0.6400 \mathbf{j} + 0.4800 \mathbf{k}$$

$$\mathbf{T}_{AC} = T_{AC} \lambda_{AC} = (60 \text{ N})(0.600 \mathbf{i} - 0.6400 \mathbf{j} + 0.4800 \mathbf{k})$$

$$= (36.0 \text{ N}) \mathbf{i} - (38.4 \text{ N}) \mathbf{j} + (28.8 \text{ N}) \mathbf{k}$$

$$d_{AD} = \sqrt{(250 \text{ mm})^2 + (-480 \text{ mm})^2 + (-360 \text{ mm})^2} = 650 \text{ mm}$$

$$\lambda_{AD} = \frac{1}{650}(250 \mathbf{i} - 480 \mathbf{j} - 360 \mathbf{k}) = 0.3846 \mathbf{i} - 0.7384 \mathbf{j} - 0.5538 \mathbf{k}$$

$$\mathbf{T}_{AD} = T_{AD} \lambda_{AD} = T_{AD} (0.3846 \mathbf{i} - 0.7384 \mathbf{j} - 0.5538 \mathbf{k})$$

$$\Sigma \mathbf{F} = 0 \Rightarrow \mathbf{T}_{AB} + \mathbf{T}_{AC} + \mathbf{T}_{AD} + \mathbf{P} = 0$$

$$\Sigma F_x = 0 ; -0.4706 T_{AB} + (36.0 \text{ N}) + 0.3846 T_{AD} = 0 \quad \dots \textcircled{1}$$

$$\Sigma F_y = 0 ; -0.7059 T_{AB} - (38.4 \text{ N}) - 0.7384 T_{AD} + P = 0 \quad \dots \textcircled{2}$$

$$\Sigma F_z = 0 ; 0.5294 T_{AB} + (28.8 \text{ N}) - 0.5538 T_{AD} = 0 \quad \dots \textcircled{3}$$

$$\textcircled{1} \times 0.5538 + \textcircled{3} \times 0.3846$$

$$[(-0.4706)(0.5538) + (0.5294)(0.3846)] T_{AB} + [(36.0 \text{ N})(0.5538) + (28.8 \text{ N})(0.3846)] = 0$$

$$\Rightarrow T_{AB} = 544.0 \text{ N}$$

$$\textcircled{1} \Rightarrow T_{AD} = \frac{1}{0.3846} [(0.4706)(544.0 \text{ N}) - (36.0 \text{ N})] = 572.0 \text{ N}$$

$$\textcircled{2} \Rightarrow P = (0.7059)(544.0 \text{ N}) + (38.4 \text{ N}) + (0.7384)(572.0 \text{ N}) = 844.4 \text{ N}$$

$$\Rightarrow P = 844 \text{ N}$$

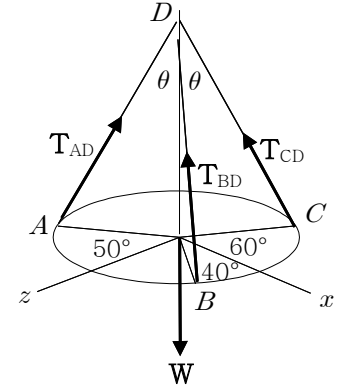
2.120 [ 공간에서 질점의 평형 ]

$$W = 60 \text{ N}, \quad \theta = 30^\circ$$

$$\begin{aligned} (T_{AD})_y &= T_{AD} \cos\theta, & (T_{AD})_h &= T_{AD} \sin\theta \\ (T_{AD})_x &= (T_{AD})_h \sin 50^\circ = T_{AD} \sin\theta \sin 50^\circ \\ (T_{AD})_z &= -(T_{AD})_h \cos 50^\circ = -T_{AD} \sin\theta \cos 50^\circ \end{aligned}$$

