

<4.1~4.5절>

4.3 [ 반력(롤러, 힌지), 평형(힘, 모멘트) ]

(a)  $a = 10 \text{ cm}$

$$\rightarrow \Sigma F_x = 0 ; \quad B_x = 0$$

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

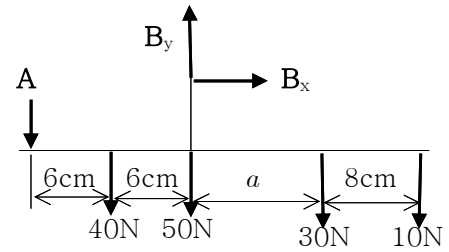
$$-(6 \text{ cm})(40 \text{ N}) + (12 \text{ cm})(B_y - 50 \text{ N}) - (22 \text{ cm})(30 \text{ N}) - (30 \text{ cm})(10 \text{ N}) = 0$$

$$\Rightarrow B_y = \frac{(1800 \text{ N} \cdot \text{cm})}{(12 \text{ cm})} = 150.0 \text{ N} \quad \Rightarrow \quad \mathbf{B} = 150.0 \text{ N} \uparrow$$

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

$$(12 \text{ cm}) A + (6 \text{ cm})(40 \text{ N}) - (10 \text{ cm})(30 \text{ N}) - (18 \text{ cm})(10 \text{ N}) = 0$$

$$\Rightarrow A = \frac{(240 \text{ N} \cdot \text{cm})}{(12 \text{ cm})} = 20.0 \text{ N} \quad \Rightarrow \quad \mathbf{A} = 20.0 \text{ N} \downarrow$$



(b)  $a = 7 \text{ cm}$

$$\rightarrow \Sigma F_x = 0 ; \quad B_x = 0$$

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

$$-(6 \text{ cm})(40 \text{ N}) + (12 \text{ cm})(B_y - 50 \text{ N}) - (19 \text{ cm})(30 \text{ N}) - (27 \text{ cm})(10 \text{ N}) = 0$$

$$\Rightarrow B_y = \frac{(1680 \text{ N} \cdot \text{cm})}{(12 \text{ cm})} = 140.0 \text{ N} \quad \Rightarrow \quad \mathbf{B} = 140.0 \text{ N} \uparrow$$

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

$$(12 \text{ cm}) A + (6 \text{ cm})(40 \text{ N}) - (7 \text{ cm})(30 \text{ N}) - (15 \text{ cm})(10 \text{ N}) = 0$$

$$\Rightarrow A = \frac{(120 \text{ N} \cdot \text{cm})}{(12 \text{ cm})} = 10.00 \text{ N} \quad \Rightarrow \quad \mathbf{A} = 10.00 \text{ N} \downarrow$$

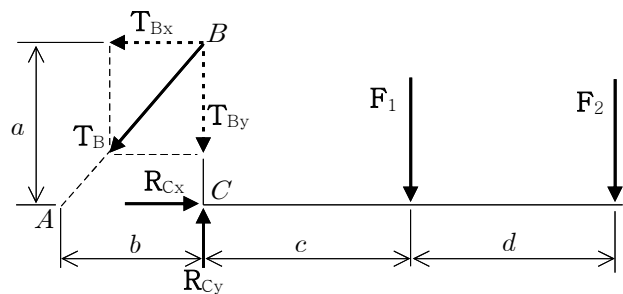
4.15 [ 반력(케이블, 힌지), 평형(힘, 모멘트) ]

$$a = 0.18 \text{ m}, \quad b = 0.24 \text{ m}$$

$$c = 0.4 \text{ m}, \quad d = 0.4 \text{ m}$$

$$F_1 = F_2 = 240 \text{ N}$$

$$T_{Bx} = \frac{4}{5} T_B, \quad T_{By} = \frac{3}{5} T_B$$



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

$$a T_{Bx} - c F_1 - (c+d) F_2 = 0$$

$$\Rightarrow T_{Bx} = \frac{1}{a} [c F_1 + (c+d) F_2]$$

$$= \frac{1}{0.18 \text{ m}} [(0.4 \text{ m})(240 \text{ N}) + (0.8 \text{ m})(240 \text{ N})]$$

