<9.6~9.7절>

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

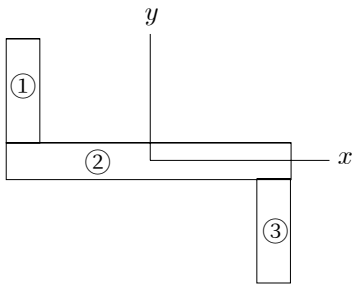
$$I_{x1} = \frac{1}{12}(10\text{ mm})(40\text{ mm})^3 + (400\text{ mm}^2)(20\text{ mm} + 5\text{ mm})^2 = 303{,}333\text{ mm}^4$$

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

$$I_{x2} = \frac{1}{12}(90\text{ mm})(10\text{ mm})^3 = 7{,}500\text{ mm}^4$$

③ $A_3 = A_1$

$I_{x3} = I_{x1}$



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

$I_x = I_{x1} + I_{x2} + I_{x3} = 2\ (303{,}333\text{ mm}^4) + (7{,}500\text{ mm}^4) = 614{,}166\text{ mm}^4$

$\Rightarrow \quad I_x = 614{,}000\text{ mm}^4$

$$k_x = \sqrt{\frac{I_x}{A}} = \sqrt{\frac{614{,}166\text{ mm}^4}{1{,}700\text{ mm}^2}} = 19.007\text{ mm} \quad \Rightarrow \quad k_x = 19.01\text{ mm}$$

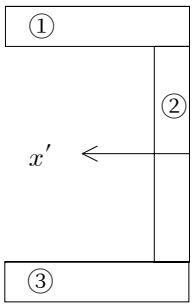
9.41 centroid ;

①,③ $A_1 = A_3 = (76\text{ mm})(19\text{ mm}) = 1{,}444\text{ mm}^2$

$$\bar{x}_1 = \bar{x}_3 = \frac{1}{2}(76\text{ mm}) = 38\text{ mm}$$

② $A_2 = 2(19\text{ mm})(95 - 19\text{ mm}) = 2{,}888\text{ mm}^2$

$$\bar{x}_2 = \frac{1}{2}(19\text{ mm}) = 9.5\text{ mm}$$



$\Sigma A = 2\ (1{,}444\text{ mm}^2) + (2{,}888\text{ mm}^2) = 5{,}776\text{ mm}^2$

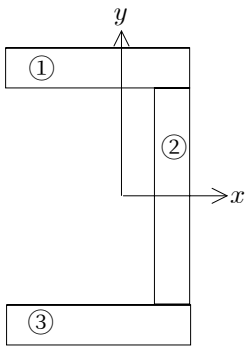
$\Sigma(\bar{x}A) = 2\ (38\text{ mm})\ (1{,}444\text{ mm}^2) + (9.5\text{ mm})\ (2{,}888\text{ mm}^2) = 137{,}180\text{ mm}^3$

$$\bar{X} = \frac{137{,}180\text{ mm}^3}{5{,}776\text{ mm}^2} = 23.95\text{ mm}$$

I_x ;

①,③ $I_{x1} = I_{x3} = \frac{1}{12}(76\text{ mm})(19\text{ mm})^3 + (1{,}444\text{ mm}^2)(95 - 9.5\text{ mm})^2 = 10{,}599{,}441\text{ mm}^4$

② $I_{x2} = \frac{1}{12}(19\text{ mm})(152\text{ mm})^3 = 5{,}560{,}363\text{ mm}^4$



$\bar{I}_x = 2\ (10{,}599{,}441\text{ mm}^4) + (5{,}560{,}363\text{ mm}^4) = 26{,}759{,}245\text{ mm}^4$

$\Rightarrow \quad I_x = 26{,}800{,}000{,}000\text{ mm}^4 = 26.8 \times 10^6\text{ mm}^4$

I_y ;

①,③ $I_{y1} = I_{y3} = \frac{1}{12}(19\ \text{mm})(76\ \text{mm})^3 + (1{,}444\ \text{mm}^2)(23.75-38\ \text{mm})^2$

$= 988{,}268\ \text{mm}^4$

② $I_{y2} = \frac{1}{12}(152\ \text{mm})(19\ \text{mm})^3 + (2{,}888\ \text{mm}^2)(23.75-9.5\ \text{mm})^2 = 673{,}325\ \text{mm}^4$

$\bar{I}_y = 2\ (988{,}268\ \text{mm}^4) + (673{,}325\ \text{mm}^4) = 2{,}649{,}861\ \text{mm}^4$

$\Rightarrow \quad I_y = 2{,}650{,}000\ \text{mm}^4 = 2.65\times10^6\ \text{mm}^4$