{3.9~3.11절}

3.48 [좌표축에 관한 모멘트]

T_{AC} = 1,065 N

$\mathbf{r}_{C/O}$ = 0.9 $\mathbf{i}$ + (0.92+0.36) $\mathbf{k}$ (m)

= 0.9 $\mathbf{i}$ + 1.28 $\mathbf{k}$ (m)

$(d_{CA})x$ = −0.9 m, $(d_{CA})y$ = 0.6 m, $(d_{CA})z$ = −0.92 m

d_{CA} = $\sqrt{(-0.9 \text{ m})^2 + (0.6 \text{ m})^2 + (-0.92 \text{ m})^2}$ = 1.42 m

λ_{CA} = $\dfrac{1}{1.42}$ (−0.9 $\mathbf{i}$ + 0.6 $\mathbf{j}$ − 0.92 $\mathbf{k}$)

$\mathbf{F}_{C}$ = $T_{AC}\,\lambda_{CA}$

= (1,065 N) $\dfrac{1}{1.42}$ (−0.9 $\mathbf{i}$ + 0.6 $\mathbf{j}$ − 0.92 $\mathbf{k}$)

= −675 $\mathbf{i}$ + 450 $\mathbf{j}$ − 690 $\mathbf{k}$ (N)

$\mathbf{M}_{O}$ = $\mathbf{r}_{C/O} \times \mathbf{F}_{C}$

= [0.9 $\mathbf{i}$ + 1.28 $\mathbf{k}$ (m)] × [−675 $\mathbf{i}$ + 450 $\mathbf{j}$ − 690 $\mathbf{k}$ (N)]

= [−(1.28)(450)] $\mathbf{i}$ + [(1.28)(−675)−(0.9)(−690)] $\mathbf{j}$ + [(0.9)(450)] $\mathbf{k}$ (N·m)

= (−576) $\mathbf{i}$ + (−243) $\mathbf{j}$ + (405) $\mathbf{k}$ (N·m)

⇒ M_{x} = $\mathbf{M}_{O} \cdot \mathbf{i}$ = [(−576) $\mathbf{i}$ + (−243) $\mathbf{j}$ + (405) $\mathbf{k}$ (N·m)] · $\mathbf{i}$ = −576 N·m

M_{y} = $\mathbf{M}_{O} \cdot \mathbf{j}$ = [(−576) $\mathbf{i}$ + (−243) $\mathbf{j}$ + (405) $\mathbf{k}$ (N·m)] · $\mathbf{j}$ = −243 N·m

M_{z} = $\mathbf{M}_{O} \cdot \mathbf{k}$ = [(−576) $\mathbf{i}$ + (−243) $\mathbf{j}$ + (405) $\mathbf{k}$ (N·m)] · $\mathbf{k}$ = 405 N·m

3.49 $|M_{z}|$ ≤ 558 N·m, x = 2.4 m

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

λ_{AD} = $\dfrac{(2.4 \text{ m})\mathbf{i} + (-3.1 \text{ m})\mathbf{j} + (-1.2 \text{ m})\mathbf{k}}{\sqrt{(2.4 \text{ m})^2 + (-3.1 \text{ m})^2 + (-1.2 \text{ m})^2}}$

= 0.5854 $\mathbf{i}$ − 0.7561 $\mathbf{j}$ − 0.2927 $\mathbf{k}$

$\mathbf{T}_{AD}$ = $T\,\lambda_{AD}$ = T (0.5854 $\mathbf{i}$ − 0.7561 $\mathbf{j}$ − 0.2927 $\mathbf{k}$)

$\mathbf{R}_{A}$ = 2 $\mathbf{T}_{AB}$ + $\mathbf{T}_{AD}$

= −2 T $\mathbf{j}$ + T (0.5854 $\mathbf{i}$ − 0.7561 $\mathbf{j}$ − 0.2927 $\mathbf{k}$)

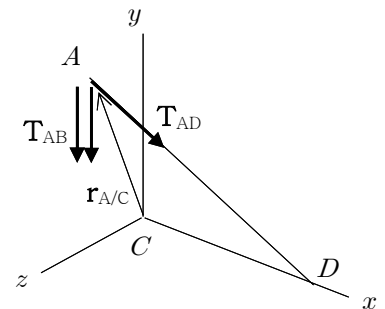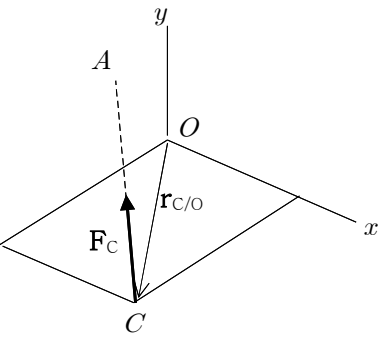= T (0.5854 $\mathbf{i}$ − 2.7561 $\mathbf{j}$ − 0.2927 $\mathbf{k}$)

