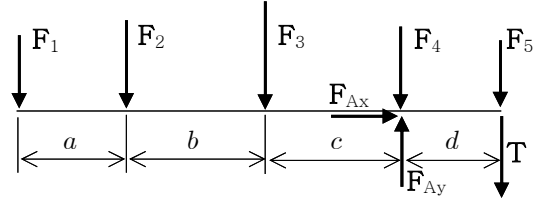


{4.1~4.5절}

4.8 [ 반력(힌지, 줄), 평형(모멘트, 힘) ]

$$F_1 = F_5 = 60 \text{ N}, \quad F_2 = F_4 = 80 \text{ N}, \quad F_3 = 140 \text{ N}$$

$$a = d = 0.15 \text{ m}, \quad b = c = 0.2 \text{ m}$$



$$(a) \rightarrow \Sigma F_x = 0; \quad F_{Ax} = 0$$

$$+ \curvearrowright \Sigma M_B = 0;$$

$$(a+b+c+d) F_1 + (b+c+d) F_2 + (c+d) F_3 + d (F_4 - F_{Ay}) = 0$$

$$\Rightarrow F_{Ay} = \frac{1}{d} [(a+b+c+d) F_1 + (b+c+d) F_2 + (c+d) F_3 + d F_4]$$

$$= \frac{1}{0.15 \text{ m}} [(0.7 \text{ m})(60 \text{ N}) + (0.55 \text{ m})(80 \text{ N}) + (0.35 \text{ m})(140 \text{ N}) + (0.15 \text{ m})(80 \text{ N})]$$

$$= \frac{147 \text{ N} \cdot \text{m}}{0.15 \text{ m}} = 980 \text{ N} \quad \Rightarrow \quad \mathbf{F_A = 980 \text{ N} \uparrow}$$

(b) &lt;방법1&gt;

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

$$(a+b+c) F_1 + (b+c) F_2 + c F_3 - d (F_5 + T) = 0$$

$$\Rightarrow T = \frac{1}{d} [(a+b+c) F_1 + (b+c) F_2 + c F_3 - d F_5]$$

$$= \frac{1}{0.15 \text{ m}} [(0.55 \text{ m})(60 \text{ N}) + (0.4 \text{ m})(80 \text{ N}) + (0.2 \text{ m})(140 \text{ N}) - (0.15 \text{ m})(60 \text{ N})]$$

$$= \frac{84 \text{ N} \cdot \text{m}}{0.15 \text{ m}} = 560 \text{ N} \quad \Rightarrow \quad \mathbf{T = 560 \text{ N}}$$

&lt;방법2&gt;

$$\uparrow \Sigma F_y = 0;$$

$$- F_1 - F_2 - F_3 - F_4 - F_5 + A_y - T = 0$$

$$\Rightarrow T = A_y - F_1 - F_2 - F_3 - F_4 - F_5$$

$$= (980 \text{ N}) - (60 \text{ N}) - (80 \text{ N}) - (140 \text{ N}) - (80 \text{ N}) - (60 \text{ N})$$

$$= 560 \text{ N} \quad \Rightarrow \quad \mathbf{T = 560 \text{ N}}$$

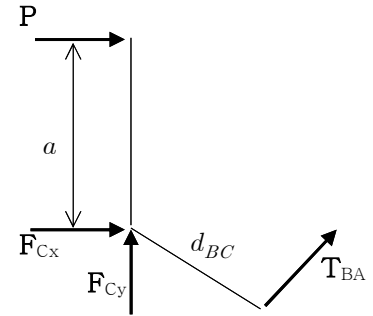
4.17 [ 반력(힘, 줄), 평형(힘, 모멘트) ]

$$P = 100 \text{ N}, \quad a = 7.5 \text{ cm}, \quad d_{BC} = 5 \text{ cm}$$

(a)  $+\uparrow \Sigma M_C = 0 :$

$$d_{BC} T_{BA} - a P = 0$$

$$\Rightarrow T_{BA} = \frac{a}{d_{BC}} P = \frac{7.5 \text{ cm}}{5 \text{ cm}} (100 \text{ N}) = 150.0 \text{ N}$$



