[5.4절]

5.121 ① 유리 원판 + ② 철 다리 상부 + ③ 철 다리 하부

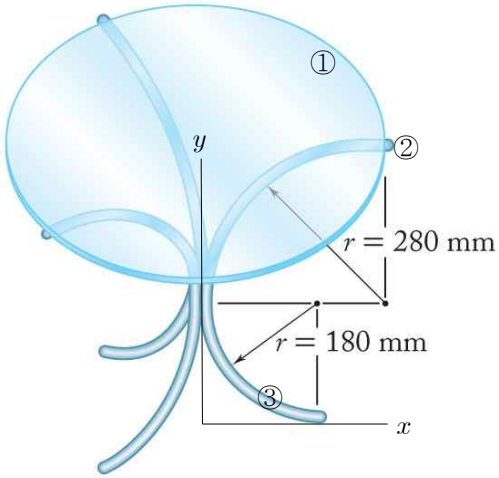
d_1 = 600 mm, t_1 = 10 mm

ρ_g = 2,190 kg/m^3 = 2.19×10^{-6} kg/mm^3

r_2 = 280 mm, r_3 = 180 mm

d_s = 24 mm, a_s = 150 mm^2

ρ_s = 7,860 kg/m^3 = 7.86×10^{-6} kg/mm^3



대칭구조 ⇒ $\overline{X} = \overline{Z} = 0$

$W = mg = \rho V g \quad \Rightarrow \quad m = \rho V$

$$\overline{Y} = \frac{\Sigma(\overline{y}\,W)}{\Sigma W} = \frac{\Sigma(\overline{y}\,m)}{\Sigma m}$$

① $V = \frac{\pi}{4} d_1^2\, t_1 = \frac{\pi}{4}(600\text{ mm})^2\,(10\text{ mm}) = 2{,}827{,}433\text{ mm}^3 = 2.827\times10^6\text{ mm}^3$

$m = \rho_g\, V = (2.19\times10^{-6}\text{ kg/mm}^3)(2.827\times10^6\text{ mm}^3) = 6.192\text{ kg}$

$\overline{y} = \frac{1}{2}t_1 + r_2 + r_3 + d_s = \frac{1}{2}(10) + 280 + 180 + 24\text{ mm} = 489\text{ mm}$

② $V = \frac{\pi}{2} r_2\, a_s = \frac{\pi}{2}(280\text{ mm})(150\text{ mm}^2) = 65{,}973\text{ mm}^3 = 65.97\times10^3\text{ mm}^3$

$m = \rho_s\, V = (7.86\times10^{-6}\text{ kg/mm}^3)(65.97\times10^3\text{ mm}^3) = 518.6\times10^{-3}\text{ kg}$

$\overline{y} = \frac{1}{2}d_s + r_3 + \frac{2}{\pi}r_2 = \frac{1}{2}(24) + 180 + \frac{2}{\pi}(280)\text{ mm} = 370.3\text{ mm}$

③ $V = \frac{\pi}{2} r_3\, a_s = \frac{\pi}{2}(180\text{ mm})(150\text{ mm}^2) = 42{,}412\text{ mm}^3 = 42.41\times10^3\text{ mm}^3$

$m = \rho_s\, V = (7.86\times10^{-6}\text{ kg/mm}^3)(42.41\times10^3\text{ mm}^3) = 333.3\times10^{-3}\text{ kg}$

$\overline{y} = \frac{1}{2}d_s + r_3 - \frac{2}{\pi}r_3 = \frac{1}{2}(24) + 180 - \frac{2}{\pi}(180)\text{ mm} = 77.41\text{ mm}$

$\Sigma m = [6{,}192 + 3\,(518.6) + 3\,(333.3)]\times10^{-3}\text{ kg} = 8{,}748\times10^{-3}\text{ kg}$

$\Sigma(\overline{y}\,m) = [(489)\,(6{,}192) + (370.3)\,3\,(518.6) + (77.41)\,3\,(333.3)]\times10^{-3}\text{ kg}\cdot\text{mm}$

$= 3{,}681\text{ kg}\cdot\text{mm}$

$$\overline{Y} = \frac{\Sigma(\overline{y}\,m)}{\Sigma m} = \frac{3{,}681\text{ kg}\cdot\text{mm}}{8{,}748\times10^{-3}\text{ kg}} = 420.8\text{ mm} \quad \Rightarrow \quad \text{중심} = (0,\ 421\text{ mm},\ 0)$$