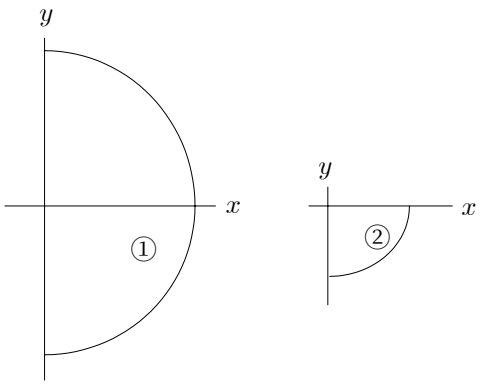
<5.1~5.5절>

5.8　① $r_2$ = 150 mm

$A = \frac{\pi}{2} r_2^2 = \frac{\pi}{2}(150\ \text{mm})^2 = 35{,}343\ \text{mm}^2$

$\bar{x} = \frac{4}{3\pi} r_2 = \frac{4}{3\pi}(150\ \text{mm}) = 63.66\ \text{mm}$

$\bar{y} = 0$




② $r_1$ = 75 mm

$A = -\frac{\pi}{4}(75\ \text{mm})^2 = -4{,}418\ \text{mm}^2$

$\bar{x} = \frac{4}{3\pi} r_1 = \frac{4}{3\pi}(75\ \text{mm}) = 31.83\ \text{mm}$

$\bar{y} = -31.83\ \text{mm}$

$\Sigma A = 35{,}343 + (-4{,}418)\ (\text{mm}^2) = 30{,}925\ \text{mm}^2$

$\Sigma(\bar{x}A) = (63.66\ \text{mm})(35{,}343\ \text{mm}^2) + (31.83\ \text{mm})(-4{,}418\ \text{mm}^2) = 2{,}109{,}310\ \text{mm}^3$

$\Sigma(\bar{y}A) = 0 + (-31.83\ \text{mm})(-4{,}418\ \text{mm}^2) = 140{,}625\ \text{mm}^3$

$\bar{X} = \frac{\Sigma(\bar{x}A)}{\Sigma A} = \frac{2{,}109{,}310\ \text{mm}^3}{30{,}925\ \text{mm}^2} = 68.21\ \text{mm}$

$\bar{Y} = \frac{\Sigma(\bar{y}A)}{\Sigma A} = \frac{140{,}625\ \text{mm}^3}{30{,}925\ \text{mm}^2} = 4.547\ \text{mm}$　　도심 = (68.2 mm, 4.55 mm)

5.17　<1단계 : centroid>

① $A = (8\ \text{cm})(15\ \text{cm}) = 120\ \text{cm}^2$

$\bar{y} = \frac{1}{2}(15\ \text{cm}) = 7.5\ \text{cm}$

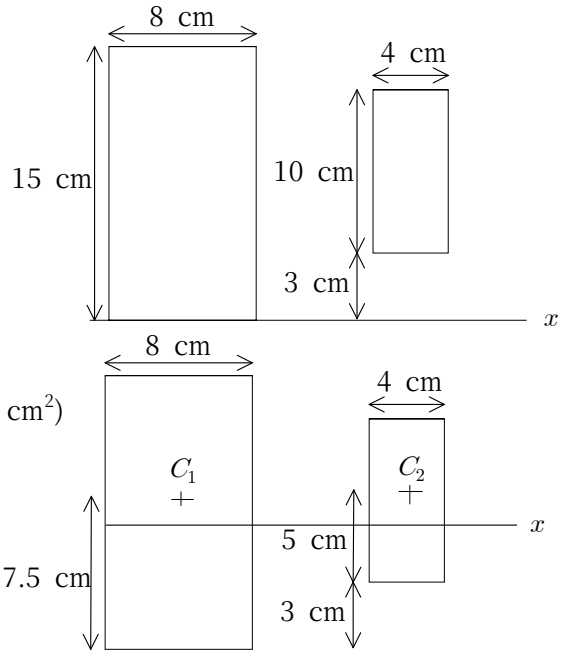
② $A = -(4\ \text{cm})(10\ \text{cm}) = -40\ \text{cm}^2$

$\bar{y} = (3\ \text{cm}) + \frac{1}{2}(10\ \text{cm}) = 8\ \text{cm}$

$\Sigma A = 120 + (-40)\ (\text{cm}^2) = 80\ \text{cm}^2$

$\Sigma(\bar{y}A) = (7.5\ \text{cm})(120\ \text{cm}^2) + (8\ \text{cm})(-40\ \text{cm}^2) = 580\ \text{cm}^3$

$\bar{Y} = \frac{\Sigma(\bar{y}A)}{\Sigma A} = \frac{580\ \text{cm}^3}{80\ \text{cm}^2} = 7.25\ \text{cm}$




<2단계 : 면적 1차 모멘트>

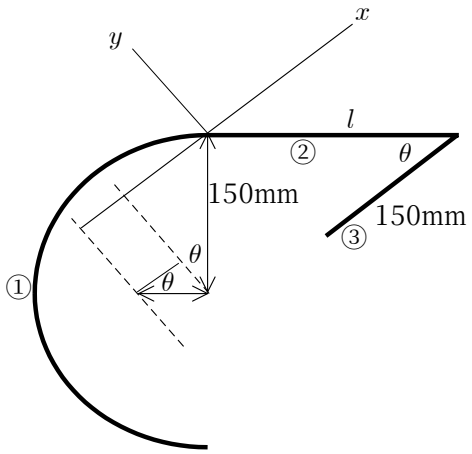
$Q_{xI} = \Sigma(\bar{y}A) = (7.5 - 7.25\ \text{cm})(120\ \text{cm}^2) = 30\ \text{cm}^3$

$Q_{xII} = \Sigma(\bar{y}A) = (8.0 - 7.25\ \text{cm})\ (-40\ \text{cm}^2) = -30\ \text{cm}^3$

$Q_x = Q_{xI} + Q_{xII} = 0$

$x$축이 도심 축이므로 $\bar{y} = 0$이다. 따라서 $Q_x = \bar{y}\,A = 0$ 이다.

5.27 $\theta = 30°$




$\Sigma M_B = 0 \quad \Rightarrow \quad \bar{X} = 0$

$\Rightarrow \quad \Sigma(\bar{x}L) = 0$

① $L = \pi$ (150 mm) = 471.2 mm

$\bar{x} = -(150 \text{ mm}) \sin 30° - \frac{2}{\pi}(150 \text{ mm}) \cos 30°$

$= -157.7$ mm

② $L = l$

$\bar{x} = \frac{l}{2} \cos 30° = 0.4330\ l$

③ $L = 150$ mm

$\bar{x} = l \cos 30° - \frac{1}{2}(150 \text{ mm}) = 0.866\ l - 75 \text{ mm}$

$\Sigma(\bar{x}L) = (-157.7 \text{ mm})(471.2 \text{ mm}) + (0.4330\ l)\ l + (0.866\ l - 75 \text{ mm})(150 \text{ mm}) = 0$

$\Rightarrow \quad 0.433\ l^2 + (129.9 \text{ mm})\ l - (85{,}558 \text{ mm}^2) = 0$

$\Rightarrow \quad l = \frac{-(129.9) \pm \sqrt{(129.9)^2 - 4(0.433)(-85{,}558)}}{2(0.433)}$ mm = 319, -619 mm

$l > 0 \quad \Rightarrow \quad l = 319$ mm