(b)  $\Sigma F_y = 0 :$

$$F_{Cy} + T_{BAx} = 0$$

$$\Rightarrow F_{Cy} = -T_{BAx} = -\frac{4}{5} T_{BA} = -\frac{4}{5} (150.0 \text{ N}) = -120.0 \text{ N}$$

$\Sigma F_x = 0 :$

$$F_{Cx} + P + T_{BAx} = 0$$

$$\Rightarrow F_{Cx} = -P - \frac{3}{5} T_{BA} = -(100 \text{ N}) - \frac{3}{5} (150.0 \text{ N}) = -190.0 \text{ N}$$

$$F_C = \sqrt{F_{Cx}^2 + F_{Cy}^2} = \sqrt{(-190 \text{ N})^2 + (-120 \text{ N})^2} = 224.7 \text{ N}$$

$$\tan \theta = \frac{F_{Cy}}{F_{Cx}} = \frac{-120}{-190} = 0.6316 \quad \Rightarrow \quad \theta = \tan^{-1}(0.6316) = 32.3^\circ$$

$$\Rightarrow \quad \mathbf{F}_C = 225 \text{ N} \quad \swarrow 32.3^\circ$$

4.23 [ 반력(힌지, 롤러), 평형(힘, 모멘트) ]

$$W = 150 \text{ N}, \quad \theta = 60^\circ$$

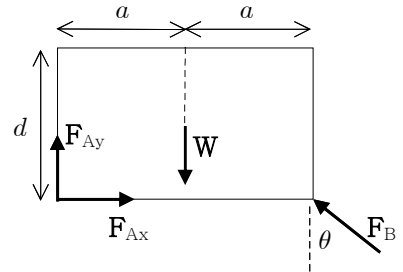
$$d = 300 \text{ mm}, \quad a = 250 \text{ mm}$$

(a)  $h = 0$

$$+\uparrow \Sigma M_A = 0 ; (2a) F_B \cos\theta - a W = 0$$

$$\Rightarrow F_B = \frac{W}{2 \cos\theta} = \frac{150 \text{ N}}{2 \cos 60^\circ} = 150.0 \text{ N}$$

$$\Rightarrow \mathbf{F}_B = 150.0 \text{ N} \searrow 30.0^\circ$$



$$\rightarrow \Sigma F_x = 0 ; F_{Ax} - F_B \sin\theta = 0$$

$$\Rightarrow F_{Ax} = F_B \sin\theta = (150.0 \text{ N}) \sin 60^\circ = 129.90 \text{ N}$$

$$\uparrow \Sigma F_y = 0 ; F_{Ay} - W + F_B \cos\theta = 0$$

$$\Rightarrow F_{Ay} = W - F_B \cos\theta = (150 \text{ N}) - (150.0 \text{ N}) \cos 60^\circ = 75.00 \text{ N}$$

$$F_A = \sqrt{F_{Ax}^2 + F_{Ay}^2} = \sqrt{(129.90 \text{ N})^2 + (75.00 \text{ N})^2} = 150.0 \text{ N}$$

$$\tan\theta = \frac{F_{Ay}}{F_{Ax}} = \frac{75.00 \text{ N}}{129.90 \text{ N}} = 0.5774 \quad \Rightarrow \quad \theta = \tan^{-1}(0.5774) = 30.0^\circ$$

$$\Rightarrow \mathbf{F}_A = 150.0 \text{ N} \nearrow 30.0^\circ$$

(b)  $h = 200 \text{ mm}$

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

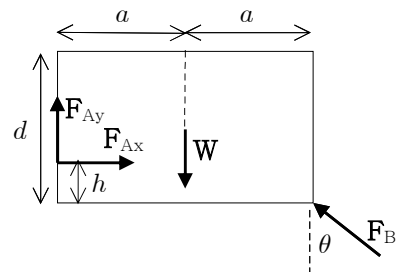
$$(2a) F_B \cos\theta - h F_B \sin\theta - a W = 0$$

$$\Rightarrow F_B = \frac{a W}{2a \cos\theta - h \sin\theta}$$

$$= \frac{(250 \text{ mm})(150 \text{ N})}{2(250 \text{ mm}) \cos 60^\circ - (200 \text{ mm}) \sin 60^\circ}$$

