

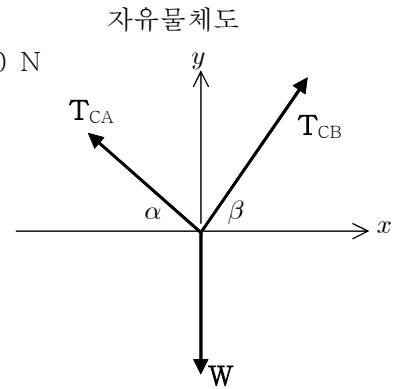
[2.9~11절]

2.43 [ 질점의 평형 문제 ]

$$W = (1600 \text{ kg})(9.806 \text{ m/s}^2) = 15,689.6 \text{ kg}\cdot\text{m/s}^2 = 15,690 \text{ N}$$

$$\alpha = \tan^{-1} \frac{960}{1100} = \tan^{-1}(0.8727) = 41.11^\circ$$

$$\beta = \tan^{-1} \frac{960}{400} = \tan^{-1}(2.40) = 67.38^\circ$$



<방법 1 : 직각 성분>

$$\Sigma F_x = -T_{CA} \cos\alpha + T_{CB} \cos\beta = 0 \quad \dots \textcircled{1}$$

$$\Sigma F_y = T_{CA} \sin\alpha + T_{CB} \sin\beta - W = 0 \quad \dots \textcircled{2}$$

(a)  $\textcircled{1} \times \sin\beta - \textcircled{2} \times \cos\beta$

$$(-\cos\alpha \sin\beta - \sin\alpha \cos\beta) T_{CA} + W \cos\beta = 0$$

$$\Rightarrow T_{CA} = W \frac{\cos\beta}{\sin(\alpha+\beta)} = (15,690 \text{ N}) \frac{\cos 67.38^\circ}{\sin(41.11^\circ + 67.38^\circ)} = 6,363 \text{ N}$$

$$\Rightarrow T_{CA} = 6,360 \text{ N} = 6.36 \text{ kN}$$

(b)  $\textcircled{1} \times \sin\alpha + \textcircled{2} \times \cos\alpha$

$$(\cos\beta \sin\alpha + \sin\beta \cos\alpha) T_{CB} - W \cos\alpha$$

$$\Rightarrow T_{CB} = W \frac{\cos\alpha}{\sin(\alpha+\beta)} = (15,690 \text{ N}) \frac{\cos 41.11^\circ}{\sin(41.11^\circ + 67.38^\circ)} = 12,465 \text{ N}$$

또는

$$\textcircled{1} \Rightarrow T_{CB} = T_{CA} \frac{\cos\alpha}{\cos\beta} = (6,363 \text{ N}) \frac{\cos 41.11^\circ}{\cos 67.38^\circ} = 12,465 \text{ N}$$

$$\Rightarrow T_{CB} = 12,470 \text{ N} = 12.47 \text{ kN}$$

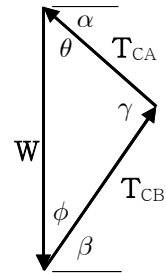
<방법 2 : 힘 삼각형>

$$\gamma = \alpha + \beta = 41.11^\circ + 67.38^\circ = 108.49^\circ$$

$$\theta = 90^\circ - \alpha = 90^\circ - 41.11^\circ = 48.89^\circ$$

$$\phi = 90^\circ - \beta = 90^\circ - 67.38^\circ = 22.62^\circ$$

$$\text{sine 공식 } \frac{T_{CA}}{\sin\phi} = \frac{T_{CB}}{\sin\theta} = \frac{W}{\sin\gamma}$$



$$(a) T_{CA} = W \frac{\sin\phi}{\sin\gamma} = (15,690 \text{ N}) \frac{\sin 22.62^\circ}{\sin 108.49^\circ} = 6,363 \text{ N}$$

$$\Rightarrow T_{CA} = 6,360 \text{ N} = 6.36 \text{ kN}$$

$$(b) T_{CB} = W \frac{\sin\theta}{\sin\gamma} = (15,690 \text{ N}) \frac{\sin 48.89^\circ}{\sin 108.49^\circ} = 12,465 \text{ N}$$

$$\Rightarrow T_{CB} = 12,470 \text{ N} = 12.47 \text{ kN}$$

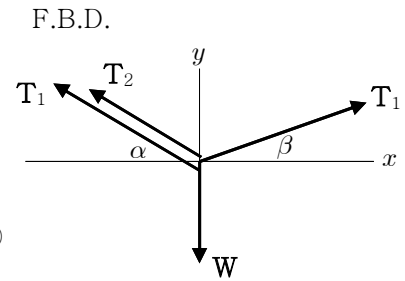
2.53 [ 질점의 평형 문제 ]

