1/8/22
Monday.

4010310 - Mechanics of Solids.

Stress :- $\frac{\text{Force}}{\text{area}} \Rightarrow \frac{P}{A}$ N/mm²

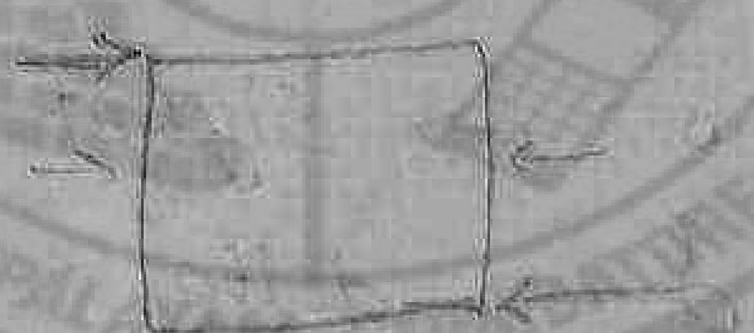
Strain :- $\frac{\text{change in dimension}}{\text{original dimension}} = \frac{\delta l}{l}$ (or)

delta, l is length

$= \frac{\delta b}{b}$ → breadth

Tensile Stress : 

Compressive Stress : 

Shear Stress : 

Torsional Stress : 

↓
Twist

Mechanical Properties Of Materials.

1. Rigidity → no failure. eg:
2. Elasticity → eg: Rubber band & Spring.
3. plasticity → Temporary deformation.
4. Hardness → No change,
5. Toughness → Permanent deformation.
6. Stiffness → No change → permanent & Temporary
7. Brittleness → glass, chalk (Property is breakdown).

8. Ductility → Tensile load → material → wire
9. Melleability → compressive road → material → metal sheet
10. creep → constant load → particular Interval deformation.
11. Fatigue → Ex: Machine → continues working Efficiency decrease
12. Durability → No wear & tear (ஓய்வதில்லை)
13. Strength → (..........) . maximum load

Deformation → bend, cut
↓
shape change.

Permanent deformation → Not come back to original shape.
Temporary deformation → come back to original shape.

σ → sigma.
δ → delta.
τ → Tow
ε →
N → Newton. GPa → giga pascal.
MN → Mega Newton. Mpa → mega pascal.
pa → pascal

Unit - I

Simple Stress And Strain

Formula,

1. Stress, $\sigma = \frac{P \rightarrow load}{A \rightarrow Area}$ N/m^2 (or) N/mm^2.

2. Tensile stress, $\sigma_t = \frac{P_t}{A}$ N/m^2 (or) N/mm^2.

3. Compressive stress, $\sigma_c = \frac{P_c}{A}$ N/m^2 (or) N/mm^2

4. Shear stress, $\tau \Longrightarrow \frac{V \rightarrow volume}{A}$ N/m^2 (or) N/mm^2

5. Strain, $\frac{\delta L}{L}$ (or) $\frac{\delta b}{b}$

6. Linear strain $(\varepsilon_L) = \frac{\text{change in length}}{\text{original length}}$

$$\boxed{\varepsilon_L = \frac{\delta l}{l}}$$

7. Lateral Strain $= \frac{\text{change in lateral dimension}}{\text{original dimension}}$

$$= \varepsilon_d = \frac{\delta d}{d}, \text{ (or) } \varepsilon_b = \frac{\delta b}{b} \text{ (or) } \varepsilon_t = \frac{\delta t}{t}$$

8. Shear Strain = $\dfrac{\text{Transverese (or) Shear displacement}}{\text{original position length}}$

Shear strain $\boxed{(\phi) = \dfrac{\delta L}{L}}$

9. Volumetric strain = $\dfrac{\text{change in volume}}{\text{original volume.}}$

Volumetric strain = $\boxed{\varepsilon_v = \dfrac{\delta v}{v}}$.

10. poisson's ratio = $\boxed{\gamma \ \dfrac{\text{Lateral strain}}{\text{Linear strain}}}$

For steel $\rightarrow$ 0.25 to 0.33.

For concrete $\rightarrow$ 0.08 to 0.18.

Elastic Constant.

1. Young's Modulus,

$$E = \frac{\sigma}{\varepsilon} \ N/mm^2.$$

$$= \frac{\text{Axial Stress}}{\text{Linear strain}} \ N/m^2 \text{ (or) } N/mm^2.$$

2. Modulus of Rigidity,

$$G = \frac{\tau}{\phi} \ N/mm^2.$$

$$= \frac{\text{Shear stress}}{\text{Shear strain}} \ N/mm^2.$$

3. Bulk Modulus,

$$K = \frac{\sigma}{\varepsilon_v} \ N/mm^2$$

$$= \frac{\text{Direct stress (or) Axial stress}}{\text{Volumetric Strain.}}$$

4. Poisson's Ratio,

$$\gamma = \frac{\text{Lateral strain}}{\text{Linear strain}}$$

For steel $\rightarrow$ 0.25 to 0.33

For concrete $\rightarrow$ 0.08 to 0.18.

Relationship between Young's Modulus (E) & Rigidity Modulus

1). $E = 2G\left(1 + \frac{1}{M}\right)$.

2). $E = 3K\left(1 - 2\frac{1}{M}\right)$.

3). $E = \frac{9KG}{3K + G}$.

4). $\frac{1}{M} = \frac{3K - 2G}{2G + 6K}$.

6/8/22 Saturday

Stress And Strain Curve Of A Ductile Material.

1). yield point (or) yield stress.

$$\text{yield stress } \sigma_y = \frac{\text{yield load}}{\text{Actual load of c/s}}$$

$$= \frac{P_Y}{A}\ N/mm^2.$$

2). Ultimate load Point (F) and Ultimate Stress :

$$\text{Ultimate Stress } (\sigma_U) = \frac{\text{Ultimate load}}{\text{original load of c/s.}}$$

$$= \frac{P_U}{A} \; N/mm^2.$$

3). Breaking stress and Breaking Point :

$$\text{Breaking stress } (\sigma_b) \Rightarrow \frac{\text{Breaking load}}{\text{waist area of c/s}}$$

c/s → crossectional area. $= \frac{P_b}{A} \; N/mm^2$.

4). Actual Stress

$$\text{Breaking Stress (Actual)} \Rightarrow \frac{\text{Breaking load}}{\text{waist area of c/s}} \; N/mm^2$$

5). Nominal stress

$$\text{Breaking stress (Nominal)} \Rightarrow \frac{\text{Breaking load}}{\text{original area of c/s}} \; N/mm^2$$

6). Working Stress $= \frac{\text{Ultimate Stress}}{\text{Factor of safety}} = \frac{P_U}{F_s} \; N/mm^2$

Factor of safety

$$FOS = \frac{\text{Ultimate load}}{\text{Working stress}}$$

Significance of Percentage Elongations Reduction Area of cross section:

i). Percentage Elongation:

$$\text{Percentage Elongation} = \frac{\text{Final length} - \text{original length}}{\text{original length}} \times 100$$

$$= \frac{l - l}{l} \times 100$$

ii). Percentage Reduction in area:

Percentage Reduction in Area =

$$= \frac{\text{original Area} - \text{waist area}}{\text{original Area}} \times 100$$

$$= \frac{A - A1}{A} \times 100$$

$$\text{yield stress } (\sigma_y) = \frac{\text{load at yield point}}{\text{original area}} \; N/mm^2$$

$$\text{Ultimate stress } (\sigma_U) = \frac{\text{Ultimate (or) maximum load}}{\text{original area of c/s}} \; N/mm^2$$

8/8/22
Monday.

Problem's Based On stress, Strain, Poisson's Ratio, Change In Dimensions, volume etc..

Que : A Steel ~~rate~~ rod of 16mm diameter and 30mm long is subjected to a tensile load of 30kN. Determine the intensity of stress and strain. if the Elongation of the rod due to the load is 0.21mm.

Given :-

diameter of Rod $(d) = 16$ mm.

Length of Rod $(l) = 300$ mm

Tensile load $P_t = 30$ kN. 30000

Elongation of the Rod $(\delta L) = 0.21$ mm.

Area of the Cross Section $(A) = \frac{\pi d^2}{4} = \frac{\pi \times 16^2}{4}$

$30\,kN = 30 \times 10^3$

$= 30 \times 10 \times 10 \times 10$

$= 30 \times 30000$

To find

(i) Stress $\sigma = ?$

(ii) Strain $\varepsilon l = ?$

Sol :

Stress $\sigma = \frac{\text{Tensile load}}{\text{Area of cross section}}$

8/8/22
Monday

Problem's Based On stress, Strain, Poisson's Ratio, Change In Dimensions, volume etc...

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$\Rightarrow$

$30\,kN = 30 \times 10^3$

$= 30 \times 10 \times 10 \times 10$

$= 30 \times 30000$

=

To find

(i) Stress $\sigma = ?$

(ii) Strain $\varepsilon l = ?$

Sol :

$$\text{Stress } \sigma = \frac{\text{Tensile load}}{\text{Area of Cross section}}$$

$$= \frac{30 \times 10^3}{201}$$

Area of cross section $= A = \frac{\pi d^2}{4}$

$$= \frac{\pi \times 16^2}{4}$$

$$\Rightarrow \boxed{\sigma \Rightarrow 149.25\ N/mm^2}$$

$$= \frac{3.14 \times 256}{4}$$

$A = 200.96$ round off

$\rightarrow 201\ mm^2$

Strain $\varepsilon l = \frac{\delta l}{l} = \frac{\text{change in length}}{\text{original length}}$

$$= \frac{0.21}{300} = 7 \times 10^{-4}$$

$$= 0.0007$$

Result :

Stress $(\sigma) = 149.25\ N/mm^2$

Strain $(\varepsilon l) = 0.0007$

8/8/22
Monday

Problem's No: 2

A steel rod of 20mm diameter and 400 mm long is subjected to a tensile load of 45 kN. Determine the intensity of stress and strain. if the elongation of the rod due to the load is 0.32 mm.

Given:

diameter of a rod $(d) = 20\,mm$

length of a rod $(l) = 400\,mm$

Tensile load $(P_t) = 45\,kN$

Elongation of the rod $(\delta l) = 0.32\,mm$

Area of the cross section $\boxed{(A) = \frac{\pi d^2}{4}}$

Area $= \frac{\pi d^2}{4} = \frac{3.14 \times 400}{4}$

$= 314.15\,mm^2$

To find,

stress σ =

strain e_l = ?

