MEC CA-2

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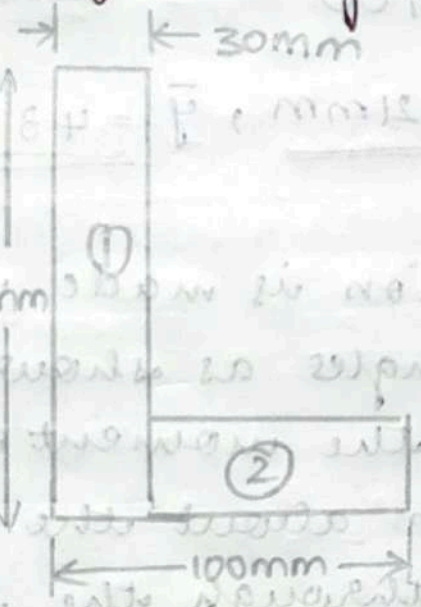
Q1). Calculate the centre of gravity from the following figure.



Solution:

For section ① Area (a_1) = 120mm × 30mm

= 3600mm²

$x_1 = \frac{30mm}{2} = 15mm$, $y_1 = \frac{120mm}{2} = 60mm$

For section ② Area (a_2) = 70mm × 30mm

= 2100mm²

$x_2 = 30mm + \frac{70mm}{2} = 65mm$

$y_2 = \frac{30mm}{2} = 15mm$

$$\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2} = \frac{3600 * 15 + 2100(65)}{3600 + 2100}$$

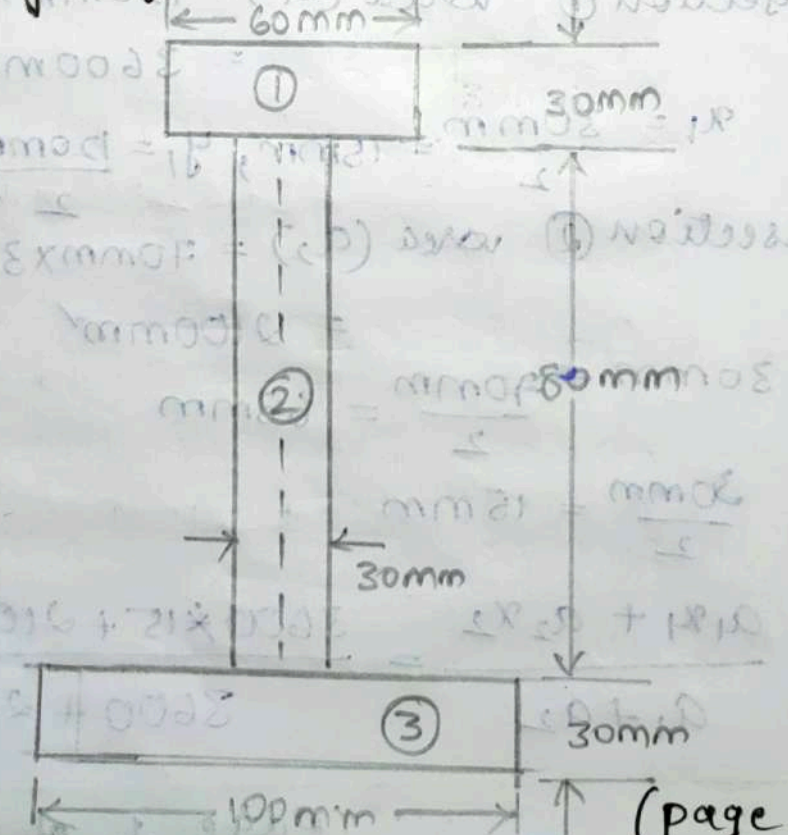
$$= \frac{190500}{5700} = 33.421\,mm$$

$$\bar{y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2} = \frac{3600(60) + 2100(15)}{3600 + 2100}$$

$$= \frac{247500}{5700} = 43.42\,mm$$

$\therefore \bar{x} = 33.421\,mm$, $\bar{y} = 43.42\,mm$.

