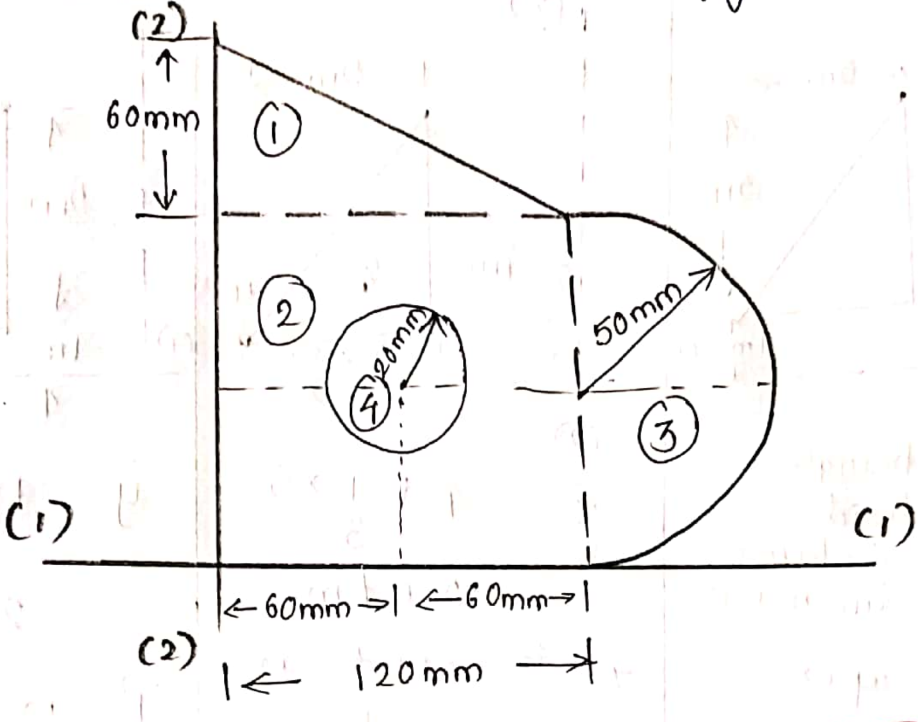
(2) Determine the position of centroid for the lamina with a circular cutout shown in figure.



Note: Circular cutout means the circular portion is hollow and hence the area of the circle is to be taken with a negative sign.

Component	Area 'a' mm^2	$\bar{x}$ distance from (2)-(2) 'mm'	$\bar{y}$ distance from (1)-(1) 'mm'	$a\bar{x}$ mm^3	$a\bar{y}$ mm^3
① Triangle	$\frac{1}{2}bh$ $= \frac{1 \times 120}{2} \times 60$ $= 3600$	$\frac{1}{3} \times b$ $= \frac{1}{3} \times 120$ $= 40$	$100 + \frac{1}{3} \times h$ $= 100 + \frac{1}{3} \times 60$ $= 120$	144×10^3	432×10^3
② Rectangle	~~b×h~~ $d \times b$ $= 120 \times 100$ $= 12000$	$\frac{b}{2}$ $= 120/2$ $= 60$	$\frac{d}{2}$ $= 100/2$ $= 50$	720×10^3	600×10^3
③ Semi-circle	$\pi r^2/2$ $\pi(50)^2/2$ $= 3926.99$	$120 + \frac{4r}{3\pi}$ $= 141.22$	r $= 50$	554.57×10^3	196.35×10^3

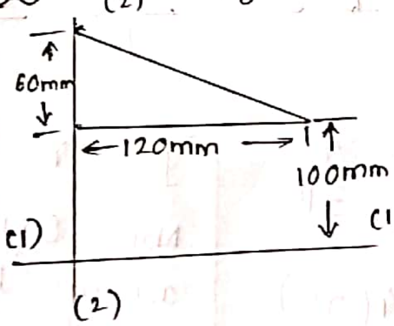
Comp	'a'	$\bar{x}$	$\bar{y}$	$a\bar{x}$	$a\bar{y}$
(4) circle	$-\pi r^2$ $= -\pi(20)^2$ $= -1.256 \times 10^3$	60	50	-75.36×10^3	-62.8×10^3
	$\Sigma a = 18270.99$			$\Sigma a\bar{x} = 1343210$	$\Sigma a\bar{y} = 1165550$