$$= 488.3 \text{ N}$$

$$\Rightarrow \mathbf{F}_B = 488 \text{ N} \searrow 30.0^\circ$$



$$\rightarrow \Sigma F_x = 0 ; F_{Ax} - F_B \sin\theta = 0$$

$$\Rightarrow F_{Ax} = F_B \sin\theta = (488.3 \text{ N}) \sin 60^\circ = 422.9 \text{ N}$$

$$\uparrow \Sigma F_y = 0 ; F_{Ay} - W + F_B \cos\theta = 0$$

$$\Rightarrow F_{Ay} = W - F_B \cos\theta = (150 \text{ N}) - (488.3 \text{ N}) \cos 60^\circ = -94.15 \text{ N}$$

$$F_A = \sqrt{F_{Ax}^2 + F_{Ay}^2} = \sqrt{(422.9 \text{ N})^2 + (-94.15 \text{ N})^2} = 433.2 \text{ N}$$

$$\tan\theta = \frac{F_{Ay}}{F_{Ax}} = \frac{-94.15 \text{ N}}{422.9 \text{ N}} = -0.2226 \quad \Rightarrow \quad \theta = \tan^{-1}(-0.2226) = -12.55^\circ$$

$$\Rightarrow \mathbf{F}_A = 433 \text{ N} \searrow 12.55^\circ$$

4.43 [ 반력(고정지지, 줄), 평형(힘, 모멘트) ]

$$F_A = F_C = 200 \text{ N},$$

$$a = 4 \text{ m}, \quad b = 5 \text{ m}, \quad T = W$$

(a)  $W = 500 \text{ N}$

$$\rightarrow \Sigma F_x = 0 ; \quad F_{Dx} = 0$$

$$\uparrow \Sigma F_y = 0 ; \quad F_{Dy} - F_A - F_C + T = 0$$

$$\Rightarrow F_{Dy} = F_A + F_C - T$$

$$= (200 \text{ N}) + (200 \text{ N}) - (500 \text{ N}) = -100 \text{ N}$$

$$\Rightarrow \mathbf{F}_D = 100.0 \text{ N} \downarrow$$

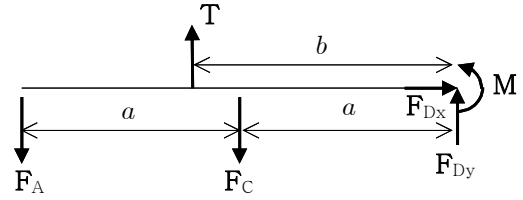
$$+\curvearrowright \Sigma M_D = 0 ; \quad M + 2a F_A + a F_C - b T = 0$$

$$\Rightarrow M = -2a F_A - a F_C + b T$$

$$= -2(4 \text{ m})(200 \text{ N}) - (4 \text{ m})(200 \text{ N}) + (5 \text{ m})(500 \text{ N})$$

$$= 100.0 \text{ N}\cdot\text{m}$$

$$\Rightarrow \mathbf{M} = 100.0 \text{ N}\cdot\text{m} \uparrow$$



(b)  $W = 450 \text{ N}$

$$\rightarrow \Sigma F_x = 0 ; \quad F_{Dx} = 0$$

$$\uparrow \Sigma F_y = 0 ; \quad F_{Dy} - F_A - F_C + T = 0$$

$$\Rightarrow F_{Dy} = F_A + F_C - T$$

$$= (200 \text{ N}) + (200 \text{ N}) - (450 \text{ N}) = -50 \text{ N}$$

$$\Rightarrow \mathbf{F}_D = 50.0 \text{ N} \downarrow$$

$$+\curvearrowright \Sigma M_D = 0 ; \quad M + 2a F_A + a F_C - b T = 0$$

$$\Rightarrow M = -2a F_A - a F_C + b T$$

$$= -2(4 \text{ m})(200 \text{ N}) - (4 \text{ m})(200 \text{ N}) + (5 \text{ m})(450 \text{ N})$$

$$= -150.0 \text{ N}\cdot\text{m}$$

$$\Rightarrow \mathbf{M} = 150.0 \text{ N}\cdot\text{m} \curvearrowright$$