

ROHININ COLLEGE OF ENGINEERING AND TECHNOLOGY

Approved by AICTE & Affiliated to Anna University

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DEPARTMENT OF MECHANICAL ENGINEERING



NAME OF THE SUBJECT: ENGINEERING MECHANICS

SUBJECT CODE : ME3351

REGULATION 2021

UNIT III: DISTRIBUTED FORCES

Unit-III

PROPERTIES OF SURFACES AND SOLIDS

Centroid:

Centroid is defined as a point on a surface the whole area of the surface acts.

Centre of gravity:

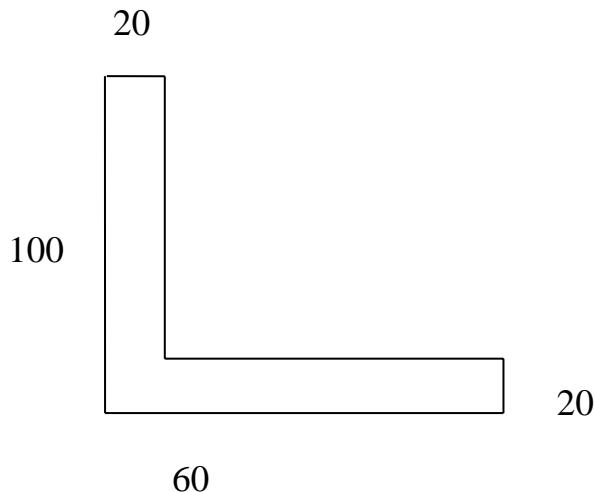
Centre of gravity is defined as the point through which the entire weight of the body acts.

Centroid of simple plane figure:

S1.No	Name	Shape	X	Y	Area
1.	Square	<p>A square of side length a is shown centered at the origin of a 2D Cartesian coordinate system. The horizontal axis is labeled X and the vertical axis is labeled Y. The centroid is marked with the letter G. The distance from the center to each side is $\frac{a}{2}$.</p>	$\frac{a}{2}$	$\frac{a}{2}$	a^2
2.	Rectangle	<p>A rectangle of width l and height b is shown centered at the origin of a 2D Cartesian coordinate system. The horizontal axis is labeled X and the vertical axis is labeled Y. The centroid is marked with the letter G. The distance from the center to the vertical sides is $\frac{l}{2}$ and to the horizontal sides is $\frac{b}{2}$.</p>	$\frac{l}{2}$	$\frac{l}{2}$	lb
3.	Triangle (Isosceles)	<p>An isosceles triangle of base b and height h is shown in a 2D Cartesian coordinate system. The horizontal axis is labeled X and the vertical axis is labeled Y. The vertex of the triangle is at the origin O. The centroid is marked with the letter G. The distance from the base to the centroid is $\frac{h}{3}$.</p>	$\frac{b}{2}$	$\frac{h}{3}$	$\frac{1}{2}bh$

Problem 1:

Determine the Centroid of L section



Centroid

$$\bar{X} = \frac{a_1 x_1 + a_2 x_2}{a_1 + a_2}$$

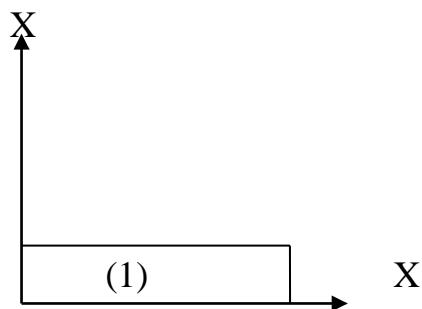
$$\bar{Y} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2}$$