Sol.

Stress $\sigma = \frac{\text{Tensile load}}{\text{Crossectional area}}$

Tensile load $= 45 \times 10 \times 10 \times 10$

$= \underline{\underline{45000}}$

Stress $\sigma = \dfrac{\text{Tensile load}}{\text{area of crosssection}}$

$= \dfrac{45000}{314.15}$

$$\boxed{\sigma = 143.24\ N/mm^2}$$

Strain $\varepsilon l = \dfrac{\text{change in length}}{\text{original length}}$

$= \dfrac{0.32}{400}$

$= 8 \times 10^{-4}$

$= \underline{\underline{0.0008}}$

Result

Stress $(\sigma) = \underline{143.24\ N/mm^2}$

Strain $(\varepsilon l) = \underline{0.0008}$

Problem's No: 3

A rectangular wooden column of length 3 km and size 300 x 200 mm. carryies an axial load of 300 kN. The column is found to be shorten by 1.5 mm under the load. Find the stress and strain.

δl

Given

Rectangular wooden column.

Length of the coloum $(l) \Rightarrow 3m$.

Size of the colum. ~~(P)~~ $= 300 \times 200$ mm.

300×200 mm.

shortening of column $(\delta L) = 1.5$ mm.

Axial load $(P) = 300$ kN $\rightarrow 300 \times 10^3$

To find

Stress $(\sigma) = ?$

Strain $(\delta l) = ?$

Axial load $(P) = 300$ kN $= 300 \times 10^3$

$= 300 \times 10 \times 10 \times 10$

$= 300000$.

Stress $\sigma = \dfrac{load}{area}$

$= \dfrac{(300 \times 10^3)}{(300 \times 200)}$

$= 5\ N/mm^2$.

Strain $\varepsilon l = \dfrac{\delta L}{L} = \dfrac{\text{Change in length}}{\text{original length}}$

$= \frac{1.5}{3000}$

$= 5 \times 10^{-4}$

length = 3 M → mm

$= 3 \times 1000$

$= 3000 mm$

Result

stress $(\sigma) = 5 N/mm^2$

strain $(\varepsilon l) = 5 \times 10^{-4} = 0.0005$

Problem's No: 4.

A rectangular wooden column of length ~~3 kN~~ 6 m and size ~~300~~ 400 x ~~200~~ 300 mm. carries an axial load of ~~300~~ 450 kN. The colom is fond to be shorten by 5 mm under the load. find the stress and strain.

Given: Rectangular wooden column.

length of column $(l) = 6 m$.

size of column 400×300 mm.

Axial load = 450 kN.

Shortening of column $(\delta l) = 5 mm$.

~~Axial load = 450 kN~~ $= 450 \times 10^3$

stress $\sigma = \frac{load}{area}$

$= \frac{(450 \times 10^3)}{(400 \times 300)} = 3.75 N/mm^2$

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$$= \frac{1.5}{3000}$$

length = 3 m → mm
= 3 × 1000
= 3000 mm.

$$= \underline{5 \times 10^{-4}}.$$

Result

stress (σ) = 5 N/mm².

strain (εl) = 5×10^{-4} = 0.0005.

Problem's No: 4.

A rectangular wooden column of length ~~3 kN~~ 6 m and size ~~300~~ 400 × ~~200~~ 300 mm. carries an axial load of ~~300~~ 450 kN. The colum is found to be shorten by .5 mm under the load. find the stress and strain.

Given : Rectangular wooden column.

Length of column (l) = 6 m.

Size of column 400 × 300 mm.

Axial load = 450 kN.

Shortening of column (δl) = 5 mm

~~Axial load = 450 kN = 450 × 10³~~

$$\text{stress } \sigma = \frac{\text{load}}{\text{area}}$$

$$= \frac{(450 \times 10^3)}{(400 \times 300)} = \underline{3.75 \text{ N/mm}^2}$$

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$$\text{Strain}\ (\varepsilon_l) = \frac{\delta L}{L} = \frac{\text{change in length}}{\text{original length}}$$

$$= \frac{5}{6000}$$

$6 \times 1000 = 6000$

$$= 8.33 \times 10^{-4}$$

$$= 0.0008$$

Result

Stress $(\sigma) = 3.75\ N/mm^2$

Strain $(\varepsilon_l) = 0.0008$

Problem's No: 5

An axial tensile load of 10 KN applied on a steel rod. Find the minimum diameter of the steel rod. If the stress not to exceed $90\ MN/m^2$.

Given:

Tensile load $P_t = 10\ KN$

Stress $\sigma = 90\ MN/m^2$ 90×10^6

To find:

Minimum diameter $(d) = ?$

$$\text{Stress} = \frac{90 \times \cancel{10}^{3}}{10 \times \cancel{10}^{3}} = \frac{90 \times}{10}$$

$$= \frac{90 \times 10^3}{\underset{100}{10 \times 10}}$$

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

$$90 \times 10^3 = \frac{\overset{100}{10 \times 10^3}}{A} \qquad = 10 kN = 10 \times 10^3$$

$$A = \frac{\overset{100}{10 \times \cancel{10^3}}}{90 \times \cancel{10^3}}$$

$$1.11 mm^2$$

$$A \longrightarrow$$

$$\text{Stress } \sigma = \frac{90 \times 10^{3}}{P \; 10 \times \cancel{10^3}}$$

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

$$90 \times 10^3 = \frac{10}{A}$$

$$A = \frac{10}{90 \times 10^3}$$

$$A = \underline{\underline{0.0001 mm^2}}.$$

12/8/22
Friday

$$A = \frac{\pi d^2}{4}$$

$$\frac{\pi}{4} \times d^2 = \frac{10}{90 \times 10^3}$$

$$d^2 \Rightarrow \frac{10 \times 4}{90 \times 10^3 \times \pi}$$

$$d^2 = \frac{40}{282600}$$

( ) → apply

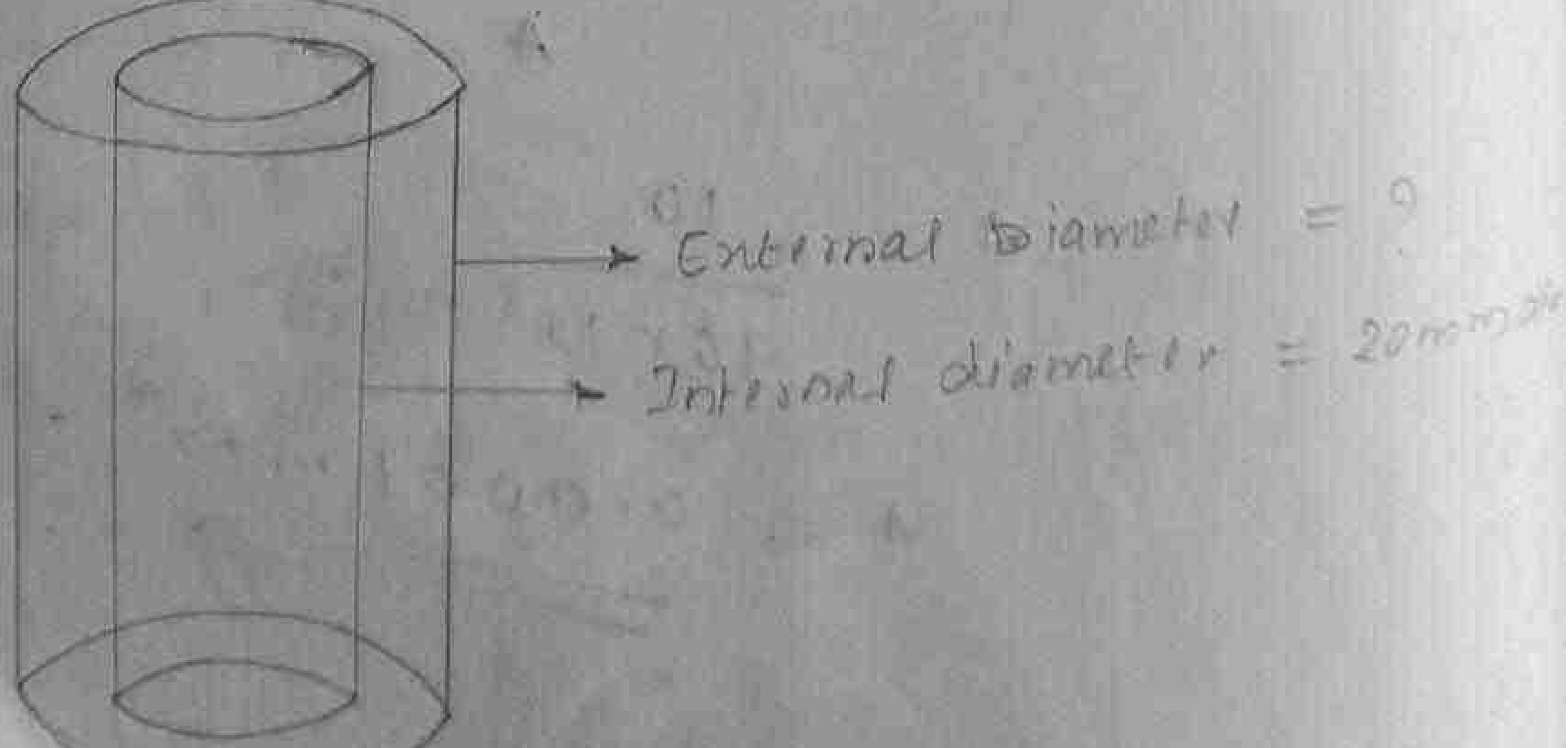
$$d = \sqrt{1.415 \times 10^4}$$

$$\boxed{d = 0.011\ M}$$

Problem No: 6

Que:

A cast iron column has an internal diameter of 200 mm. What should be the minimum external diameter so that it main carry the load of 1.7MN without the stress exceeding 100 N/mm²?



GIVEN :

Internal diameter $(d) = 200\,mm$

Load $(P) = 1.7\,MN \Rightarrow 1.7 \times 10^6\,N$.

stress $\sigma = 100\,N/mm^2$.

