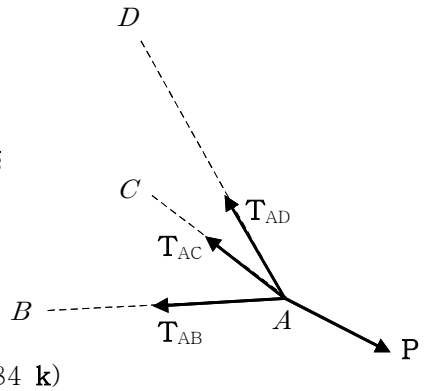
[2.15절]

2.107 [공간에서 질점의 평형]

T_{AD} = 305 N, $\mathbf{P} = -P\,\mathbf{i}$



$$d_{AB} = \sqrt{(-960\text{ mm})^2 + (-240\text{ mm})^2 + (380\text{ mm})^2}$$
$$= 1060\text{ mm}$$
$$\boldsymbol{\lambda}_{AB} = \frac{1}{1060}(-960\,\mathbf{i} - 240\,\mathbf{j} + 380\,\mathbf{k})$$
$$= -0.9057\,\mathbf{i} - 0.2264\,\mathbf{j} + 0.3584\,\mathbf{k}$$
$$\mathbf{T}_{AB} = T_{AB}\,\boldsymbol{\lambda}_{AB} = T_{AB}\,(-0.9057\,\mathbf{i} - 0.2264\,\mathbf{j} + 0.3584\,\mathbf{k})$$

$$d_{AC} = \sqrt{(-960\text{ mm})^2 + (-240\text{ mm})^2 + (-320\text{ mm})^2} = 1040\text{ mm}$$
$$\boldsymbol{\lambda}_{AC} = \frac{1}{1040}(-960\,\mathbf{i} - 240\,\mathbf{j} - 320\,\mathbf{k}) = -0.9231\,\mathbf{i} - 0.2308\,\mathbf{j} - 0.3077\,\mathbf{k}$$
$$\mathbf{T}_{AC} = T_{AC}\,\boldsymbol{\lambda}_{AC} = T_{AC}\,(-0.9231\,\mathbf{i} - 0.2308\,\mathbf{j} - 0.3077\,\mathbf{k})$$

$$d_{AD} = \sqrt{(-960\text{ mm})^2 + (720\text{ mm})^2 + (-220\text{ mm})^2} = 1220\text{ mm}$$
$$\boldsymbol{\lambda}_{AD} = \frac{1}{1220}(-960\,\mathbf{i} + 720\,\mathbf{j} - 220\,\mathbf{k}) = -0.7869\,\mathbf{i} + 0.5902\,\mathbf{j} - 0.1803\,\mathbf{k}$$
$$\mathbf{T}_{AD} = T_{AD}\,\boldsymbol{\lambda}_{AD} = (305\text{ N})\,(-0.7869\,\mathbf{i} + 0.5902\,\mathbf{j} - 0.1803\,\mathbf{k})$$

$\Sigma\mathbf{F} = 0 \Rightarrow \quad \mathbf{T}_{AB} + \mathbf{T}_{AC} + \mathbf{T}_{AD} + \mathbf{P} = 0$

$\Sigma F_x = 0$; $-0.9057\ T_{AB} - 0.9231\ T_{AC} - (240\text{ N}) + P = 0$ … ①

$\Sigma F_y = 0$; $-0.2264\ T_{AB} - 0.2308\ T_{AC} + (180\text{ N}) = 0$ … ②

$\Sigma F_z = 0$; $0.3584\ T_{AB} - 0.3077\ T_{AC} - (55.0\text{ N}) = 0$ … ③

②×0.3077 − ③×0.2308

$[(-0.2264)(0.3077)-(0.3584)(0.2308)]\,T_{AB} + [(180\text{ N})(0.3077)-(-55.0\text{ N})(0.2308)] = 0$

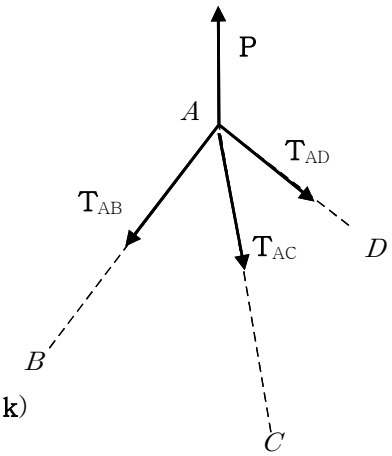
$\Rightarrow \quad T_{AB} = 446.8\text{ N}$

