LECTURE NOTES

ON

STRUCTURAL MECHANICS (TH. 1)

FOR

DIPLOMA IN CIVIL ENGINEERING

(3RD SEMESTER STUDENTS)

AS PER SCTE&VT SYLLABUS

PREPARED BY:

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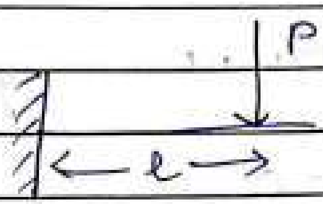
www.gpsambalpur.com

Moment :-

- The turning effect of the force on the body on which it is acting is measured by moment.

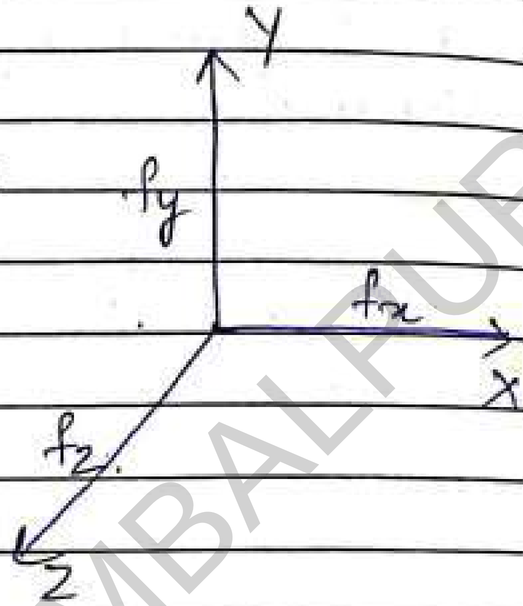
- It is found by multiplying the force by ⊥r distance



$$M = P \times l$$
$$= N \times m$$
$$= Nm \quad \text{(Newton meter)}$$

Conditions for Equilibrium:-

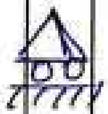
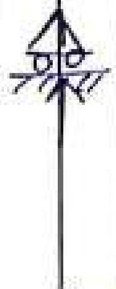
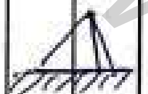
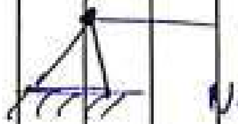
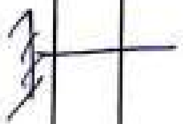
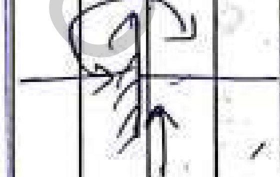
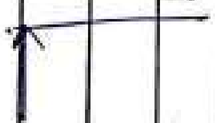
It may be defined as a state of rest or uniform motion of a body whose net force and net moment is acting upon a body is equal to zero.



Net force	Net moment
$\Sigma f_x = 0$	$\Sigma M_x = 0$
$\Sigma f_y = 0$	$\Sigma M_y = 0$
$\Sigma f_z = 0$	$\Sigma M_z = 0$

Net force = Net moment = zero.

Support conditions:-

Sl NO	Types of Supports	Represented By	Reaction force	Resisting load
1.	Roller Support		 ① Vertical	Vertical force
2.	Pinned Support / Hinged support		 ② Vertical and Horizontal	Vertical and Horizontal
3.	Fixed Support		 ③ Vertical, Horizontal, Rotational	~~Vertical~~ all type of loads & mom (Vertical, Horizontal, Rotational).
4.	Single Support.		 ① Vertical	Vertical loads

Centre of gravity (CG) :-

- Centre of gravity is an imaginary balancing point where the body weight can be assumed to be concentrated.

- It symbol is C.G

Moment of inertia (M.I) :-

- Moment of inertia measures the resistance to a change in rotation.

- $MI = M \times Distance$

$= Pl \times l$

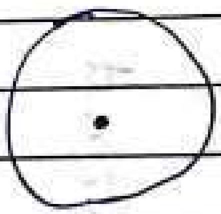
$\boxed{M = Pl^2}$

CG and MI of different section.

① Rectangle

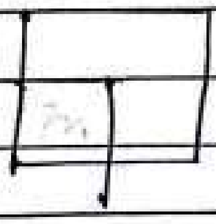
CG: $\frac{B}{2}, \frac{D}{2}$ | MI: $\frac{BD^3}{12}$

② circle



CG: $\frac{D}{2}$ or r | MI: $\frac{\pi D^4}{64}$

③ Square



CG: $\frac{a}{2}, \frac{a}{2}$ | MI: $\frac{a^4}{12}$

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  $= Pl \times l$
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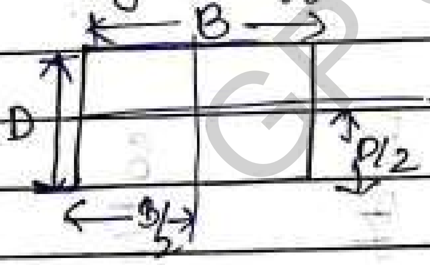
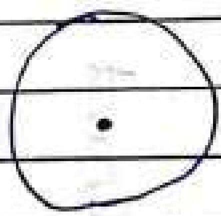
CG and MI of different section.