To Find :

External dia $(D) = ?$

$$A = \frac{\pi d^2}{4}.$$

$$A = \frac{\pi}{4}\left(D^2 - d^2\right).$$

stress $\sigma = \dfrac{P}{A} \rightarrow \dfrac{10^2 \quad 20^2}{}$

$$100 = \frac{1.7 \times 10^6}{\frac{\pi}{4}\left(D^2 - 200^2\right)}$$

$$D^2 - 200^2 \Rightarrow \frac{4 \times 1.7 \times 10^6}{\pi \times 100}.$$

$$D^2 - 200^2 \Rightarrow 21645.07 + 200^2$$

$$D^2 = \sqrt{21645.07 + 200^2}$$

$$D = \sqrt{21645.07 + 200^2} \quad (\quad) \text{ apply}$$

$$\underline{D} = \underline{\underline{248.28\,MM}}.$$

Exter

13/8/22 saturday

Problem No: 7

Que: A load of 20 ~~kip~~ KN is to be lifted by a steel wire find the diameter of the wire required. If the maximum stress in the wires 100 ~~mm~~ N/mm².

Given :

Load (P) = 20 KN ⟹ 20×10^3 N.

stress (σ) = 100 N/mm².

To find :

diameter (d) = ?

Sol :

$$\text{Stress } (\sigma) = \frac{P}{A}$$

$$\text{Area } (A) = \frac{P}{\sigma}$$

$$A = \frac{20 \times 10^3}{100} = 200 \text{ mm}^2$$

$$\text{Area } A = \frac{\pi d^2}{4}$$

$$200 = \frac{\pi d^2}{4}$$

$$d^2 = \frac{200 \times 4}{\pi}$$

$$d = \sqrt{\frac{200 \times 4}{\pi}}$$

$$d = \sqrt{\frac{800}{\pi}}$$

$$\boxed{d = 15.95 \text{ mm}^2}$$

Poroblem No: 8

Que: Find the minimum diameter of the steel wire which is used to eriser load of 4000 N. If the stress in the load as not enceed to $95 N/mm^2$.

Given :

Load (P) = 4000 N.

Stress (σ) = $95 N/mm^2$.

To find :

diameter (d) = ?

Sol :

$$\text{Stress } (\sigma) = \frac{P}{A}$$

$$\text{Area } (A) = \frac{P}{\sigma}$$

$$A = \frac{4000}{95} = 42.10 \ mm^2$$

$$\text{Area } A = \frac{\pi d^2}{4}$$

$$42.10 = \frac{\pi d^2}{4}, \quad d^2 = \frac{42.10 \times 4}{\pi}$$

$$d = \sqrt{\frac{42.10 \times 4}{\pi}} \quad d = \sqrt{\frac{168.4}{\pi}}$$

$$= \cancel{8.261}$$

$$= \sqrt{53.60}$$

$$\boxed{d = 7.321 mm^2}$$

Problems No: 9

Que:

An fan having a weight of 10 KN is to be fixed in a ceiling of a roof on a steel rod find the diameter of the steel rod $F_e = 415$ is used form and take $F_s = 3$

Given :

weight (P) = 10 KN ⟹ 10×10^3 N.

Stress (σ) = 415 N/mm².

Factor of safety (F.S) = 3.

$$\text{Stress } \sigma = \frac{415}{3}$$

Stress (σ) = 138.3 N/mm².

$$\text{Stress } (\sigma) = \frac{\text{Load}}{\text{Area}}$$

$$\text{Area (A)} = \frac{\text{load (P)}}{\text{Stress}}$$

$$= \frac{10 \times 10^3}{138.3}$$

$$\boxed{= 72.30 \text{ mm}^2}$$

$$A = \frac{\pi d^2}{4}$$

$$72.30 = \frac{\pi d^2}{4}$$

$$d^2 = \sqrt{\frac{72.3 \times 4}{\pi}} = \sqrt{92.05521}$$

$$\boxed{d = 9.59 \ mm^2}$$

Problem No: 10.

A ~~whole~~ hollow of circular column

Que:

H.W

A hollow circular column external diameter 200 mm as to carry an axial compressive of 420 kN. Find the internal diameter of the column. If the stress in the column is 120 N/mm².

$$A = \frac{\pi d^2}{4}$$

$$A = \frac{\pi}{4}(D^2 - d^2)$$

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

$$120 = \frac{420 \times 10^3}{\frac{\pi}{4}(D^2 - d^2)}$$

$$120 = \frac{420 \times 10^3}{\frac{\pi}{4}(200^2 - d^2)}$$

$$d^2 - 200^2 = \frac{4 \times 420 \times 10^3}{\pi \times 120}$$

$$D^2 - 200^2 = 4456.33$$

$$D^2 = 4456.33 + 200^2$$

$$D = \sqrt{4456.33 + 200^2}$$

$$D = \underline{\underline{210.846\ mm}}.$$

Given data : $D = 200\ mm$, $P = 420 \times 10^3\ N$,

$\sigma = 120\ N/mm^2$.

To find : Internal diameter of the column, d

Hint : $\sigma = P/A$, $A = 3500\ mm^2$,

$$A = \frac{\pi (D^2 - d^2)}{4}$$

$$A = \frac{\pi (200^2 - d^2)}{4}$$

$$d = \underline{\underline{188.53\ mm}}.$$

Result

Internal diameter of the column, d

$$d = \underline{\underline{188.53\ mm}}.$$

Problems : 11.

Que: Find the young's modulus of brass rod of diameter 25mm & length of 250 mm which is subjected to a tensile load of 50 KN. when the extention of the rod is equals to 0.3 mm

Given :

diameter (d) = 25mm.

Length (l) = 250mm.

Tensile load (P) = 50 KN ⟹ 50×10^3 N.

Extension of Rod (δl) = 0.3mm.

To find

young's modulus (E) = ?

$$E = \frac{Stress}{Strain}$$

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

$$\sigma = \frac{50 \times 10^3}{A} = \frac{50 \times 10^3}{490.87} =$$

$$\boxed{\sigma = 101.8\ N/mm^2}$$

$$A = \frac{\pi d^2}{4} = \frac{\pi (25)^2}{4}$$

$$A = 490.87 mm^2$$

$$\text{strain} = \frac{\text{change in length}}{\text{original length}} \Rightarrow \frac{\delta l}{l}$$

$$\Rightarrow \frac{0.3}{250} = \underline{\underline{1.2 \times 10^{-3}}}$$

$$\boxed{\text{Strain} = 0.0012}$$

$$\text{young's modulus} = \frac{\text{stress}}{\text{strain}} \Rightarrow \frac{101.8}{0.0012}$$

$$\boxed{= 84.83 \times 10^{3}\ N/mm^2}$$

Problem NO: 12

Que: A steel flat of 150 mm wide and 12 mm thick is 1m long. This subjected to a axial tensile of 180 kN. Determine the elongation at the flat and contraction in width and thickness.

Given :-

young's modulus $E = 2 \times 10^5\ N/mm^2$.

Poission's ratio $(1/m) = 0.33$

wide $(b) = 150\ mm$

thick $(d) = 12\ mm$

length $(l) = 1m = 1000\ mm$

Axial tensile load $(P_t) = 180\ kN$

$= 180 \times 10^3\ N$

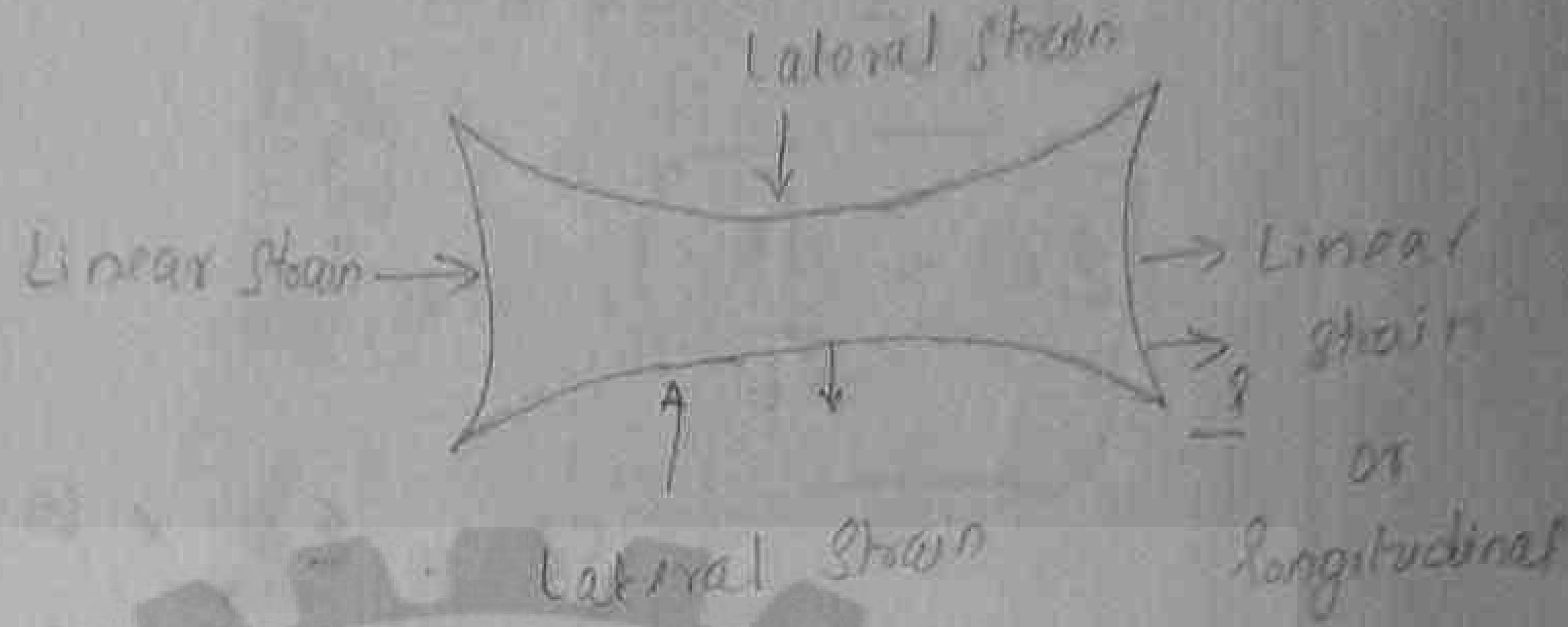
14/8/22
Tuesday

To Find :

Elongation at flat (δL) = ?

Contraction in width, (δb) = ?

contraction in thickness (δt) = ?



