

Course Code: ESC106A

Course Title: Construction Materials and Engineering Mechanics

Lecture No. 41:

Determination of Moment of Inertia

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Lecture Intended Learning Outcomes

At the end of this lecture, students will be able to:

- Determine the Moment of Inertia for different sections by integration method
- Apply parallel axis theorem for determination of MI



Contents

Moment of inertia of triangular section and uniform thin rod



Moment of Inertia of triangular section

Case 1: MI about the base

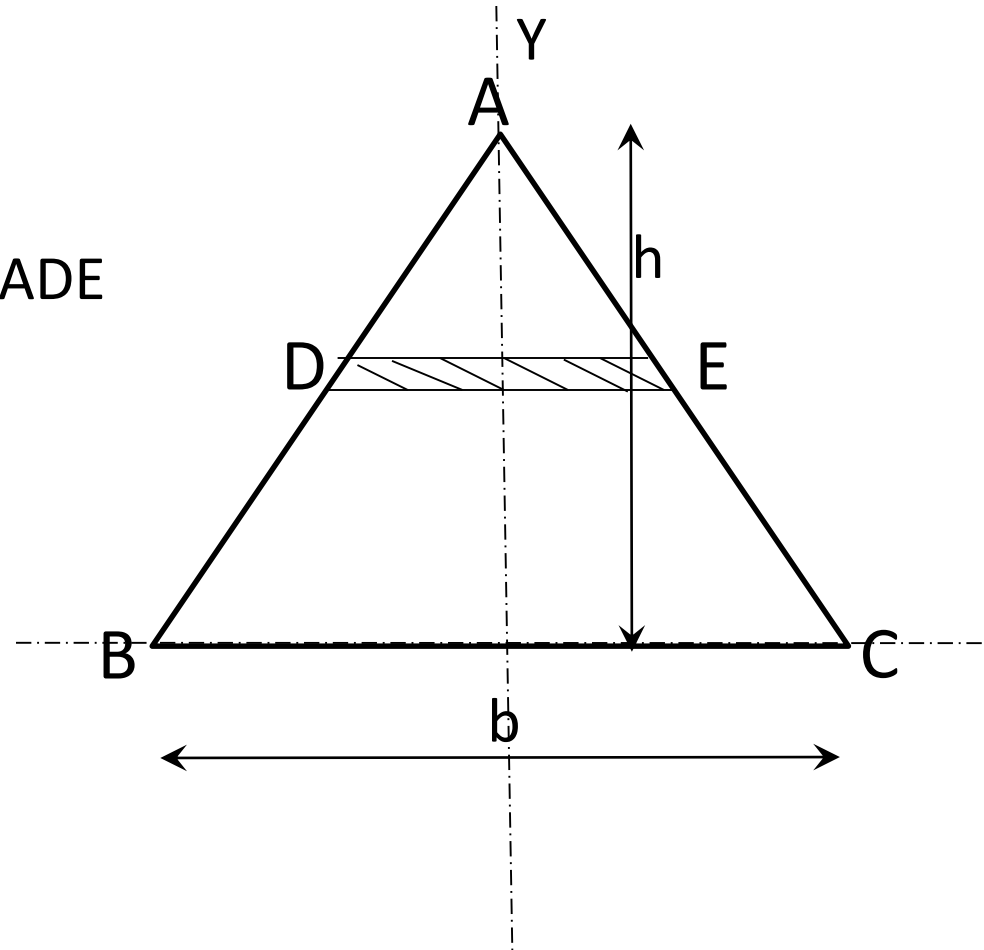
$$dA = DE \cdot dy$$

