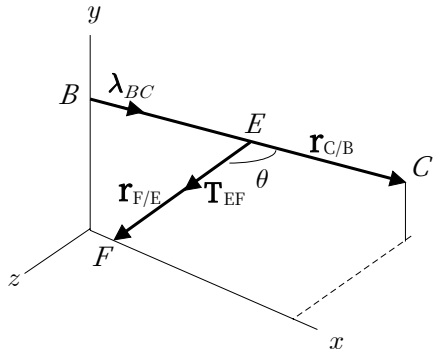
{3.9~3.11절}

3.39 [스칼라 곱 응용 : 각, 투영]



(a) EF; $d_x = 2 - \frac{32}{2}$ (m) = -14 m

$d_y = 0 - \frac{16.5+7.5}{2}$ (m) = -12 m

$d_z = 0 - \frac{-24}{2}$ (m) = 12 m

$\mathbf{r}_{F/E}$ = -14 **i** - 12 **j** + 12 **k** (m)

$r_{F/E} = \sqrt{(-14\,\text{m})^2 + (-12\,\text{m})^2 + (12\,\text{m})^2}$ = 22 m

BC; d_x = 32 m, d_y = 7.5 - 16.5 (m) = -9 m, d_z = (-24) - 0 (m) = -24 m

$\mathbf{r}_{C/B}$ = 32 **i** - 9 **j** - 24 **k** (m)

$r_{C/B} = \sqrt{(32\,\text{m})^2 + (-9\,\text{m})^2 + (-24\,\text{m})^2}$ = 41 m

$\mathbf{r}_{F/E} \cdot \mathbf{r}_{C/B}$ = [-14 **i** - 12 **j** + 12 **k** (m)] · [32 **i** - 9 **j** - 24 **k** (m)]

= (-14)(32) + (-12)(-9) + (12)(-24) (m^2) = -628 (m^2)

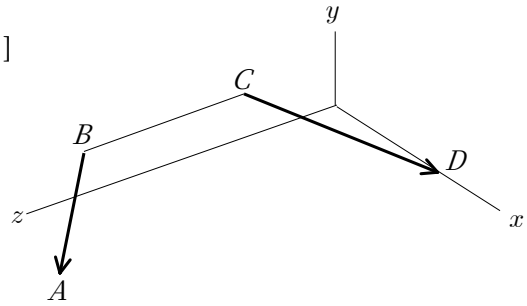
$\cos\theta = \frac{\mathbf{r}_{F/E} \cdot \mathbf{r}_{C/B}}{r_{F/E}\, r_{C/B}} = \frac{(-628\,\text{m}^2)}{(22\,\text{m})(41\,\text{m})}$ = -0.6962

$\theta = \cos^{-1}(-0.6962) = 134.12°$ ⇒ θ = 134.1°

(b) $\mathbf{T}_{EF} \cdot \boldsymbol{\lambda}_{BC} = (T_{EF}\ \boldsymbol{\lambda}_{EF}) \cdot \boldsymbol{\lambda}_{BC} = T_{EF}\ (\boldsymbol{\lambda}_{EF} \cdot \boldsymbol{\lambda}_{BC}) = T_{EF} \cos\theta$

= (110 N) (-0.6962) = -76.585 N ⇒ $\mathbf{T}_{EF} \cdot \boldsymbol{\lambda}_{BC}$ = -76.6 N

3.47 [좌표 축 z에 대한 모멘트 $M_z = \mathbf{k} \cdot (\mathbf{r} \times \mathbf{F})$]



$\mathbf{M}_z$ = -(48 N·m) **k** , T_{BA} = 14 N

$(\mathbf{r}_B)_y = (\mathbf{r}_C)_y$ = (3 m) **j**

$\mathbf{T}_{BA} = T_{BA}\ \frac{(4.5\,\text{m})\mathbf{i} + (-3\,\text{m})\mathbf{j} + (9\,\text{m})\mathbf{k}}{\sqrt{(4.5\,\text{m})^2 + (-3\,\text{m})^2 + (9\,\text{m})^2}}$

= $\frac{14\,\text{N}}{10.5}$ (4.5 **i** - 3 **j** + 9 **k**) = 6 **i** - 4 **j** + 12 **k** (N)

$(\mathbf{r}_B)_y \times \mathbf{T}_{BA}$ = [(3 m) **j**] × [6 **i** - 4 **j** + 12 **k** (N)] = 36 **i** - 18 **k** (N·m)

k · $[(\mathbf{r}_B)_y \times \mathbf{T}_{BA}]$ = **k** · [36 **i** - 18 **k** (N·m)] = -18 (N·m)