$(\delta L, \delta b, \delta t) = ?$

Sol :

$$\delta L = \frac{PL}{AE} = \frac{180 \times 10^3 \times 1000}{1800 \times 2 \times 10^5}$$

$$= 0.50\,mm$$

Linear strain $\varepsilon l = \frac{\delta l}{l} = \frac{0.50}{1000} = 5 \times 10^{-4}$

$$\varepsilon l = 0.0005$$

$$\text{Poisson's Ratio } \tfrac{1}{m} = \frac{\text{Lateral strain } (\varepsilon b)}{\text{Linear strain } (\varepsilon l)}$$

$$0.33 = \frac{\varepsilon b\,?}{0.0005}$$

$\varepsilon b \Rightarrow 0.33 \times 0.0005 \Rightarrow 1.65 \times 10^{-4}$

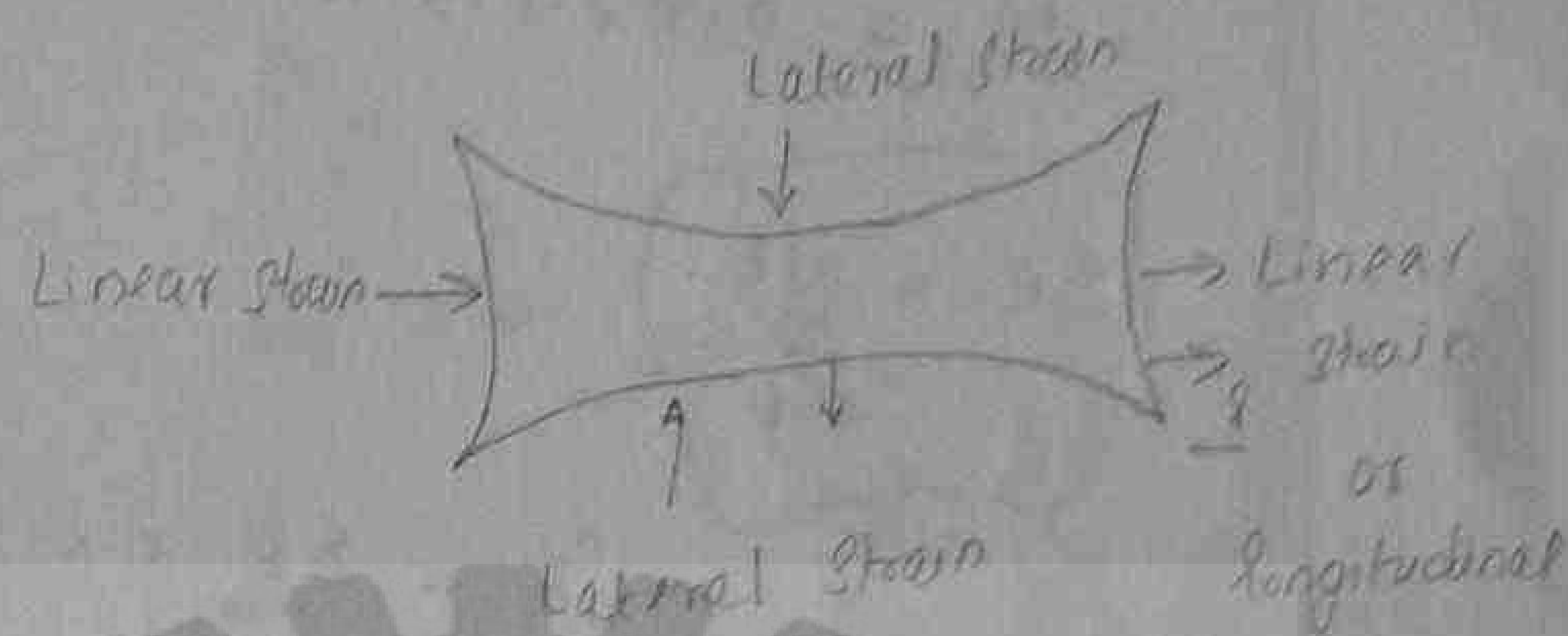
16/8/22
Tuesday.

To Find :

Elongation at flat $(\delta L) = ?$

Contraction in width, $(\delta b) = ?$

contraction in thickness $(\delta t) = ?$



$(\delta L, \delta b, \delta t) = ?$

Sol :

$$\delta L = \frac{PL}{AE} = \frac{180 \times 10^3 \times 1000}{1800 \times 2 \times 10^5}$$

$$= 0.50\,mm$$

Linear Strain $\varepsilon l = \frac{\delta l}{l} = \frac{0.50}{1000} = 5 \times 10^{-4}$

$$\varepsilon l = 0.0005$$

Poisson's Ratio $= \frac{\text{Lateral strain } (\varepsilon b)}{\text{Linear Strain } (\varepsilon l)}$

1/m

$$0.33 = \frac{\varepsilon b\,?}{0.0005}$$

$$\boxed{\varepsilon b \Rightarrow 0.33 \times 0.0005 \Rightarrow 1.65 \times 10^{-4}}$$

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$= \frac{\ }{23800}$

$= 0.000238\,mm.$

$$\varepsilon_d = \frac{\delta d}{d}$$

$$\delta d = \varepsilon_d \times d$$

$$\delta d = 2.38 \times 10^{-4} \times 80$$

$$\delta d \Rightarrow 0.019\,mm.$$

Problems based on elastic constants

Que :- A steel plate has modulus of elasticity as 200 GPA and poission's ratio 0.3. what is the value of bulk modulus for the steel plate?

Ans. Given :-

Modulus of Elasticity = 200 GPa

$$E = 200 \times 10^3\ N/mm^2$$

Poisson's ratio $(1/m) = 0.3$

To find

Bulk modulus (K)?

$$E = 3K\left(1 - 2\frac{1}{m}\right).$$

24/8/22
Wednesday

Ans.

$$200 \times 10^3 = 3k\left(1 - \frac{2}{0.3}\right)$$

$2 \times \frac{1}{m}$ $= \cancel{2 \times \frac{1}{0.3}}$

$$200 \times 10^3 \Rightarrow 3K\left(1 - (2 \times 0.3)\right)$$

$= 2 \times 0.3$

$$200 \times 10^3 = 3K\left(1 - 0.6\right)$$

$$200 \times 10^3 = 3K\ (0.4)$$

$$K = \frac{(200 \times 10^3)}{(3 \times 0.4)}$$

$$\boxed{K \Rightarrow 166.67 \times 10^3\ N/mm^2}$$

Problems No: 2

Que: 2 Find the modulus of rigidity and bulk modulus of the material ~~of~~ if $E = 2.1 \times 10^5\ N/mm^2$ and $1/m = 0.30$?

Ans. Given :-

Modulus of Rigidity (G) = ?

Bulk modulus (K) = ?

Modulus of Rigidity (G)

$$E = 2G\left(1 + \frac{1}{m}\right)$$

$$2.1 \times 10^5 = 2G\ (1 + 0.30)$$

$$2.1 \times 10^5 = G\ (2 + 0.6)$$

$$G = \frac{2.1 \times 10^5}{2.6}$$

$$G \Rightarrow 80.77 \times 10^3 \ N/mm^2.$$

Bulk modulus $E = 3K\left(1 - \frac{2}{m}\right).$

$$2.1 \times 10^5 = 3K\left(1 - \frac{2}{0.3}\right).$$

$$K = \frac{2.1 \times 10^5}{3 \times 0.4}$$

$$K = 175 \times 10^3 \ N/mm^2$$

Problem No : 3

A bar of 15 mm diameter is subjected to a pull of 45 KN.

Que : 3 The measured extension on a gauge length of 200mm is 0.08mm and change in diameter is 0.0023mm. Calculate the poision's ratio and determine the values of 3 elastic constant ?

Given

diameter of bar $(d) = 15mm$

load $(P) = 45KN = 45 \times 10^3 N.$

Gauge length $(l) = 200mm.$

Change in length $(\delta l) = 0.8mm$

Change in diameter $(\delta d) = 0.0023mm.$

To find :

Poisson's Ratio :

Three elastic constant : (E, G, K)

$$\text{Poisson's Ratio} = \frac{\text{lateral strain}}{\text{linear strain}}$$

$$= \frac{\varepsilon d}{\varepsilon l}$$

$$\varepsilon d = \frac{\delta d}{d} = \frac{\text{change in dia}}{\text{original dia}}$$

$$\varepsilon l = \frac{\delta l}{l} = \frac{\text{change in length}}{\text{original length}}$$

Area of cross section :

$$A = \frac{\pi d^2}{4}$$

$$A = \frac{\pi (15)^2}{4} = 176.71 \text{ mm}^2$$

$$\text{Stress } \sigma = \frac{P}{A} = \frac{45 \times 10^3}{176.71}$$

$$\sigma = \underline{254.654} \quad \underline{N/mm^2}$$

$$\text{Linear strain } \varepsilon l = \frac{\delta l}{l} \Rightarrow \frac{0.8}{200} \Rightarrow 4 \times 10^{-3}$$

$$\text{Lateral strain } \varepsilon d = \varepsilon b = \varepsilon t$$

$$= \frac{\delta d}{d} = \frac{0.0023}{15}$$

$$= \underline{1.53 \times 10^{-4}}$$

Poisson's Ratio $1/m = \frac{\varepsilon_d}{\varepsilon_l} = \frac{\delta d/d}{\delta l/l}$

$$\Rightarrow \frac{1.53 \times 10^{-4}}{4 \times 10^{-3}}$$

$$1/m \Rightarrow 0.38$$

young's modulus 'E' $= \frac{\sigma}{\varepsilon_l}$

$$E = \frac{254.65}{4 \times 10^{-4}}$$

$$= 63.66 \times 10^3 \ N/mm^2.$$

Modulus of rigidity

$$E = 2G\left(1 + \frac{1}{m}\right)$$

$$63.66 \times 10^3 = 2G\left(1 + 0.038\right)$$

$$G = \frac{63.66 \times 10^3}{2.076}$$

$$G = 30.66 \times 10^3 \ N/mm^2.$$

Bulk modulus K,

$$E = 3K\left(1 - 2\left(\frac{1}{m}\right)\right)$$

$$63.66 \times 10^3 = 3K\left(1 - (2 \times 0.038)\right).$$

$$K = \frac{63.66 \times 10^3}{3 \times 0.924}$$

$= 22.96 \times 10^3 \; N/mm^2$

Que: 4 A circular rod of diameter 10 mm and length 200 mm elongates (change in length) 0.50 mm under an axial load of 50 kN. If the change in diameter is 0.01 mm, calculate the values of Young's modulus, modulus of rigidity, bulk modulus and Poisson's ratio?