① Rectangle.



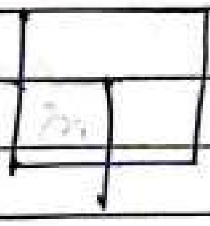
$\frac{B}{2}, \frac{D}{2}$. $\frac{BD^3}{12}$.

② circle



$\frac{D}{2}$ or r $\frac{\pi D^4}{64}$

③ Square



$\frac{a}{2}, \frac{a}{2}$. $\frac{a^4}{12}$.

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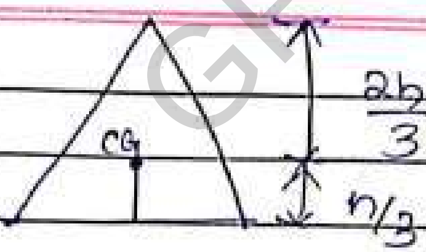
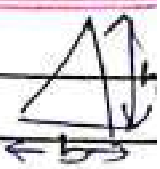
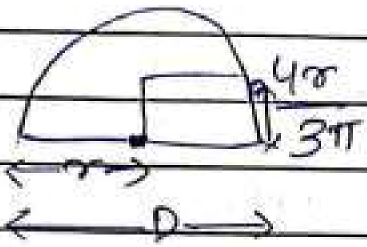
(4) Triangle



$\frac{Bh^3}{36}$



(5) Semicircle



$\frac{\pi D^4}{128}$

CW
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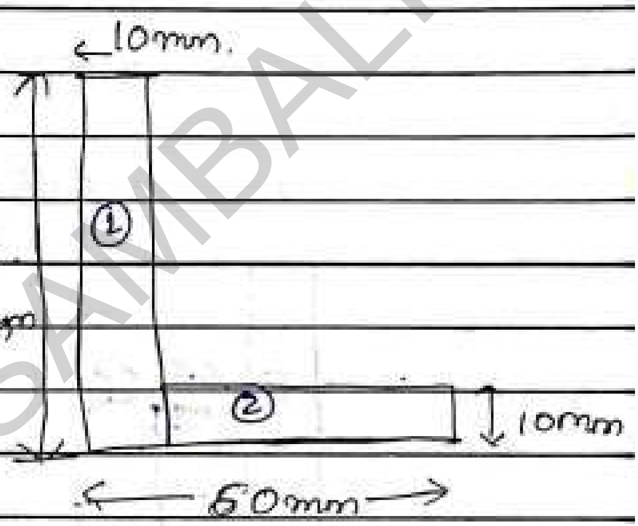
find the CG of given section.



Rectangle - (1)

$a_1 = 80 \times 10$
$= 800\ mm^2.$

$x_1 = \frac{10}{2} = 5\ mm.$

$y_1 = \frac{80}{2} = 40mm.$

Rectangle - (2).

$a_2 = 50 \times 10$
$= 500\ mm^2.$

$x_2 = \frac{50}{2} = 35\ mm$

$y_2 = \frac{10}{2} = 5\ mm.$

$\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2}.$

$= \frac{800 \times 5 + 500 \times 35}{800 + 500}.$ $= 16.5\ mm.$

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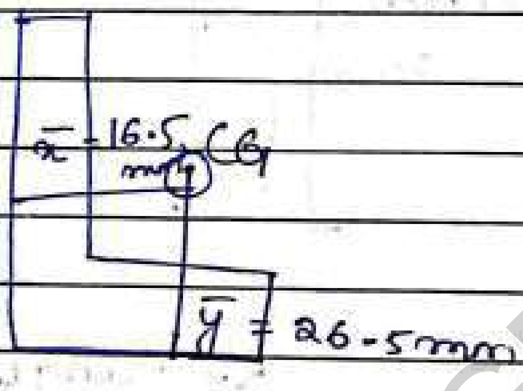
$$\bar{y} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2}$$

$$= \frac{800 \times 40 + 500 \times 5}{800 + 500}$$

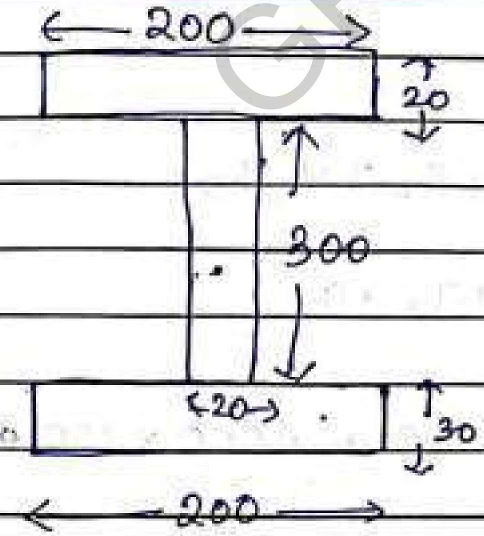
$$= \frac{34500}{1300}$$

$$= 26.5 \text{ mm}$$



② Find the CG of a T-section for the given data.

