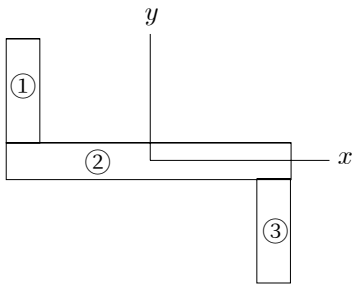
<9.6~9.7절>

9.33 <방법1>



① $A_1 = (10\ \text{mm})(50 - 10\ \text{mm}) = 400\ \text{mm}^2$

$I_{y1} = \frac{1}{12}(10\ \text{mm})^3(40\ \text{mm}) + (400\ \text{mm}^2)(35\ \text{mm} + 5\ \text{mm})^2$

$= 643{,}333\ \text{mm}^4$

② $A_2 = (90\ \text{mm})(10\ \text{mm}) = 900\ \text{mm}^2$

$I_{y2} = \frac{1}{12}(90\ \text{mm})^3(10\ \text{mm}) = 607{,}500\ \text{mm}^4$

③ $A_3 = A_1$

$I_{y3} = I_{y1}$

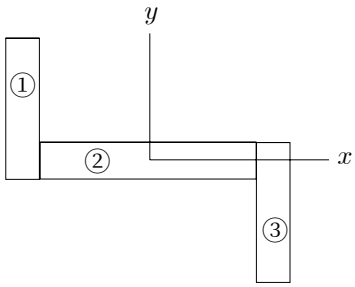
$A = A_1 + A_2 + A_3 = 2\ (400\ \text{mm}^2) + (900\ \text{mm}^2) = 1{,}700\ \text{mm}^2$

$I_y = I_{y1} + I_{y2} + I_{y3} = 2\ (643{,}333\ \text{mm}^4) + (607{,}500\ \text{mm}^4) = 1{,}894{,}166\ \text{mm}^4$

$\Rightarrow \quad I_y = 1{,}894{,}000\ \text{mm}^4$

$k_y = \sqrt{\frac{I_y}{A}} = \sqrt{\frac{1{,}894{,}166\ \text{mm}^4}{1{,}700\ \text{mm}^2}} = 33.38\ \text{mm} \quad \Rightarrow \quad k_y = 33.4\ \text{mm}$

<방법2>



① $A_1 = (10\ \text{mm})(50\ \text{mm}) = 500\ \text{mm}^2$

$I_{y1} = \frac{1}{12}(10\ \text{mm})^3(50\ \text{mm}) + (500\ \text{mm}^2)(35\ \text{mm} + 5\ \text{mm})^2$

$= 804{,}167\ \text{mm}^4$

② $A_2 = (70\ \text{mm})(10\ \text{mm}) = 700\ \text{mm}^2$

$I_{y2} = \frac{1}{12}(70\ \text{mm})^3(10\ \text{mm}) = 285{,}833\ \text{mm}^4$

③ $A_3 = A_1$

$I_{y3} = I_{y1}$

$A = A_1 + A_2 + A_3 = 2\ (500\ \text{mm}^2) + (700\ \text{mm}^2) = 1{,}700\ \text{mm}^2$

$I_y = I_{y1} + I_{y2} + I_{y3} = 2\ (804{,}167\ \text{mm}^4) + (285{,}833\ \text{mm}^4) = 1{,}894{,}166\ \text{mm}^4$

$\Rightarrow \quad I_y = 1{,}894{,}000\ \text{mm}^4$

$k_y = \sqrt{\frac{I_y}{A}} = \sqrt{\frac{1{,}894{,}166\ \text{mm}^4}{1{,}700\ \text{mm}^2}} = 33.38\ \text{mm} \quad \Rightarrow \quad k_y = 33.4\ \text{mm}$

9.42 centroid ;

대칭 ⇒ $\overline{X}$ = 42.0 mm

① 사각형

A_1 = (4×21 mm)(60+45 mm) = 8,820 mm^2

$\bar{y}_1 = \frac{1}{2}(105\ mm) = 52.5\ mm$

② 삼각형

$A_2 = -\frac{1}{2}(42\ mm)(45\ mm) = -945\ mm^2$

$\bar{y}_2 = (60\ mm) + \frac{2}{3}(45\ mm) = 90\ mm$

$\Sigma A = (8{,}820\ mm^2) + (-945\ mm^2) = 7{,}875\ mm^2$

$\Sigma(\bar{y}A) = (52.5\ mm)\ (8{,}820\ mm^2) + (90\ mm)\ (-945\ mm^2) = 378{,}000\ mm^3$

$\overline{Y} = \frac{378{,}000\ mm^3}{7{,}875\ mm^2} = 48.0\ mm$

I_x ;

① $I_{x1} = \frac{1}{12}\ (84\ mm)\ (105\ mm)^3$
$+ (8{,}820\ mm^2)\ (52.5-48.0\ mm)^2$
$= 8{,}281{,}980\ mm^4$

② $I_{x2} = \frac{1}{36}\ (42\ mm)\ (45\ mm)^3$
$+ (945\ mm^2)\ (90-48.0\ mm)^2 = 1{,}773{,}293\ mm^4$

$\bar{I}_x = (8{,}281{,}980\ mm^4) - (1{,}773{,}293\ mm^4) = 6{,}508{,}687\ mm^4$

⇒ $I_x = 6{,}509{,}000\ mm^4 = 6.51\times10^6\ mm^4$

I_y ;

① $I_{y1} = \frac{1}{12}(105\ mm)(84\ mm)^3 = 5{,}186{,}160\ mm^4$

② $I_{y2} = 2\times\frac{1}{12}(45\ mm)(21\ mm)^3 = 69{,}458\ mm^4$

$\bar{I}_y = (5{,}186{,}160\ mm^4) - (69{,}458\ mm^4) = 5{,}116{,}703\ mm^4$

⇒ $I_y = 5{,}117{,}000\ mm^4 = 5.12\times10^6\ mm^4$