GIVEN

diameter of rod (d) = 10 mm

original length = 200 mm

change in length = 0.50 mm

Load (P) = 50 kN

Change in diameter = 0.01 mm

To find

Poisson's ratio

Three elastic constants (E, G, K)

$$\text{Poisson's ratio} = \frac{\text{Lateral strain}}{\text{Linear strain}} = \frac{\varepsilon_d}{\varepsilon_l}$$

$$\varepsilon_d = \frac{\delta d}{d} = \frac{\text{change in dia}}{\text{original dia}}$$

$$= \frac{0.01\,mm}{10\,mm} = 1 \times 10^{-3}$$

$$\varepsilon_l = \frac{\text{change in length}}{\text{original length}} = \frac{0.50\,mm}{200} = 2.5 \times 10^{-3}$$

Area of cross section:

$$A = \frac{\pi d^2}{4} \qquad A = \frac{\pi (10^2)}{4} = 78.53\,mm^2$$

$$\text{Stress } \sigma = \frac{P}{A} = \frac{50 \times 10^3}{78.53} = 636.69\,N/mm^2$$

Poission's Ratio $1/m = \frac{\varepsilon d}{\varepsilon l}$

$= \frac{1 \times 10^{-3}}{2.5 \times 10^{-3}} = 0.4$

$1/m = \underline{0.4}$

young's modulus $= \frac{\sigma}{\varepsilon l}$

$= \frac{636.69}{2.5 \times 10^{-3}}$

$= \underline{254.676 \times 10^{3}\ N/mm^2}$

Modulu's of rigidity $- E = 2G\left(1 + \frac{1}{m}\right)$

$254.67 \times 10^{3} = 2G(1 + 0.4)$

$G = \frac{254.676 \times 10^{3}}{2 \times 0.4} = \underline{318.25 \times 10^{3}\ N/mm^2}$

Bulk's modulu's K,

$E = 3K\left(1 - 2\left(\frac{1}{m}\right)\right)$

$256.67 \times 10^{3} = 3K(1 - (2 \times 0.4))$

$K = \frac{256.67 \times 10^{3}}{3 \times 0.8}$

$\Rightarrow \underline{106.94 \times 10^{3}}$

$a \times a = 50 \times 50$

Que 5 A bar of length 10mm and square in section of side 50mm is subjected to one axial pull load of 150 KN. The extension in length was 0.05mm. and the decrease in side was 0.00625 mm. Find the elastic constant's and poission's ratio?

Given :-

original length = 10mm

change in length = 0.05mm

load (P) = 150 KN = 150×10^3 N

width of square = 50mm

change in width = 0.00625

To find

poisson's ratio, =

Three elastic constant = (E, G, K)

solve :-

Area = $a \times a = 50 \times 50 = 2500\ mm^2$

Stress $\frac{P}{A} = \frac{150 \times 10^3}{2500} = 60\ N/mm^2$

Linear strain $\varepsilon l = \frac{\delta l}{l} = \frac{0.05}{10}$

$= 5 \times 10^{-3}$

lateral strain $\varepsilon d = \frac{\delta d}{d} = \frac{0.00625}{50}$

$= 1.25 \times 10^{-4}$

poisson's ratio $= \frac{\varepsilon d}{\varepsilon l} = \frac{1.25 \times 10^{-4}}{5 \times 10^{-3}}$

$1/m = 0.025$

Young's modulus : $E = \frac{\sigma}{\varepsilon_l}$

$= \frac{60}{5 \times 10^{-3}}$

$= \underline{12000 \ N/mm^2}$

Modulus of Rigidity

$= E = 2G\left(1+\frac{1}{m}\right)$

$12000 = 2G\left(1+0.025\right)$

$12000 = G\left(2+0.025\right)$

$G = \frac{12000}{2.025}$

$G = \underline{5925.92 \ N/mm^2}$

Bulk modulus, $K =$

$E = 3K\left(1-2\frac{1}{m}\right)$

$12000 = 3K\left(1-2 \times 0.025\right)$

$12000 = 3K\left(1-0.05\right)$

$12000 = K\left(3-0.15\right)$

$K = \frac{12000}{2.85}$

$K = \underline{4210.52 \ N/mm^2}$

Que 6. A steel bar of 300mm length & section 50mm x 12 mm is subjected to an axial compression of 84 kN. calculate volumetric strain & change in volume of the bar if $E = 2 \times 10^5 N/mm^2$, $1/m = 0.3$.

Given :-

length = 300mm

Section = 50 mm x 12 mm.

$b = 50\ mm$

$t = 12\ mm$.

Compression load = 84 kN $\Rightarrow 84 \times 10^3 N$

$E = 2 \times 10^5 N/mm^2$ (young's modulus).

$1/m = 0.3$ (poisson's ratio).

To find

Volumetric strain (εv).

change in volume (δv).

Sol :

$$\boxed{\delta v = \varepsilon v \times v}$$

$$\varepsilon \quad \varepsilon v = -\varepsilon l + \varepsilon b + \varepsilon t$$

Area of cross section

$A = b \times t$

$= 50 \times 12 = 600 mm^2$

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

$= \frac{84 \times 10^3}{600}$ $\quad \sigma = 140 N/mm^2$

Linear ~~Lateral~~ strain $\varepsilon l = \frac{\delta l}{l} = \frac{\text{change in length}}{\text{original length}}$

$\delta l = \varepsilon l \times l$

$= 7 \times 10^{-4} \times 300$

$= \delta l = 0.21 mm$

Young's modulus $= E = \frac{\sigma}{\varepsilon l}$ $\sigma \rightarrow$ stress, $\varepsilon l \rightarrow$ Linear strain.

$$2 \times 10^5 = \frac{140}{\varepsilon l}$$

$$\varepsilon l = \frac{140}{2 \times 10^5} = 7 \times 10^{-4}$$

Given :-

Poisson's Ratio

$$\left(\frac{1}{m}\right) = \frac{\text{Lateral strain } (\varepsilon b)}{\text{Linear strain } (\varepsilon l)}$$

$$0.3 = \frac{\varepsilon b}{\varepsilon l} \qquad 0.3 = \frac{\varepsilon b}{7 \times 10^{-4}}$$

$$\varepsilon b = 2.1 \times 10^{-4} \qquad \varepsilon b = \frac{\delta b}{b}$$

$$\delta b = \varepsilon b \times b$$

$$= 2.1 \times 10^{-4} \times 12$$

$$\boxed{\delta b = 0.0105}$$

$$\varepsilon t = 0$$

$$\varepsilon t = \frac{\delta t}{t} \qquad \delta t = \varepsilon t \times t$$

$$\varepsilon b = \varepsilon t$$

$$\delta t = 2.1 \times 10^{-4} \times \cancel{\delta t}\ 12$$

$$\delta t = 2.5 \times 10^{-3}$$

$$\delta v = \varepsilon v \times v$$

$$\varepsilon v = -\varepsilon l + \varepsilon b + \varepsilon t$$

$$= -7 \times 10^{-4} + 2.1 \times 10^{-4} + 2.1 \times 10^{-4}$$

$$\varepsilon v = -2.8 \times 10^{-4}$$

δv = change in volume.

$$\delta v = \varepsilon v \times V$$

$$V = b \times t \times l$$

$$V = 50 \times 12 \times 300$$

$$V \Longrightarrow 1,80,000$$

$$\delta v = -2.8 \times 10^{-4} \times 1,80,000$$

$$\delta v \Longrightarrow -50.4\ mm^3$$

Final length $(lt) = l - \delta l = 300 - 0.21$

$$\Longrightarrow 299.79\ mm$$

Final breath $(bt) = b + \delta b = 50 + 0.0105$

$$\Longrightarrow 50.01\ mm$$

Final thickness $(Ft) = t + \delta t = 12 + 2.52 \times 10^{-7}$

$$= 12.00\ mm$$

29/8/22
Monday

A Steel flat of 500 mm length 60 mm wide and 20 mm thickness is subjected to one axial compression of 168 kN. Calculate the final dimensions and final volume of flat. modulus of elasticity of steel is 2.1×10^5 N/mm² and poisson's ratio 0.3?

Given :

Length of flat (l) = 500 mm.
width of flat (b) = 60 mm.
Thickness of flat (t) = 20 mm.
Compressive load (P) = 168 kN $\Rightarrow 168 \times 10^3$ N
$E = 2.1 \times 10^5$ N/mm².
Poisson's Ratio (1/m) = 0.3

To find :

final dimensions, (l_1, b_1, t_1).
Final volume,

Sol :

Area = $b \times t$ = 60×20 = 1200 mm².

Stress = $\frac{\text{load}}{\text{area}} = \frac{168 \times 10^3}{1200} \Rightarrow \sigma = 140$ N/mm²

young's modulus $E = \frac{\sigma}{\varepsilon l} = \frac{\text{Axial stress}}{\text{linear strain}}$.

$$\varepsilon l = \frac{\sigma}{E}$$

$$\varepsilon l = \frac{140}{(2.1 \times 10^5)}$$

$$\varepsilon l = 6.67 \times 10^{-4}$$

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$\varepsilon l = \frac{\delta l}{l}$

$\delta l = \varepsilon l \times l$

$\delta l = 6.67 \times 10^{-4} \times 500$

$\delta l = 0.3335$

$\delta l \Rightarrow 0.33mm.$

Poisson's Ratio.

