

[3.1~3.8절]

3.6 [한 점에 관한 모멘트 (2차원, 직각성분)]

$$P = 300 \text{ N}, \quad r = 200 \text{ mm}$$

$$\alpha = 40^\circ, \quad \beta = 30^\circ$$

$$(a) \quad x = r \cos\alpha = (200 \text{ mm}) \cos 40^\circ = 153.21 \text{ mm}$$

$$y = r \sin\alpha = (200 \text{ mm}) \sin 40^\circ = 128.56 \text{ mm}$$

$$\mathbf{r}_{A/O} = x \mathbf{i} + y \mathbf{j} = (153.21 \text{ mm}) \mathbf{i} + (128.56 \text{ mm}) \mathbf{j}$$

$$P_x = P \sin\beta = (300 \text{ N}) \sin 30^\circ = 150 \text{ N}$$

$$P_y = P \cos\beta = (300 \text{ N}) \cos 30^\circ = 260 \text{ N}$$

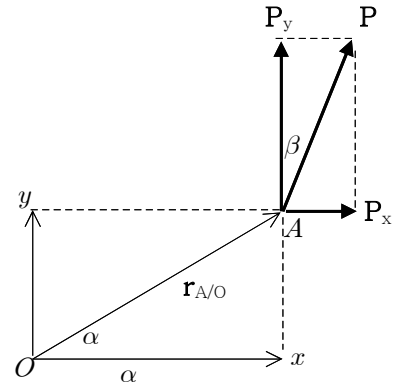
$$\mathbf{P} = P_x \mathbf{i} + P_y \mathbf{j} = (150 \text{ N}) \mathbf{i} + (260 \text{ N}) \mathbf{j}$$

$$\begin{aligned} M_O &= \mathbf{r}_{A/O} \times \mathbf{P} = [(153.21 \text{ mm}) \mathbf{i} + (128.56 \text{ mm}) \mathbf{j}] \times [(150 \text{ N}) \mathbf{i} + (260 \text{ N}) \mathbf{j}] \\ &= (153.21 \text{ mm}) \times (260 \text{ N}) \mathbf{k} - (128.56 \text{ mm}) \times (150 \text{ N}) \mathbf{k} \\ &= 20,551 \text{ N}\cdot\text{mm} \mathbf{k} = 20.551 \text{ N}\cdot\text{m} \mathbf{k} \quad \Rightarrow \quad 20.6 \text{ N}\cdot\text{m} \uparrow \end{aligned}$$

$$(b) \quad M_O = P d$$

$$\Rightarrow \quad d = \frac{M_O}{P} = \frac{20,551 \text{ N}\cdot\text{mm}}{300 \text{ N}} = 68.50 \text{ mm} \quad \Rightarrow \quad 68.5 \text{ mm}$$

F.B.D.



3.10 [모멘트 직각성분 (2차원, 직각성분)]

$$F = 2.5 \text{ kN}, \quad d_1 = 42 \text{ mm},$$

$$d_2 = 56 \text{ mm}, \quad d_3 = 88 \text{ mm}$$

$$\mathbf{r}_{B/C} = -d_1 \mathbf{i} - d_2 \mathbf{j} = -(42 \text{ mm}) \mathbf{i} - (56 \text{ mm}) \mathbf{j}$$

$$\tan\theta = \frac{d_2 + d_3}{d_1} = \frac{56 \text{ mm} + 88 \text{ mm}}{42 \text{ mm}} = 3.429$$

$$\Rightarrow \quad \theta = \tan^{-1}(3.429) = 73.74^\circ$$

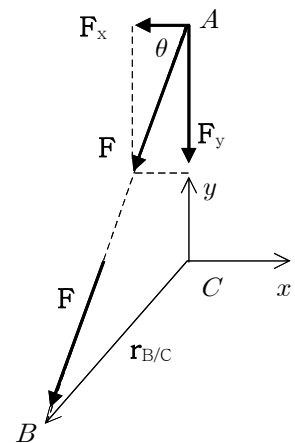
$$F_x = F \cos\theta = (2.5 \text{ kN}) \cos 73.74^\circ = 0.700 \text{ kN}$$

