ENGINEERING MECHANICS - STATICS

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DISTRIBUTED FORCES

Session- 7

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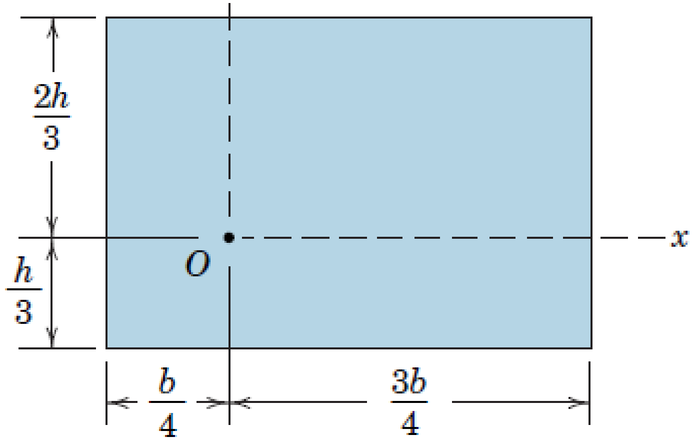
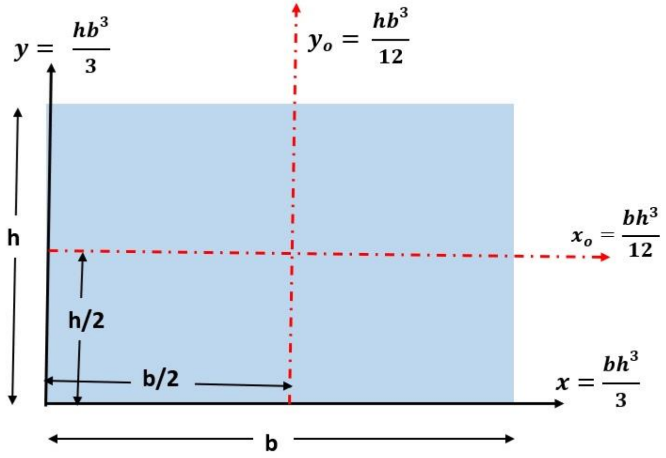
Moment of Inertia: Numerical

Problem A/1 Determine the moments of inertia of the rectangular area about the x- and y-axes and find the polar moment of inertia about point O.





Moment of inertia of the rectangular area about the x-axis:

$$I_x = \overline{I_x} + Ad^2 \text{------}(1)$$

Here,

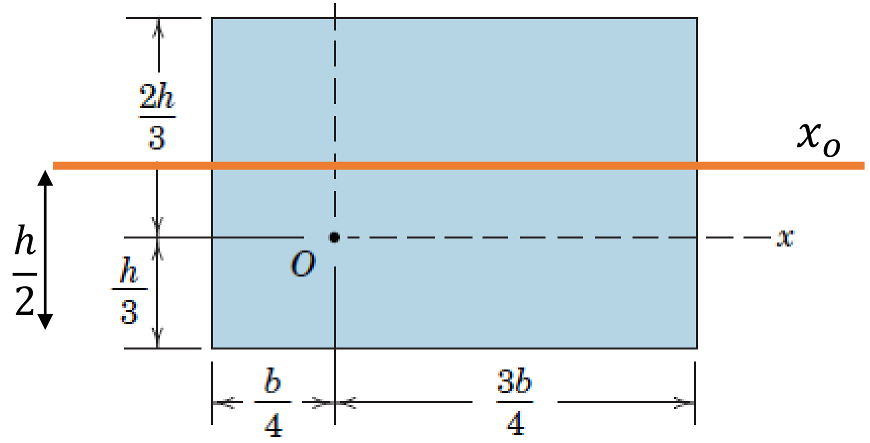
$$\overline{I_x} = \frac{bh^3}{12}$$

$$A = \text{bh}$$

$$d = \frac{h}{2} - \frac{h}{3} = \frac{h}{6}$$

Substituting in equation (1)

$$I_x = \frac{bh^3}{12} + (bh)\left(\frac{h}{6}\right)^2$$



$$\boxed{\boldsymbol{I_x = \frac{bh^3}{9}}}$$

Moment of inertia of the rectangular area about the y-axis:

$$I_y = \bar{I_y} + Ad^2 \text{------}(2)$$

Here, $\bar{I_y} = \dfrac{hb^3}{12}$

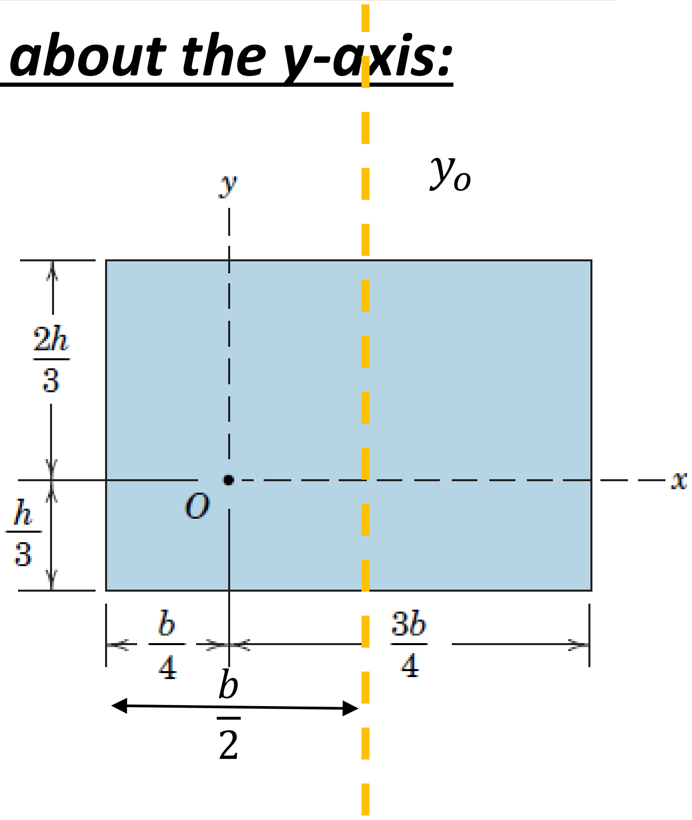
$A = \text{bh}$

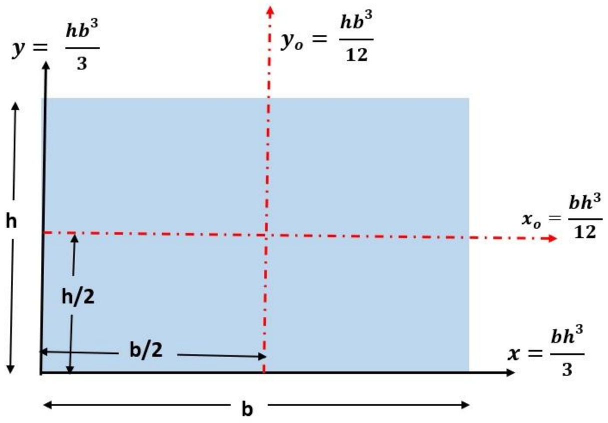
$$d = \frac{b}{2} - \frac{b}{4} = \frac{b}{4}$$

Substituting in equation (2)

$$I_y = \frac{hb^3}{12} + (\text{bh})\left(\frac{b}{4}\right)^2 = \frac{7hb^3}{48}$$

$$\boxed{I_y = \frac{7hb^3}{48}}$$



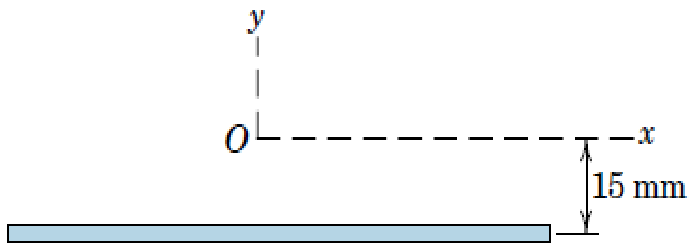


Polar Moment of Inertia about point "O" $= I_x + I_y = \dfrac{bh^3}{9} + \dfrac{7hb^3}{48}$

$$\boxed{I_z = bh\left(\frac{h^2}{9} + \frac{7b^2}{48}\right)}$$

Moment of Inertia: Numerical

Problem A/3. The narrow rectangular strip has an area of 300 mm², and its moment of inertia about the y-axis is 35(10³) mm⁴. Obtain a close approximation to the polar radius of gyration about point O.



Solution:

Given: A= 300 mm²

$I_y = 35(10^3)\ mm^4$

$k_x = 15\text{mm (from fig.)}$

We know that $k_y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{35(10^3)}{300}} = 10.8\ mm$

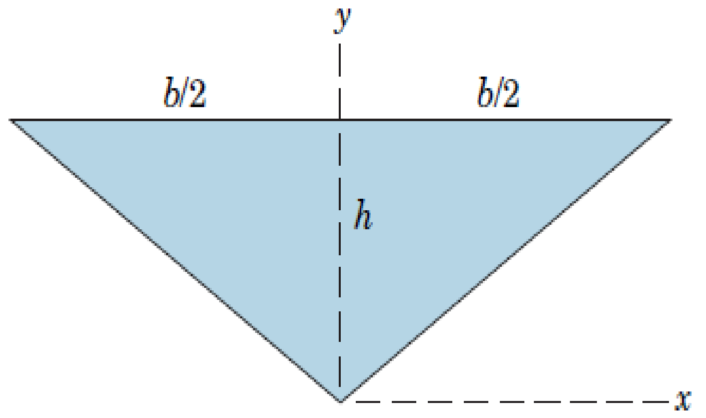
${k_z}^2 = (k_x)^2 + (k_y)^2 = (15)^2 + (10.8)^2$

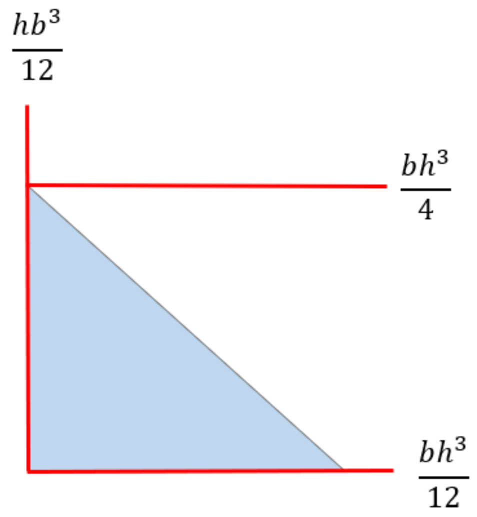
= 341.64

Polar radius of gyration k_z = 18.48 mm

Moment of Inertia: Numerical

Problem A/4. Determine the ratio b/h such that $I_x = I_y$ for the area of the isosceles triangle.





Solution:

$$I_x = \frac{bh^3}{4}$$

$$I_y = 2\left(\frac{hb^3}{12}\right) = 2\left(\frac{h\left(\frac{b}{2}\right)^3}{12}\right) = \frac{hb^3}{48}$$

Given $I_x = I_y$

$$\frac{bh^3}{4} = \frac{hb^3}{48}$$

$$\boxed{\frac{b}{h} = \sqrt{12}}$$

THANK YOU

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