$0.3 = \frac{\text{Lateral strain}}{\text{Linear strain}}$

$0.3 = \frac{\varepsilon b}{\varepsilon l}$

$\varepsilon b = \varepsilon l \times 0.3$

$\varepsilon b \Rightarrow 6.67 \times 10^{-4} \times 0.3 = 2.001 \times 10^{-4}$

$\varepsilon b \Rightarrow \frac{\delta b}{b}$

$\delta b = \varepsilon b \times b$

$\delta b = 2.001 \times 10^{-4} \times 60$

$\boxed{\delta b = 0.012mm.}$

$\boxed{\varepsilon b = \varepsilon t.}$

$\varepsilon t = \frac{\delta t}{t}$

$\delta t = \varepsilon t \times t$

$\delta t = 2.001 \times 10^{-4} \times 20$

$\delta t \Rightarrow 4.002 \times 10^{-3}$

Final dimensions :

Final length (l_1) = $l - \delta l$

$= 500 - 0.33$

$l_1 \Rightarrow 499.67\ mm$

Final width (b_1) = $b + \delta b$

$\Rightarrow 60 + 0.012$

$b_1 \Rightarrow 60.012\ mm$

Final thickness (t_1) $\Rightarrow t + \delta t$

$\Rightarrow 20 + (4.002 \times 10^{-3})$

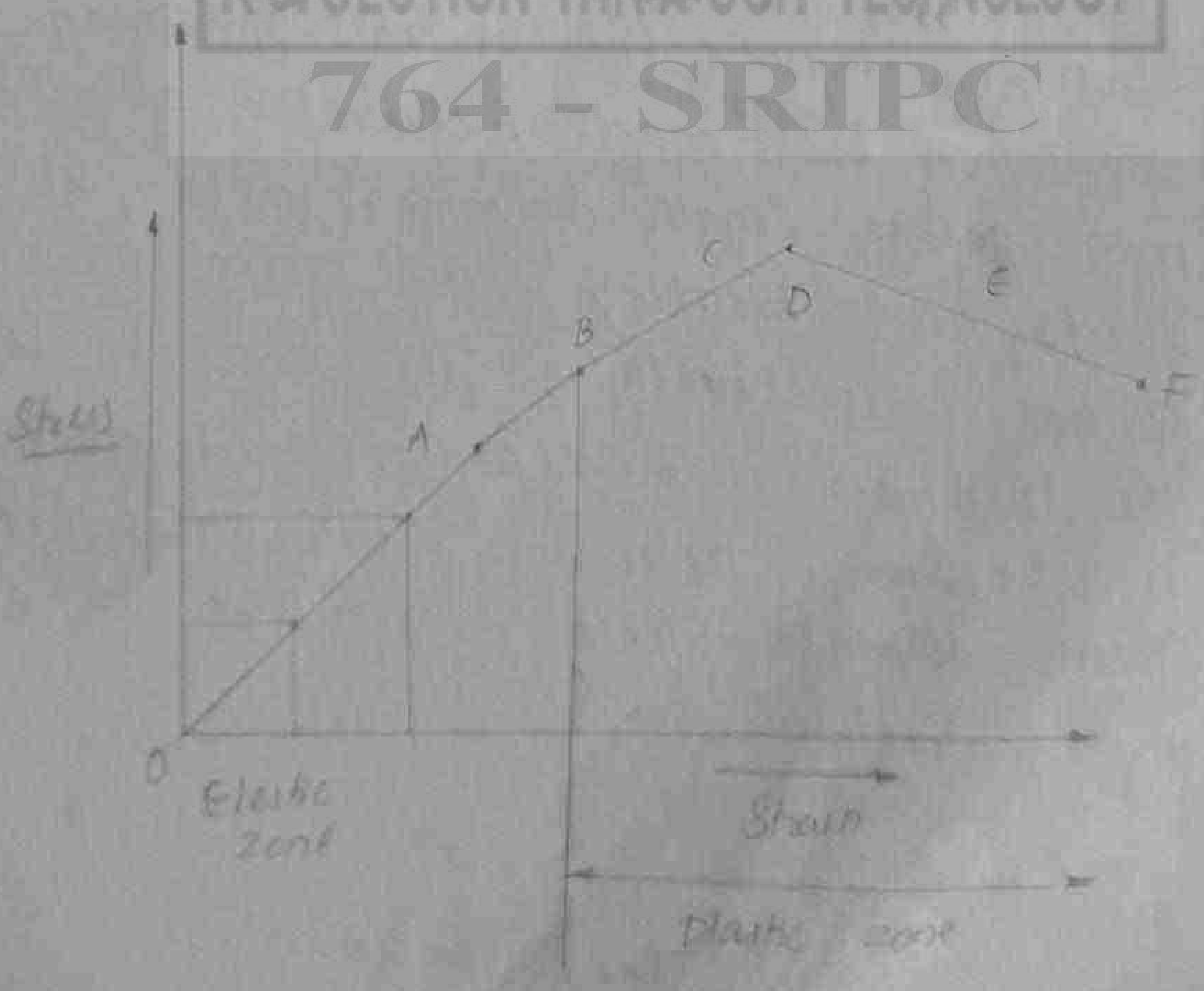
$t_1 \Rightarrow 20.004\ mm$

Final volume (V) = $l_1 \times b_1 \times t_1$

$= 499.67 \times 60.012 \times 20.004$

$V \Rightarrow 599843.87\ mm^3$

Stress Strain curve.



OA → proportional limit

OB → Elastic limit

C → upper yield point

D → lower yield point

E → Ultimate Stress

F → Breaking Stress

~~Giv~~ Stress : $\frac{\text{load}}{\text{area}}$

Strain = $\frac{\text{change in dimension}}{\text{original dimension}}$

young's modulus $E = \frac{\text{Stress}}{\text{Strain}}$

~~Que~~: Problems :

Problem based on Stress Strain curve.

Que: ~~a~~ During tension test on M.S Specimen the following observation ~~back~~ were made. diameter of the rod 20 mm gauge length 200 mm. yield, ~~a~~ ultimate loads and breaking loads are 85 kN, 120 kN, 90 kN respectively. The final ~~a~~ length of the Specimen is 205.6 mm and neck diameter is 14.5 mm. Determine yield stress, breaking Stress, Ultimate Stress, percentage of elongation and Contraction.

Given :-

Mild Steel Specimen.

Dia of the Rod (d) = 20 mm.

Gauge length (l) = 200 mm.

yield load (P_y) = 85 kN = 85×10^3 N.

ultimate load (P_u) = 120 kN = 120×10^3 N.

Breaking load (P_b) = 90 kN = 90×10^3 N.

final length (l) = 205.6 mm

Neck diameter (d_1) = 14.5 mm.

To find:

yield stress = ?

ultimate stress = ?

Breaking stress = ?

% Elongation & contraction = ?

Sol:

(i) yield stress (σ_y) ⟹ $\dfrac{\text{load at yield point } (P_y)}{\text{original area of the rod } (A)}$

$\sigma_y = \dfrac{P_y}{A}$

$A = \dfrac{\pi d^2}{4} = \dfrac{\pi (20)^2}{4} \Rightarrow 314.15\ mm^2$

$\sigma_y = \dfrac{85 \times 10^3}{314.15}$

$\sigma_y = 270.57\ N/mm^2$

(ii) Ultimate stress (σ_u) ⟹ $\dfrac{\text{ultimate load (or) maximum load}}{\text{original area c/s}}$

$\Rightarrow \dfrac{120 \times 10^3}{314.15}$

$\sigma_u = 381.98 \ N/mm^2$

Breaking stress : (2)

a). Nominal breaking stress :

(X) $\longrightarrow \dfrac{\text{Load at breaking point } (P_b)}{\text{original area of c/s } (A)}$

Nominal $\Rightarrow \dfrac{90 \times 10^3}{314.15} \Rightarrow 286.48 \ N/mm^2$

Actual breaking stress $= \dfrac{\text{Load at breaking point } (P_b)}{\text{waist area}}$

waist area $= \dfrac{\pi d1^2}{4}$

$= \dfrac{\pi (14.5)^2}{4}$

$= 165.12 \ mm^2$

Actual breaking $= \cancel{90 \times} \dfrac{P_b}{WA}$

$= \dfrac{90 \times 10^3}{165.12}$

$= 545.05 \ N/mm^2$

% elongation :

(X) $\dfrac{\text{Total elongation}}{\text{gauge length}} \times 100$

$\Longrightarrow \dfrac{\text{final length} - \text{original length}}{(\text{Gauge length } l_{orig})} \times 100$

$\Longrightarrow \dfrac{205.6 - 200}{200} \times 100$

$\Longrightarrow 2.8\ \%$

% contraction :

$X = \dfrac{\text{original area} - \text{waist area}}{\text{original area}}$

$= \dfrac{314.15 - 165.12}{314.15} \times 100$

% contraction $\Longrightarrow 47.63\ \%$

Result

yield stress (σ_y) = 270.57 N/mm²

Ultimate stress (σ_u) = 381.98 N/mm²

Breaking stress :

Nominal breaking stress = 286.48 N/mm²

~~Actual breaking stress = 165.12 mm²~~

waist area = 165.12 mm²

Actual breaking = 545.05 N/mm²

% of elongation = 2.8 %

% of contraction = 47.63 %

2/8/22 Friday

Que: The following data refer to a tension test conducted on a mild steel bar of 16mm diameter with a gauge length of 200mm.
Elongation at a load of 30 kN = 0.144mm, Diameter of bar at fracture = 10.20mm, final length of the bar = 253mm, load at yield point = 70 kN, ultimate load = 130 kN,

Breaking load = 110 kN. Calculate Young's modulus, yield stress, ultimate stress, Breaking stress (Nominal), Breaking stress (Actual) and percentage of elongation and percentage reduction in area?

Given :-

Mild steel bar (d) = 16mm

Gauge length (l) = 200 mm.

Elongation of load at 30 kN = 0.144 mm.

dia of bar at fracture (d1) = 10.20 mm.

final length of the bar = 253mm.

Load at yield point (P_y) = 70kN.

ultimate load (P_u) = 130 kN.

Breaking load (P_b) = 110kN.

To find :-

young's modulus (E) = ?

yield stress (σ_y) = ?

ultimate stress (σ_u) = ?

Breaking Stress (σ_b) = ?

Elongation & percentage of Reduction in Area = ?

Young's modulus $E = \frac{\sigma}{e} \Rightarrow \frac{\text{stress}}{\text{strain}}$

Stress (σ) = P/A

$$\text{Area} = \frac{\pi d^2}{4} \Rightarrow \frac{\pi (16)^2}{4}$$

$A = 201.06\ mm^2$

$$\text{Stress } (\sigma) = \frac{30 \times 10^3}{201.06}$$

$(\sigma) = 149.20\ N/mm^2$

$$e = \frac{\text{change in length } (\delta l)}{\text{original length } (l)}$$

$$e = \frac{0.144}{200} \Rightarrow 7.2 \times 10^{-4}$$

$$E = \frac{\text{stress}}{\text{strain}} = \frac{149.20}{(7.2 \times 10^{-4})}$$

$= 207.2 \times 10^3\ N/mm^2$

$$\text{yield stress } (\sigma_y) = \frac{\text{load at yield point}}{\text{original area}}$$

$$\Rightarrow \frac{70 \times 10^3}{201.06}$$

$348.15\ N/mm^2$

Ultimate stress (σ_u) = $\frac{\text{ultimate load}}{\text{original area}}$

$= \frac{130 \times 10^3}{201.06}$

$= 646.57 \, N/mm^2$

Breaking stress (σ_b) = ?