Top flange :- 200x20
web :- 300x20
Bottom flange :- 200x30



Bottom flange

$a_1 = 200 \times 30$
$= 6000\ mm^2$

$x_1 = \frac{200}{2}$
$= 100\ mm$

$y_1 = \frac{30}{2}$
$= 15\ mm$

Web

$a_2 = 300 \times 20$
$= 6000\ mm^2$

$x_2 = \frac{20}{2} + 30$
$= 10 + 30$
$= 40\ mm$

$x_2 = 100\ mm$

$y_2 = 30 + \frac{300}{2}$
$= 30 + 150$
$= 180\ mm$

Web = $a_3 = 200 \times 20$
$= 4000\ mm^2$

$x_3 = \frac{200}{2} = 100\ mm$

$y_3 = 300 + 30 + \frac{20}{2}$
$= 340\ mm$

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

$$= \frac{6000 \times 100 + 6000 \times 100 + 4000 \times 100}{6000 + 6000 + 4000}$$

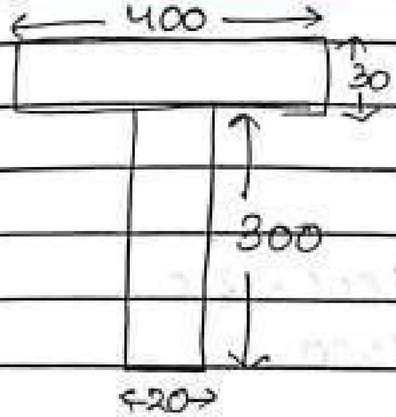
$= 100mm$

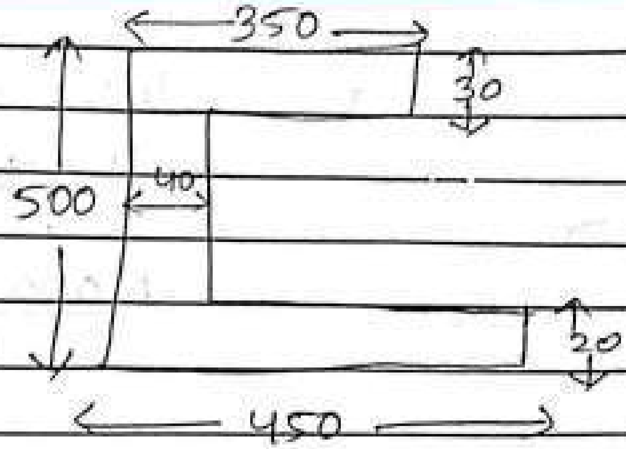
$$\bar{y} = \frac{a_1y_1 + a_2y_2 + a_3y_3}{a_1 + a_2 + a_3}$$

$$= \frac{6000 \times 15 + 6000 \times 180 + 4000 \times 340}{6000 + 6000 + 4000}$$

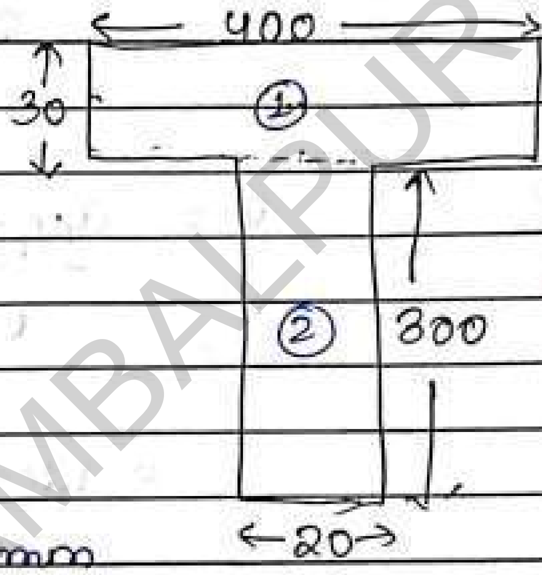
$= 158.2mm$

Assignment :-





Q1



Rectangle - ①

area $(a_1) = 400 \times 30$
$= 12000 \, mm^2$.

$x_1 =$ ~~200mm~~ $190 + 10 = 200 \, mm$

$y_1 = 300 + \frac{30}{2} = 300 + 15 = 315 \, mm$

Rectangle - ②

area $(a_2) = 300 \times 20$
$= 6000 \, mm^2$.

$x_2 = 200 \, mm$.