$$F_y = F \sin\theta = (2.5 \text{ kN}) \sin 73.74^\circ = 2.400 \text{ kN}$$

$$\mathbf{F} = -F_x \mathbf{i} - F_y \mathbf{j} = -(0.700 \text{ kN}) \mathbf{i} - (2.400 \text{ kN}) \mathbf{j}$$

$$\begin{aligned} M_C &= \mathbf{r}_{B/C} \times \mathbf{F} = [-(42 \text{ mm}) \mathbf{i} - (56 \text{ mm}) \mathbf{j}] \times [-(0.700 \text{ kN}) \mathbf{i} - (2.400 \text{ kN}) \mathbf{j}] \\ &= (42 \text{ mm})(2.400 \text{ kN}) \mathbf{k} - (56 \text{ mm})(0.700 \text{ kN}) \mathbf{k} \\ &= 61.60 \text{ kN}\cdot\text{mm} \mathbf{k} = 61.60 \text{ N}\cdot\text{m} \mathbf{k} \quad \Rightarrow \quad M_C = 61.6 \text{ N}\cdot\text{m} \uparrow \end{aligned}$$

F.B.D.



3.24 [합력의 모멘트의 직각성분 (3차원, 직각성분)]

$$T = 900 \text{ N}$$

$$\mathbf{r}_{OB} = 2.5 \mathbf{i} + 2.0 \mathbf{j} \text{ (m)}$$

$$(d_{BD})_x = -1 \text{ m}, \quad (d_{BD})_y = -2 \text{ m}, \quad (d_{BD})_z = 2 \text{ m}$$

$$d_{BD} = \sqrt{(-1 \text{ m})^2 + (-2 \text{ m})^2 + (2 \text{ m})^2} = 3 \text{ m}$$

$$\lambda_{BD} = \frac{1}{3} (-1 \mathbf{i} - 2 \mathbf{j} + 2 \mathbf{k})$$

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

$$= (900 \text{ N}) \frac{1}{3} (-1 \mathbf{i} - 2 \mathbf{j} + 2 \mathbf{k})$$

$$= -300 \mathbf{i} - 600 \mathbf{j} + 600 \mathbf{k} \text{ (N)}$$

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

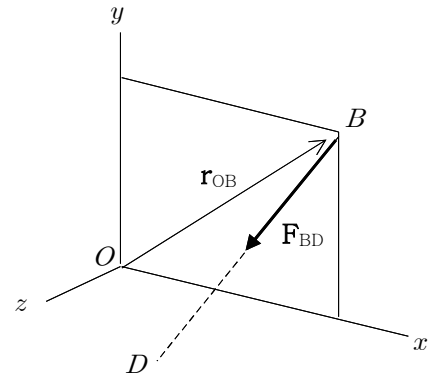
$$= [2.5 \mathbf{i} + 2.0 \mathbf{j} \text{ (m)}] \times [-300 \mathbf{i} - 600 \mathbf{j} + 600 \mathbf{k} \text{ (N)}]$$

$$= [(2.0)(600)] \mathbf{i} + [-(2.5)(600)] \mathbf{j} + [(2.5)(-600) - (2.0)(-300)] \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$= (1,200) \mathbf{i} + (-1,500) \mathbf{j} + (-900) \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$\Rightarrow \mathbf{M}_O = (1,200 \text{ N}\cdot\text{m}) \mathbf{i} + (-1,500 \text{ N}\cdot\text{m}) \mathbf{j} + (-900 \text{ N}\cdot\text{m}) \mathbf{k}$$

F.B.D.



3.32 [점에 관한 모멘트 (3차원)]

$$3.24 \quad T = 900 \text{ N}$$

$$M_O = \sqrt{(1,200)^2 + (-1,500)^2 + (-900)^2} \text{ (N}\cdot\text{m)} = 2,121 \text{ (N}\cdot\text{m)}$$

$$M_O = T d$$

$$\Rightarrow d = \frac{M_O}{T} = \frac{2,121 \text{ N}\cdot\text{m}}{900 \text{ N}} = 2.357 \text{ m} \quad \Rightarrow \quad d = 2.36 \text{ m}$$