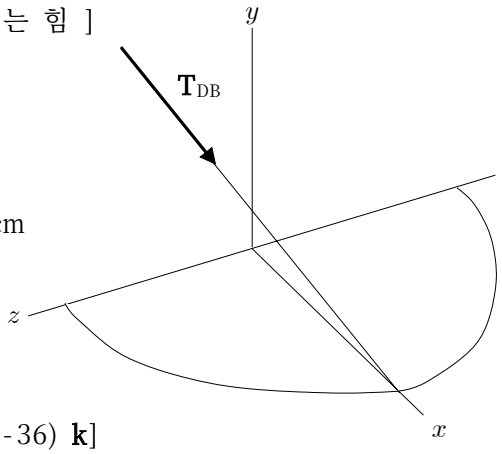
[2.12~2.14절]

2.87 [힘의 작용선 상의 두 점과 힘 크기에 의해 정의되는 힘]



R = 36 cm, 힘의 크기 T_{DB} = 55 N

$d_x = R$ = 36 cm, d_y = -42 cm, d_z = -36 cm

$d = \sqrt{d_x^2 + d_y^2 + d_z^2}$

$= \sqrt{(36\text{ cm})^2 + (-42\text{ cm})^2 + (-36\text{ cm})^2}$ = 66 cm

$\boldsymbol{\lambda} = \frac{1}{d}\ (d_x\ \mathbf{i} + d_y\ \mathbf{j} + d_z\ \mathbf{k})$

$= \frac{1}{66}\ [36\ \mathbf{i} + (-42)\ \mathbf{j} + (-36)\ \mathbf{k}]$

$\mathbf{T}_{DB} = T_{DB}\ \boldsymbol{\lambda} = (55\text{ N})\ \frac{1}{66}\ [36\ \mathbf{i} + (-42)\ \mathbf{j} + (-36)\ \mathbf{k}]$

$= (30\text{ N})\ \mathbf{i} - (35\text{ N})\ \mathbf{j} - (30\text{ N})\ \mathbf{k}$

$(\mathbf{T}_{DB})_x = (30.0\text{ N})\ \mathbf{i}$, $(\mathbf{T}_{DB})_y = (-35.0\text{ N})\ \mathbf{j}$, $(\mathbf{T}_{DB})_z = (-30.0\text{ N})\ \mathbf{k}$

2.93 [공간에서 힘의 합성]

P = 4 kN, Q = 8 kN

$P_y = -P\sin30°$, $P_h = P\cos30°$, $P_x = P_h\sin20°$, $P_z = P_h\cos20°$

$\mathbf{P} = P_y\ \mathbf{j} + P_x\ \mathbf{i} + P_z\ \mathbf{k} = -P\sin30°\ \mathbf{j} + P_h\ (\sin20°\ \mathbf{i} + \cos20°\ \mathbf{k})$

$= P\ [-\sin30°\ \mathbf{j} + \cos30°\ (\sin20°\ \mathbf{i} + \cos20°\ \mathbf{k})]$

$= (4\text{ kN})\ [-\sin30°\ \mathbf{j} + \cos30°\sin20°\ \mathbf{i} + \cos30°\cos20°\ \mathbf{k}]$

$= (1.1848\text{ kN})\ \mathbf{i} + (-2\text{ kN})\ \mathbf{j} + (3.255\text{ kN})\ \mathbf{k}$

$Q_y = Q\sin45°$, $Q_h = Q\cos45°$, $Q_x = -Q_h\sin15°$, $Q_z = -Q_h\cos15°$

$\mathbf{Q} = Q_y\ \mathbf{j} + Q_x\ \mathbf{i} + Q_z\ \mathbf{k} = Q\sin45°\ \mathbf{j} + Q_h\ (-\sin15°\ \mathbf{i} - \cos15°\ \mathbf{k})$

$= Q\ [\sin45°\ \mathbf{j} + \cos45°\ (-\sin15°\ \mathbf{i} - \cos15°\ \mathbf{k})]$

$= (8\text{ kN})\ [\sin45°\ \mathbf{j} - \cos45°\sin15°\ \mathbf{i} - \cos45°\cos15°\ \mathbf{k}]$

$= (-1.4641\text{ kN})\ \mathbf{i} + (5.657\text{ kN})\ \mathbf{j} + (-5.4641\text{ kN})\ \mathbf{k}$

$\mathbf{R} = \mathbf{P} + \mathbf{Q}$

$= [(1.1848\text{ kN})\ \mathbf{i} + (-2\text{ kN})\ \mathbf{j} + (3.255\text{ kN})\ \mathbf{k}]$

$+ [(-1.4641\text{ kN})\ \mathbf{i} + (5.657\text{ kN})\ \mathbf{j} + (-5.4641\text{ kN})\ \mathbf{k}]$

