[4.1~4.5절]

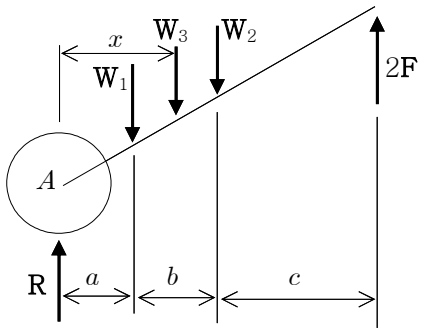
4.3 [반력(롤러), 평형(모멘트, 힘)]

W_1 = 60 N, W_2 = W_3 = 250 N, F = 75 N

a = b = 0.15 m, c = 0.7 m

d_2 = $a+b$ = (0.15 + 0.15) m = 0.30 m

d_3 = $a+b+c$ = (0.30 + 0.7) m = 1.00 m



$+\circlearrowleft \Sigma M_A = 0$;

$$-a\ W_1 - d_2\ W_2 - x\ W_3 + d_3\ (2F) = 0$$

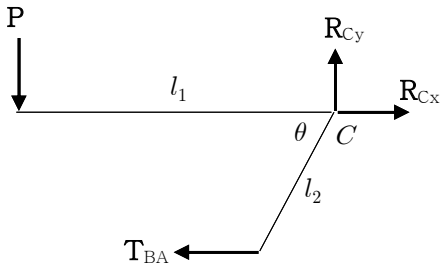
$$\Rightarrow \quad x = \frac{1}{W_3}[-a\ W_1 - d_2\ W_2 + d_3\ (2F)]$$

$$= \frac{1}{250\ \text{N}}[-(0.15\ \text{m})(60\ \text{N}) - (0.30\ \text{m})(250\ \text{N}) + (1.00\ \text{m})(2\times 75\ \text{N})]$$

$$= \frac{66.0\ \text{N}\cdot\text{m}}{250\ \text{N}} = 0.2640\ \text{m} \qquad \Rightarrow \qquad x = 0.264\ \text{m}$$

4.17 [반력(핀, 케이블), 평형(힘, 모멘트)]

T_{BA} = 200 N, l_1 = 15 cm, l_2 = 7 cm, θ = 60°



(a) $+\circlearrowleft \Sigma M_C = 0$;

$$l_1\ P - (l_2\ \sin\theta)\ T_{BA} = 0$$

$$\Rightarrow \quad P = \frac{l_2\ \sin\theta}{l_1}\ T_{BA}$$

$$= \frac{(7\ \text{cm})\ \sin 60^\circ}{15\ \text{cm}}\ (200\ \text{N}) = 80.83\ \text{N} \qquad \Rightarrow \qquad \text{P} = 80.8\ \text{N} \downarrow$$

(b) $\rightarrow \Sigma F_x = 0$;

$$R_{Cx} - T_{BA} = 0 \qquad \Rightarrow \qquad R_{Cx} = T_{BA} = 200\ \text{N}$$

$\uparrow \Sigma F_y = 0$;

$$R_{Cy} - P = 0 \qquad \Rightarrow \qquad R_{Cy} = P = 80.83\ \text{N}$$

$$R_C = \sqrt{R_{Cx}^2 + R_{Cy}^2} = \sqrt{(200\ \text{N})^2 + (80.83\ \text{N})^2} = 215.7\ \text{N}$$

$$\tan\theta = \frac{R_{Cy}}{R_{Cx}} = \frac{80.83\ \text{N}}{200\ \text{N}} = 0.40415$$

