

<3.1~3.8절>

3.1 [ 한 점에 대한 모멘트 (2차원, 직각성분) ]

$$F = 90 \text{ N}, \quad \alpha = 25^\circ, \quad L = 0.225 \text{ m}, \quad \theta = 65^\circ$$

$$x_{A/B} = -L \cos\theta = -(0.225 \text{ m}) \cos 65^\circ = -0.09509 \text{ m}$$

$$y_{A/B} = L \sin\theta = (0.225 \text{ m}) \sin 65^\circ = 0.2039 \text{ m}$$

$$\mathbf{r}_{A/B} = x_{A/B} \mathbf{i} + y_{A/B} \mathbf{j} = -0.09509 \mathbf{i} + 0.2039 \mathbf{j} \text{ (m)}$$

$$F_x = F \cos\alpha = (90 \text{ N}) \cos 25^\circ = 81.57 \text{ N}$$

$$F_y = -F \sin\alpha = -(90 \text{ N}) \sin 25^\circ = -38.04 \text{ N}$$

$$\mathbf{F}_A = F_x \mathbf{i} + F_y \mathbf{j} = 81.57 \mathbf{i} - 38.04 \mathbf{j} \text{ (N)}$$

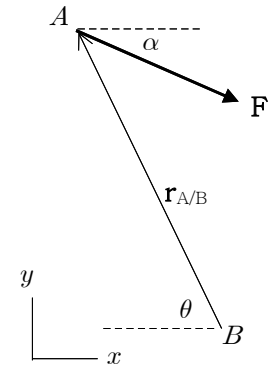
$$\mathbf{M}_B = \mathbf{r}_{A/B} \times \mathbf{F}_A$$

$$= [-0.09509 \mathbf{i} + 0.2039 \mathbf{j} \text{ (m)}] \times [81.57 \mathbf{i} - 38.04 \mathbf{j} \text{ (N)}]$$

$$= [(-0.09509)(-38.04) - (0.2039)(81.57)] \mathbf{k} \text{ (N}\cdot\text{m)} = -13.014 \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$\Rightarrow \mathbf{M}_B = 13.01 \text{ N}\cdot\text{m} \uparrow$$

F. B. D.



3.9 [ 모멘트 직각성분 (2차원, 직각성분) ]

$$F_B = 2,500 \text{ N}$$

$$x_{B/A} = -0.042 \text{ m}, \quad y_{B/A} = -0.144 \text{ m}$$

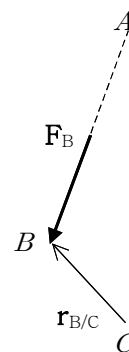
$$r_{B/A} = \sqrt{(-0.042 \text{ m})^2 + (-0.144 \text{ m})^2} = 0.150 \text{ m}$$

$$F_x = F_B \frac{x_{B/A}}{r_{B/A}} = (2,500 \text{ N}) \frac{-0.042 \text{ m}}{0.150 \text{ m}} = -700 \text{ N}$$

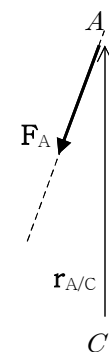
$$F_y = F_B \frac{y_{B/A}}{r_{B/A}} = (2,500 \text{ N}) \frac{-0.144 \text{ m}}{0.150 \text{ m}} = -2,400 \text{ N}$$

$$\mathbf{F}_B = -700 \mathbf{i} - 2,400 \mathbf{j} \text{ (N)}$$

FBD1



FBD2



<방법 1>

$$x_{B/C} = -0.042 \text{ m}, \quad y_{B/C} = 0.056 \text{ m}, \quad \mathbf{r}_{B/C} = -0.042 \mathbf{i} + 0.056 \mathbf{j} \text{ (m)}$$

$$\mathbf{M}_C = \mathbf{r}_{B/C} \times \mathbf{F}_B$$

$$= [-0.042 \mathbf{i} + 0.056 \mathbf{j} \text{ (m)}] \times [-700 \mathbf{i} - 2,400 \mathbf{j} \text{ (N)}]$$

$$= [(-0.042)(-2,400) - (0.056)(-700)] \mathbf{k} \text{ (N}\cdot\text{m)} = 140.0 \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$\Rightarrow \mathbf{M}_C = 140.0 \text{ N}\cdot\text{m} \uparrow$$

