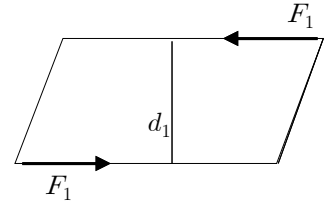


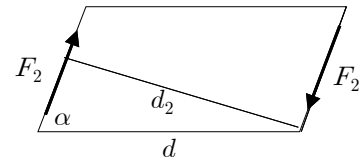
<3.12~3.16절>

3.70 [우력 모멘트, 우력 벡터 합성]

(a) $F_1 = 84 \text{ N}$, $d_1 = 16 \text{ cm} = 0.16 \text{ m}$
 $M_1 = F_1 d_1 = (84 \text{ N})(0.16 \text{ m}) = 13.44 \text{ N}\cdot\text{m}$
 $\Rightarrow \mathbf{M}_1 = 13.44 \text{ N}\cdot\text{m} \uparrow$



(b) $F_2 = 48 \text{ N}$
 $\mathbf{M}_1 + \mathbf{M}_2 = 0 \Rightarrow \mathbf{M}_2 = -\mathbf{M}_1 = 13.44 \text{ N}\cdot\text{m} \uparrow$
 $M_2 = 13.44 \text{ N}\cdot\text{m}$
 $d_2 = \frac{M_2}{F_2} = \frac{13.44 \text{ N}\cdot\text{m}}{48 \text{ N}} = 0.280 \text{ m}$
 $\Rightarrow d_2 = 28.0 \text{ cm}$

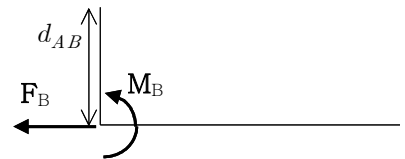


(c) $\mathbf{M} = 2.88 \text{ N}\cdot\text{m} \uparrow$, $d = 42 \text{ cm} = 0.42 \text{ m}$
 $\mathbf{M}_1 + \mathbf{M}_2 = \mathbf{M} \Rightarrow M_1 - M_2 = -M$
 $\Rightarrow M_2 = M_1 + M$
 $= (13.44 \text{ N}\cdot\text{m}) + (2.88 \text{ N}\cdot\text{m}) = 16.32 \text{ N}\cdot\text{m}$
 $M_2 = F_2 (d \sin \alpha)$
 $\Rightarrow \sin \alpha = \frac{M_2}{F_2 d} = \frac{16.32 \text{ N}\cdot\text{m}}{(48 \text{ N})(0.42 \text{ m})} = 0.8095$
 $\Rightarrow \alpha = \sin^{-1}(0.8095) = 54.049^\circ$
 $\Rightarrow \alpha = 54.0^\circ$

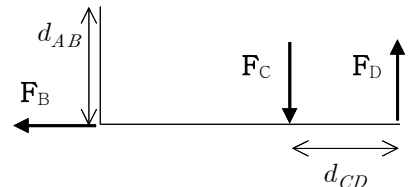
3.85 [2차원 등가 힘-우력]

$P = 80 \text{ N}$
 $d_{AB} = 0.050 \text{ m}$, $d_{BC} = 0.100 \text{ m}$, $d_{CD} = 0.040 \text{ m}$

(a) $\Sigma \mathbf{F} : F_B = P = 80 \text{ N} \Rightarrow \mathbf{F}_B = 80.0 \text{ N} \leftarrow$
 $\uparrow \Sigma M_A : M_B - F_B d_{AB} = 0$
 $\Rightarrow M_B = F_B d_{AB} = (80 \text{ N})(0.050 \text{ m}) = 4.00 \text{ N}\cdot\text{m}$
 $\Rightarrow \mathbf{M}_B = 4.00 \text{ N}\cdot\text{m} \uparrow$



(b) $\Sigma F_x : F_B = P = 80 \text{ N} \Rightarrow \mathbf{F}_B = 80.0 \text{ N} \leftarrow$
 $\Sigma F_y : -F_C + F_D = 0 \Rightarrow F_C = F_D = F$
 $\uparrow \Sigma M_A : F d_{CD} - F_B d_{AB} = 0$
 $\Rightarrow F = \frac{F_B d_{AB}}{d_{CD}} = \frac{(80.0 \text{ N})(0.050 \text{ m})}{(0.040 \text{ m})} = 100.0 \text{ N}$
 $\Rightarrow \mathbf{F}_C = 100.0 \text{ N} \downarrow$, $\mathbf{F}_D = 100.0 \text{ N} \uparrow$



3.95 [3차원 등가 힘-우력]

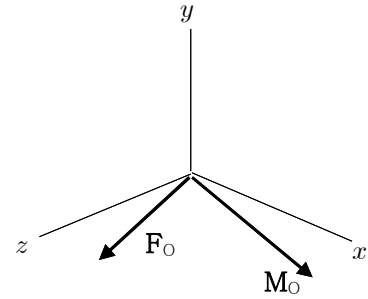
$$P = 110 \text{ N}, \quad h = 0.150 \text{ m}, \quad L = 0.220 \text{ m}$$

$$\alpha = 15^\circ, \quad \beta = 35^\circ$$

$$\Sigma \mathbf{F} : \mathbf{F}_O = \mathbf{P}$$

$$\begin{aligned} \mathbf{P} &= P (-\sin\alpha \mathbf{j} + \cos\alpha \mathbf{k}) \\ &= (110 \text{ N}) (-\sin 15^\circ \mathbf{j} + \cos 15^\circ \mathbf{k}) \\ &= -28.47 \mathbf{j} + 106.25 \mathbf{k} \text{ (N)} \end{aligned}$$

$$\Rightarrow \mathbf{F}_O = (-28.5 \text{ N}) \mathbf{j} + (106.3 \text{ N}) \mathbf{k}$$



$$\begin{aligned} \mathbf{r}_{B/O} &= h \mathbf{j} + L (\cos\beta \mathbf{i} - \sin\beta \mathbf{k}) \\ &= (0.150 \text{ m}) \mathbf{j} + (0.220 \text{ m}) (\cos 35^\circ \mathbf{i} - \sin 35^\circ \mathbf{k}) \\ &= 0.1802 \mathbf{i} + 0.150 \mathbf{j} - 0.1262 \mathbf{k} \text{ (m)} \end{aligned}$$

$$\begin{aligned} \Sigma \mathbf{M} : \mathbf{M}_O &= \mathbf{r}_{B/O} \times \mathbf{P} \\ &= [0.1802 \mathbf{i} + 0.150 \mathbf{j} - 0.1262 \mathbf{k} \text{ (m)}] \times [-28.5 \text{ N } \mathbf{j} + 106.3 \text{ N } \mathbf{k} \text{ (N)}] \\ &= [(0.150)(106.3) - (-0.1262)(-28.5)] \mathbf{i} + [-(0.1802)(106.3)] \mathbf{j} \\ &\quad + [(0.1802)(-28.5)] \mathbf{k} \text{ (N}\cdot\text{m)} \\ &= (12.348) \mathbf{i} + (-19.155) \mathbf{j} + (-5.136) \mathbf{k} \text{ (N}\cdot\text{m)} \end{aligned}$$

$$\Rightarrow \mathbf{M}_O = (12.35 \text{ N}\cdot\text{m}) \mathbf{i} + (-19.16 \text{ N}\cdot\text{m}) \mathbf{j} + (-5.14 \text{ N}\cdot\text{m}) \mathbf{k}$$