Nominal breaking stress = $\frac{\text{load at breaking point}}{\text{original area}}$

$= \frac{110 \times 10^3}{201.06}$

$= 547.10 \, N/mm^2$

Actual breaking area

$= \frac{\text{load at breaking point}}{\text{waist area}}$

waist area = $\frac{\pi d_1^2}{4}$

$= \frac{\pi (10.20)^2}{4}$

$= \cancel{78.85} = 81.71 \, mm^2$

Actual breaking area = $\frac{\text{load at breaking point}}{\text{waist area}}$

$= \frac{110 \times 10^3}{81.71}$

3

$= 1346.22 \, N/mm^2$

Elongation :

$$= \frac{\text{final length} - \text{original length}}{\text{original length}} \times 100$$

$$= \frac{253 - 200}{200} \times 100$$

$= 26.5\ \%$

Contraction :

$$= \frac{\text{original area} - \text{waist area}}{\text{original area}}$$

$$= \frac{201.06 - 81.71}{201.06} \times 100$$

$= 59.36\ \%$

Result

young's modulus (E) = 149.20 N/mm^2

yield stress (σ_y) = 348.15 N/mm^2.

ultimate stress (σ_U) = 646.57 N/mm^2.

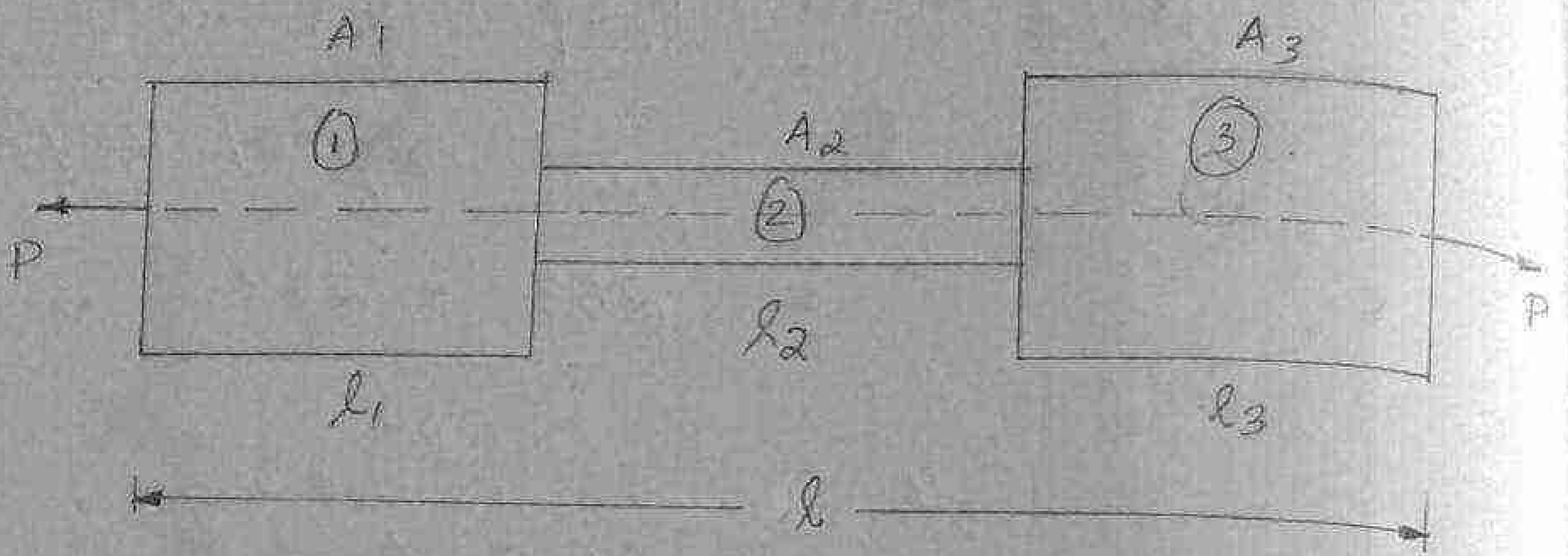
Breaking stress (σ_b) = 1346.22 N/mm^2.

elongation of percentage of Reduction in area = 59.36 %.

5/9/22
Monday

Deformation of Stepped ~~doors~~ bars :

Que :



l_1 = length of section 1.

A_1 = cross section area of sectio 1

l_2 = length in section 2.

A_2 = cross sectional area of section 2

l_3 = length in section 3.

A_3 = cross sectional area of section 3.

change in length of section 1 $\delta_1 = \frac{Pl_1}{A_1E}$

change in length of section 2 $\delta_2 = \frac{Pl_2}{A_2E}$

change in length of section 3 $\delta_3 = \frac{Pl_3}{A_3E}$

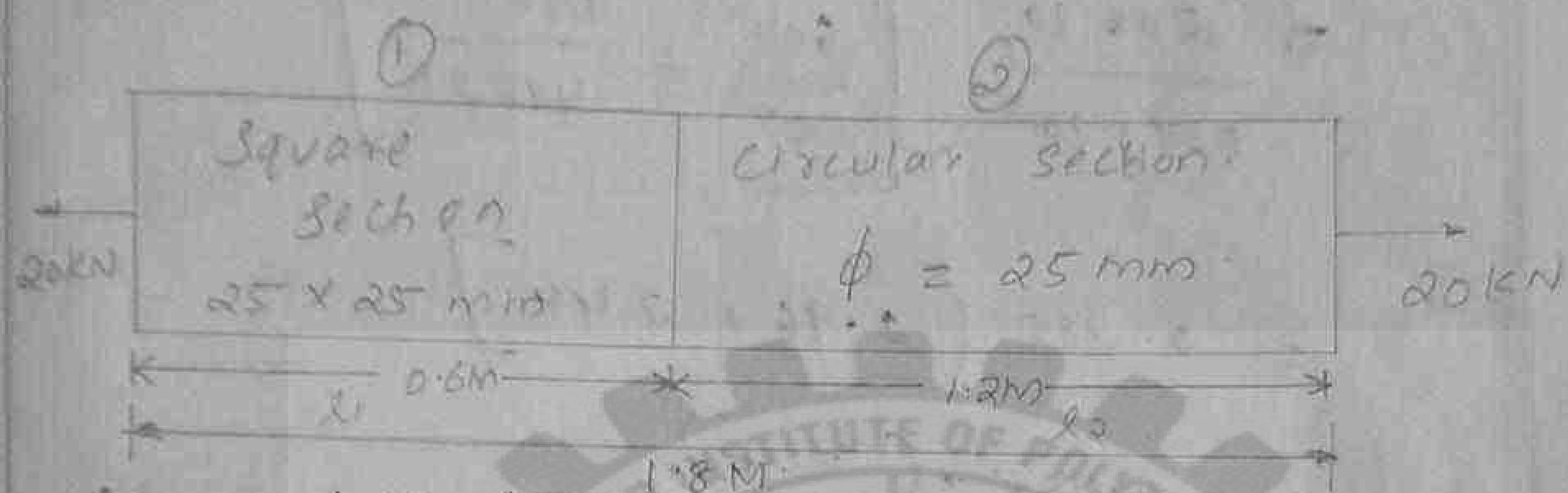
Total deformation $\delta l + \delta_1 + \delta_2 + \delta_3$

$$\delta l = \frac{Pl_1}{A_1E} + \frac{Pl_2}{A_2E} + \frac{Pl_3}{A_3E}$$

$$\delta l = \frac{P}{E}\left[\frac{l_1}{A_1} + \frac{l_2}{A_2} + \frac{l_3}{A_3}\right] \text{ in mm}$$

Prob : Sum

An aluminium bar of 1.8 m long has a 25 mm sided ~~of~~ square setion ~~over~~ over 0.6 m of it's length under the circular section of 25 mm dia over the remaining length. Calculate the elonguation under the pull of 20 kN. E is equal to ~~to~~ 0.7×10^5 N/mm².



Given data :-

$L = 1.8$ m $\qquad E = 0.7 \times 10^5$ N/mm²

$l_1 = 0.6$ m $\qquad P = 20$ kN

$l_2 = 1.2$ m $\qquad = 20 \times 10^3$ N.

$A_1 = b \times t = 25 \times 25$

$= \underline{625 \text{ mm}^2}$

$$A_2 = \frac{\pi d^2}{4}$$

$$= \frac{\pi (25)^2}{4} = \underline{490.87 \text{ mm}^2}$$

To find :

$$\frac{\delta l}{l} = \frac{Pl}{E}$$

$$\delta l = \frac{P l_1}{A_1 E} + \frac{P l_2}{A_2 E}$$

$$= \frac{P}{E}\left[\frac{l_1}{A_1} + \frac{l_2}{A_2}\right]$$

$$= \frac{20\times10^3}{0.7\times10^5}\left[\frac{0.8}{625}+\frac{1.2}{490.87}\right]$$

$$= 0.285\,(0.96+2.44)$$

$$= 0.285\times(3.4)$$

$$= \frac{20\times10^3}{0.7\times10^5}\left[\frac{600}{625}+\frac{1200}{490.87}\right]$$