$y_2 = \frac{300}{2} = 150 \, mm$

$$\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2}$$

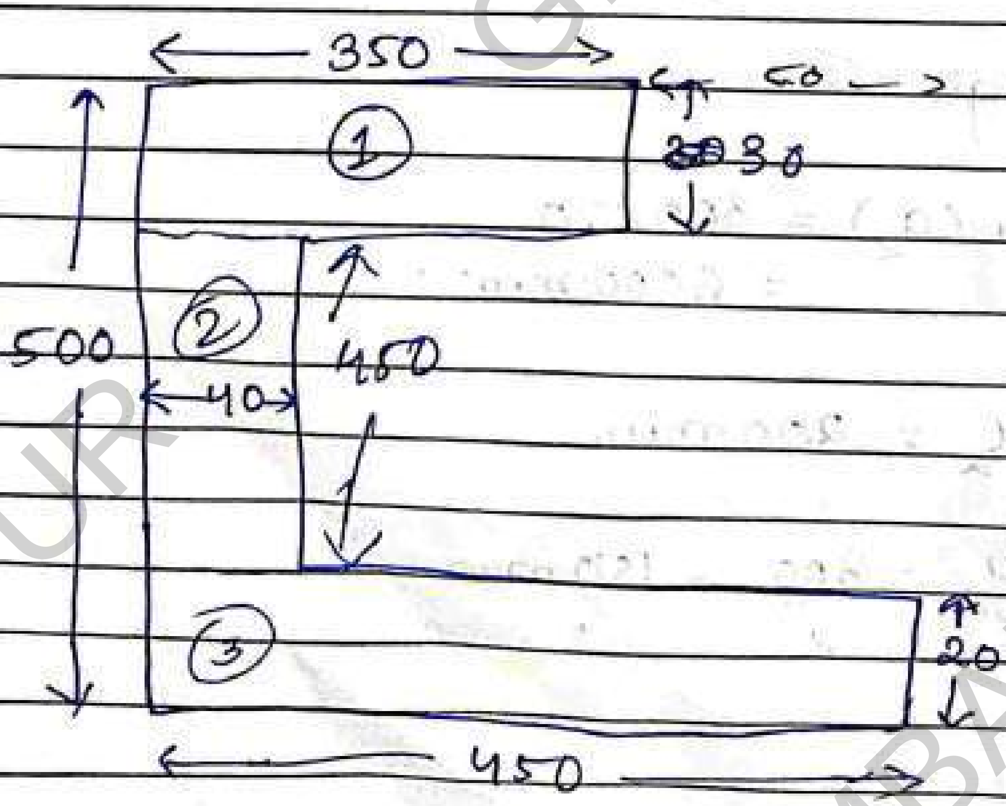
$$= \frac{12000 \times 200 + 6000 \times 200}{12000 + 6000}$$

$$= 200\,mm$$

$$\bar{y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2}$$

$$= \frac{12000 \times 315 + 600 \times 150}{12000 + 6000}$$

$$= 260\,mm$$



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Rectangle-①

area $= 350 \times 30$
(a_1) $= 10500 mm^2$.

$x_1 = \frac{350}{2}$

$= 175 mm$

$y_1 = 20 + 450 + \frac{30}{2}$.

$= 20 + 450 + 15$
$= 485 mm$

Rectangle-②

area $= 450 \times 40$
(a_2) $= 18000 mm^2$.

$x_2 = \frac{40}{2} = 20 mm$

$y_2 = 20 + \frac{450}{2}$.

$= 245 mm$

Rectangle-③.

area $= 450 \times 20$
(a_3) $= 9000 mm^2$.

$x_3 = \frac{450}{2} = 225 mm$

$y_3 = \frac{20}{2} = 10 mm$

$\bar{x} = \frac{10500 \times 175 + 18000 \times 20 + 9000 \times 225}{10500 + 18000 + 9000}$.

$= 112.6 mm$.

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$$\bar{y} = \frac{10500 \times 485 + 18000 \times 245 + 9000 \times 10}{10500 + 18000 + 9000}$$

$$= 255.8\ mm$$

<u>Moment of inertia</u>

MI of Rectangle ① :-

$$I_{xx_1} = I_x + Al^2$$

$$= \frac{350 \times 30^3}{12} + 10500 \times 485^2$$

$$= 2.47 \times 10^9\ mm$$

MI of Rectangle ①.

$$I_{xx_2} = I_x + Al^2.$$

$$= \frac{40 \times 450^3}{12} + 18000 \times 245^2$$

$$= 1.38 \times 10^9\ mm$$

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MI of Rectangle ③

$$I_{xx_3} = I_x + Al^2.$$

$$= \frac{450 \times 20^3}{12} + 9000 \times 10^2$$

$$= 1.2 \times 10^6 mm.$$

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

$$= (2.47 \times 10^9 + 1.39 \times 10^9 + 1.2 \times 10^6) mm.$$

$$= 3.86 \times 10^9 mm$$

(Ans)

$$I_{yy} = (I_{y_1} + Al^2) + (I_{y_2} + Al^2) + (I_{y_3} + Al^2)$$

~~30m~~

$$Rec\text{-}① = I_{y_1} + Al^2.$$

$$= \frac{30 \times 350^3}{12} + 10500 \times 175^2$$

$= ~~429.02 \times 10^6 mm~~$ $428.75 \times 10^6 mm$

$$Rec\text{-}② = I_{y_2} + Al^2.$$

$$= \frac{450 \times 40^3}{12} + 18000 \times 20^2.$$

$= 9.6 \times 10^6 mm$

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Rectangle-③

$I_{xy_3} = I_{y_3} + A r^2$

$= \frac{20 \times 450^3}{12} + 9000 \times 225^2$.

$= 607.5 \times 10^6$ mm

$I_{yy} = I_{y_1} + I_{y_2} + I_{y_3}$

$= 428.75 \times 10^6 + 9.6 \times 10^6 + 607.5 \times 10^6$ mm

$= 1.04 \times 10^9$ mm.

