[2.5절]

2.120 $W = 300$ N, $\alpha = 30°$, $\theta_A = 50°$, $\theta_B = 40°$, $\theta_C = 60°$

  S; known W, α, θ_A, θ_B, θ_C

  unknown T_{DA}, T_{DB}, T_{DC}

  ⇒ 공간에서 힘의 직각성분 (각도 이용)

M; FBD1

  A; FBD1에서 $\Sigma F_y = 0$, $P - W = 0$

$\Rightarrow P = W = 300$ N

  FBD2에서

FBD2

$(T_{DA})_y = -T_{DA} \cos\alpha$, $(T_{DA})_h = T_{DA} \sin\alpha$

$(T_{DA})_x = -(T_{DA})_h \sin\theta_A = -T_{DA} \sin\alpha \sin\theta_A$

$(T_{DA})_z = (T_{DA})_h \cos\theta_A = T_{DA} \sin\alpha \cos\theta_A$

$(T_{DB})_y = -T_{DB} \cos\alpha$, $(T_{DB})_h = T_{DB} \sin\alpha$

$(T_{DB})_x = (T_{DB})_h \cos\theta_B = T_{DB} \sin\alpha \cos\theta_B$

$(T_{DB})_z = (T_{DB})_h \sin\theta_B = T_{DB} \sin\alpha \sin\theta_B$

$(T_{DC})_y = -T_{DC} \cos\alpha$, $(T_{DC})_h = T_{DC} \sin\alpha$

$(T_{DC})_x = (T_{DC})_h \cos\theta_C = T_{DC} \sin\alpha \cos\theta_C$

$(T_{DC})_z = -(T_{DC})_h \sin\theta_C = -T_{DC} \sin\alpha \sin\theta_C$

$\Sigma \mathbf{F} = 0 \Rightarrow \mathbf{P} + \mathbf{T}_{DA} + \mathbf{T}_{DB} + \mathbf{T}_{DC} = 0$

$\Sigma F_x = 0$, $(T_{DA})_x + (T_{DB})_x + (T_{DC})_x = 0$

$-T_{DA} \sin\alpha \sin\theta_A + T_{DB} \sin\alpha \cos\theta_B + T_{DC} \sin\alpha \cos\theta_C = 0$

$-T_{DA} \sin\theta_A + T_{DB} \cos\theta_B + T_{DC} \cos\theta_C = 0$

$-T_{DA} \sin 50° + T_{DB} \cos 40° + T_{DC} \cos 60° = 0$

$\Rightarrow -0.7660\, T_{DA} + 0.7660\, T_{DB} + 0.5\, T_{DC} = 0$ ⋯ ①

$\Sigma F_y = 0$, $P + (T_{DA})_y + (T_{DB})_y + (T_{DC})_y = 0$

$T_{DA} \cos\alpha + T_{DB} \cos\alpha + T_{DC} \cos\alpha = P$

$T_{DA} + T_{DB} + T_{DC} = \dfrac{P}{\cos\alpha} = \dfrac{300 \text{ N}}{\cos 30°}$

$\Rightarrow T_{DA} + T_{DB} + T_{DC} = 346.4$ N   ⋯ ②

$\Sigma F_z = 0$, $(T_{DA})_z + (T_{DB})_z + (T_{DC})_z = 0$

$T_{DA} \sin\alpha \cos\theta_A + T_{DB} \sin\alpha \sin\theta_B - T_{DC} \sin\alpha \sin\theta_C = 0$

$T_{DA} \cos\theta_A + T_{DB} \sin\theta_B - T_{DC} \sin\theta_C = 0$

$T_{DA} \cos 50° + T_{DB} \sin 40° - T_{DC} \sin 60° = 0$

$\Rightarrow 0.6428\, T_{DA} + 0.6428\, T_{DB} - 0.8660\, T_{DC} = 0$ ⋯ ③

연립방정식 ①, ②, ③의 해 ⇒ $T_{DA} = 147.6$N, $T_{DB} = 51.3$ N, $T_{DC} = 147.6$ N

  R; (과정의 타당성 서술)   (가령, 방향여현 표현)

  T; (결과의 의미 서술)   (가령, $T_{DA} + T_{DB} + T_{DC} > W$ 인 이유)