<방법 2>

$$\mathbf{F}_A = \mathbf{F}_B = -700 \mathbf{i} - 2,400 \mathbf{j} \text{ (N)}$$

$$x_{A/C} = 0, \quad y_{A/C} = 0.056 \text{ m} + 0.144 \text{ m} = 0.200 \text{ m}, \quad \mathbf{r}_{A/C} = 0.200 \mathbf{j} \text{ (m)}$$

$$\mathbf{M}_C = \mathbf{r}_{A/C} \times \mathbf{F}_A$$

$$= (y_{A/C} \mathbf{j}) \times (F_x \mathbf{i} + F_y \mathbf{j}) = -y_{A/C} F_x = -(0.200 \text{ m}) \times (-700 \text{ N}) = 140.0 \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$\Rightarrow \mathbf{M}_C = 140.0 \text{ N}\cdot\text{m} \uparrow$$

3.24 [ 합력의 모멘트의 직각성분 (3차원, 직각성분) ]

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

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

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

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

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

$$\mathbf{F}_{BD} = T \boldsymbol{\lambda}_{BD}$$

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

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

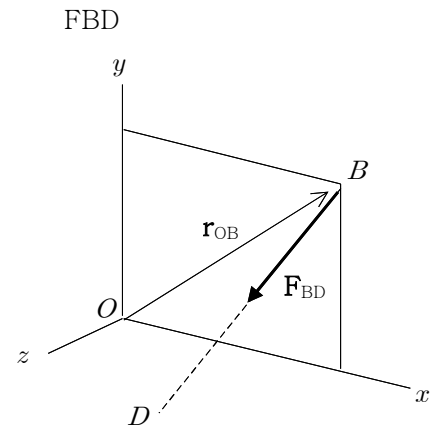
$$\mathbf{M}_O = \mathbf{r}_{OB} \times \mathbf{F}_{BD}$$

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

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

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

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



3.27 [ 점에 대한 모멘트 (3차원) ]

3.21

$$T = 435 \text{ N}$$

$$\mathbf{r}_{OA} = -0.09 \mathbf{i} + 0.16 \mathbf{j} \text{ (m)}$$

$$(d_{AE})_x = 0.21 \text{ m}, \quad (d_{AE})_y = -0.16 \text{ m},$$

$$(d_{AE})_z = 0.12 \text{ m}$$

$$d_{AE} = \sqrt{(0.21 \text{ m})^2 + (-0.16 \text{ m})^2 + (0.12 \text{ m})^2}$$

$$= 0.29 \text{ m}$$

$$\boldsymbol{\lambda}_{AE} = \frac{1}{0.29} (0.21 \mathbf{i} - 0.16 \mathbf{j} + 0.12 \mathbf{k})$$

$$\mathbf{F}_{AE} = T \boldsymbol{\lambda}_{AE}$$

$$= (435 \text{ N}) \frac{1}{0.29} (0.21 \mathbf{i} - 0.16 \mathbf{j} + 0.12 \mathbf{k})$$

$$= 315 \mathbf{i} - 240 \mathbf{j} + 180 \mathbf{k} \text{ (N)}$$

$$\mathbf{M}_O = \mathbf{r}_{OA} \times \mathbf{F}_{AE}$$

$$= [-0.09 \mathbf{i} + 0.16 \mathbf{j} \text{ (m)}] \times [315 \mathbf{i} - 240 \mathbf{j} + 180 \mathbf{k} \text{ (N)}]$$

$$= [(0.16)(180)] \mathbf{i} + [ -(-0.09)(180) ] \mathbf{j} + [ (-0.09)(-240) - (0.16)(315) ] \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$= (28.8) \mathbf{i} + (16.2) \mathbf{j} + (-28.8) \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$M_O = \sqrt{(28.8)^2 + (16.2)^2 + (-28.8)^2} \text{ (N}\cdot\text{m)} = 43.83 \text{ (N}\cdot\text{m)}$$

$$M_O = F d$$

$$\Rightarrow d = \frac{M_O}{F} = \frac{43.83 \text{ N}\cdot\text{m}}{435 \text{ N}} = 0.1008 \text{ m} = 100.8 \text{ mm}$$