Q1 Find the CG of the T-Section with flange 150mm × 50mm and web as 150 × 50 mm. [5]

Q2 Find the CG of an I-Section for the given data [5]

Data:-

Top flange = 300 × 30 mm
Bottom flange = 200 × 20 mm
web - 350 × 10 mm

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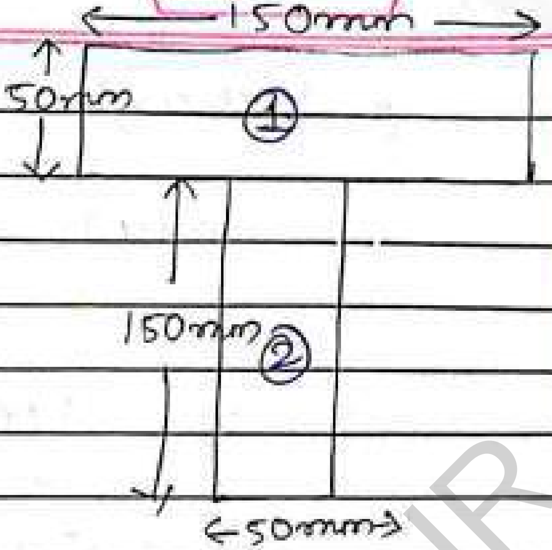
Assignment.

Rectangle - ①



$$\text{area}(a_1) = (150 \times 50)\,mm^2$$
$$= 7500\,mm^2.$$

$$x_1 = \frac{150}{2} = 75\,mm.$$

$$y_1 = 150 + \frac{50}{2}$$
$$= 150 + 25$$
$$= 175\,mm$$

Rectangle - ②

$$\text{area}(a_2) = 150 \times 50\ mm^2.$$
$$= 7500\,mm^2.$$

$$x_2 = 50 + 25 = 75\,mm$$

$$y_2 = \frac{150}{2} = 75\,mm.$$

$$\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2}$$

$$= \frac{7500 \times 75 + 7500 \times 75}{7500 + 7500}$$

$$= 75\,mm$$

$$\bar{y} = \frac{a_1y_1 + a_2y_2}{a_1 + a_2}$$

$$= \frac{7500 \times 175 + 7500 \times 75}{7500 + 7500}$$

$$= 125\,mm$$

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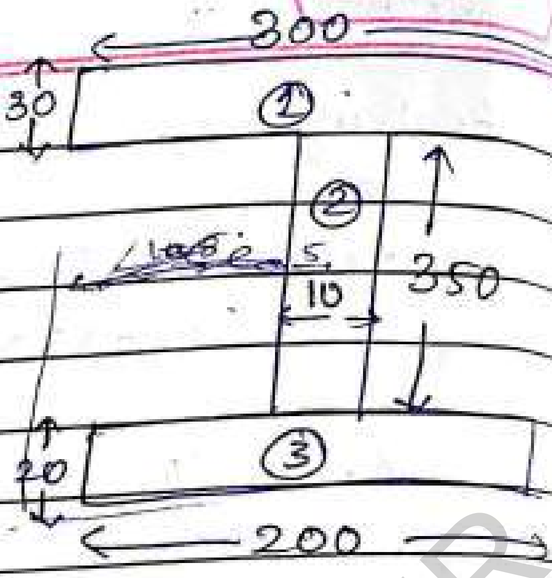

Q2 Rectangle - ①

area (a_1) = 300 x 30
= 9000 mm^2.

$x_1 = \frac{300}{2} = 150mm$

$y_1 = 20 + 350 + 15 = 385 mm$

Rectangle - ②

area (a_2) = 350 x 10
= 3500 mm^2.

$x_2 = 150mm$

$y_2 = 20 + \frac{350}{2}$
$= 20 + 175$
$= 195 mm$

Rectangle - ③

area (a_3) = 200x20 = 4000 mm^2.

$x_3 = \frac{200}{2} = 150 mm$

$y_3 = \frac{20}{2} = 10 mm$

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

$$= \frac{9000 \times 150 + 3500 \times 150 + 4000 \times 150}{9000 + 3500 + 4000}$$

$$= 150 \text{ mm}$$

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

$$= \frac{9000 \times 385 + 3500 \times 195 + 4000 \times 10}{9000 + 3500 + 4000}$$

$$= 253.78 \text{ mm}$$

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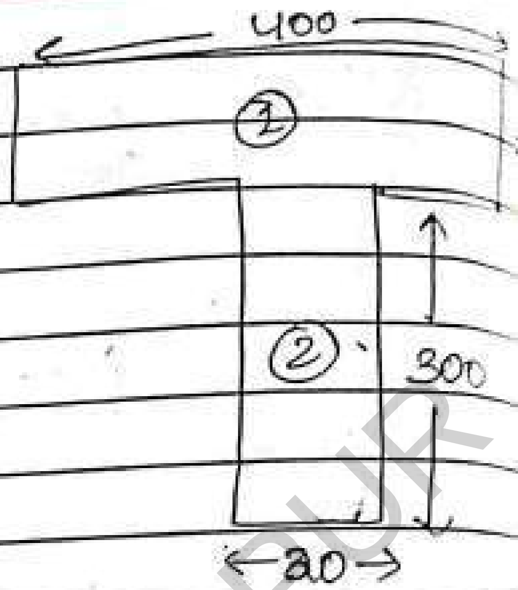
Assign. MI of T section



From Rectangle-①

area $(a_1) = 400 \times 30$
$= 12000 \text{ mm}^2$.

