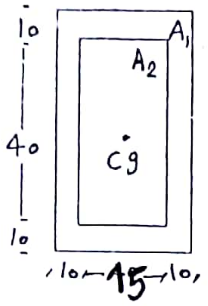
Sheet 3

» Calculate The Moment Of Inertia About The Horizonal And Vertical Axes For The Following Sections :-

1-

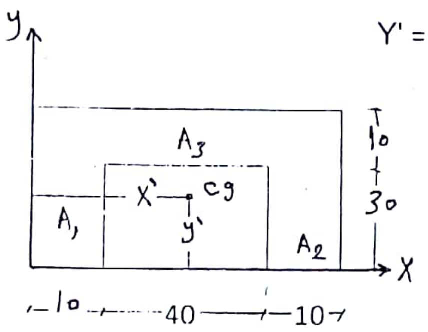


$$I_x = I_{x1} + A1*(S1)^2 - I_{x2} - A2*(S2)^2$$

$$= \frac{(35)*(60)^3}{12} + 35*60*0 - \frac{(15)*(40)^3}{12} - 0 = 550000\ cm^4$$

$$I_y = \frac{(60)*(35)^3}{12} + 0 - \frac{(10)*(15)^3}{12} - 0 = 203125\ cm^4$$

2-



$A1 = A2 = A3 = 400\ cm^2$

$$Y' = \frac{A1*Y1 + A2*Y2 + A3*Y3}{A1 + A2 + A3} = \frac{400*20+400*20+400*35}{400+400+400} = 25\ cm$$

$$X' = \frac{400*5+400*55+400*20}{400+400+400} = 30\ cm$$

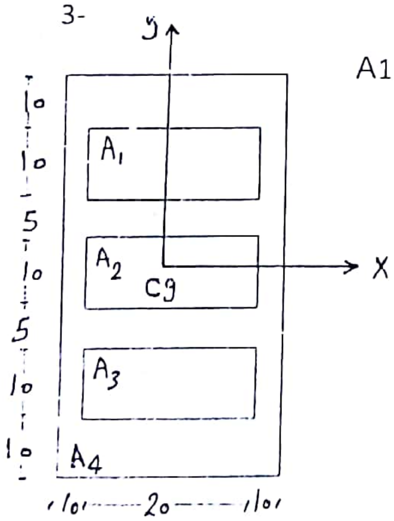
$$I_x = \frac{10*40^3}{12} + 400*5^2 + \frac{10*40^3}{12} + 400*5^2 + \frac{40*10^3}{12} + 400*10^2$$

$$= 170000\ cm^4$$

$$I_y = \frac{40*10^3}{12} + 400*5^2 + \frac{40*10^3}{12} + 400*35^2 + \frac{10*40^3}{12} + 400*0$$

$$= 560000\ cm^4$$

3-



$A1 = 10*20 = 200\ cm^2$, $A2 = A3$, $A4 = 40*60 = 2400\ cm^2$

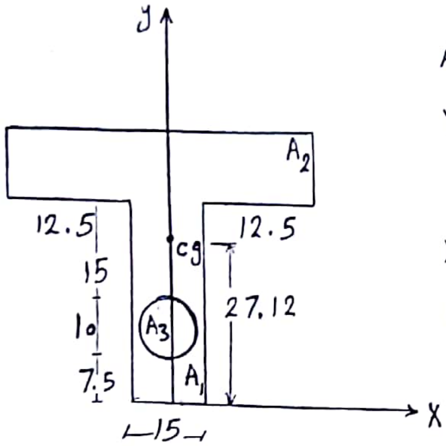
$$I_x = \frac{40*60^3}{12} + 0 - 2\left(\frac{20*10^3}{12} + 15^2*200\right) - \frac{20*10^3}{12} + 0$$

$$= 625000\ cm^4$$

$$I_y = \frac{60*40^3}{12} + 0 - 2\left(\frac{10*20^3}{12} + 0\right) - \frac{10*20^3}{12} + 0$$