$\mathbf{M}_{C}$ = $\mathbf{r}_{A/C} \times \mathbf{R}_{A}$ ($\mathbf{r}_{A/C}$ 대신 (3.1 m)$\mathbf{j}$ 를 사용하는 게 더 좋음)

= [3.1 $\mathbf{j}$ + 1.2 $\mathbf{k}$ (m)] × [T (0.5854 $\mathbf{i}$ − 2.7561 $\mathbf{j}$ − 0.2927 $\mathbf{k}$)]

= T {[(3.1)(−0.2927)−(1.2)(−2.7561)] $\mathbf{i}$

+ [(1.2)(0.5854)] $\mathbf{j}$ + [−(3.1)(0.5854)] $\mathbf{k}$ (m)}

= T [(2.40) $\mathbf{i}$ + (0.702) $\mathbf{j}$ + (−1.814) $\mathbf{k}$ (m)]

M_{z} = $\mathbf{k} \cdot \mathbf{M}_{C}$ = $\mathbf{k} \cdot T$ [(2.40) $\mathbf{i}$ + (0.702) $\mathbf{j}$ + (−1.814) $\mathbf{k}$ (m)] = (−1.814 m) T

$|M_{z}|$ = (1.814 m) T ≤ 558 N·m

$T \leq \dfrac{558 \text{ N} \cdot \text{m}}{1.814 \text{ m}}$ = 307.6 N   ⇒ T_{max} = 308 N

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

$\quad T_{CF}$ = 33 N

$\boldsymbol{\lambda}_{DB} = \dfrac{(0.9 + 0.3 \text{ m})\mathbf{i} - (0.7 - 0.35 \text{ m})\mathbf{j}}{\sqrt{(1.2 \text{ m})^2 + (-0.35 \text{ m})^2}}$

$\qquad = 0.96 \ \mathbf{i} - 0.28 \ \mathbf{j}$

$\mathbf{r}_{C/D} = 0 \ \mathbf{i} + (0.9 - 0.7) \ \mathbf{j} + (-0.4) \ \mathbf{k} \text{ (m)}$

$\qquad = 0.2 \ \mathbf{j} - 0.4 \ \mathbf{k} \text{ (m)}$

$\mathbf{T}_{CF} = T_{CF} \quad \boldsymbol{\lambda}_{CF}$

$\qquad = (33 \text{ N}) \ \dfrac{(0.6 \text{ m})\mathbf{i} + (-0.9 \text{ m})\mathbf{j} - (0.6 \text{ m} - 0.4 \text{ m})\mathbf{k}}{\sqrt{(0.6 \text{ m})^2 + (-0.9 \text{ m})^2 + (-0.2 \text{ m})^2}}$

$\qquad = \dfrac{33 \text{ N}}{1.1}(0.6 \ \mathbf{i} - 0.9 \ \mathbf{j} - 0.2 \ \mathbf{k})$

$\qquad = 18 \ \mathbf{i} - 27 \ \mathbf{j} - 6 \ \mathbf{k} \text{ (N)}$

$\mathbf{r}_{C/D} \times \mathbf{T}_{CF} = [0.2 \ \mathbf{j} - 0.4 \ \mathbf{k} \text{ (m)}] \times [18 \ \mathbf{i} - 27 \ \mathbf{j} - 6 \ \mathbf{k} \text{ (N)}]$

$\qquad = [(0.2)\times(-6) - (-0.4)\times(-27)] \ \mathbf{i} + [(-0.4)\times(18)] \ \mathbf{j} + [-(0.2)\times(18)] \ \mathbf{k} \text{ (N·m)}$

$\qquad = -12 \ \mathbf{i} - 7.2 \ \mathbf{j} - 3.6 \ \mathbf{k} \text{ (N·m)}$

$M_{DB} = \boldsymbol{\lambda}_{DB} \cdot \mathbf{M}_D = \boldsymbol{\lambda}_{DB} \cdot (\mathbf{r}_{A/D} \times \mathbf{T}_{AE})$

$\qquad = (0.96 \ \mathbf{i} - 0.28 \ \mathbf{j}) \cdot [-12 \ \mathbf{i} - 7.2 \ \mathbf{j} - 3.6 \ \mathbf{k} \text{ (N·m)}]$

$\qquad = (0.96)(-12) + (-0.28)(-7.2) + 0 = -9.504 \text{ (N·m)}$

$\Rightarrow \qquad M_{DB} = -9.50 \text{ N·m}$