$y_1 = 300 + 15$
$= 315 \text{ mm}$

Rectangle-②

area $(a_2) = 300 \times 20$
$= 6000 \text{ mm}^2$.

$y_2 = \frac{300}{2}$
$= 150 \text{ mm}$

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

$= \frac{12000 \times 315 + 6000 \times 150}{12000 + 6000}$

$= 260 \text{ mm}$

MI of Rectangle-①

$$I_{xx_1} = I_x + Al^2$$

$$= \frac{400 \times 30^3}{12} + 12000 \times (315 - 260)^2$$

$$= \sout{1.56 \times 10^6\ mm^4}\ \ 37.2 \times 10^6$$

MI of Rectangle-②

$$I_{xx_2} = I_x + Al^2$$

$$= \frac{20 \times 300^3}{12} + 6000 \times (260 - 150)^2$$

$$= \sout{45.66 \times 10^6\ mm^4}\ \ 117.6 \times 10^6$$

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

$$= 1.56 \times 10^6 + 45.66 \times 10^6$$

$$= 47.22 \times 10^6\ mm^4$$

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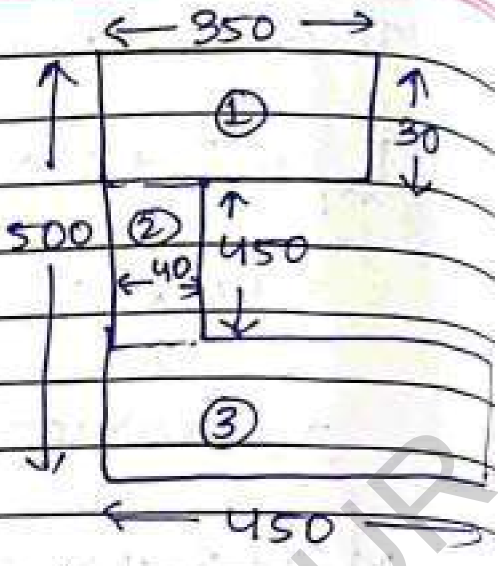
MI of C-Section:-



Rectangle-①

$area(a_1) = 350 \times 30$
$= 10500\ mm^2$.

$x_1 = \frac{350}{2} = 175\ mm$

$y_1 = 20 + 450 + \frac{30}{2}$
$= 485\ mm$

Rectangle-②

$area(a_2) = 450 \times 40$
$= 18000\ mm^2$.

$x_2 = \frac{40}{2} = 20\ mm$

$y_2 = 20 + \frac{450}{2}$
$= 245\ mm$

Rectangle-③

$area(a_3) = 450 \times 20$
$= 9000\ mm^2$

$x_3 = 225\ mm$

$y_3 = 10\ mm$

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

$$= \frac{10500 \times 175 + 18000 \times 20 + 9000 \times 225}{10500 + 18000 + 9000}$$

$$= 112.6 \text{ mm}$$

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

$$= \frac{10500 \times 485 + 18000 \times 245 + 9000 \times 10}{10500 + 18000 + 9000}$$

$$= 255.8 \text{ mm}$$

$$I_{xx_1} = I_x + Al^2.$$

$$= \frac{350 \times 30^3}{12} + 10500 \times (485 - 255.8)^2$$

$$= ~~3059 \times 10^6 \text{ mm}~~.\ 552.38 \times 10^6 \text{ mm}^4$$

$$I_{xx_2} = I_x + Al^2.$$

$$= \frac{40 \times 450^3}{12} + 18000 \times (255.8 - 245)^{10.8}$$

$$= ~~3039.84 \times 10^6 \text{ mm}~~$$

$$= 305.84 \times 10^6 \text{ mm}^4$$

$I_{xx_3} = I_{x_3} + Al^2$ w.r.t. x

$= \frac{450 \times 20^3}{12} + 9000 \times (255.8 - 10)^2$

$= 544.05 \times 10^6 \text{ mm}^4$

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

$= 552.38 \times 10^6 + 305.84 \times 10^6 + 544.06 \times 10^6$

$= 1.402 \times 10^9 \text{ mm}^4$

$I_{yy_1} = I_{y_1} + Al^2$

$= \frac{30 \times 350^3}{12} + 10500 \times (175 - 112.6)^2$

$= 148.07 \times 10^6 \text{ mm}^4$

$I_{yy_2} = I_{y_2} + Al^2$

$= \frac{450 \times 40^3}{12} + 18000 \times (112.6 - 20)^2$ i.e.

$= 156.74 \times 10^6 \text{ mm}^4$

$I_{yy_3} = I_{y_3} + Al^2$

$= \frac{20 \times 450^3}{12} + 9000 \times (225 - 112.6)^2$

$= 265.57 \times 10^6 \text{ mm}^4$

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$$I_{yy} = I_{yy_1} + I_{yy_2} + I_{yy_3}$$

$$= (148.07\times10^6 + 156.74\times10^6 + 265.57\times10^6)\ mm^4$$

$$= 570.38\times10^6\ mm^4.$$

MI of Rectangle - ① $I_{xx_1} = I_x + Ae^2$.