Centroid of the whole lamina $G(\bar{X}, \bar{Y})$

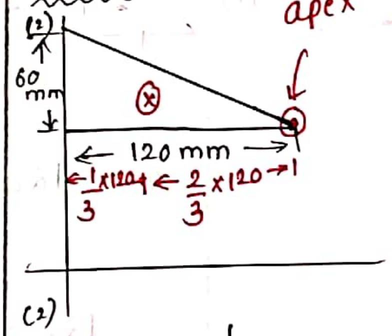
$$\bar{X} = \frac{\Sigma a\bar{x}}{\Sigma a} = 73.52 \text{ mm} \qquad \bar{Y} = \frac{\Sigma a\bar{y}}{\Sigma a} = 63.79 \text{ mm}$$

$$\therefore G(\bar{x}, \bar{y}) = (73.52 \text{ mm}, 63.79 \text{ mm})$$

Comp (1) Triangle:

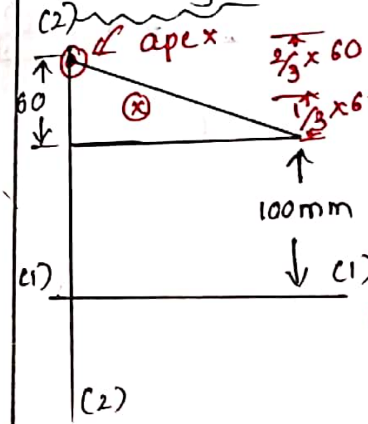


For $\bar{x}$



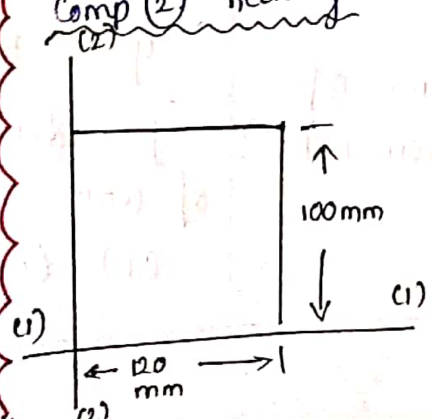
$$\bar{x} = \frac{1}{3}\times b$$
$$= \frac{1}{3}\times 120 = 40$$
$$\bar{x} = 40$$