Q2). An I-section is made up of three rectangles as shown in figure. Find the moment of inertia of the section about the horizontal axis passing through the centre of gravity of section.



Solution:

From part ①,

Area $A_1 = 60mm \times 30mm = 1800mm^2$

$y_1 = 30 + 80 + \frac{30}{2} = 125mm.$

From part ②,

Area $A_2 = 80mm \times 30mm = 2400mm^2$

$y_2 = 30 + \frac{80}{2} = 70mm$

From part ③,

Area $A_3 = 100mm \times 30mm = 3000mm^2$

$y_3 = \frac{30}{2} = 15mm$

$$\bar{y} = \frac{A_1y_1 + A_2y_2 + A_3y_3}{A_1 + A_2 + A_3}$$

$$= \frac{1800(125) + 2400(70) + 3000(15)}{1800 + 2400 + 3000}$$

$$= \frac{438000}{7200} = \underline{60.8mm}$$

Moment of inertia of x-x axis

$$I_{xx} = I_G + Ah^2$$

For Part ① (section ①).

$$I_{xx_1} = I_{G_1} + Ah^2$$

$$I_{G_1} = \frac{bd^3}{12} = \frac{60 \times (30)^3}{12} = \underline{135 \times 10^3 mm^4}$$

$h_1 = 125 - 60.8 = 64.2\,mm$

$I_{xx_1} = 135 \times 10^3 + 1800 \times (64.2)^2$

$= 7553.952 \times 10^3\ mm^4$

For part ②,

$I_{xx_2} = I_{G_2} + A_2 h_2^2$

$I_{G_2} = \frac{bd^3}{12} = \frac{30 \times (20)^3}{12} = 1280 \times 10^3\ mm^4$

$h_2 = 70 - 60.8 = 9.2\,mm$

$I_{xx_2} = 1280 \times 10^3 + 2400 \times (9.2)^2$

$= 1483.136 \times 10^3\ mm^4$

For part ②,

$I_{xx_3} = I_{G_3} + A_3 h_3^2$

$I_{G_3} = \frac{bd^3}{12} = \frac{100 \times 30 \times 30 \times 30}{12}$

$= 225 \times 10^3\ mm^4$

$h_3 = 60.8 - 15 = 45.8\,mm$

$I_{xx_3} = 225 \times 10^3 + 3000 (45.8)^2$

$= 6517.92 \times 10^3\ mm^4$

Now, the entire I-section moment of inertia around xx axis and

passing through centre of gravity of section

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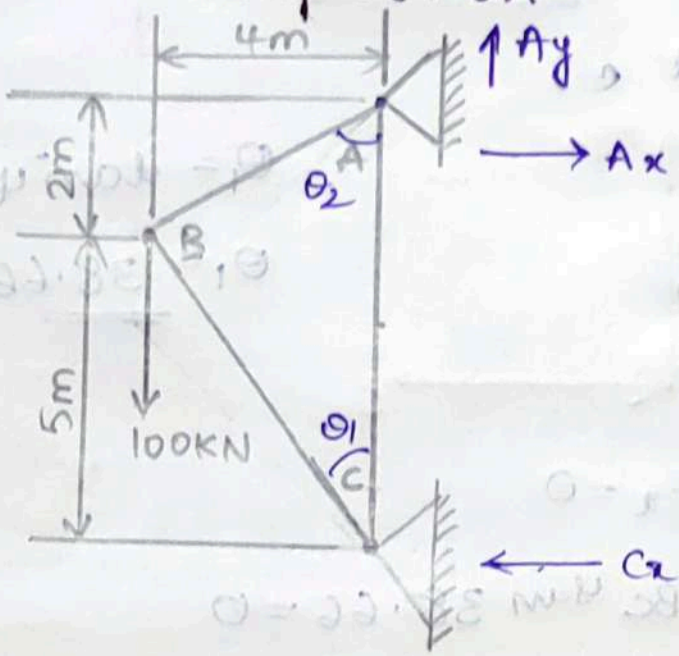
$I_{xx} = I_{xx_1} + I_{xx_2} + I_{xx_3}$

$= 7553.952 \times 10^3 + 1483.136 \times 10^3 + 6517.92 \times 10^3$

$= 15,555.008 \times 10^3 mm^4$

Q3). Determine the force in each member of the truss shown. State whether each member is in tension or compression.