Assign

$$= \frac{150\times50^3}{12} + 7500\times(175-125)^2$$

$$= 20.31\times10^6\ mm^4.$$

Rect - ② $I_{xx_2} = I_x + Ae^2$.

$$= \frac{50\times150^3}{12} + 7500\times(125-75)^2.$$

$$= 32.81\times10^6\ mm^4.$$

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

$$= 20.31\times10^6 + 32.81\times10^6\ mm^4$$

$$= 53.12\times10^6\ mm^4$$

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$I_{YY_1} = I_{Y_1} + Al^2$

$= \frac{50 \times 150^3}{12} + 7500 \times (25-2$

$= 14.06 \times 10^6 \; mm^4$

$I_{YY_2} = I_{Y_2} + Al^2$

$= \frac{150 \times 50^3}{12} + 7500(0)^2$

$= 1.56 \times 10^6 \; mm^4$

$I_{YY} = I_{YY_1} + I_{XX_2}$

$= 14.06 \times 10^6 + 1.56 \times 10^6 \; mm^4$

$= 15.62 \times 10^6 \; mm^4$

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I-section

MI of Rectangle ①

$$I_{xx_1} = I_{x_1} + Al^2.$$

$$= \frac{300 \times 30^3}{12} + 9000 \times (385 - 253.78)^2$$

$$= 155.64 \times 10^6 \text{ mm}^4.$$

$$I_{xx_2} = I_{x_2} + A_2 l_2^2.$$

$$= \frac{10 \times 350^3}{12} + 3500 \times (253.78 - 195)^2$$

$$= 47.82 \times 10^6 \text{ mm}^4$$

$$I_{xx_3} = I_{x_3} + Al^2.$$

$$= \frac{200 \times 20^3}{12} + 4000 \times (253.78 - 10)^2.$$

$$= 237.84 \times 10^6 \text{ mm}^4.$$

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

$$= 155.64 \times 10^6 + 47.82 \times 10^6 + 15.62 \times 10^6$$

$$= 219.08 \times 10^6 \text{ mm}^4$$

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Ch-4

Columns & Structs

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Structs:- A member on structure or bar which carries an axial compressive load is known as structs.

Columns:- If the struct is vertical i.e, at 90° to the horizontal, is known as column.

→ All columns are structs but all structs are not column.

Difference between ~~crossing~~ crushing and buckling:-

Crushing	Buckling
(i) It is applicable to short column only.	(i) It is applicable to long column only.
(ii) Stress (σ) = $\frac{P}{A}$ unit = N/m^2.	(ii) $P_e = \frac{\pi^2 EI}{l_e^2}$ *** where P_e = Euler's load I = moment of inertia E = young's modulus of elasticity l_e = Effective length

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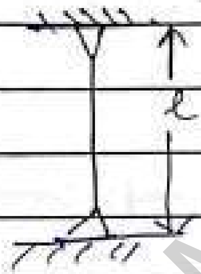
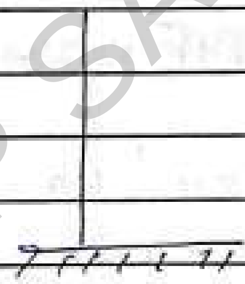
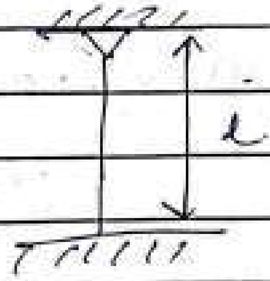
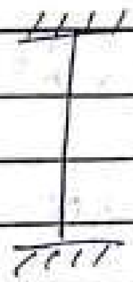
Young's modulus of Elasticity :- (E)

The material which has ability to return its original shape after removing the load is known as elasticity

Effective length of column :- (l_e)

Sl No.	column condition	figure	Effective length (l_e)
1.	Both ends are Hinged/pinned		$l_e = l$
2.	One end fixed and other end free		$l_e = 2l$
3.	one end is fixed and another end is Hinged		$l_e = \frac{l}{\sqrt{2}}$
4.	Both ends are fixed		$l_e = \frac{l}{2}$

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Q. A steel rod is 5m long and 50mm diameter is used as column with one end fixed and other free. Determine the Buckling load by using Euler's formula. Take E = 200 GPa

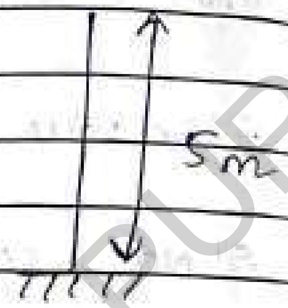
$E = 200$ GPa

$I = \frac{\pi d^4}{64}$

$= \frac{3.14 \times (50 \times 10^{-3})^4}{64}$

~~$= 306.64 \times 10^3$~~ $\frac{3.14 \times (0.05)^4}{64}$

~~$P_e = (3.14)^2 \times 200 \times 306.64$~~ $= 3.06 \times 10^{-7}\ m^4$



$l_e = 2l$

$= 2 \times 5$

$= 10m$

$E = 200 \times 10^9$ Pa

$P_e = \frac{(3.14)^2 \times 200 \times 10^9 \times \sout{306.64 \times 10^3}\ 3.06 \times 10^{-7}}{(10)^2}$

~~$= 6.04 \times 10^{15}$~~

$= 6.03 \times 10^3$

$= 6.03$ KN

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$1\,Pa = 1\,N/m^2$.