Section (1)

$$a_1 = 60 \times 20 = 1200 \text{ mm}^2$$

$$x_1 = \frac{60}{2} = 30 \text{ mm}$$

$$y_1 = \frac{20}{2} = 10 \text{ mm}$$

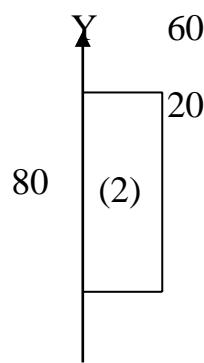


Section (2)

$$a_2 = 20 \times 80 = 160 \text{ mm}^2$$

$$x_2 = \frac{20}{2} = 10 \text{ mm}$$

$$y_2 = 20 + \frac{80}{2} = 60 \text{ mm}$$



→ X

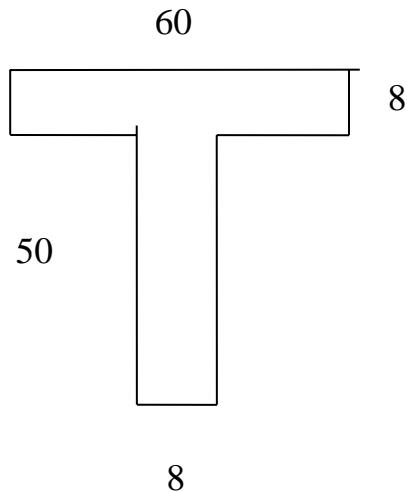
$$\bar{X} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2} = \frac{1200 \times 30 + 1600 \times 10}{1200 + 1600}$$

$$\bar{X} = 18.57 \text{ mm}$$

$$\bar{Y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2} = \frac{1200 \times 10 + 1600 \times 60}{1200 + 1600}$$

$$\bar{Y} = 38.57 \text{ mm}$$

2. Find the Centroid of T section



Section (1)

$$a_1 = 8 \times 50 = 400 \text{ mm}^2$$

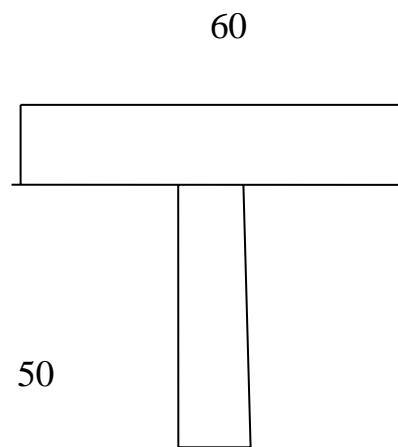
$$x_1 = 26 + \frac{8}{2} = 30 \text{ mm}$$

$$y_1 = \frac{50}{2} = 25 \text{ mm}$$

Section(2)

$$a_2 = 60 \times 8 = 480 \text{ mm}^2$$

$$x_2 = \frac{60}{2} = 30 \text{ mm}$$



$$y_2 = 50 + \frac{8}{2} = 54 \text{ mm}$$

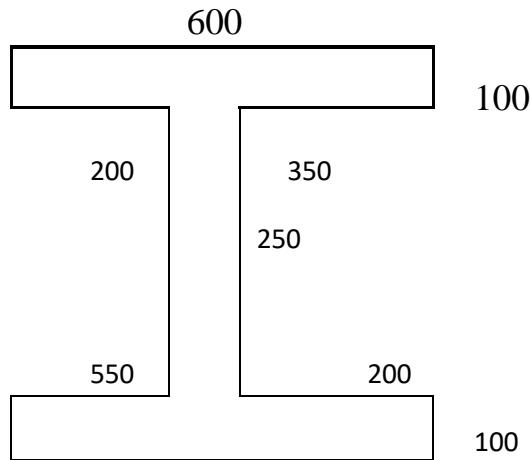
$$\bar{X} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2} = \frac{400 \times 30 + 480 \times 300}{1200 + 480}$$

$$\bar{X} = 30 \text{ mm}$$

$$\bar{Y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2} = \frac{400 \times 25 + 480 \times 54}{400 + 480}$$

$$\bar{Y} = 40.81 \text{ mm}$$

3. Locate the Centroid of the I section shown.



Soln:

$$\bar{X} = \frac{a_1x_1 + a_2x_2 + a_3x_3}{a_1 + a_2 + a_3}$$

$$\bar{Y} = \frac{a_1y_1 + a_2y_2 + a_3y_3}{a_1 + a_2 + a_3}$$

Section (1)

$$a_1 = 800 \times 100 = 80000 \text{ mm}^2$$

$$x_1 = \frac{800}{2} = 400 \text{ mm}$$

$$y_1 = \frac{100}{2} = 50\text{mm}$$

Section(2)

$$a_2 = 250 \times 100 = 25 \times 10^3 \text{mm}^2$$

$$x_2 = 550 + \frac{100}{2} = 600\text{mm}$$

$$y_2 = 100 + \frac{250}{2} = 225\text{mm}$$

Section (3)

$$a_3 = 600 \times 100 = 60 \times 10^3 \text{mm}^2$$

$$x_3 = 350 + \frac{600}{2} = 650\text{mm}$$

$$y_3 = 100 + 250 + \frac{100}{2} = 400\text{mm}$$

$$\bar{X} = \frac{(80 \times 10^3 \times 400) + (25 \times 10^3 \times 600) + (60 \times 10^3 \times 650)}{80 \times 10^3 + 25 \times 10^3 + 60 \times 10^3}$$

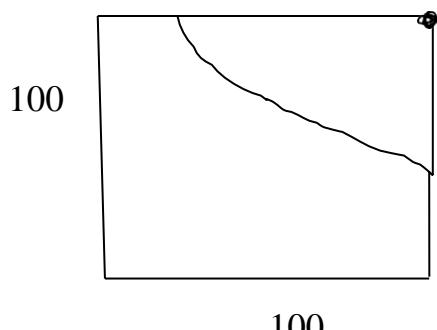
$$\bar{X} = 521.21\text{mm}$$

$$\bar{Y} = \frac{(80 \times 10^3 \times 50) + (25 \times 10^3 \times 225) + (60 \times 10^3 \times 400)}{80 \times 10^3 + 25 \times 10^3 + 60 \times 10^3}$$

$$\bar{Y} = 203.78\text{mm}$$

4. Locate the Centroid of the Area.

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Soln:

$$\bar{X} = \frac{a_1 x_1 - a_2 x_2}{a_1 + a_2}$$

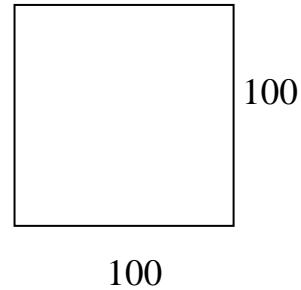
$$\bar{Y} = \frac{a_1 y_1 - a_2 y_2}{a_1 + a_2}$$

Section (1)

$$a_1 = 100 \times 100 = 10 \times 10^3 \text{ mm}^2$$

$$x_1 = \frac{100}{2} = 50 \text{ mm}$$

$$y_1 = \frac{100}{2} = 50 \text{ mm}$$



Section (2)

$$a_2 = \frac{1}{4} \times \pi r^2 = \frac{1}{4} \times \pi \times 70^2 = 38.48 \text{ mm}^2$$

$$x_2 = \frac{4r}{3\pi} = \frac{4 \times 70}{3\pi} = 70.29 \text{ mm}$$

$$y_2 = \frac{4r}{3\pi} = \frac{4 \times 70}{3\pi} = 70.29 \text{ mm}$$

$$\bar{X} = \frac{a_1 x_1 - a_2 x_2}{a_1 + a_2}$$

$$\bar{X} = \frac{(10 \times 10^3 \times 50) - (3848 \times 70.29)}{10 \times 10^3 - 3848}$$

$$\bar{X} = 37.3 \text{ mm}$$

$$\bar{Y} = \frac{a_1 y_1 - a_2 y_2}{a_1 + a_2}$$

$$\bar{Y} = \frac{(10 \times 10^3 \times 50) - (3848 \times 70.29)}{10 \times 10^3 - 3848}$$

$\bar{Y} = 373mm$