$$W = 900\text{N}, \quad \alpha = 30^\circ, \quad \beta = 10^\circ$$

<방법 1 : 직각 성분>

$$\begin{aligned} \Sigma F_x = 0 ; T_1 \cos\beta - (T_1 + T_2) \cos\alpha &= 0 \\ \Rightarrow T_1 (\cos\beta - \cos\alpha) - T_2 \cos\alpha &= 0 \quad \cdots \textcircled{1} \end{aligned}$$

$$\begin{aligned} \Sigma F_y = 0 ; T_1 \sin\beta + (T_1 + T_2) \sin\alpha - W &= 0 \\ \Rightarrow T_1 (\sin\beta + \sin\alpha) + T_2 \sin\alpha &= W \quad \cdots \textcircled{2} \end{aligned}$$



(a) ①×sinα + ②×cosα

$$T_1 (\cos\beta - \cos\alpha) \sin\alpha + T_1 (\sin\beta + \sin\alpha) \cos\alpha = W \cos\alpha$$

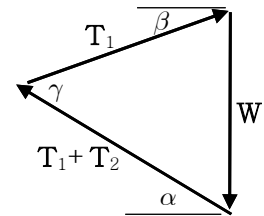
$$\begin{aligned} \Rightarrow T_1 &= W \frac{\cos\alpha}{\sin\alpha \cos\beta + \cos\alpha \sin\beta} = W \frac{\cos\alpha}{\sin(\alpha + \beta)} \\ &= (900 \text{ N}) \frac{\cos 30^\circ}{\sin(30^\circ + 10^\circ)} = 1212.6 \text{ N} \quad \Rightarrow \quad T_1 = 1213 \text{ N} \end{aligned}$$

$$\begin{aligned} \text{(b) } \textcircled{1} \Rightarrow T_2 &= T_1 \frac{\cos\beta - \cos\alpha}{\cos\alpha} = (1212.6 \text{ N}) \frac{\cos 10^\circ - \cos 30^\circ}{\cos 30^\circ} = 166.32 \text{ N} \\ &\Rightarrow T_2 = 166.3 \text{ N} \end{aligned}$$

<방법 2 : 힘 삼각형>

$$\gamma = \alpha + \beta = 30^\circ + 10^\circ = 40^\circ$$

$$\begin{aligned} \text{(a) } \frac{T_1}{\sin(90^\circ - \alpha)} &= \frac{W}{\sin\gamma} \\ \Rightarrow T_1 &= W \frac{\sin(90^\circ - \alpha)}{\sin\gamma} = (900 \text{ N}) \frac{\sin(90^\circ - 30^\circ)}{\sin 40^\circ} \\ &= 1212.6 \text{ N} \quad \Rightarrow \quad T_1 = 1213 \text{ N} \end{aligned}$$



$$\begin{aligned} \text{(b) } \frac{T_1 + T_2}{\sin(90^\circ - \beta)} &= \frac{W}{\sin\gamma} \\ \Rightarrow T_1 + T_2 &= W \frac{\sin(90^\circ - \beta)}{\sin\gamma} = (900 \text{ N}) \frac{\sin(90^\circ - 10^\circ)}{\sin 40^\circ} = 1378.9 \text{ N} \\ \Rightarrow T_2 &= 1378.9 \text{ N} - T_1 = 1378.9 \text{ N} - 1212.6 \text{ N} = 166.3 \text{ N} \end{aligned}$$

2.67 [ 도르래, 질점의 평형 문제 ]

$$W = 6 \text{ kN}$$

$$(a) \Sigma F_y = 0 ; 2T - W = 0$$

$$\Rightarrow T = \frac{1}{2} W = \frac{1}{2}(6 \text{ kN}) = 3 \text{ kN}$$

$$(b) \Sigma F_y = 0 ; 2T - W = 0$$

$$\Rightarrow T = \frac{1}{2} W = \frac{1}{2}(6 \text{ kN}) = 3 \text{ kN}$$

$$(c) \Sigma F_y = 0 ; 3T - W = 0$$

$$\Rightarrow T = \frac{1}{3} W = \frac{1}{3}(6 \text{ kN}) = 2 \text{ kN}$$

$$(d) \Sigma F_y = 0 ; 3T - W = 0$$

$$\Rightarrow T = \frac{1}{3} W = \frac{1}{3}(6 \text{ kN}) = 2 \text{ kN}$$

$$(e) \text{ pulley 1 } \Sigma F_y = 0 ; 2T - P = 0$$

$$\Rightarrow P = 2T$$

$$\text{ pulley 2 } \Sigma F_y = 0 ; 2T + P - W = 0$$

$$\Rightarrow T = \frac{1}{4} W = \frac{1}{4}(6 \text{ kN}) = 1.5 \text{ kN}$$

F.B.D.