$1\,KPa = 10^3\,N/m^2$.

$1\,MPa = 10^6\,N/m^2$

$1\,GPa = 10^9\,N/m^2$.

Q2 A steel rod of 60mm diameter and 15m length is used as column. Determine the buckling load by using Euler's formula. Take $E = 250\,GPa$

(Asst. 19th)

(i) Both ends are fixed
(ii) ~~Both~~ one end is fixed and an other end is Hinged

$E = 250\,GPa$
$= 250 \times 10^9\,N/m^2$.

$I = \frac{\pi d^4}{64} = \frac{3.14 \times (0.06)^4}{64}$
$=$ ~~$1.76 \times 10^{-4}\,m^4$~~ 6.35×10^{-7}.

$l_e = \frac{l}{2} = \frac{15}{2} = 7.5\,m$

$P_e = \frac{\pi^2 E I}{l_e^2}$.

$= \frac{(3.14)^2 \times 250 \times 10^9 \times}{(7.5)^2}$ ~~1.76×10^{-4}~~ 6.35×10^{-7}

$=$ ~~$7.71 \times 10^6\,N$~~ $= 27.85\,KN$

$E = 250\,GPa$

$= 250 \times 10^9\,N/m^2$.

$I = \frac{\pi d^4}{64}$

$= \frac{3.14 \times (0.06)^4}{64}$

$= ~~1.76 \times 10^{-4}\,mm^4~~.\ 6.35 \times 10^{-7}$.

$l_e = \frac{15}{\sqrt{2}}$

$= 10.06\,m$

$P_e = \frac{\pi^2 E I}{l_e^2}$.

$= \frac{(3.14)^2 \times 250 \times 10^9 \times 1.76 \times 10^{-4}}{(10.06)^2}$.

$= ~~4.28 \times 10^6\,N~~$

$= 15.48\,kN$.

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Assumptions made in Euler's Formula :- [5 M]

1)- Material should be elastic, isotropic & homogeneous.

2)- The column should be perfectly straight and uniform

(3)- Load is applied axially and passes through the its centroid.

4. These is valid for long column only

Slenderness ratio :- [2 Mark]

- The ratio of Effective length to minimum Radius of Gyration is called Slenderness ratio

$$SR = \frac{\text{Effective length } (l_e)}{\text{Min}^m \text{ Radius of gyration}}$$

$$SR \text{ or } \lambda = \frac{l_e}{k}$$

Minimum Radius of Gyration :- [2 M]

It may be defined as the square root of the ratio of moment of inertia of a body to its cross-sectional area.

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** $$K = \sqrt{\frac{I}{A}}$$

It is unitless

$$SR = \frac{le}{\sqrt{\frac{\frac{BD^3}{12}}{BD}}}$$

$$= \frac{le}{\sqrt{\frac{BD^{3}}{12} \times \frac{1}{BD}}}$$

$$= \frac{le\sqrt{12}}{D}$$

SHORT COLUMN and Long column :-

(1) Short column:- Columns having their length $<$ 8 times of their respective diameter or Slenderness ratio $<$ 32, are known as Short column.

(2) Long column:- The columns having their length greater than 30 times of the diameter or Slenderness ratio greater than 120 are known as long column.

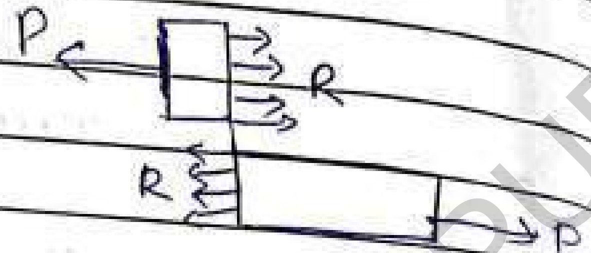
Between $<$32 and $>$120 is known as Intermediate column.

2 Marks

Simple Stresses and Strains

Stress - It is the resistance offered by a body against the deformation is known as stress.

$$\sigma = \frac{P}{A}$$



It is denoted by the symbol Sigma (σ)

where P = force or load
A = cross-sectional area

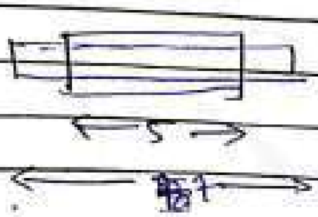
unit of stress - N/m^2

Strains :- It is the ratio of change in dimension to original dimension

- It is denoted by symbol 'e'

$$e = \frac{\Delta l}{l}$$ → Δl : change in length, l : original length.

- It is a unitless quantity



$= \frac{2}{5}$ ← $\frac{\text{change in length}}{\text{original length}}$