

<9.6~9.7절>

$$9.31\&33 \quad A_1 = (12+12 \text{ mm})(6 \text{ mm}) = 144 \text{ mm}^2$$

$$A_2 = (8 \text{ mm})(24+24 \text{ mm}) = 384 \text{ mm}^2$$

$$A_3 = (24+24 \text{ mm})(6 \text{ mm}) = 288 \text{ mm}^2$$

$$A = A_1 + A_2 + A_3$$

$$= 144+384+288 \text{ mm}^2 = 816 \text{ mm}^2$$

$$I_{x1} = \bar{I}_{x1} + A_1 d_1^2$$

$$= \frac{1}{12}(12+12 \text{ mm})(6 \text{ mm})^3 + (144 \text{ mm}^2)(3+24 \text{ mm})^2$$

$$= 432 + 104,976 \text{ mm}^4 = 105,408 \text{ mm}^4$$

$$I_{x2} = \frac{1}{12}(8 \text{ mm})(24+24 \text{ mm})^3 = 73,728 \text{ mm}^4$$

$$I_{x3} = \bar{I}_{x3} + A_3 d_3^2 = \frac{1}{12}(24+24 \text{ mm})(6 \text{ mm})^3 + (288 \text{ mm}^2)(3+24 \text{ mm})^2$$

$$= 864 + 209,952 \text{ mm}^4 = 210,816 \text{ mm}^4$$

$$I_x = I_{x1} + I_{x2} + I_{x3}$$

$$= 105,408 + 73,728 + 210,816 \text{ mm}^4 = 389,952 \text{ mm}^4$$

$$\Rightarrow I_x = 390,000 \text{ mm}^4 = 390 \times 10^3 \text{ mm}^4 = 0.390 \times 10^6 \text{ mm}^4$$

$$k_x = \sqrt{\frac{I_x}{A}} = \sqrt{\frac{389,952 \text{ mm}^4}{816 \text{ mm}^2}} = 21.86 \text{ mm}$$

$$\Rightarrow k_x = 21.9 \text{ mm}$$

$$I_{y1} = \frac{1}{12}(6 \text{ mm})(12+12 \text{ mm})^3 = 6,912 \text{ mm}^4$$

$$I_{y2} = \frac{1}{12}(24+24 \text{ mm})(8 \text{ mm})^3 = 2,048 \text{ mm}^4$$

$$I_{y3} = \frac{1}{12}(6 \text{ mm})(24+24 \text{ mm})^3 = 55,296 \text{ mm}^4$$

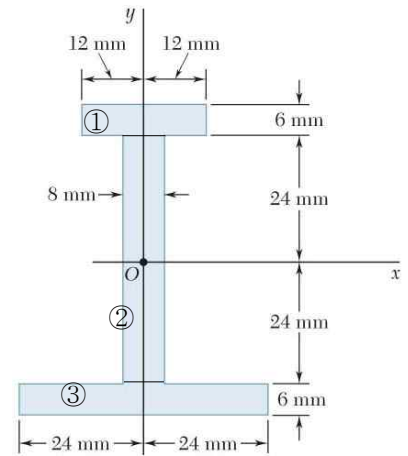
$$I_y = I_{y1} + I_{y2} + I_{y3}$$

$$= 6,912 + 2,048 + 55,296 \text{ mm}^4 = 64,256 \text{ mm}^4$$

$$\Rightarrow I_y = 64,300 \text{ mm}^4 = 64.3 \times 10^3 \text{ mm}^4$$

$$k_y = \sqrt{\frac{I_y}{A}} = \sqrt{\frac{64,256 \text{ mm}^4}{816 \text{ mm}^2}} = 8.874 \text{ mm}$$