$$= \frac{288 \text{ N} \cdot \text{m}}{0.18 \text{ m}} = 1600 \text{ N}$$

$$T_B = \frac{5}{4} T_{Bx} = \frac{5}{4} (1600 \text{ N}) = 2000 \text{ N} = 2.00 \text{ kN}$$

$$\begin{aligned}
\text{(b) } \rightarrow \Sigma F_x = 0 ; \quad R_{Cx} - T_{Bx} &= 0 \\
&\Rightarrow R_{Cx} = T_{Bx} = 1600 \text{ N} \\
\uparrow \Sigma F_y = 0 ; \quad R_{Cy} - T_{By} - F_1 - F_2 &= 0 \\
&\Rightarrow R_{Cy} = T_{By} + F_1 + F_2 \\
&= \frac{3}{5} (2000 \text{ N}) + (240 \text{ N}) + (240 \text{ N}) = 1680 \text{ N}
\end{aligned}$$

$$R_C = \sqrt{R_{Cx}^2 + R_{Cy}^2} = \sqrt{(1600 \text{ N})^2 + (1680 \text{ N})^2} = 2320 \text{ N} = 2.32 \text{ kN}$$

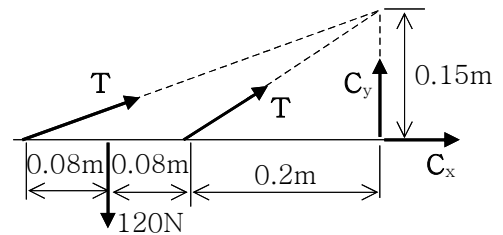
$$\tan \theta = \frac{R_{Cy}}{R_{Cx}} = \frac{1680 \text{ N}}{1600 \text{ N}} = 1.050 \quad \Rightarrow \quad \theta = \tan^{-1}(1.050) = 46.40^\circ$$

$$\Rightarrow \quad \mathbf{R}_C = 2.32 \text{ kN} \nearrow 46.4^\circ$$

4.32 [ 반력(힌지, 케이블), 평형(힘, 모멘트) ]

$$AD = \sqrt{(0.36 \text{ m})^2 + (0.15 \text{ m})^2} = 0.390 \text{ m}$$

$$BD = \sqrt{(0.20 \text{ m})^2 + (0.15 \text{ m})^2} = 0.250 \text{ m}$$



$$\text{(a) } +\uparrow \Sigma M_C = 0 ;$$

$$(0.28 \text{ m})(120 \text{ N}) - (0.36 \text{ m}) \frac{0.15}{0.39} T - (0.20 \text{ m}) \frac{0.15}{0.25} T = 0$$

$$\Rightarrow \quad T = 130.0 \text{ N}$$

$$\text{(b) } \rightarrow \Sigma F_x = 0 ; \quad C_x + \frac{0.36}{0.39}(130.0 \text{ N}) + \frac{0.20}{0.25}(130.0 \text{ N}) = 0$$

$$\Rightarrow \quad C_x = -224 \text{ N}$$

$$\uparrow \Sigma F_y = 0 ; \quad C_y - (120 \text{ N}) + \frac{0.15}{0.39}(130.0 \text{ N}) + \frac{0.15}{0.25}(130.0 \text{ N}) = 0$$

$$\Rightarrow \quad C_y = -8.00 \text{ N}$$

$$C = \sqrt{C_x^2 + C_y^2} = \sqrt{(-224 \text{ N})^2 + (-8 \text{ N})^2} = 224.14 \text{ N}$$

$$\tan \theta = \frac{C_y}{C_x} = \frac{-8 \text{ N}}{-224 \text{ N}} = 0.03571 \quad \Rightarrow \quad \theta = \tan^{-1}(0.03571) = 2.0454^\circ$$