Distance DE is obtained from $\triangle ABC$ & $\triangle ADE$

$$\frac{DE}{BC} = \frac{y}{h}$$

$$DE = \frac{by}{h}$$

$$dA = \frac{by}{h} dy$$



Moment of Inertia of triangular section

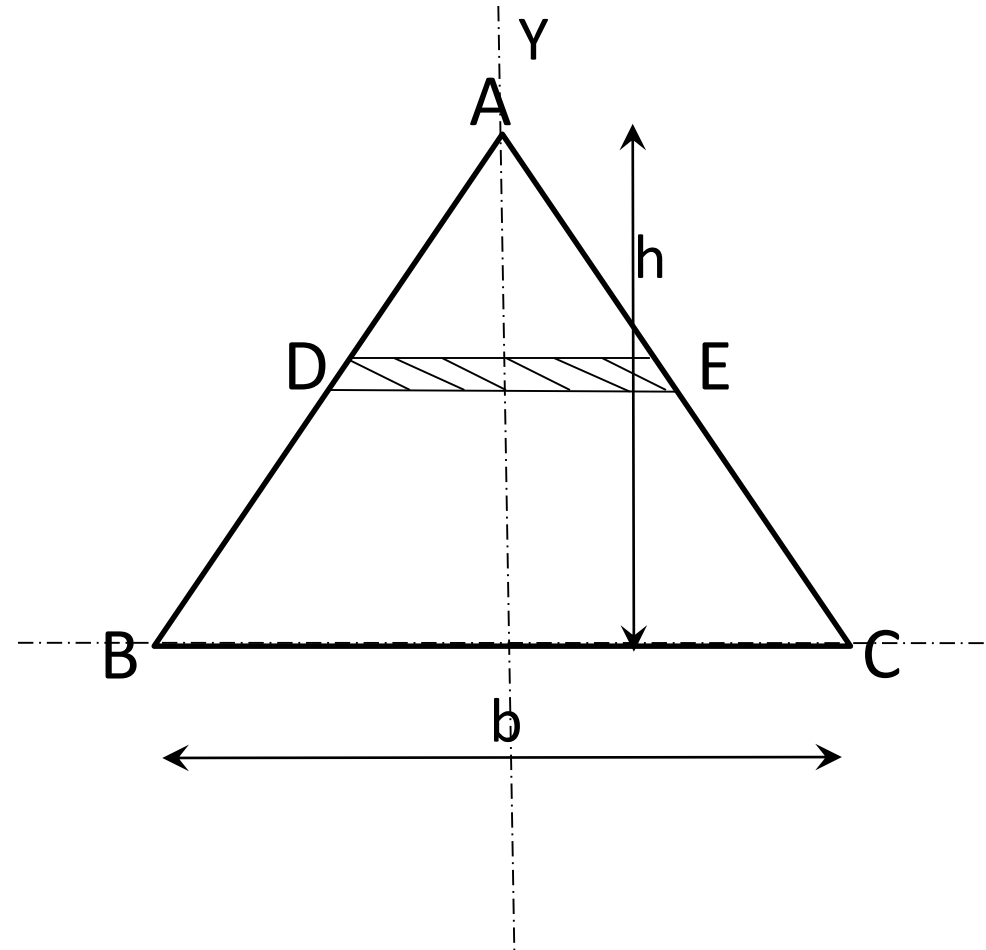
MI of the strip about the base

$$(I_{BC})_{DE} = \frac{by}{h} dy \cdot (h - y)^2$$

$$I_{BC} = \int_0^h \frac{by}{h} [h - y]^2 \cdot dy$$

$$I_{BC} = \frac{b}{h} \int_0^h y [h^2 - 2hy + y^2] dy$$

$$I_{BC} = \frac{b}{h} \cdot h^4 \left[\frac{6 + 3 - 8}{12} \right] = \frac{bh^3}{12}$$



Moment of Inertia of triangular section

Case 2: MI about an axis passing through CG and parallel to base.