$$\Rightarrow k_y = 8.87 \text{ mm}$$



9.41

<centroid 구하기>

symmetry $\Rightarrow \bar{Y} = 30 \text{ mm}$

① 직사각형

$$a = 22 + 72 + 14 \text{ mm} = 108 \text{ mm}$$

$$b = 12 + 18 + 18 + 12 \text{ mm} = 60 \text{ mm}$$

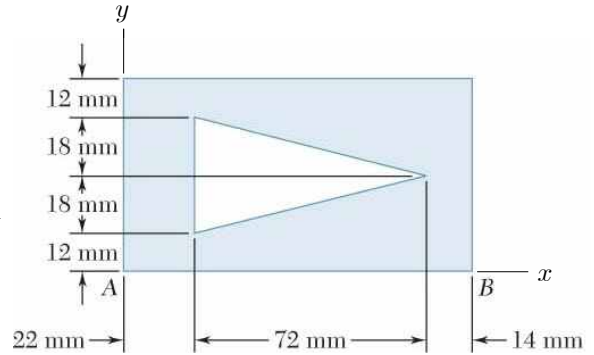
$$A = (108 \text{ mm})(60 \text{ mm}) = 6,480 \text{ mm}^2$$

$$\bar{x} = \frac{1}{2}(108 \text{ mm}) = 54 \text{ mm}$$

② 삼각형 구멍

$$A = -(18 \text{ mm})(72 \text{ mm}) = -1,296 \text{ mm}^2$$

$$\bar{x} = (22 \text{ mm}) + \frac{1}{3}(72 \text{ mm}) = 46 \text{ mm}$$



$$\Sigma A = 6,480 - 1,296 \text{ mm}^2 = 5,184 \text{ mm}^2$$

$$\Sigma \bar{x}A = (54)(6,480) + (46)(-1,296) \text{ mm}^3 = 290,304 \text{ mm}^3$$

$$\bar{X} = \frac{\Sigma \bar{x}A}{\Sigma A} = \frac{290,304 \text{ mm}^3}{5,184 \text{ mm}^2} = 56.0 \text{ mm}$$

<moment of inertia 구하기>

$$I_{x1} = \frac{1}{12}(108 \text{ mm})(60 \text{ mm})^3 = 1,944,000 \text{ mm}^4$$

$$I_{x2} = 2 \left[\frac{1}{12}(72 \text{ mm})(18 \text{ mm})^3 \right] = 69,984 \text{ mm}^4$$

$$I_x = I_{x1} - I_{x2} = 1,944,000 - 69,984 \text{ mm}^4 = 1,874,016 \text{ mm}^4$$

$$\Rightarrow I_x = 1,874,000 \text{ mm}^4 = 1.874 \times 10^6 \text{ mm}^4$$

$$d_1 = \bar{X} - \frac{a}{2} = (56.0 \text{ mm}) - \frac{1}{2}(108 \text{ mm}) = 2.00 \text{ mm}$$

$$\begin{aligned} I_{y1} &= \bar{I}_{y1} + A_1 d_1^2 = \frac{1}{12}(60 \text{ mm})(108 \text{ mm})^3 + (6,480 \text{ mm}^2)(2.00 \text{ mm})^2 \\ &= 6,324,480 \text{ mm}^4 \end{aligned}$$

$$d_2 = \bar{X} - \left[22 \text{ mm} + \frac{1}{3}(72 \text{ mm}) \right] = 56.0 - 46 \text{ mm} = 10 \text{ mm}$$

$$I_{y2} = \bar{I}_{y2} + A_2 d_2^2 = \frac{1}{36}(36 \text{ mm})(72 \text{ mm})^3 + (1,296 \text{ mm}^2)(10 \text{ mm})^2 = 502,848 \text{ mm}^4$$

$$I_y = I_{y1} - I_{y2} = 6,324,480 - 502,848 \text{ mm}^4 = 5,821,632 \text{ mm}^4$$

$$\Rightarrow I_y = 5,820,000 \text{ mm}^4 = 5.82 \times 10^6 \text{ mm}^4$$