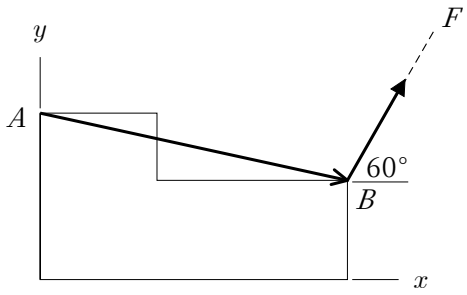
{3.1~3.8절}

3.7　[모멘트 직각성분 (2차원)]

T_{BF} = 200 N,



(a) $\mathbf{r}_{B/A}$ = 2 **i** - (1.35 - 0.95) **j** (m)

= 2 **i** - 0.40 **j** (m)

$\mathbf{T}_{BF}$ = (200 N) (cos60° **i** + sin60° **j**)

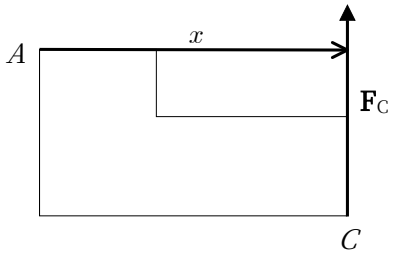
= 100 **i** + 173.2 **j** (N)

$\mathbf{M}_A = \mathbf{r}_{B/A} \times \mathbf{T}_{BF}$

= [2 **i** - 0.40 **j** (m)] × [100 **i** + 173.2 **j** (N)]

= [(2)(173.2) - (-0.40)(100)] **k** (N·m) = 386.4 N·m **k**

⇒　$\mathbf{M}_A$ = 386 N·m ⟩

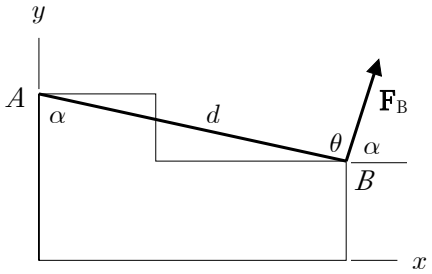


(b) M_A = 386.4 N·m,　x = 2 m

$M_A = x\, F_C$

⇒　$F_C = \dfrac{M_A}{x} = \dfrac{386.4\ \text{N}\cdot\text{m}}{2\ \text{m}} = 193.2\ \text{N}$

⇒　$\mathbf{F}_C$ = 193.2 N ↑



(c) $d = \sqrt{(2\ \text{m})^2 + (0.40\ \text{m})^2} = 2.040$ m

$M_A = d\, F_B \sin\theta = d\, (F_B)_{\min}$　　θ = 90°

⇒　$(F_B)_{\min} = \dfrac{M_A}{d} = \dfrac{386.4\ \text{N}\cdot\text{m}}{2.040\ \text{m}} = 189.4$ N

$\tan\alpha = \dfrac{2\ \text{m}}{0.4\ \text{m}} = 5$　⇒　$\alpha = \tan^{-1}(5) = 78.7°$

$(\mathbf{F}_B)_{\min}$ = 189.4 N ∠78.7°

3.9　[모멘트 직각성분 (2차원)]

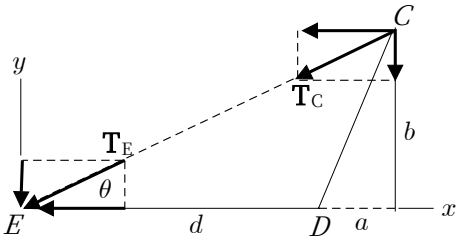
T_{BC} = 260 N,　a = 8 cm,　b = 35 cm,　d = 76 cm

$\tan\theta = \dfrac{b}{a+d} = \dfrac{35\ \text{cm}}{(8+76)\ \text{cm}} = \dfrac{5}{12}$

⇒　$\cos\theta = \dfrac{12}{13}$,　$\sin\theta = \dfrac{5}{13}$

$T_x = T_{BC}\cos\theta = (260\ \text{N})\ \dfrac{12}{13} = 240$ N

$T_y = T_{BC}\sin\theta = (260\ \text{N})\ \dfrac{5}{13} = 100$ N



$\mathbf{T}_C = \mathbf{T}_E = -T_x\,\mathbf{i} - T_y\,\mathbf{j}$ = -240 **i** - 100 **j** (N)

(a) $\mathbf{r}_{C/D} = a\,\mathbf{i} + b\,\mathbf{j}$ = 8 **i** + 35 **j** (cm)

$\mathbf{M}_D = \mathbf{r}_{C/D} \times \mathbf{T}_C$ = [8 **i** + 35 **j** (cm)] × [-240 **i** - 100 **j** (N)]

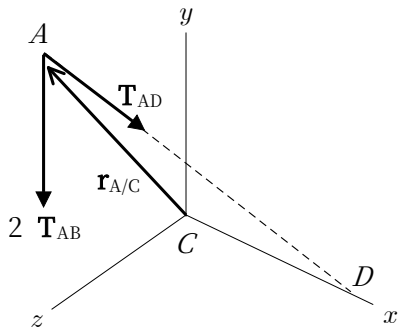
= [(8)(-100) - (35)(-240)] **k** (N·cm) = 7600 **k** N·cm = 76.0 **k** N·m = 76.0 N·m ⟩

