

<3.12~3.16 >

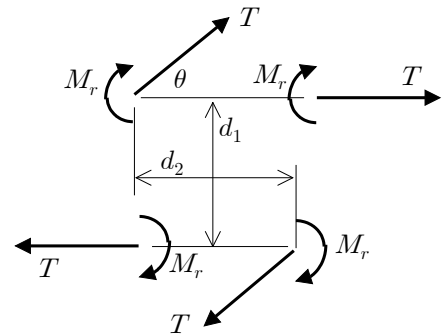
3.70 [(20 cm 8 cm)]

$$r = 0.02 \text{ m}, \quad T = 10 \text{ N}, \quad M_r = T r$$

$$d_1 = a + (0.08 \text{ m}), \quad d_2 = 2a$$

$$\begin{aligned} M &= -T d_1 - (T \cos\theta)d_1 - (T \sin\theta)d_2 - 4 M_r \\ &= -T [d_1 (1+\cos\theta) + d_2 \sin\theta + 4 r] \\ &= -(10 \text{ N}) [(a + 0.08 \text{ m})(1+\cos\theta) \\ &\quad + 2a \sin\theta + 4(0.02 \text{ m})] \end{aligned}$$

$$\tan\theta = \frac{a + (0.08 \text{ m})}{2a}$$



(a) $a = 0.08 \text{ m}, \quad \theta = \tan^{-1}1 = 45^\circ$

$$\begin{aligned} M &= -(10 \text{ N}) [(0.08 \text{ m} + 0.08 \text{ m})(1+\cos45^\circ) + 2(0.08 \text{ m}) \sin45^\circ + 4(0.02 \text{ m})] \\ &= -4.66 \text{ N}\cdot\text{m} \quad \mathbf{M} = 4.66 \text{ N}\cdot\text{m} \uparrow \quad (\quad) \end{aligned}$$

(b) < challenge >

$$\cos\theta = \frac{2a}{\sqrt{(2a)^2 + (a+0.08 \text{ m})^2}}, \quad \sin\theta = \frac{a+0.08 \text{ m}}{\sqrt{(2a)^2 + (a+0.08 \text{ m})^2}}$$

$$M = -480 \text{ N}\cdot\text{cm} = -4.8 \text{ N}\cdot\text{m}$$

$$-4.8 \text{ N}\cdot\text{m} = -(10 \text{ N}) [(a + 0.08 \text{ m})(1+\cos\theta) + 2a \sin\theta + 4(0.02 \text{ m})]$$

$$(a + 0.08 \text{ m})(1+\cos\theta) + 2a \sin\theta + 4(0.02 \text{ m}) = 0.48 \text{ m}$$

$$(a + 0.08 \text{ m})(1+\cos\theta) + 2a \sin\theta = 0.40 \text{ m}$$

$$(a + 0.08 \text{ m}) \cos\theta + 2a \sin\theta = (0.40 \text{ m}) - (a + 0.08 \text{ m})$$

$$(a + 0.08 \text{ m}) \frac{2a}{\sqrt{(2a)^2 + (a+0.08 \text{ m})^2}} + 2a \frac{a+0.08 \text{ m}}{\sqrt{(2a)^2 + (a+0.08 \text{ m})^2}} = 0.32 \text{ m} - a$$

$$2 (2a) (a + 0.08 \text{ m}) = (0.32 \text{ m} - a) \sqrt{(2a)^2 + (a+0.08 \text{ m})^2}$$

software (가 Mathematica, Matlab), computer programming
 $a = 0.0844 \text{ m} = 8.44 \text{ cm}$ ()

3.86 []

$$\begin{aligned} \mathbf{F} ; \quad \mathbf{R} &= \mathbf{F}_A + \mathbf{F}_C \\ &= (260 \text{ N})(\cos 10^\circ \mathbf{i} - \sin 10^\circ \mathbf{k}) \\ &\quad + (320 \text{ N})(-\cos 8^\circ \mathbf{i} - \sin 8^\circ \mathbf{k}) \\ &= -60.836 \mathbf{i} - 89.684 \mathbf{k} \text{ (N)} \end{aligned}$$