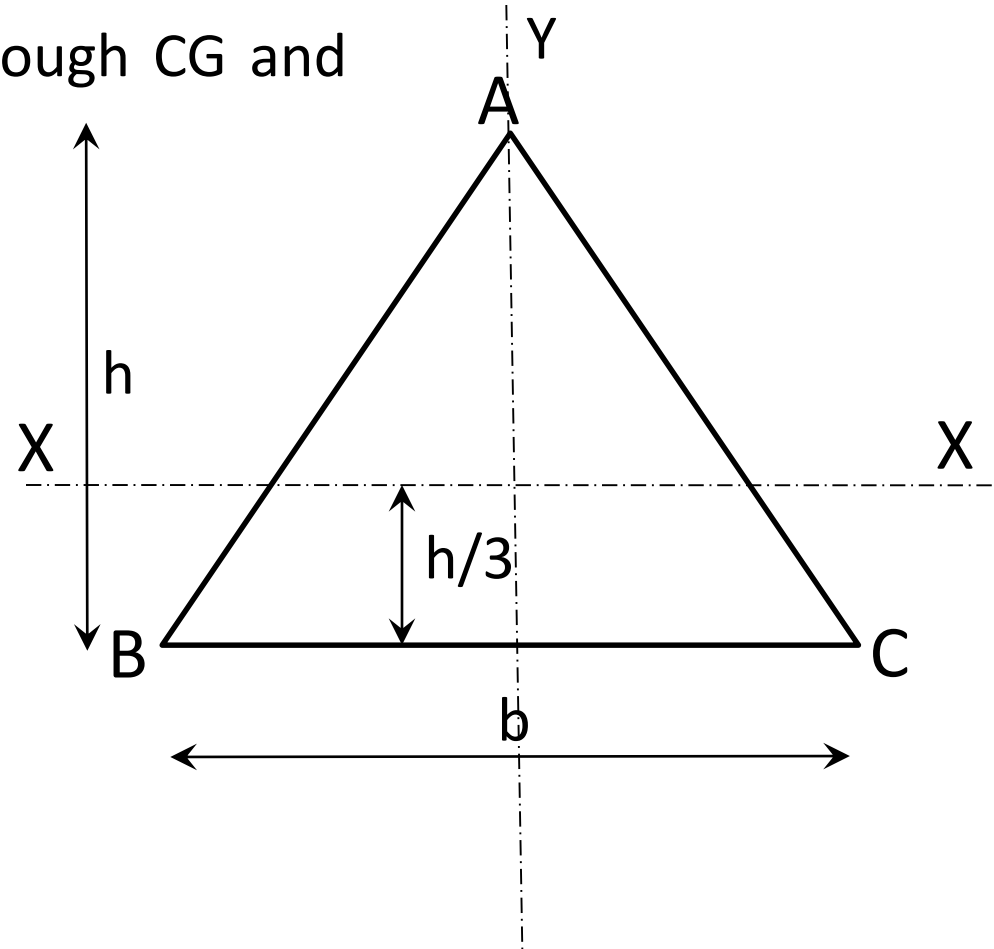
From parallel axis theorem,

$$I_{BC} = I_G + A\left(\frac{h}{3}\right)^2$$

$$I_G = I_{BC} - A\left(\frac{h}{3}\right)^2$$

$$I_G = \frac{bh^3}{12} - \frac{1}{2}bh\left(\frac{h}{3}\right)^2$$

$$I_G = \frac{bh^3}{36}$$



Moment of Inertia of uniform thin rod

- Consider a uniform thin rod AB of length L. If m is the mass per unit length of the rod,

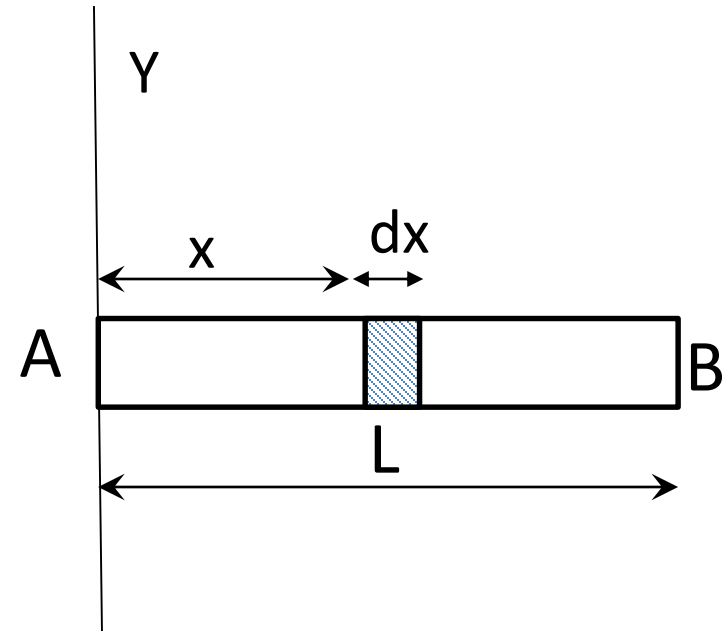
- Total mass of the rod $M = m.L$

$$M_{strip} = m.dx$$

$$(I_{YY})_{strip} = m dx . x^2 = m x^2 dx$$

$$I_{YY} = \int_0^L m x^2 dx = \left[m \frac{x^3}{3} \right]_0^L = \frac{mL^3}{3}$$

$$I_{YY} = \frac{ML^2}{3}$$



Summary

- Moment of inertia of area (mass) of various sections about the considered reference axis is obtained by integration method.
- Parallel axis theorem is applied for finding out the moment of inertia of various sections.