Solution:

A is Rocker support, so it has two reaction force (A_x and A_y)

C is Roller support, it can move and adjust itself. so, it will have only one reaction force (C_x)

Now, we Assume that clockwise moment as negative moment (-ve) and Anticlockwise as positive moment (+ve)

$$\sum M_A = 0$$

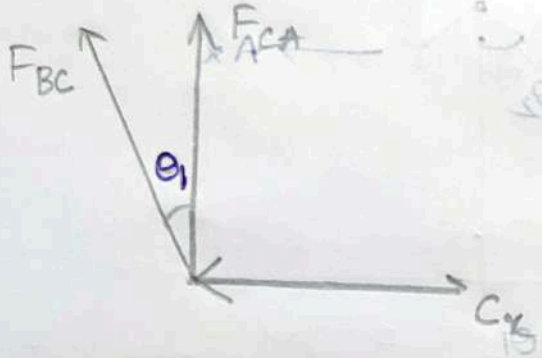
$$(100 \times 4\,KNm - C_x(5+2)) = 0$$

$$400\,KNM - 7C_x = 0$$

$$C_x = \frac{400}{7}\,KNm$$

$$C_x = 57.14\,KNm$$

FBD at c:



$$\theta_1 = \tan^{-1} 4/5$$

$$\theta_1 = 38.66°$$

$$\sum F_x = 0$$

$$-C_x - F_{BC} \sin 38.66 = 0$$

$$F_{BC} \sin 38.66 = -C_x$$

$$F_{BC} = \frac{-C_x}{\sin 38.66} = \frac{-57.14}{\sin 38.66} = -91.47\,KN$$

$$F_{BC} = 91.47\,KN\,(C)$$

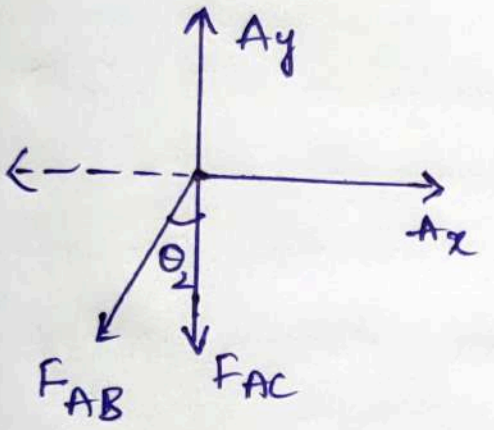
$F_y = 0$

$F_{AC} + F_{BC} \cos 38.66 = 0$

$F_{AC} = -F_{BC} \cos 38.66 = 0$

$\therefore F_{AC} = \underline{71.43\ (T)KN}$

FBD at A:



$\theta_2 = \tan^{-1}(4/2)$

$= \tan^{-1}(2) = 63.43$

$\therefore \theta_2 = 63.43$

$\Sigma F_x = 0$

$A_x - F_{AB} \sin 63.43 = 0$

$F_{AB} = \dfrac{A_x}{\sin 63.43^\circ} = \dfrac{57.14}{\sin 63.43} = 63.89KN$

$\therefore F_{AB} = 63.89\,KN(T)$

Member	Force (KN)	Nature
F_{AB}	63.89KN	Tensile
F_{BC}	91.47KN	compressive
F_{AC}	71.43KN	Tensile.