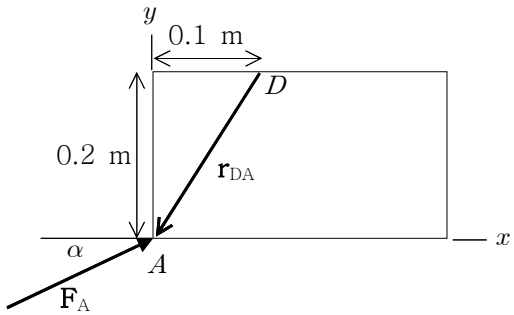
[3.1~3.8절]

3.3　[한 점에 대한 모멘트 (2차원)]

F = 300 N,　α = 25°



(a) $\mathbf{r}_{DA}$ = (−0.100 m) **i** + (−0.200 m) **j**

$F_x = F\cos\alpha$ = (300 N) cos25° = 271.9 N

$F_y = F\sin\alpha$ = (300 N) sin25° = 126.79 N

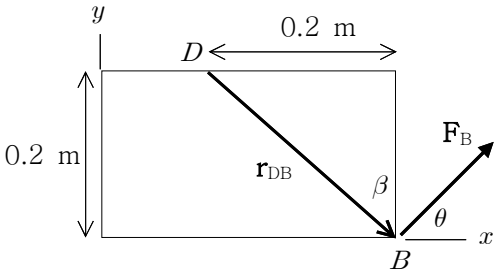
$\mathbf{F}_A$ = (271.9 N) **i** + (126.79 N) **j**

$\mathbf{M}_D = \mathbf{r}_{DA} \times \mathbf{F}_A$

= [(−0.100 m) **i** + (−0.200 m) **j**] × [(271.9 N) **i** + (126.79 N) **j**]

= [(−0.100 m)(126.79 N) − (−0.200 m)(271.9 N)] **k**

= (41.70 N·m) **k**　⇒　$\mathbf{M}_D$ = 41.7 N·m ⤴



(b) $\mathbf{r}_{DB}$ = (0.200 m) **i** + (−0.200 m) **j**

β = 45°

smallest force $\mathbf{F}_B \perp \mathbf{r}_{DB}$　⇒　θ = 45°

$d_{DB} = 0.200\sqrt{2}$ m = 0.2828 m

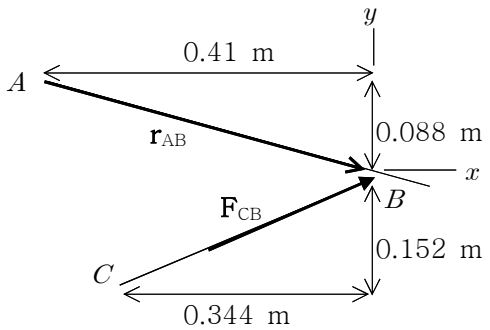
$M_D = d_{DB}\ F_B$

$$\Rightarrow \quad F_B = \frac{M_D}{d_{DB}} = \frac{41.70\ \text{N}\cdot\text{m}}{0.2828\ \text{m}} = 147.45\ \text{N}$$

⇒　$\mathbf{F}_B$ = 147.4 N ⤢45.0°

3.13　[모멘트 직각성분 (2차원)]

F_{CB} = 500 N



$\mathbf{r}_{AB}$ = (0.410 m) **i** + (−0.088 m) **j**

$(d_{CB})x$ = 0.344 m,　$(d_{CB})y$ = 0.152 m

$d_{CB} = \sqrt{(0.344\ \text{m})^2 + (0.152\ \text{m})^2}$ = 0.3761 m

$\boldsymbol{\lambda}_{CB} = \dfrac{1}{0.3761}$ (0.344 **i** + 0.152 **j**)

= 0.9147 **i** + 0.4041 **j**

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

= (500 N) (0.9147 **i** + 0.4041 **j**) = (457.4 N) **i** + (202.1 N) **j**

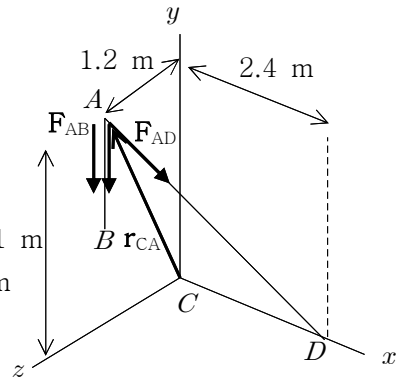
$\mathbf{M}_A = \mathbf{r}_{AB} \times \mathbf{F}_{CB}$

