

[3.9~3.11절]

3.42 [스칼라곱을 응용한 각도 산출, 투영, 좌표로부터 벡터 표현]

$$x_E = \frac{32 \text{ m}}{2} = 16 \text{ m}, \quad y_E = \frac{16.5 \text{ m} + 7.5 \text{ m}}{2} = 12 \text{ m}, \quad z_E = \frac{-24 \text{ m}}{2} = -12 \text{ m}$$

$$T_{EG} = 178 \text{ N}$$

$$(a) \quad \mathbf{r}_{C/B} = 32 \mathbf{i} + (7.5-16.5) \mathbf{j} - 24 \mathbf{k} \text{ (m)}$$

$$= 32 \mathbf{i} - 9 \mathbf{j} - 24 \mathbf{k} \text{ (m)}$$

$$r_{C/B} = \sqrt{(32)^2 + (-9)^2 + (-24)^2} \text{ m} = 41 \text{ m}$$

$$\mathbf{r}_{G/E} = (32-16) \mathbf{i} + (-12) \mathbf{j} + [-2.25-(-12)] \mathbf{k} \text{ (m)}$$

$$= 16 \mathbf{i} - 12 \mathbf{j} + 9.75 \mathbf{k} \text{ (m)}$$

$$r_{G/E} = \sqrt{(16)^2 + (-12)^2 + (9.75)^2} \text{ m} = 22.25 \text{ m}$$

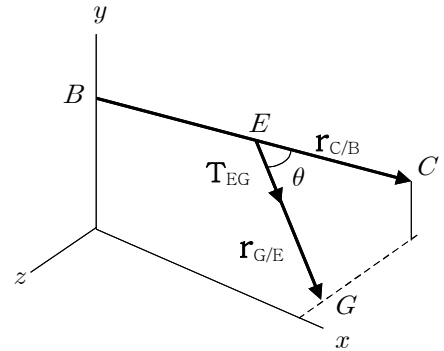
$$\mathbf{r}_{C/B} \cdot \mathbf{r}_{G/E} = (32 \mathbf{i} - 9 \mathbf{j} - 24 \mathbf{k}) \cdot (16 \mathbf{i} - 12 \mathbf{j} + 9.75 \mathbf{k}) \text{ (m}^2)$$

$$= (32)(16) + (-9)(-12) + (-24)(9.75) \text{ (m}^2) = 386 \text{ (m}^2)$$

$$\cos \theta = \frac{\mathbf{r}_{C/B} \cdot \mathbf{r}_{G/E}}{r_{C/B} r_{G/E}} = \frac{386 \text{ m}^2}{(41 \text{ m})(22.25 \text{ m})} = 0.4231$$

$$\Rightarrow \theta = \cos^{-1}(0.423) = 65.0^\circ$$

$$(b) \quad (T_{EG})_{BC} = T_{EG} \cos \theta = (178 \text{ N})(0.4231) = 75.3 \text{ N}$$



3.47 [좌표축에 관한 모멘트]

$$T = 570 \text{ N}$$

$$\mathbf{r}_{OB} = 0.9 \mathbf{i} \text{ (m)}$$

$$(d_{BA})_x = -0.9 \text{ m}, \quad (d_{BA})_y = 0.6 \text{ m}, \quad (d_{BA})_z = 0.36 \text{ m}$$

$$d_{BA} = \sqrt{(-0.9 \text{ m})^2 + (0.6 \text{ m})^2 + (0.36 \text{ m})^2} = 1.14 \text{ m}$$

$$\lambda_{BA} = \frac{1}{1.14} (-0.9 \mathbf{i} + 0.6 \mathbf{j} + 0.36 \mathbf{k})$$

$$\mathbf{F}_{BA} = T \lambda_{BA}$$

$$= (570 \text{ N}) \frac{1}{1.14} (-0.9 \mathbf{i} + 0.6 \mathbf{j} + 0.36 \mathbf{k})$$

$$= -450 \mathbf{i} + 300 \mathbf{j} + 180 \mathbf{k} \text{ (N)}$$

$$\mathbf{M}_O = \mathbf{r}_{OB} \times \mathbf{F}_{BD}$$

$$= [0.9 \mathbf{i} \text{ (m)}] \times [-450 \mathbf{i} + 300 \mathbf{j} + 180 \mathbf{k} \text{ (N)}]$$

$$= [0] \mathbf{i} + [-(0.9)(180)] \mathbf{j} + [(0.9)(300)] \mathbf{k} \text{ (N}\cdot\text{m)}$$

