<3.1~3.8절>

3.2　[한 점에 대한 모멘트 (2차원)]

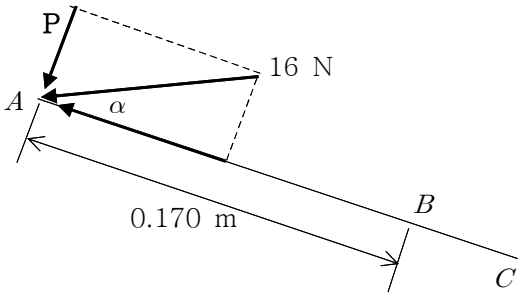
α = 28°,　$r_{A/B}$ = 0.170 m

P = (16 N) sin28° = 7.512 N

$M_B = r_{A/B}\ P$

= (0.170 m)(7.512 N) = 1.2770 N·m

⇒　$\mathbf{M}_B$ = 1.277 N·m ↻



3.12　[모멘트 직각성분 (2차원)]

F = 500 N

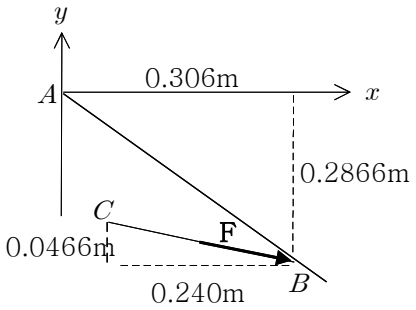
$x_{B/A}$ = 0.306 m,　　$y_{B/A}$ = -0.2866 m

d_x = 0.240 m,　d_y = -0.0466 m

$d_{CB} = \sqrt{(0.240\ \text{m})^2 + (-0.0466\ \text{m})^2}$ = 0.2444 m

$F_x = (500\ \text{N})\dfrac{0.240\ \text{m}}{0.2444\ \text{m}}$ = 491.0 N

$F_y = -(500\ \text{N})\dfrac{0.0466\ \text{m}}{0.2444\ \text{m}}$ = -95.34 N



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

$= (x_{B/A}\ \mathbf{i} + y_{B/A}\ \mathbf{j}) \times (F_x\ \mathbf{i} + F_y\ \mathbf{j}) = [x_{B/A}\ F_y\ - y_{B/A}\ F_x]\ \mathbf{k}$

= [(0.306 m)(-95.34 N) - (-0.2866 m)(491.0 N)] $\mathbf{k}$ = 111.54 N·m $\mathbf{k}$

⇒　$\mathbf{M}_A$ = 111.5 N·m ↻

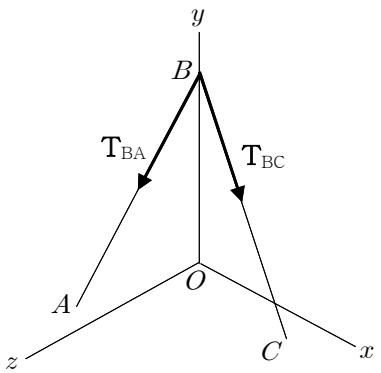
3.22　[합력의 모멘트의 직각성분 (3차원)]

T_{BA} = 555 N,　T_{BC} = 660 N

$\mathbf{r}_{B/O}$ = 7.00 $\mathbf{j}$ (m)

$\boldsymbol{\lambda}_{BA} = \dfrac{-0.75\,\mathbf{i} - 7\,\mathbf{j} + 6\,\mathbf{k}}{\sqrt{(-0.75)^2 + (-7)^2 + (6)^2}}$

$= \dfrac{1}{9.25}\ (-0.75\ \mathbf{i} - 7\ \mathbf{j} + 6\ \mathbf{k})$



$\mathbf{T}_{BA} = T_{BA}\ \boldsymbol{\lambda}_{BA} = \dfrac{555\ \text{N}}{9.25}\ (-0.75\ \mathbf{i} - 7\ \mathbf{j} + 6\ \mathbf{k}) = -45.0\ \mathbf{i} - 420\ \mathbf{j} + 360\ \mathbf{k}$ (N)

$\boldsymbol{\lambda}_{BC} = \dfrac{4.25\,\mathbf{i} - 7\,\mathbf{j} + 1\,\mathbf{k}}{\sqrt{(4.25)^2 + (-7)^2 + (1)^2}} = \dfrac{1}{8.25}\ (4.25\ \mathbf{i} - 7\ \mathbf{j} + 1\ \mathbf{k})$

$\mathbf{T}_{BC} = T_{BC}\ \boldsymbol{\lambda}_{BC} = \dfrac{660\ \text{N}}{8.25}\ (4.25\ \mathbf{i} - 7\ \mathbf{j} + 1\ \mathbf{k}) = 340\ \mathbf{i} - 560\ \mathbf{j} + 80\ \mathbf{k}$ (N)

