

<9.6~9.7 >

9.31 $A_1 = (30 \text{ mm})(7.5 \text{ mm}) = 225 \text{ mm}^2$

$$I_{x1} = \frac{1}{12}(30 \text{ mm})(7.5 \text{ mm})^3 + (225 \text{ mm}^2)(30 \text{ mm} + \frac{7.5}{2} \text{ mm})^2$$

$$= 257,344 \text{ mm}^4$$

$A_2 = (10 \text{ mm})(60 \text{ mm}) = 600 \text{ mm}^2$

$$I_{x2} = \frac{1}{12}(10 \text{ mm})(60 \text{ mm})^3 = 180,000 \text{ mm}^4$$

$A_3 = (60 \text{ mm})(7.5 \text{ mm}) = 450 \text{ mm}^2$

$$I_{x3} = \frac{1}{12}(60 \text{ mm})(7.5 \text{ mm})^3 + (450 \text{ mm}^2)(30 \text{ mm} + \frac{7.5}{2} \text{ mm})^2 = 514,688 \text{ mm}^4$$

$$A = A_1 + A_2 + A_3 = (225 \text{ mm}^2) + (600 \text{ mm}^2) + (450 \text{ mm}^2) = 1,275 \text{ mm}^2$$

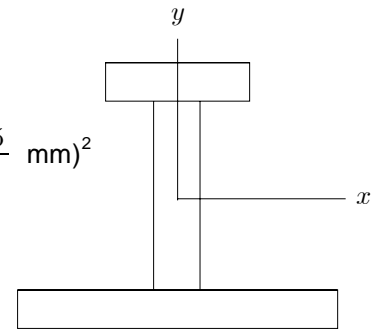
$$I_x = I_{x1} + I_{x2} + I_{x3} = (257,344 \text{ mm}^4) + (180,000 \text{ mm}^4) + (514,688 \text{ mm}^4)$$

$$= 952,032 \text{ mm}^4$$

$$I_x = 952,000 \text{ mm}^4$$

$$k_x = \sqrt{\frac{I_x}{A}} = \sqrt{\frac{952,032 \text{ mm}^4}{1,275 \text{ mm}^2}} = 27.33 \text{ mm}$$

$$k_x = 27.3 \text{ mm}$$



9.35 x

$$I_{x1} = \frac{1}{3}(2a)(4a)^3 = \frac{128}{3}a^4$$

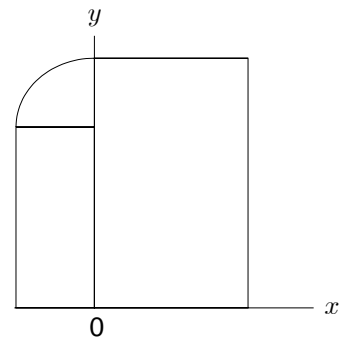
$$I_{x2} = \frac{1}{3}a(3a)^3 = 9a^4$$

$$I_{x3} = \left[\frac{\pi}{16}a^4 - \left(\frac{\pi}{4}a^2 \right) \left(\frac{4}{3\pi}a \right)^2 \right] + \left(\frac{\pi}{4}a^2 \right) \left(\frac{4}{3\pi}a + 3a \right)^2$$

$$= \left[\frac{\pi}{16} - \left(\frac{\pi}{4} \right) \left(\frac{16}{9\pi^2} \right) + \left(\frac{\pi}{4} \right) \left(\frac{16}{9\pi^2} + \frac{8}{\pi} + 9 \right) \right] a^4$$

$$= \left(\frac{\pi}{16} - \frac{4}{9\pi} + \frac{4}{9\pi} + 2 + \frac{9\pi}{4} \right) a^4 = \left(2 + \frac{37\pi}{16} \right) a^4$$

$$I_x = I_{x1} + I_{x2} + I_{x3} = \frac{128}{3}a^4 + 9a^4 + \left(2 + \frac{37\pi}{16} \right) a^4 = \left(\frac{161}{3} + \frac{37\pi}{16} \right) a^4 = 60.9 a^4$$



y

$$I_{y1} = \frac{1}{3}(4a)(2a)^3 = \frac{32}{3}a^4$$

$$I_{y2} = \frac{1}{3}(3a)a^3 = a^4$$

$$I_{y3} = \frac{\pi}{16}a^4$$

$$I_y = I_{y1} + I_{y2} + I_{y3} = \frac{32}{3}a^4 + a^4 + \frac{\pi}{16}a^4 = \left(\frac{35}{3} + \frac{\pi}{16} \right) a^4 = 11.86 a^4$$