For $\bar{y}$

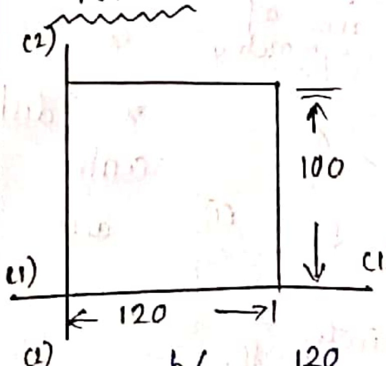


$$\bar{y} = 100 + \frac{1}{3}\times 60$$
$$\bar{y} = 120$$

Comp (2) Rectangle

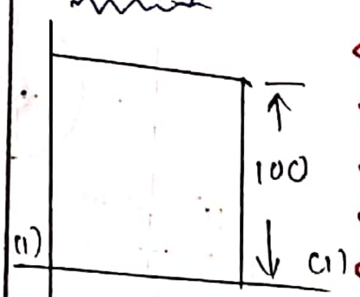


For $\bar{x}$



$$\bar{x} = b/2 = \frac{120}{2}$$
$$\bar{x} = 60 \text{ mm}$$

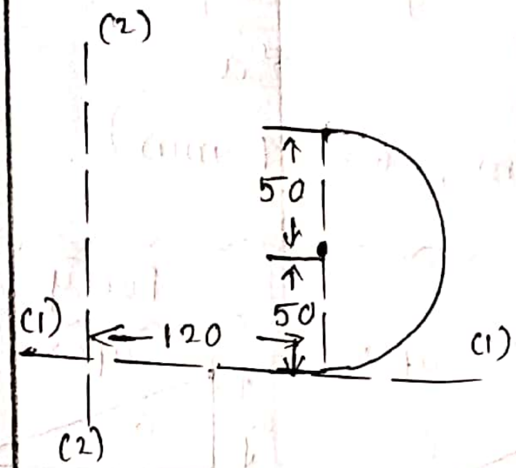
For $\bar{y}$



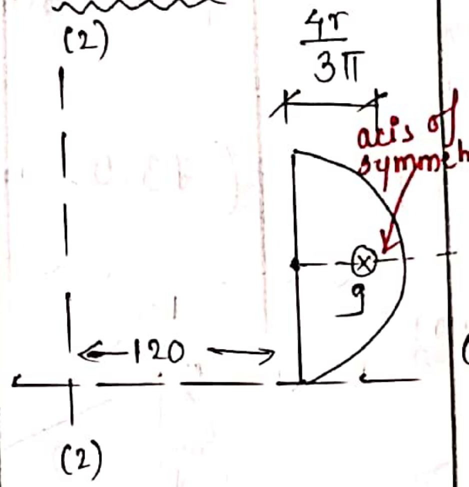
$$\bar{y} = d/2 = \frac{100}{2}$$
$$\bar{y} = 50 \text{ mm}$$

$= 3$

③ Semi-circle.



For $\bar{x}$

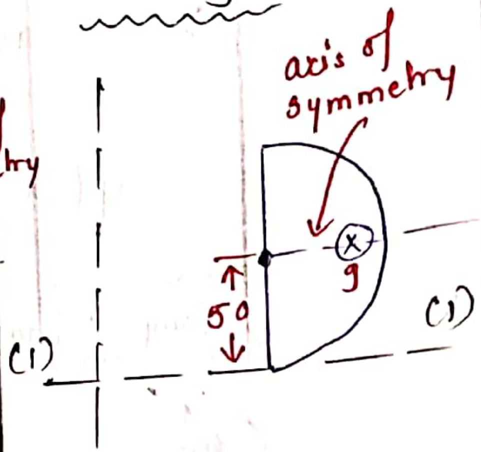


$$\bar{x} = 120 + \frac{4r}{3\pi}$$

$$= 120 + \frac{4(50)}{3\pi}$$

$$= 141.22 \text{ mm}$$

For $\bar{y}$

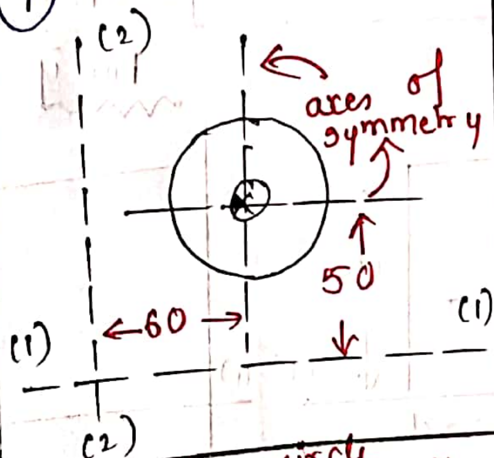


$\bar{y} = r = 50$ mm

Note: Centroid always lies on the axis of symmetry

$\therefore \bar{y} = r =$ distance of axis of symmetry from (1)-(1)

④ Circle.



Note: For circle centroid lies at the centre of the circle

For $\bar{x}$

$\bar{x} = 60$

$\bar{x} =$ distance of centre from (2)-(2) axis

For $\bar{y}$

$\bar{y} = 50$

$\bar{y} =$ distance of centre from (1) - (1) axis