$\mathbf{R} = \mathbf{T}_{BA} + \mathbf{T}_{BC} = [-45.0\ \mathbf{i} - 420\ \mathbf{j} + 360\ \mathbf{k}\ \text{(N)}] + [340\ \mathbf{i} - 560\ \mathbf{j} + 80\ \mathbf{k}\ \text{(N)}]$

$= 295\ \mathbf{i} - 980\ \mathbf{j} + 440\ \mathbf{k}\ \text{(N)}$

$\mathbf{M}_O = \mathbf{r}_{B/O} \times \mathbf{R} = [7.00\ \mathbf{j}\ \text{(m)}] \times [295\ \mathbf{i} - 980\ \mathbf{j} + 440\ \mathbf{k}\ \text{(N)}]$

$= [(7.00)(440)]\ \mathbf{i} + [\ 0\ ]\ \mathbf{j} + [-(7.00)(295)]\ \mathbf{k}\ \text{(N·m)}$

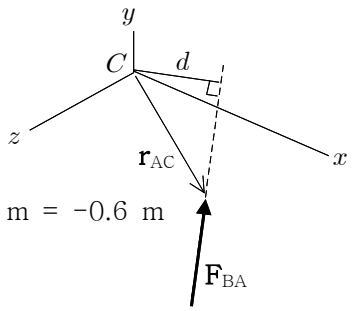
$= 3080\ \mathbf{i} - 2065\ \mathbf{k}\ \text{(N·m)}$

$\Rightarrow \quad \mathbf{M}_O = 3080\ \mathbf{i} - 2070\ \mathbf{k}\ \text{(N·m)}$

3.30 [점에 대한 모멘트 (3차원)]

$F_{BA} = 228\ \text{N}$

$\mathbf{r}_{A/C} = (0.96\ \text{m})\ \mathbf{i} + (-0.12\ \text{m})\ \mathbf{j} + (0.72\ \text{m})\ \mathbf{k}$



$\mathbf{F}_{BA} = \boldsymbol{\lambda}_{BA}\ F_{BA}$

$d_x = -0.1\ \text{m}, \quad d_y = 1.8\ \text{m}, \quad d_z = (0.72 - 1.32)\ \text{m} = -0.6\ \text{m}$

$d = \sqrt{(-0.1\ \text{m})^2 + (1.8\ \text{m})^2 + (-0.6\ \text{m})^2} = 1.90\ \text{m}$

$$\boldsymbol{\lambda}_{BA} = \frac{(-0.1\ \text{m})\mathbf{i} + (1.8\ \text{m})\mathbf{j} + (-0.6\ \text{m})\mathbf{k}}{(1.90\ \text{m})}$$

$$\mathbf{F}_{BA} = F_{BA}\ \boldsymbol{\lambda}_{BA} = (228\ \text{N})\ \frac{(-0.1\ \text{m})\mathbf{i} + (1.8\ \text{m})\mathbf{j} + (-0.6\ \text{m})\mathbf{k}}{(1.90\ \text{m})}$$

$= 120\ (-0.1\ \mathbf{i} + 1.8\ \mathbf{j} - 0.6\ \mathbf{k})\ \text{(N)}$

$= -12.0\ \mathbf{i} + 216\ \mathbf{j} - 72\ \mathbf{k}\ \text{(N)}$

$\mathbf{M}_C = \mathbf{r}_{A/C} \times \mathbf{F}_{BA}$

$= [0.96\ \mathbf{i} - 0.12\ \mathbf{j} + 0.72\ \mathbf{k}\ \text{(m)}] \times [-12.0\ \mathbf{i} + 216\ \mathbf{j} - 72\ \mathbf{k}\ \text{(N)}]$

$= [(-0.12)\times(-72) - 0.72\times216]\ \mathbf{i} + [0.72\times(-12.0) - 0.96\times(-72)]\ \mathbf{j}$

$+ [0.96\times216 - (-0.12)\times(-12.0)]\ \mathbf{k}\ \text{(N·m)}$

$= -146.88\ \mathbf{i} + 60.48\ \mathbf{j} + 205.92\ \mathbf{k}\ \text{(N·m)}$

$\Rightarrow \mathbf{M}_C = -146.9\ \mathbf{i} + 60.5\ \mathbf{j} + 205.9\ \mathbf{k}\ \text{(N·m)}$ <이상 노트 예제: 연습 3.24>

$|M_C| = \sqrt{(-146.88)^2 + (60.48)^2 + (205.92)^2}\ \text{N·m} = 260.07\ \text{N·m}$

$= F_{BA}\ d$

$$\Rightarrow \quad d = \frac{|M_C|}{F_{BA}} = \frac{260.07\ \text{N}\cdot\text{m}}{228\ \text{N}} = 1.1407\ \text{m} \qquad \Rightarrow \quad d = 1.141\ \text{m}$$