$$= 300000\ cm^4$$

4-



$A1 = 487.5\ cm^2$, $A2 = 400cm^2$, $A3 = 25\pi$

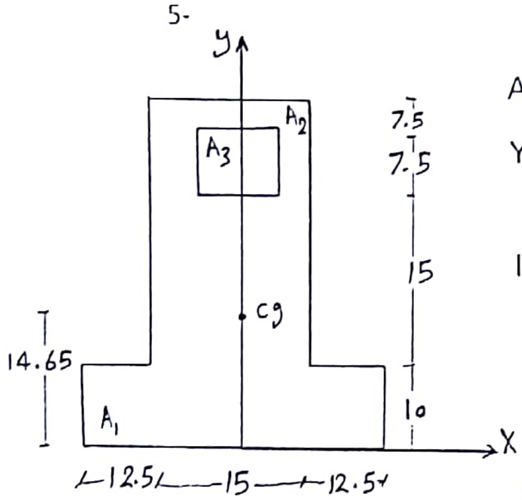
$$Y' = \frac{487.5*16.25 + 400*37.5 - 25\pi*12.5}{487.5 + 400 + 25\pi} = 27.12\ cm$$

X' = zero

$$Ix = \frac{40*10^3}{12} + 400*(10.38)^2 + \frac{15*(32.5)^3}{12} + 487.5*(10.87)^2 - \frac{\pi*5^4}{4} - 25\pi*(14.62)^2 = 129664.4\ cm^4$$

$$Iy = \underline{10*40^3} + \underline{32.5*15^3} - \underline{\pi*5^4} = 61983.08\ cm^4$$

5-



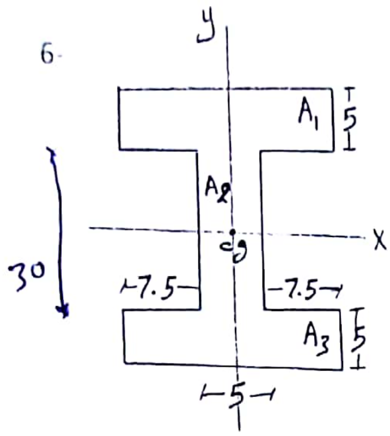
$A1 = 400\ cm^2$, $A2 = 450\ cm^2$, $A3 = 56.23\ cm^2$

$$Y' = \frac{400*5 + 450*25 + 56.23*28.75}{400 + 450 + 56.23} = 14.65\ cm$$

$$Ix = \frac{40*10^3}{12} + 400*(9.65)^2 + \frac{15*30^3}{12} + 450*(10.35)^2 - \frac{7.5*(7.5)^3}{12} - 56.25*(14.1)^2 = 111090.72\ cm^4$$

$$Iy = \frac{10*40^3}{12} + 0 + \frac{30*15^3}{12} - \frac{7.5*(7.5)^3}{12} = 61507.16\ cm^4$$

6-

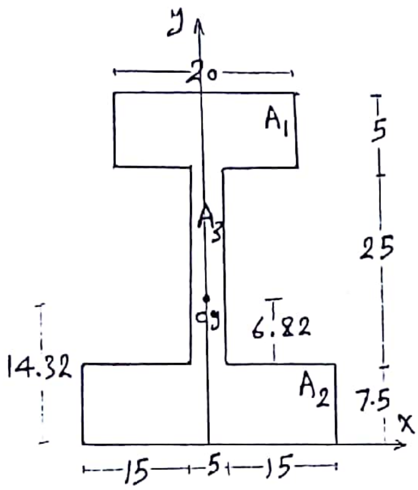


$$A1 = A3 = 100\ cm^2\ ,\ A2 = 150\ cm^2$$

$$Ix = \left[\frac{20*5^3}{12} + 100*(17.5)^2\right]*2 + \frac{5*30^3}{12} = 72916.67\ cm^4$$