$\mathbf{T}_{CD} = T_{CD}\ \frac{(6\,\text{m})\mathbf{i} + (-3\,\text{m})\mathbf{j} + (-6\,\text{m})\mathbf{k}}{\sqrt{(6\,\text{m})^2 + (-3\,\text{m})^2 + (-6\,\text{m})^2}} = \frac{T_{CD}}{9}$ (6 **i** - 3 **j** - 6 **k**)

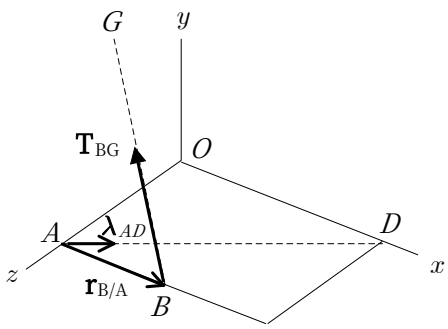
$(\mathbf{r}_C)_y \times \mathbf{T}_{CD}$ = [(3 m) **j**] × [$\frac{T_{CD}}{9}$ (6 **i** - 3 **j** - 6 **k**)] = T_{CD} [-2 **i** - 2 **k** (m)]

k · $[(\mathbf{r}_C)_y \times \mathbf{T}_{CD}]$ = **k** · {T_{CD} [-2 **i** - 2 **k** (m)]} = -(2 m) T_{CD}

$M_z = \mathbf{k} \cdot [(\mathbf{r}_B)_y \times \mathbf{T}_{BA}] + \mathbf{k} \cdot [(\mathbf{r}_C)_y \times \mathbf{T}_{CD}]$

-(48 N·m) = -18 (N·m) - (2 m) T_{CD} ⇒ T_{CD} = 15.00 N

3.54 [축 OL에 대한 모멘트 $M_{OL} = \boldsymbol{\lambda}_{OL} \cdot (\mathbf{r} \times \mathbf{F})$]



$T_{BG} = 1125$ N

$$\boldsymbol{\lambda}_{AD} = \frac{(0.4\text{ m} + 0.4\text{m})\mathbf{i} + (-0.6\text{ m})\mathbf{k}}{\sqrt{(0.8\text{ m})^2 + (-0.6\text{ m})^2}}$$

$$= \frac{1}{1.0\text{ m}}[(0.8\text{ m})\mathbf{i} + (-0.6\text{ m})\mathbf{k}]$$

$$= 0.8\,\mathbf{i} - 0.6\,\mathbf{k}$$

$\mathbf{r}_{B/A} = (0.4\text{ m})\,\mathbf{i}$

BG ; $d_x = -0.4$ (m), $d_y = 0.74$ (m), $d_z = 0.28 - 0.6$ (m) $= -0.32$ (m)

$$\boldsymbol{\lambda}_{BG} = \frac{(-0.4\text{ m})\mathbf{i} + (0.74\text{ m})\mathbf{j} + (-0.32\text{ m})\mathbf{k}}{\sqrt{(-0.4\text{m})^2 + (0.74\text{ m})^2 + (-0.32\text{ m})^2}} = \frac{1}{0.9}[(-0.4)\mathbf{i} + (0.74)\mathbf{j} + (-0.32)\mathbf{k}]$$

$$\mathbf{T}_{BG} = T_{BG}\,\boldsymbol{\lambda}_{BG} = (1125\text{ N})\,\frac{1}{0.9}[(-0.4)\mathbf{i} + (0.74)\mathbf{j} + (-0.32)\mathbf{k}]$$

$$= (-500\text{ N})\,\mathbf{i} + (925\text{ N})\,\mathbf{j} + (-400\text{ N})\,\mathbf{k}$$

$$\mathbf{r}_{B/A} \times \mathbf{T}_{BG} = [(0.4\text{ m})\,\mathbf{i}] \times [(-500\text{ N})\,\mathbf{i} + (925\text{ N})\,\mathbf{j} + (-400\text{ N})\,\mathbf{k}]$$

$$= [0]\,\mathbf{i} + [0 - (0.4\text{ m})(-400\text{ N})]\,\mathbf{j} + [(0.4\text{ m})(925\text{ N}) - 0]\,\mathbf{k}$$

$$= 160\,\mathbf{j} + 370\,\mathbf{k} \quad (\text{N·m})$$

$$M_{AD} = \boldsymbol{\lambda}_{AD} \cdot (\mathbf{r}_{B/A} \times \mathbf{T}_{BG})$$

$$= [0.8\,\mathbf{i} - 0.6\,\mathbf{k}] \cdot [160\,\mathbf{j} + 370\,\mathbf{k}] \quad (\text{N·m})$$

$$= 0 + 0 + (-0.6)(370) \quad (\text{N·m})$$

$$= -222\ (\text{N·m}) \qquad \Rightarrow \qquad M_{AD} = -222\text{ N·m}$$