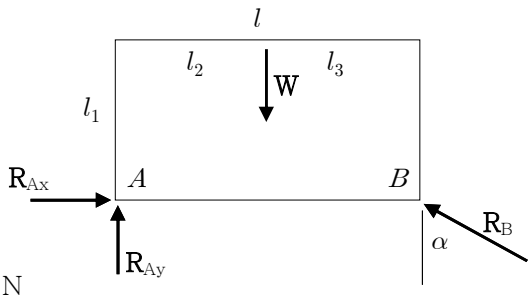
$$\Rightarrow \quad \theta = \tan^{-1}(0.40415) = 22.01^\circ$$

$$\Rightarrow \qquad \text{R}_\text{C} = 216\ \text{N} \measuredangle 22.0^\circ$$

4.21 [반력(힌지, 롤러), 평형(힘, 모멘트)]

$W = 150\ \text{N}, \quad \alpha = 60°, \quad l_1 = 0.300\ \text{m}, \quad l_2 = l_3 = 0.250\ \text{m}$

$l = l_2 + l_3 = (0.250 + 0.250)\ \text{m} = 0.500\ \text{m}$



(a) $h = 0$

$+\circlearrowleft \Sigma M_A = 0\ ;\ -l_2\ W + l\ (R_B \cos\alpha) = 0$

$$\Rightarrow \quad R_B = \frac{l_2}{l \cos\alpha}\ W$$

$$= \frac{0.250\ \text{m}}{(0.500\ \text{m})\cos 60°}\ (150\ \text{N}) = 150\ \text{N}$$

$\Rightarrow \quad R_B = 150\ \text{N} \measuredangle 30.0°$

$\rightarrow \Sigma F_x = 0\ ;\ R_{Ax} - R_B \sin\alpha = 0$

$\Rightarrow \quad R_{Ax} = R_B \sin\theta = (150\ \text{N}) \sin 60° = 129.90\ \text{N}$

$\uparrow \Sigma F_y = 0\ ;\ R_{Ay} - W + R_B \cos\alpha = 0$

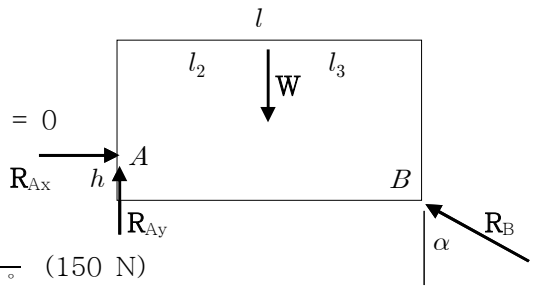
$\Rightarrow \quad R_{Ay} = W - R_B \cos\alpha = (150\ \text{N}) - (150\ \text{N}) \cos 60° = 75.00\ \text{N}$

$$R_A = \sqrt{R_{Ax}^2 + R_{Ay}^2} = \sqrt{(129.9\ \text{N})^2 + (75.0\ \text{N})^2} = 150.00\ \text{N}$$

$$\tan\theta = \frac{R_{Ay}}{R_{Ax}} = \frac{75.0\ \text{N}}{129.9\ \text{N}} = 0.5774 \quad \Rightarrow \quad \theta = \tan^{-1}(0.5774) = 30.0°$$

$\Rightarrow \quad R_A = 150.0\ \text{N} \measuredangle 30.0°$

(b) $h = 0.200\ \text{m}$



$+\circlearrowleft \Sigma M_A = 0\ ;$

$-l_2\ W + l\ (R_B \cos\alpha) - h\ (R_B \sin\alpha) = 0$

$$\Rightarrow \quad R_B = \frac{l_2}{l \cos\alpha - h \sin\alpha}\ W$$

$$= \frac{0.250\ \text{m}}{(0.500\ \text{m})\cos 60° - (0.200\ \text{m})\sin 60°}\ (150\ \text{N})$$

$= 488.3\ \text{N} \quad \Rightarrow \quad R_B = 488\ \text{N} \measuredangle 30.0°$

$\rightarrow \Sigma F_x = 0\ ;\ R_{Ax} - R_B \sin\alpha = 0$

$\Rightarrow \quad R_{Ax} = R_B \sin\theta = (488.3\ \text{N}) \sin 60° = 422.9\ \text{N}$