$$\Rightarrow \quad \mathbf{C} = 224 \text{ N} \nearrow 2.05^\circ$$

4.46 [ 반력(고정 지지), 평형(힘, 모멘트) ]

$$T = 20 \text{ N}, \quad r = 10 \text{ mm}$$

$$a = 45 \text{ mm}, \quad b = 75 \text{ mm}$$

$$\rightarrow \Sigma F_x = 0 ; \quad R_x + T = 0$$

$$\Rightarrow R_x = -T = -20 \text{ N}$$

$$\Rightarrow R_x = 20.0 \text{ N} \leftarrow$$

$$\uparrow \Sigma F_y = 0 ; \quad R_y - T = 0$$

$$\Rightarrow R_y = T = 20 \text{ N} \quad \Rightarrow \quad R_y = 20.0 \text{ N} \uparrow$$

$$+\uparrow \Sigma M_C = 0 ; \quad M_C + T(a+r) + T(2b+r) = 0$$

$$\Rightarrow M_C = -T(a+r) - T(2b+r) = -(20 \text{ N})(45+10 \text{ mm}) - (20 \text{ N})[2(75)+10 \text{ mm}]$$

$$= -4300 \text{ N}\cdot\text{mm} = -4.30 \text{ N}\cdot\text{m}$$

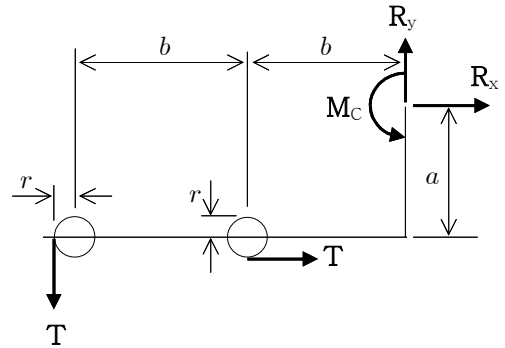
$$\Rightarrow M_C = 4.30 \text{ N}\cdot\text{m} \uparrow$$

반력의 다른 표현

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(-20 \text{ N})^2 + (20 \text{ N})^2} = 28.28 \text{ N}$$

$$\tan \theta = \frac{R_y}{R_x} = \frac{20 \text{ N}}{-20 \text{ N}} = -1.000 \quad \Rightarrow \quad \theta = \tan^{-1}(-1.000) = -45.0^\circ$$

$$\Rightarrow R = 28.3 \text{ N} \searrow 45.0^\circ$$



<다른 방법>

$$M_A = T r = (20 \text{ N})(10 \text{ mm}) = 200 \text{ N}\cdot\text{mm}$$

$$M_B = T r = (20 \text{ N})(10 \text{ mm}) = 200 \text{ N}\cdot\text{mm}$$

$$\rightarrow \Sigma F_x = 0 ; \quad R_x + T = 0$$

$$\Rightarrow R_x = -T = -20 \text{ N}$$

$$\Rightarrow R_x = 20.0 \text{ N} \leftarrow$$

$$\uparrow \Sigma F_y = 0 ; \quad R_y - T = 0$$

$$\Rightarrow R_y = T = 20 \text{ N} \quad \Rightarrow \quad R_y = 20.0 \text{ N} \uparrow$$

$$+\uparrow \Sigma M_C = 0 ; \quad M_C + M_A + M_B + T a + T(2b) = 0$$

$$\Rightarrow M_C = -M_A - M_B - T a - T(2b)$$

$$= -(200 \text{ N}\cdot\text{mm}) - (200 \text{ N}\cdot\text{mm}) - (20 \text{ N})(45 \text{ mm}) - (20 \text{ N})[2(75 \text{ mm})]$$

$$= -4300 \text{ N}\cdot\text{mm} = -4.30 \text{ N}\cdot\text{m}$$

$$\Rightarrow M_C = 4.30 \text{ N}\cdot\text{m} \uparrow$$