$$Iy = \left[\frac{5*20^3}{12}\right]*2 + \frac{30*5^3}{12} = 6979.167\ cm^4$$

7-



$$A1 = 100\ cm^2\ ,\ A2 = 262.5\ cm^2\ ,\ A3 = 125\ cm^2$$

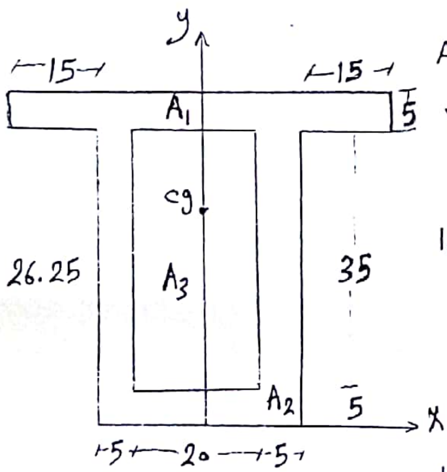
$$Y' = \frac{100*35 + 125*20 + 262.5*3.75}{100 + 125 + 262.5} = 14.32\ cm$$

$$Ix = \frac{20*5^3}{12} + 100*(20.68)^2 + \frac{35*(7.5)^3}{12} + 262.5*(10.57)^2$$

$$+ \frac{5*25^3}{12} + 125*(5.68)^2 = 84076.045\ cm^4$$

$$Iy = \frac{5*20^3}{12} + \frac{7.5*35^3}{12} + \frac{25*5^3}{12} = 30390.625\ cm^4$$

8-



$$A1 = 300\ cm^2\ ,\ A2 = 1200\ cm^2\ ,\ A3 = 700\ cm^2$$

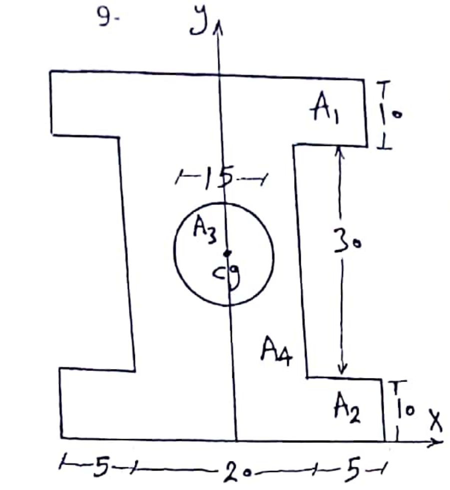
$$Y' = \frac{300*42.5 + 1200*20 - 700*22.5}{300 + 1200 - 1700} = 26.25\ cm$$

$$Ix = \frac{60*5^3}{12} + 300*(16.25)^2 + \frac{30*40^3}{12} + 1200*(6.25)^2$$

$$- \frac{20*35^3}{12} - 700*(3.75)^2 = 205416.67\ cm^4$$

$$Iy = \frac{5*60^3}{12} + \frac{40*30^3}{12} - \frac{35*20^3}{12} = 156666.67\ cm^4$$

9-



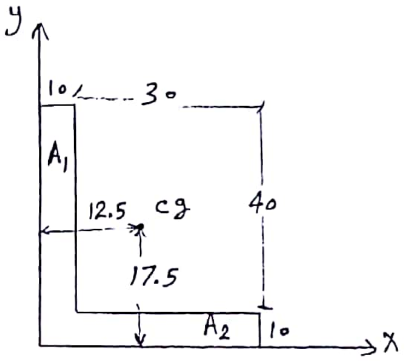
$A1 = A2 = 300\ cm^2$, $A3 = \frac{225\ \pi}{4}$, $A4 = 600\ cm^2$

$$Ix = \frac{30*10^3}{12} + 300*20^2 + \frac{30*10^3}{12} + 300*20^2 + \frac{20*30^3}{12} + 0$$

$$- \frac{\pi*(7.5)^4}{4} = 287514.95\ cm^4$$

$$Iy = \frac{10*30^3}{12} + \frac{10*30^5}{12} + \frac{30*20^3}{12} - \frac{\pi*(7.5)^4}{4} = 62514.95\ cm^4$$