$= (-0.2793\text{ kN})\ \mathbf{i} + (3.657\text{ kN})\ \mathbf{j} + (-2.2091\text{ kN})\ \mathbf{k}$

magnitude

$R = \sqrt{R_x^2 + R_y^2 + R_z^2}$

$= \sqrt{(-0.2793\text{ kN})^2 + (3.657\text{ kN})^2 + (-2.2091\text{ kN})^2}$ = 4.28 kN

direction

$\cos\theta_x = \frac{R_x}{R} = \frac{-0.2793\text{ kN}}{4.28\text{ kN}} = -0.06526 \quad \Rightarrow \quad \theta_x = \cos^{-1}(-0.06526) = 93.7°$

$\cos\theta_y = \frac{R_y}{R} = \frac{3.657\text{ kN}}{4.28\text{ kN}} = 0.8544 \quad \Rightarrow \quad \theta_y = \cos^{-1}(0.8544) = 31.3°$

$\cos\theta_z = \frac{R_z}{R} = \frac{-2.2091\text{ kN}}{4.28\text{ kN}} = -0.5161 \quad \Rightarrow \quad \theta_z = \cos^{-1}(-0.5161) = 121.1°$

2.96 [공간에서 힘의 합성]

T_{AB} = 765 N, T_{AC} = 510 N

$(d_{AB})_x$ = -600 mm, $(d_{AB})_y$ = 360 mm, $(d_{AB})_z$ = 270 mm

$$d_{AB} = \sqrt{(d_{AB})_x^2 + (d_{AB})_y^2 + (d_{AB})_z^2}$$

$$= \sqrt{(-600\text{ mm})^2 + (360\text{ mm})^2 + (270\text{ mm})^2} = 750\text{ mm}$$

$$\boldsymbol{\lambda}_{AB} = \frac{1}{d_{AB}} [(d_{AB})_x\ \mathbf{i} + (d_{AB})_y\ \mathbf{j} + (d_{AB})_z\ \mathbf{k}]$$

$$= \frac{1}{750} [(-600)\ \mathbf{i} + 360\ \mathbf{j} + 270\ \mathbf{k}]$$

$$\mathbf{T}_{AB} = T_{AB}\ \boldsymbol{\lambda}_{AB} = (765\text{ N})\ \frac{1}{750} [(-600)\ \mathbf{i} + 360\ \mathbf{j} + 270\ \mathbf{k}]$$

$$= (-612\text{ N})\ \mathbf{i} + (367.2\text{ N})\ \mathbf{j} + (275.4\text{ N})\ \mathbf{k}$$

$(d_{AC})_x$ = -600 mm, $(d_{AC})_y$ = 320 mm, $(d_{AC})_z$ = -510 mm

$$d_{AC} = \sqrt{(d_{AC})_x^2 + (d_{AC})_y^2 + (d_{AC})_z^2}$$

$$= \sqrt{(-600\text{ mm})^2 + (320\text{ mm})^2 + (-510\text{ mm})^2} = 850\text{ mm}$$

$$\boldsymbol{\lambda}_{AC} = \frac{1}{d_{AC}} [(d_{AC})_x\ \mathbf{i} + (d_{AC})_y\ \mathbf{j} + (d_{AC})_z\ \mathbf{k}]$$

$$= \frac{1}{850} [(-600)\ \mathbf{i} + 320\ \mathbf{j} + (-510)\ \mathbf{k}]$$

$$\mathbf{T}_{AC} = T_{AC}\ \boldsymbol{\lambda}_{AC} = (510\text{ N})\ \frac{1}{850} [(-600)\ \mathbf{i} + 320\ \mathbf{j} + (-510)\ \mathbf{k}]$$

$$= (-360\text{ N})\ \mathbf{i} + (192\text{ N})\ \mathbf{j} + (-306\text{ N})\ \mathbf{k}$$

$$\mathbf{R} = \mathbf{T}_{AB} + \mathbf{T}_{AC}$$

$$= [(-612\text{ N})\ \mathbf{i} + (367.2\text{ N})\ \mathbf{j} + (275.4\text{ N})\ \mathbf{k}]$$

$$+ [(-360\text{ N})\ \mathbf{i} + (192\text{ N})\ \mathbf{j} + (-306\text{ N})\ \mathbf{k}]$$

$$= (-972\text{ N})\ \mathbf{i} + (559.2\text{ N})\ \mathbf{j} + (-30.6\text{ N})\ \mathbf{k}$$

magnitude

$$R = \sqrt{R_x^2 + R_y^2 + R_z^2}$$

$$= \sqrt{(-972\text{ N})^2 + (559.2\text{ N})^2 + (-30.6\text{ N})^2} = 1122\text{ N}$$

direction

$$\cos\theta_x = \frac{R_x}{R} = \frac{-972\text{ N}}{1122\text{ N}} = -0.8663 \quad \Rightarrow \quad \theta_x = \cos^{-1}(-0.8663) = 150.0^\circ$$

$$\cos\theta_y = \frac{R_y}{R} = \frac{559.2\text{ N}}{1122\text{ N}} = 0.4984 \quad \Rightarrow \quad \theta_y = \cos^{-1}(0.4984) = 60.1^\circ$$

$$\cos\theta_z = \frac{R_z}{R} = \frac{-30.6\text{ N}}{1122\text{ N}} = -0.0273 \quad \Rightarrow \quad \theta_z = \cos^{-1}(-0.0273) = 91.6^\circ$$