② $\Rightarrow \quad T_{AC} = \dfrac{1}{0.2308}[(-0.2264)(446.8\text{ N}) + (180\text{ N})] = 341.6\text{ N}$

① $\Rightarrow \quad P = (0.9057)(446.8\text{ N}) + (0.9231)(341.6\text{ N}) + (240\text{ N}) = 960.0\text{ N}$

$\Rightarrow \quad P = 960\text{ N}$

2.111 [공간에서 질점의 평형]



T_{AC} = 60 N, P = − P **j**, W = W **j**

P + W = 0 ⇒ − P **j** + W **j** = 0 ⇒ $W = P$

$$d_{AB} = \sqrt{(-320\,\text{mm})^2 + (-480\,\text{mm})^2 + (360\,\text{mm})^2}$$
$$= 680\ \text{mm}$$
$$\boldsymbol{\lambda}_{AB} = \frac{1}{680}(-320\ \mathbf{i} - 480\ \mathbf{j} + 360\ \mathbf{k})$$
$$= -0.4706\ \mathbf{i} - 0.7059\ \mathbf{j} + 0.5294\ \mathbf{k}$$

$\mathrm{T}_{AB} = T_{AB}\,\boldsymbol{\lambda}_{AB} = T_{AB}\,(-0.4706\ \mathbf{i} - 0.7059\ \mathbf{j} + 0.5294\ \mathbf{k})$

$$d_{AC} = \sqrt{(450\,\text{mm})^2 + (-480\,\text{mm})^2 + (360\,\text{mm})^2} = 750\ \text{mm}$$
$$\boldsymbol{\lambda}_{AC} = \frac{1}{750}(450\ \mathbf{i} - 480\ \mathbf{j} + 360\ \mathbf{k}) = 0.6000\ \mathbf{i} - 0.6400\ \mathbf{j} + 0.4800\ \mathbf{k}$$

$\mathrm{T}_{AC} = T_{AC}\,\boldsymbol{\lambda}_{AC} = (60\ \text{N})\,(0.600\ \mathbf{i} - 0.6400\ \mathbf{j} + 0.4800\ \mathbf{k})$

$= (36.0\ \text{N})\ \mathbf{i} - (38.4\ \text{N})\ \mathbf{j} + (28.8\ \text{N})\ \mathbf{k}$

$$d_{AD} = \sqrt{(250\,\text{mm})^2 + (-480\,\text{mm})^2 + (-360\,\text{mm})^2} = 650\ \text{mm}$$
$$\boldsymbol{\lambda}_{AD} = \frac{1}{650}(250\ \mathbf{i} - 480\ \mathbf{j} - 360\ \mathbf{k}) = 0.3846\ \mathbf{i} - 0.7384\ \mathbf{j} - 0.5538\ \mathbf{k}$$

$\mathrm{T}_{AD} = T_{AD}\,\boldsymbol{\lambda}_{AD} = T_{AD}\,(0.3846\ \mathbf{i} - 0.7384\ \mathbf{j} - 0.5538\ \mathbf{k})$

$\Sigma \mathrm{F} = 0 \Rightarrow \quad \mathrm{T}_{AB} + \mathrm{T}_{AC} + \mathrm{T}_{AD} + \mathrm{P} = 0$

$\Sigma F_x = 0$; $-0.4706\ T_{AB} + (36.0\ \text{N}) + 0.3846\ T_{AD} = 0$ … ①

$\Sigma F_y = 0$; $-0.7059\ T_{AB} - (38.4\ \text{N}) - 0.7384\ T_{AD} + P = 0$ … ②

$\Sigma F_z = 0$; $0.5294\ T_{AB} + (28.8\ \text{N}) - 0.5538\ T_{AD} = 0$ … ③

①×0.5538 + ③×0.3846

$[(-0.4706)(0.5538) + (0.5294)(0.3846)]\,T_{AB} + [(36.0\ \text{N})(0.5538) + (28.8\ \text{N})(0.3846)] = 0$

⇒ $T_{AB} = 544.0\ \text{N}$

① ⇒ $T_{AD} = \dfrac{1}{0.3846}[(0.4706)(544.0\ \text{N}) - (36.0\ \text{N})] = 572.0\ \text{N}$

② ⇒ $P = (0.7059)(544.0\ \text{N}) + (38.4\ \text{N}) + (0.7384)(572.0\ \text{N}) = 844.4\ \text{N}$

⇒ $P = 844\ \text{N}$