$\uparrow \Sigma F_y = 0\ ;\ R_{Ay} - W + R_B \cos\alpha = 0$

$\Rightarrow \quad R_{Ay} = W - R_B \cos\alpha = (150\ \text{N}) - (488.3\ \text{N}) \cos 60° = -94.15\ \text{N}$

$$R_A = \sqrt{R_{Ax}^2 + R_{Ay}^2} = \sqrt{(422.9\ \text{N})^2 + (-94.15\ \text{N})^2} = 433.3\ \text{N}$$

$$\tan\theta = \frac{R_{Ay}}{R_{Ax}} = \frac{-94.15\ \text{N}}{422.9\ \text{N}} = -0.2226 \quad \Rightarrow \quad \theta = \tan^{-1}(-0.2226) = -12.551°$$

$\Rightarrow \quad R_A = 433\ \text{N} \measuredangle 12.55°$

4.43 [반력(고정 지지), 평형(힘, 모멘트)]

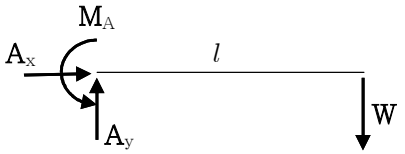
m = 8 kg, r = 0.10 m, l = 1.6 m

$W = m\,g$ = (8 kg)(9.81 m/s^2) = 78.48 N

(a) $\rightarrow \Sigma F_x = 0$; $A_x = 0$

$\uparrow \Sigma F_y = 0$; $A_y - W = 0$

$\Rightarrow$ $A_y = W$ = 78.48 N



$\Rightarrow$ **A** = 78.5 N ↑

$+\circlearrowleft \Sigma M_A = 0$; $M_A - l\,W = 0$

$\Rightarrow$ $M_A = l\,W$ = (1.6 m)(78.48 N) = 125.57 N·m

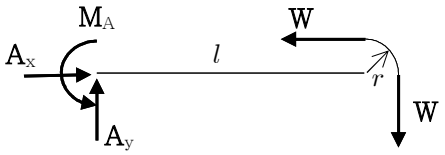
$\Rightarrow$ $\mathbf{M}_A$ = 125.6 N·m ↺

(b) $\rightarrow \Sigma F_x = 0$; $A_x - W = 0$

$\Rightarrow$ $A_x = W$ = 78.48 N

$\uparrow \Sigma F_y = 0$; $A_y - W = 0$

$\Rightarrow$ $A_y = W$ = 78.48 N



A = (78.48 N)$\sqrt{2}$ = 110.97 N

$\Rightarrow$ **A** = 111.0 N ∠45.0°

$+\circlearrowleft \Sigma M_A = 0$; $M_A + r\,W - (l+r)\,W = 0$

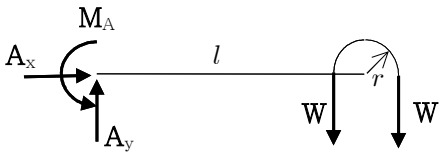
$\Rightarrow$ $M_A = l\,W$ = (1.6 m)(78.48 N) = 125.57 N·m

$\Rightarrow$ $\mathbf{M}_A$ = 125.6 N·m ↺

(c) $\rightarrow \Sigma F_x = 0$; $A_x = 0$

$\uparrow \Sigma F_y = 0$; $A_y - 2\,W = 0$

$\Rightarrow$ $A_y = 2\,W$ = 2(78.48 N) = 156.96 N



$\Rightarrow$ **A** = 157.0 N ↑

$+\circlearrowleft \Sigma M_A = 0$; $M_A - (l-r)\,W - (l+r)\,W = 0$

$\Rightarrow$ $M_A = 2\,l\,W$ = 2(1.6 m)(78.48 N) = 251.1 N·m

$\Rightarrow$ $\mathbf{M}_A$ = 251 N·m ↺