= [(0.410 m) **i** + (−0.088 m) **j**] × [(457.4 N) **i** + (202.1 N) **j**]

= [(0.410 m)(202.1 N) − (−0.088 m)(457.4 N)] **k**

= (123.11) **k**　⇒　$\mathbf{M}_A$ = 123.1 N·m ⤴

3.26 [합력의 모멘트의 직각성분 (3차원)]



T = 369 N

$\mathbf{r}_{CA}$ = (3.10 m) **j** + (1.20 m) **k**

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

$(d_{AD})x$ = 2.40 m, $(d_{AD})y$ = −3.10 m, $(d_{AD})z$ = −1.20 m

$d_{AD} = \sqrt{(2.40\text{ m})^2 + (-3.10\text{ m})^2 + (-1.20\text{ m})^2}$ = 4.10 m

$\boldsymbol{\lambda}_{AD} = \dfrac{1}{4.10}$ (2.40 **i** − 3.10 **j** − 1.20 **k**)

= 0.5854 **i** − 0.7561 **j** − 0.2927 **k**

$\mathbf{F}_{AD} = T\,\boldsymbol{\lambda}_{AD}$

= (369 N) (0.5854 **i** − 0.7561 **j** − 0.2927 **k**)

= (216.0 N) **i** + (−279.1 N) **j** + (− 108.00 N) **k**

$\mathbf{R}_A = 2\,\mathbf{F}_{AB} + \mathbf{F}_{AD}$

= 2 [(−369 N) **j**] + [(216.0 N) **i** + (−279.1 N) **j** + (− 108.00 N) **k**]

= (216.0 N) **i** + (−1017.1 N) **j** + (− 108.00 N) **k**

$\mathbf{M}_C = \mathbf{r}_{CA} \times \mathbf{R}_A$

= [(3.10 m) **j** + (1.20 m) **k**] × [(216.0 N) **i** + (−1017.1 N) **j** + (−108.00 N) **k**]

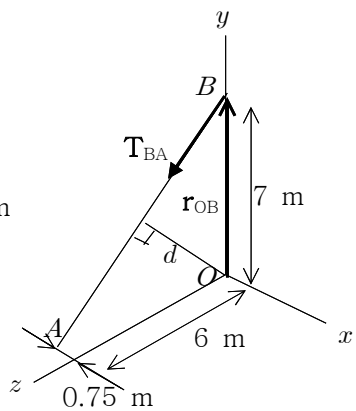
= [(3.10 m)(−108.00 N) − (1.20 m)(−1017.1 N)] **i** + [(1.20 m)(216.0 N)] **j**

+ [−(3.10 m)(216.0 N)] **k**

= (885.7 N·m) **i** + (259.2 N·m) **j** + (−669.6 N·m) **k**

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

3.27 [점에 대한 모멘트 (3차원)]



T_{BA} = 555 N

$\mathbf{r}_{OB}$ = (7.00 m) **j**

$(d_{BA})x$ = −0.75 m, $(d_{BA})y$ = −7.00 m, $(d_{BA})z$ = 6.00 m

$d_{BA} = \sqrt{(-0.75\text{ m})^2 + (-7.00\text{ m})^2 + (6.00\text{ m})^2}$ = 9.25 m

$\boldsymbol{\lambda}_{BA} = \dfrac{1}{9.25}$ (−0.75 **i** − 7.00 **j** + 6.00 **k**)

= −0.0811 **i** − 0.7568 **j** + 0.6486 **k**

$\mathbf{T}_{BA} = T_{BA}\,\boldsymbol{\lambda}_{BA}$

= (555 N) (−0.0811 **i** − 0.7568 **j** + 0.6486 **k**)

= (−45.01 N) **i** + (−420.0 N) **j** + (360.0 N) **k**

$\mathbf{M}_O = \mathbf{r}_{OB} \times \mathbf{T}_{BA}$

= [(7.00 m) **j**] × [(−45.01 N) **i** + (−420.0 N) **j** + (360.0 N) **k**]

= [(7.00 m)(360.0 N)] **i** + [0] **j** + [−(7.00 m)(−45.01 N)] **k**

= (2520 N·m) **i** + (315.0 N·m) **k**

$M_O = \sqrt{(2520\text{ N}\cdot\text{m})^2 + (315.0\text{ N}\cdot\text{m})^2}$ = 2540 N·m

$M_O = d\ T_{BA}$

⇒ $d = \dfrac{M_O}{T_{BA}} = \dfrac{2540\text{ N}\cdot\text{m}}{555\text{ N}}$ = 4.576 m ⇒ d = 4.58 m