(a) $\mathbf{r}_{E/D} = -d\,\mathbf{i}$ = -76 **i** (cm)

$\mathbf{M}_D = \mathbf{r}_{E/D} \times \mathbf{T}_E$ = [-76 **i** (cm)] × [-240 **i** - 100 **j** (N)]

= (-76)(-100) **k** (N·cm) = 7600 **k** N·cm = 76.0 **k** N·m = 76.0 N·m ⟩

3.21 [모멘트 직각성분 (3차원)]



T = 369 N

$\mathbf{r}_{A/C}$ = 3.1 **j** + 1.2 **k** (m)

$\mathbf{T}_{AB}$ = - T **j** = -(369 N) **j**

$$\boldsymbol{\lambda}_{AD} = \frac{2.4\,\mathbf{i} - 3.1\,\mathbf{j} - 1.2\,\mathbf{k}}{\sqrt{(2.4)^2 + (-3.1)^2 + (-1.2)^2}}$$

$$= \frac{1}{4.1}\ (2.4\ \mathbf{i}\ -\ 3.1\ \mathbf{j}\ -\ 1.2\ \mathbf{k})$$

$$\mathbf{T}_{AD} = T\,\boldsymbol{\lambda} = (369\ \text{N})\ \frac{1}{4.1}\ (2.4\ \mathbf{i}\ -\ 3.1\ \mathbf{j}\ -\ 1.2\ \mathbf{k})$$

= 216 **i** - 279 **j** - 108 **k** (N)

$\mathbf{R}$ = 2 $\mathbf{T}_{AB}$ +$\mathbf{T}_{AD}$ = -2 (369 N) **j** + [216 **i** - 279 **j** - 108 **k** (N)]

= 216 **i** - 1017 **j** - 108 **k** (N)

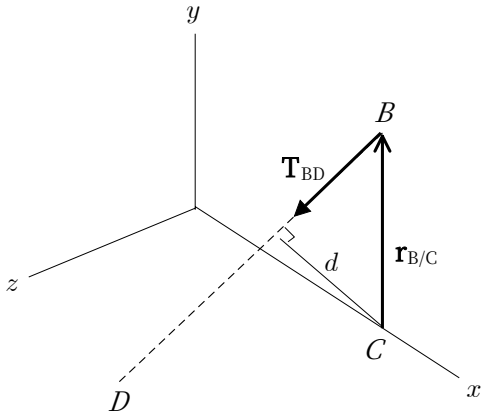
$\mathbf{M}_C = \mathbf{r}_{A/C} \times \mathbf{R}$ = [3.1 **j** + 1.2 **k** (m)] × [216 **i** - 1017 **j** - 108 **k** (N)]

= [(3.1)(-108) - (1.2)(-1017)] **i** + [(1.2)(216)] **j** + [-(3.1)(216)] **k** (N·m)

= 885.6 **i** + 259.2 **j** - 669.6 **k** (N·m)

⇒ $\mathbf{M}_C$ = 886 **i** + 259 **j** - 670 **k** (N·m)

3.30 [모멘트 직각성분 (3차원)]



T_{BD} = 900 N

$\mathbf{r}_{B/C}$ = (2 m) **j**

$$\boldsymbol{\lambda}_{BD} = \frac{-1\,\mathbf{i} - 2\,\mathbf{j} + 2\,\mathbf{k}}{\sqrt{(-1)^2 + (-2)^2 + (2)^2}}$$

$$= \frac{1}{3}\ (-1\ \mathbf{i}\ -\ 2\ \mathbf{j}\ +\ 2\ \mathbf{k})$$

$$\mathbf{T}_{BD} = T_{BD}\ \boldsymbol{\lambda}_{BD} = \frac{T_{BD}}{3}\ (-1\ \mathbf{i}\ -\ 2\ \mathbf{j}\ +\ 2\ \mathbf{k})$$

$\mathbf{M}_C = \mathbf{r}_{B/C} \times \mathbf{T}_{BD}$

$$= [(2\ \text{m})\ \mathbf{j}] \times \left[\frac{T_{BD}}{3}\ (-1\ \mathbf{i}\ -\ 2\ \mathbf{j}\ +\ 2\ \mathbf{k})\right] = \frac{(2\ \text{m})\ T_{BD}}{3}\ (2\ \mathbf{i}\ +\ 1\ \mathbf{k})$$

$$M_C = \frac{(2\ \text{m})\ T_{BD}}{3}\ \sqrt{2^2 + 1^2} = \frac{(2\ \text{m})\ \sqrt{5}\ T_{BD}}{3}$$

$M_C = d\ T_{BD}$

$$\Rightarrow \quad d = \frac{M_C}{T_{BD}} = \frac{(2\ \text{m})\ \sqrt{5}}{3} = 1.4907\ \text{m} \qquad \Rightarrow \qquad d = 1.491\ \text{m}$$