{3.12~3.16절}

3.68 [우력 모멘트, 우력 벡터 합성(2차원)]

(a) $F_1 = 40$ N, $d_1 = 0.6$ m

$M_1 = d_1 F_1 = (0.6\text{ m})(40\text{ N}) = 24.0$ N·m

$\mathbf{M}_1 = 24.0$ N·m $\circlearrowleft$

(b) $\mathbf{M} = 8$ N·m$\circlearrowright$, $d = 0.82$ m, $F_2 = 24$ N

$M_2 = (d\cos\alpha)\,F_2 = (0.82\text{ m})\cos\alpha\,(24\text{ N}) = (19.68\text{ N·m})\cos\alpha$

$\mathbf{M} = \mathbf{M}_1 + \mathbf{M}_2$

$+\circlearrowleft$ $M = M_1 - M_2 = M_1 - (d\cos\alpha)\,F_2$

$$\Rightarrow \cos\alpha = \frac{M_1 - M}{d\,F_2} = \frac{(24\text{ N}\cdot\text{m}) - (8\text{ N}\cdot\text{m})}{(0.82\text{ m})(24\text{ N})} = 0.8130$$

$\alpha = \cos^{-1}(0.8130) = 35.6°$

(c) $M_2 = d_2 F_2$

$M_1 - M_2 = 0 \quad \Rightarrow \quad M_1 - d_2 F_2 = 0$

$$\Rightarrow \quad d_2 = \frac{M_1}{F_2} = \frac{24.0\text{ N}\cdot\text{m}}{24\text{ N}} = 1.000\text{ m}$$

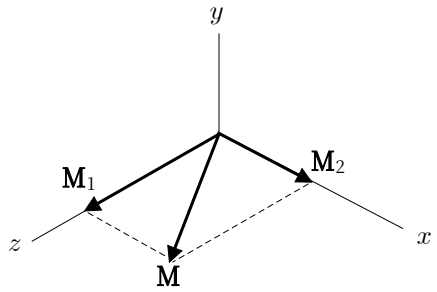
3.72 [우력 모멘트 벡터 합성(3차원)]

$M_1 = 18$ N·m, $M_2 = 7.5$ N·m

$\mathbf{M}_1 = M_1\,\mathbf{k}$, $\mathbf{M}_2 = M_2\,\mathbf{i}$

$\mathbf{M} = \mathbf{M}_1 + \mathbf{M}_2 = M_1\,\mathbf{k} + M_2\,\mathbf{i}$

$= 18\,\mathbf{k} + 7.5\,\mathbf{i}$ (N·m)



크기(magnitude)

$$M = \sqrt{M_x^2 + M_y^2 + M_z^2}$$

$$= \sqrt{(7.5)^2 + 0 + (18)^2}\ \text{(N·m)} = 19.50\text{ N·m}$$

방향(direction)

$$\boldsymbol{\lambda} = \frac{\mathbf{M}}{M} = \frac{7.5\,\mathbf{i} + 18\,\mathbf{k}}{19.50} = 0.3846\,\mathbf{i} + 0.9231\,\mathbf{k}$$

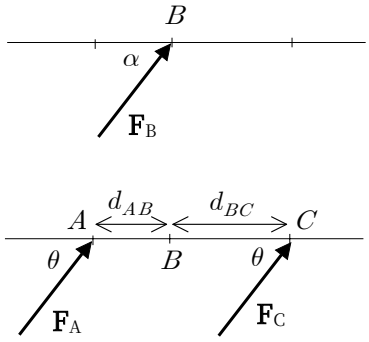
$\cos\theta_x = 0.3846 \quad \Rightarrow \quad \theta_x = \cos^{-1}(0.3846) = 67.4°$

$\cos\theta_y = 0 \quad \Rightarrow \quad \theta_y = \cos^{-1}(0) = 90.0°$

$\cos\theta_z = 0.9231 \quad \Rightarrow \quad \theta_z = \cos^{-1}(0.9231) = 22.6°$

3.81 [등가 우력]

F_B = 2.8 kN, α = 65°, d_{AB} = 27 m, d_{BC} = 45 m



$\rightarrow \Sigma F_x$; $F_B \cos\alpha = F_A \cos\theta + F_C \cos\theta$

$\Rightarrow$ $(F_A + F_C) \cos\theta = F_B \cos\alpha$ … ①

$\uparrow \Sigma F_y$; $F_B \sin\alpha = F_A \sin\theta + F_C \sin\theta$

$\Rightarrow$ $(F_A + F_C) \sin\theta = F_B \sin\alpha$ … ②

②÷① ; $\tan\theta = \tan\alpha$ $\Rightarrow$ $\theta = \alpha = 65.0°$

① $\Rightarrow$ $F_A + F_C = F_B$ … ③

$+\circlearrowleft \Sigma M_A = d_{AB} F_B \sin\alpha = (d_{AB} + d_{BC}) F_C \sin\theta$

$$\Rightarrow \quad F_C = \frac{d_{AB}}{d_{AB} + d_{BC}} F_B = \frac{27\ \text{m}}{27\ \text{m} + 45\ \text{m}} (2.8\ \text{kN}) = 1.050\ \text{kN}$$

③ $\Rightarrow$ $F_A = F_B - F_C$ = (2.8 kN) - (1.05 kN) = 1.750 kN

$\mathbf{F}_A$ = 1.750 kN ∠65.0°, $\mathbf{F}_C$ = 1.050 kN ∠65.0°