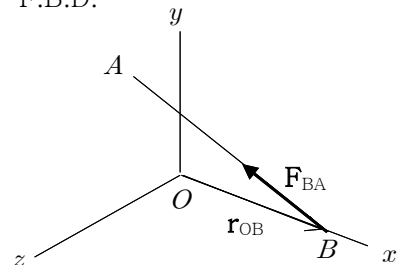
$$= (0) \mathbf{i} + (-162) \mathbf{j} + (270) \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$\Rightarrow M_x = \mathbf{M}_O \cdot \mathbf{i} = [(0) \mathbf{i} + (-162) \mathbf{j} + (270) \mathbf{k} \text{ (N}\cdot\text{m)}] \cdot \mathbf{i} = 0$$

$$M_y = \mathbf{M}_O \cdot \mathbf{j} = [(0) \mathbf{i} + (-162) \mathbf{j} + (270) \mathbf{k} \text{ (N}\cdot\text{m)}] \cdot \mathbf{j} = -162.0 \text{ N}\cdot\text{m}$$

$$M_z = \mathbf{M}_O \cdot \mathbf{k} = [(0) \mathbf{i} + (-162) \mathbf{j} + (270) \mathbf{k} \text{ (N}\cdot\text{m)}] \cdot \mathbf{k} = 270 \text{ N}\cdot\text{m}$$

F.B.D.



3.53 [점에 관한 모멘트 응용]

F.B.D.

$$M_x = 20 \text{ N}\cdot\text{m}, \quad M_y = -8.75 \text{ N}\cdot\text{m}, \quad M_z = -30 \text{ N}\cdot\text{m}$$

$$\mathbf{r}_{OC} = (0.15+0.10 \text{ m})\mathbf{i} + (0.20 \text{ m}) \sin\theta \mathbf{j} + (0.20 \text{ m}) \cos\theta \mathbf{k}$$

$$\mathbf{P} = -P \sin\phi \mathbf{j} + P \cos\phi \mathbf{k}$$

$$\begin{aligned} \mathbf{M}_O &= \mathbf{r}_{OC} \times \mathbf{P} = [0.25 \mathbf{i} + 0.20 \sin\theta \mathbf{j} + 0.20 \cos\theta \mathbf{k} \text{ (m)}] \times [-P \sin\phi \mathbf{j} + P \cos\phi \mathbf{k}] \\ &= [(0.20 \text{ m}) \sin\theta (P \cos\phi) - (0.20 \text{ m}) \cos\theta (-P \sin\phi)]\mathbf{i} \\ &\quad + [-(0.25 \text{ m})(P \cos\phi)]\mathbf{j} + [(0.25 \text{ m})(-P \sin\phi)]\mathbf{k} \\ &= [(0.20 \text{ m}) P (\sin\theta \cos\phi + \cos\theta \sin\phi)] \mathbf{i} \\ &\quad + [-(0.25 \text{ m})(P \cos\phi)] \mathbf{j} + [-(0.25 \text{ m})(P \sin\phi)]\mathbf{k} \end{aligned}$$

$$M_x = (0.20 \text{ m}) P \sin(\theta + \phi) = 20 \text{ N}\cdot\text{m} \quad \dots \textcircled{1}$$

$$M_y = -(0.25 \text{ m}) P \cos\phi = -8.75 \text{ N}\cdot\text{m} \quad \dots \textcircled{2}$$

$$M_z = -(0.25 \text{ m}) P \sin\phi = -30 \text{ N}\cdot\text{m} \quad \dots \textcircled{3}$$

$$\textcircled{2}^2 + \textcircled{3}^2$$

$$(0.25 \text{ m})^2 P^2 = (-8.75 \text{ N}\cdot\text{m})^2 + (-30 \text{ N}\cdot\text{m})^2 = 976.56 (\text{N}\cdot\text{m})^2$$

$$\Rightarrow P^2 = \frac{976.56 (\text{N}\cdot\text{m})^2}{(0.25 \text{ m})^2} = 15,625 \text{ N}^2 \quad \Rightarrow P = 125.0 \text{ N}$$

$$\textcircled{3} \Rightarrow \sin\phi = \frac{-30 \text{ N}\cdot\text{m}}{(-0.25 \text{ m})(125.0 \text{ N})} = 0.96 \quad \Rightarrow \phi = \sin^{-1}(0.96) = 73.7^\circ$$

$$\textcircled{1} \Rightarrow \sin(\theta + \phi) = \frac{20 \text{ N}\cdot\text{m}}{(0.20 \text{ m})(125.0 \text{ N})} = 0.80$$

$$\Rightarrow \theta + \phi = \sin^{-1}(0.80) = 53.1^\circ \text{ 또는 } 126.9^\circ$$

$$\theta + \phi = 53.1^\circ \text{ 일 때} \quad \theta = 53.1^\circ - 73.7^\circ = 20.6^\circ \text{ 타당하지 않음}$$

$$\theta + \phi = 126.9^\circ \text{ 일 때} \quad \theta = 126.9^\circ - 73.7^\circ = 53.2^\circ \quad \Rightarrow \theta = 53.2^\circ$$