< 1 >

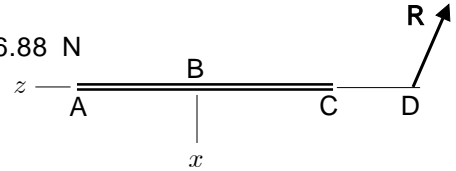
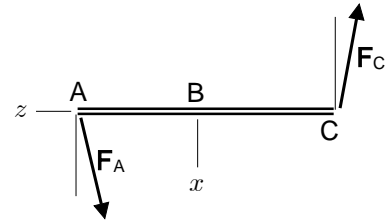
$$M_A ; r_{AD} R_x = r_{AC} F_{Cx}, \quad R_x = 60.836 \text{ N,}$$

$$F_{Cx} = (320 \text{ N}) \cos 8^\circ = 316.88 \text{ N}$$

$$r_{AD} = r_{AC} \frac{F_{Cx}}{R_x}$$

$$= (0.32 \text{ m} + 0.37 \text{ m}) \frac{316.88}{60.836} = 3.594 \text{ m}$$

$$r_{BD} = r_{AD} - r_{AB} = (3.594 \text{ m}) - (0.320 \text{ m}) = 3.274 \text{ m}$$



< 2 >

$$M_B ; r_{BD} R_x = r_{BA} F_{Ax} + r_{BC} F_{Cx}, \quad R_x = 60.836 \text{ N,}$$

$$F_{Ax} = (260 \text{ N}) \cos 10^\circ = 256.05 \text{ N}$$

$$F_{Cx} = (320 \text{ N}) \cos 8^\circ = 316.88 \text{ N}$$

$$r_{BD} = \frac{1}{R_x} (r_{BA} F_{Ax} + r_{BC} F_{Cx})$$

$$= \frac{1}{60.836 \text{ N}} [(0.32 \text{ m})(256.05 \text{ N}) + (0.37 \text{ m})(316.88 \text{ N})] = 3.274 \text{ m}$$

B C 3.27 m -60.8 i - 89.7 k (N)

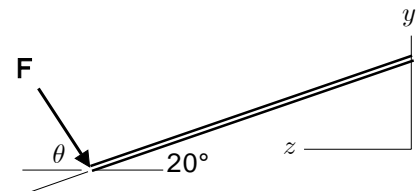
3.94 []

$$F = 220 \text{ N,} \quad \theta = 80^\circ - 20^\circ = 60^\circ$$

$$\lambda = -\sin 60^\circ \mathbf{j} - \cos 60^\circ \mathbf{k} = -0.8660 \mathbf{j} - 0.5 \mathbf{k}$$

$$\mathbf{R} = F \lambda = (220 \text{ N}) (-0.8660 \mathbf{j} - 0.5 \mathbf{k})$$

$$= -190.52 \mathbf{j} - 110.0 \mathbf{k} \text{ (N)}$$



$$\mathbf{r}_{OC} = (0.2) \mathbf{i} + (0.1 - 0.4 \sin 20^\circ) \mathbf{j} + (0.4 \cos 20^\circ) \mathbf{k} \text{ (m)}$$

$$= 0.2 \mathbf{i} - 0.03681 \mathbf{j} + 0.37588 \mathbf{k} \text{ (m)}$$

$$\mathbf{M}_O = \mathbf{r}_{OC} \times \mathbf{R}$$

$$= [0.2 \mathbf{i} - 0.03681 \mathbf{j} + 0.37588 \mathbf{k} \text{ (m)}] \times [-190.52 \mathbf{j} - 110.0 \mathbf{k} \text{ (N)}]$$

$$= [(-0.03681)(-110.0) - (0.37588)(-190.52)] \mathbf{i}$$

$$+ [0 - (0.2)(-110.0)] \mathbf{j} + [(0.2)(-190.52) - 0] \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$= 75.661 \mathbf{i} + 22.0 \mathbf{j} - 38.104 \mathbf{k} \text{ (N}\cdot\text{m)}$$

O 가 : $\mathbf{R} = -190.5 \mathbf{j} - 110.0 \mathbf{k} \text{ (N)}$

$\mathbf{M}_O = 75.7 \mathbf{i} + 22.0 \mathbf{j} - 38.1 \mathbf{k} \text{ (N}\cdot\text{m)}$