10-



$A1 = 500\ cm^2$, $A2 = 300\ cm^2$

$$Y' = \frac{500*25 + 300*5}{500 + 300} = 17.5\ cm$$

$$X' = \frac{500*5 + 300*25}{500 + 300} = 12.5\ cm$$

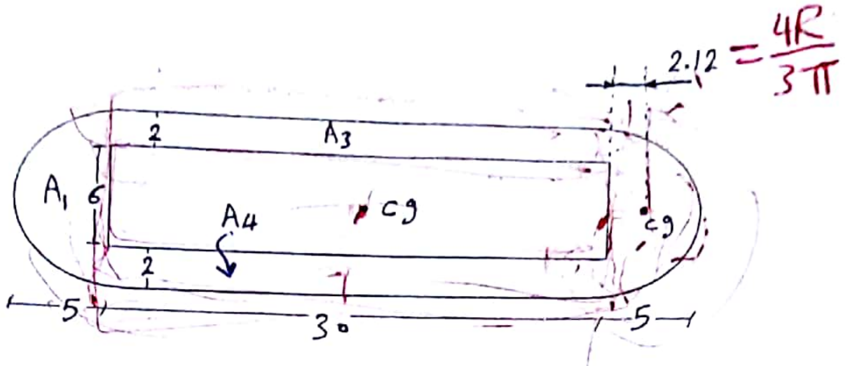
$$Ix = \frac{30*10^3}{12} + 300*(12.5)^2 + \frac{10*50^3}{12} + 500*(7.5)^2$$

$$= 181666.67\ cm^4$$

$$Iy = \frac{10*30^3}{12} + 300*(12.5)^2 + \frac{50*10^3}{12} + 500*(7.5)^2$$

$$= 101666.67\ cm^4$$

11-



A2 = A1 = $0.5\pi(5)^2 = 12.5\pi$, A3 = A4 = 30*2 = 60 , ~~A5 = 6*30 = 180~~

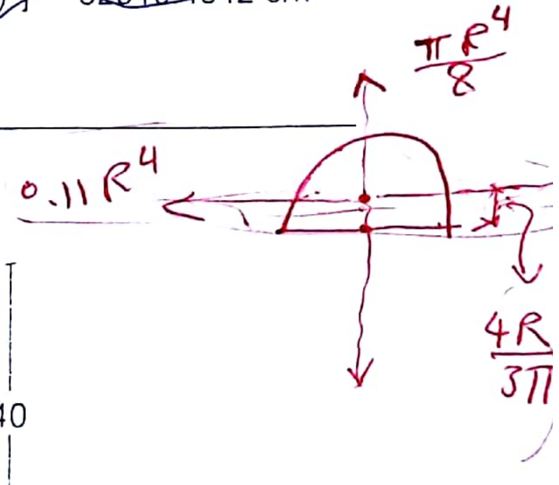
$$I_x = 2\left(\frac{\pi * 5^4}{8}\right) + \left(\frac{30*2^3}{12} + 60*4^2\right)*2 = 2941.74 \text{ cm}^4$$

$$\cancel{I_x = \frac{(30*10^3)}{12} + \frac{2(\pi*5^4)}{4}\frac{1}{2} - \frac{30*6^3}{12} = 2450.87 \text{ cm}^4}$$

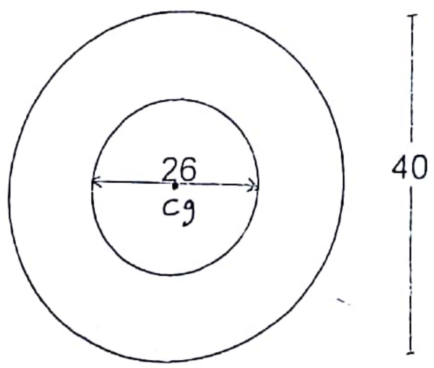
$$\cancel{I_y = \frac{10*30^3}{12} - \frac{6*30^3}{12} + 2*39.27*(15+\frac{4*5}{3\pi}) + 2*0.11*5^4 = 10482.27 \text{ cm}^4}$$

$$I_y = 2(0.11*5^4 + 39.27*17.12^2) + 2*\frac{2*30^3}{12} = 32157.13 \text{ c}$$

$$\cancel{I_y = \frac{10*30^3}{12} - \frac{6*30^3}{12} + \frac{2\pi*5^4}{4}*\frac{1}{2} + 2[0.5\pi*5^2*(17.12)^2] = 32510.4542 \text{ cm}^4}$$



12-



$$I_x = I_y = \frac{\pi(20)^4}{4} - \frac{\pi(13)^4}{4} = 10231.9492 \text{ cm}^4$$