$$\begin{aligned} (T_{BD})_y &= T_{BD} \cos\theta, & (T_{BD})_h &= T_{BD} \sin\theta \\ (T_{BD})_x &= -(T_{BD})_h \cos 40^\circ = -T_{BD} \sin\theta \cos 40^\circ \\ (T_{BD})_z &= -(T_{BD})_h \sin 40^\circ = -T_{BD} \sin\theta \sin 40^\circ \end{aligned}$$

$$\begin{aligned} (T_{CD})_y &= T_{CD} \cos\theta, & (T_{CD})_h &= T_{CD} \sin\theta \\ (T_{CD})_x &= -(T_{CD})_h \cos 60^\circ = -T_{CD} \sin\theta \cos 60^\circ \\ (T_{CD})_z &= (T_{CD})_h \sin 60^\circ = T_{CD} \sin\theta \sin 60^\circ \end{aligned}$$



$$\begin{aligned} \Sigma F_x = 0 ; & (T_{AD})_x + (T_{BD})_x + (T_{CD})_x = 0 \\ \Rightarrow & T_{AD} \sin\theta \sin 50^\circ - T_{BD} \sin\theta \cos 40^\circ - T_{CD} \sin\theta \cos 60^\circ = 0 \\ \Rightarrow & T_{AD} \sin 50^\circ - T_{BD} \cos 40^\circ - T_{CD} \cos 60^\circ = 0 \\ \Rightarrow & 0.7660 T_{AD} - 0.7660 T_{BD} - 0.5 T_{CD} = 0 \quad \dots \textcircled{1} \end{aligned}$$

$$\begin{aligned} \Sigma F_y = 0 ; & (T_{AD})_y + (T_{BD})_y + (T_{CD})_y = 0 \\ \Rightarrow & T_{AD} \cos\theta + T_{BD} \cos\theta + T_{CD} \cos\theta - W = 0 \\ \Rightarrow & T_{AD} + T_{BD} + T_{CD} = \frac{W}{\cos\theta} = \frac{60 \text{ N}}{\cos 30^\circ} = 69.28 \quad \dots \textcircled{2} \end{aligned}$$

$$\begin{aligned} \Sigma F_z = 0 ; & (T_{AD})_z + (T_{BD})_z + (T_{CD})_z = 0 \\ \Rightarrow & -T_{AD} \sin\theta \cos 50^\circ - T_{BD} \sin\theta \sin 40^\circ + T_{CD} \sin\theta \sin 60^\circ = 0 \\ \Rightarrow & -T_{AD} \cos 50^\circ - T_{BD} \sin 40^\circ + T_{CD} \sin 60^\circ = 0 \\ \Rightarrow & -0.6428 T_{AD} - 0.6428 T_{BD} + 0.8660 T_{CD} = 0 \quad \dots \textcircled{3} \end{aligned}$$

$$D = \begin{vmatrix} 0.7660 & -0.7660 & -0.5 \\ 1 & 1 & 1 \\ -0.6428 & -0.6428 & 0.8660 \end{vmatrix} = 2.3115$$

$$T_{AD} = \frac{1}{D} \begin{vmatrix} 0 & -0.7660 & -0.5 \\ 69.28 & 1 & 1 \\ 0 & -0.6428 & 0.8660 \end{vmatrix} = \frac{68.2245}{2.3115} = 29.5153$$

$$T_{BD} = \frac{1}{D} \begin{vmatrix} 0.7660 & 0 & -0.5 \\ 1 & 69.28 & 1 \\ -0.6428 & 0 & 0.8660 \end{vmatrix} = \frac{23.6909}{2.3115} = 10.2491$$

$$T_{CD} = \frac{1}{D} \begin{vmatrix} 0.7660 & -0.7660 & 0 \\ 1 & 1 & 69.28 \\ -0.6428 & -0.6428 & 0 \end{vmatrix} = \frac{68.2255}{2.3115} = 29.5157$$

$$\Rightarrow T_{AD} = 29.5 \text{ N}, \quad T_{BD} = 10.25 \text{ N}, \quad T_{CD} = 29.5 \text{ N}$$