$$= 0.285\,(0.96+2.44)$$

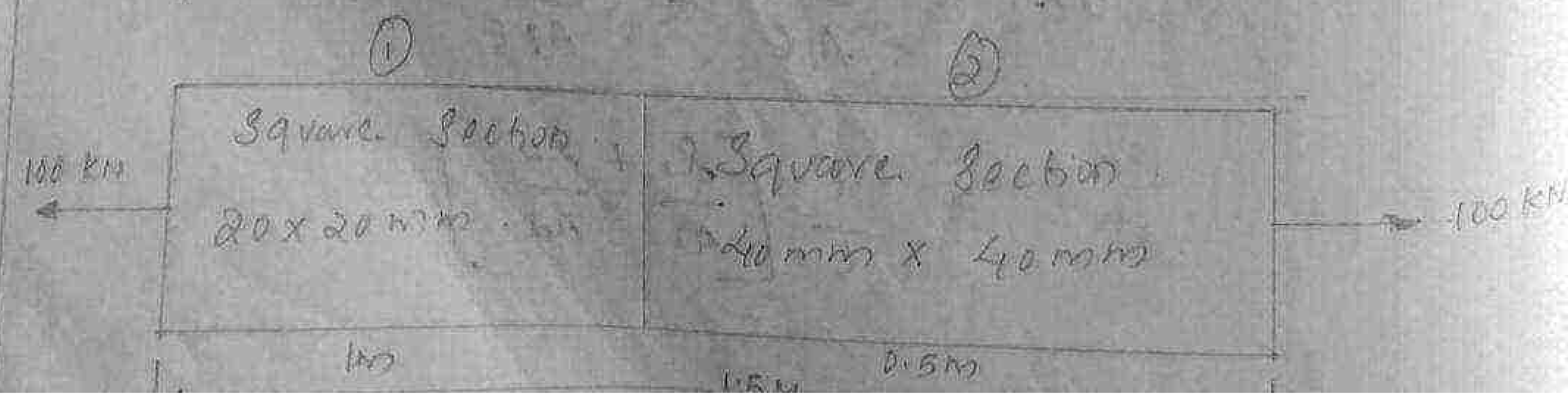
$$= 0.285\times(3.4)$$

$$\boxed{\delta l = 0.969} = 0.97\,mm$$

Prob : 2

Que: A steped bar of 1.5m long is composed of 2 segments. ~~of~~ the 1st segment of 20mm square in cross section and 1m long and the ~~Secon~~ 2nd segment is 40mm square. In cross section for the dividing length. Determine the elongation of the bar. when it is subjected to a tensile ~~force of~~ load of 100 kN take $E = 200\ kN/mm^2$.

Deformation of stepped bars.



GIVEN :

$l = 1.5m = 1500mm.$

$l_1 = 1m = 1000mm.$

$l_2 = 0.5m = 500mm.$

$A_1 = b \times t = 20 \times 20 = 400mm^2.$

$A_2 = b \times t = 40 \times 40 = 1600mm^2.$

$E = 200 kN/mm^2.$

$= 200 \times 10^3 N/mm^2.$

$P = 100 kN = 100 \times 10^3 N.$

To find :

$$(\delta l) = \frac{Pl}{AE}$$

$$\delta l = \frac{Pl_1}{A_1E} + \frac{Pl_2}{A_2E}$$

$$= \frac{P}{E}\left[\frac{l_1}{A_1} + \frac{l_2}{A_2}\right]$$

$$= \frac{100 \times 10^3}{200 \times 10^3}\left[\frac{1000}{400} + \frac{500}{1600}\right].$$

$$= 0.5\left[2.5 + 0.312\right]$$

$$(\delta l = 0.5 \times 2.812 = 1.406mm.$$

Prob : 3

Que : A bar of 300mm long is 50mm square in section for 120 mm of it's length. ~~25 mm dia~~ ϕ ~~for 80mm~~ 25mm dia of 80 mm. 40mm ϕ for remaining length. If a tensile load of 100 kN is applied to the bar at both ends. Calculate the maximum and minimum stress produced in the bar and total elongation in the member. Assume ~~E = 10~~

$E = 2 \times 10^5 \ N/mm^2$.

Given data

$L = 300 \ mm$

$l_1 = 120mm$

$l_2 = 80mm$

$l_3 = 100mm$

$E = 2 \times 10^5 \ N/mm^2$

$P = 100 \ kN$

$= 100 \times 10^3 \ N$

$A_1 = b \times t = 50 \times 50$

$= 2500 \ mm^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi (25)^2}{4}$

$= 490.87 mm^2$

$A_3 = \frac{\pi d^2}{4} = \frac{\pi (40)^2}{4} \Rightarrow 1256.63 \ mm^2$

To find (δl):

To find : maximum & min stress.

$$\delta l = \frac{Pl_1}{A_1E} + \frac{Pl_2}{A_2E} + \frac{Pl_3}{A_3E}.$$

$$= \frac{P}{E}\left[\frac{l_1}{A_1} + \frac{l_2}{A_2} + \frac{l_3}{A_3}\right].$$

$$= \frac{100 \times 10^3}{2\ \cancel{2.5} \times 10^5}\left[\frac{120}{2500} + \frac{80}{490.87} + \frac{100}{1256.63}\right].$$

$$= 0.5\left[0.048 + 0.162 + 0.079\right]$$

$$= 0.5 \times \left[0.289\right]$$

$$\delta l = 0.144\cancel{5}\ \text{mm}.$$

Max stress:

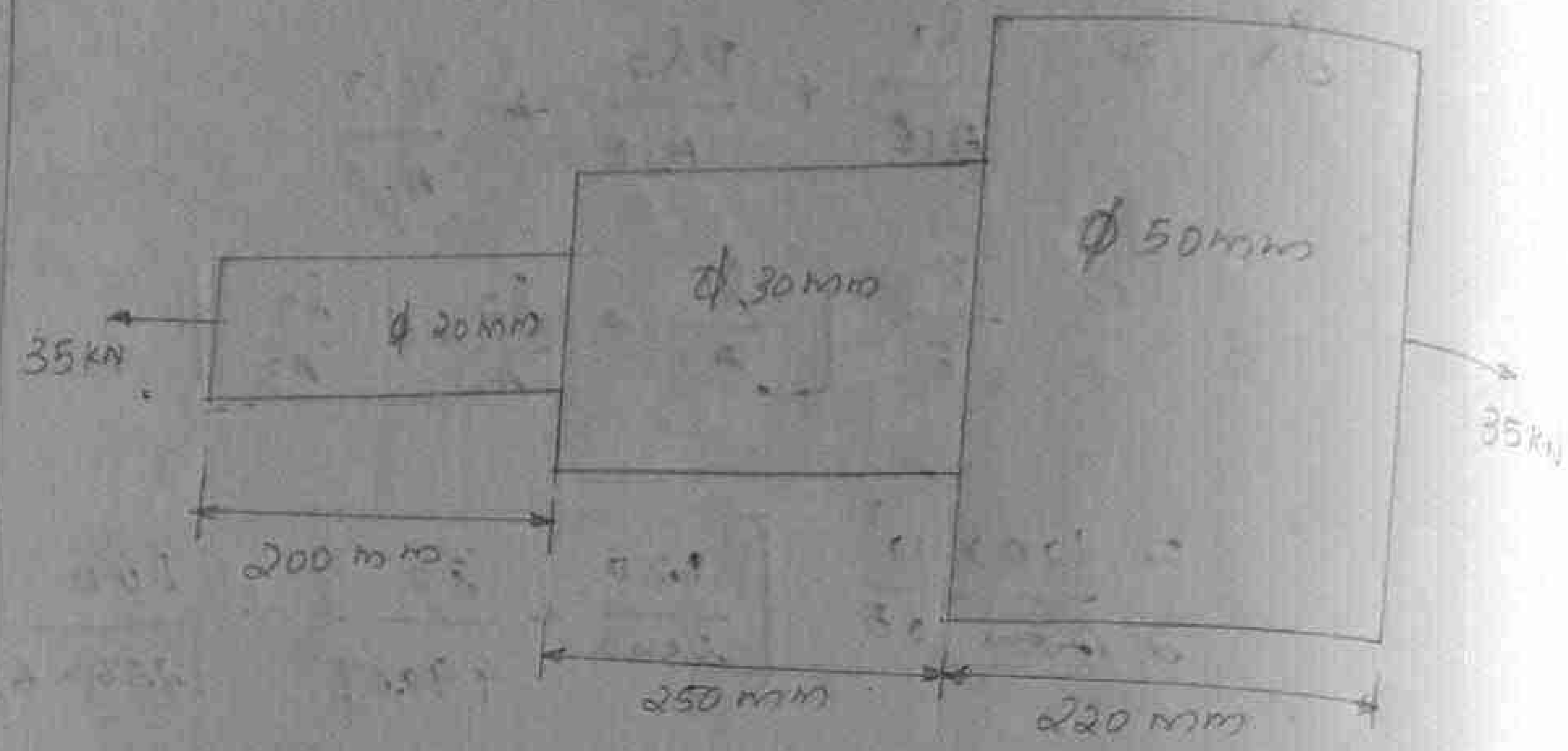
$$\sigma_{max} = \frac{P}{A_{min}} = \frac{100 \times 10^3}{490.87}$$

$$\boxed{\sigma_{max} = 203.72\ N/mm^2.}$$

min stress : $\frac{P}{A_{max}} = \frac{100 \times 10^3}{2500}$.

$$\boxed{\sigma_{min} = 40\ N/mm^2.}$$

Problems : 4



Given :

$d_1 = 20 mm$ $\quad l_1 = 200 mm$

$d_2 = 30 mm$ $\quad l_2 = 250 mm$

$d_3 = 50 mm$ $\quad l_3 = 220 mm$

$$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (20)^2}{4} = 314.15 \, mm^2$$

$$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (30)^2}{4} = 706.85 \, mm^2$$

$$A_3 = \frac{\pi d_3^2}{4} = \frac{\pi (50)^2}{4} = 1963.49 \, mm^2$$

To find :-

1. Stress in each section.
2. Total extension of bar.

Solution :-

Stress in section (1) $= \sigma_1 = \frac{P}{A_1} = \frac{35 \times 10^3}{314.16} =$

$= 111.41 \, N/mm^2$

Scanned by TapScanner

Stress in section (2) = σ_2.

$$= P/A_2 = \frac{35 \times 10^3}{706.86}$$

$$= 49.51 N/mm^2.$$

Stress in section (3) = $\sigma_3 = P/A_3$

$$= \frac{35 \times 10^3}{1963.495}$$

$$= 17.83 N/mm^2.$$

Total extension $(\delta l) = \frac{1}{E}(\sigma_1 \times l_1 + \sigma_2 \times l_2 + \sigma_3 \times l_3)$.

$$= \frac{1}{2.1 \times 10^5}[111.41 \times 200 + 49.51 \times 250 + 17.83 \times 220].$$

$$= \frac{1}{2.1 \times 10^5}[22,282 + 12,377.5 + 3922.6].$$

$$\delta l = \frac{38582.1}{2.1 \times 10^5} = 0.184 mm$$

6/9/22

Unit - 2.

Shear Force & Bending Moment :-

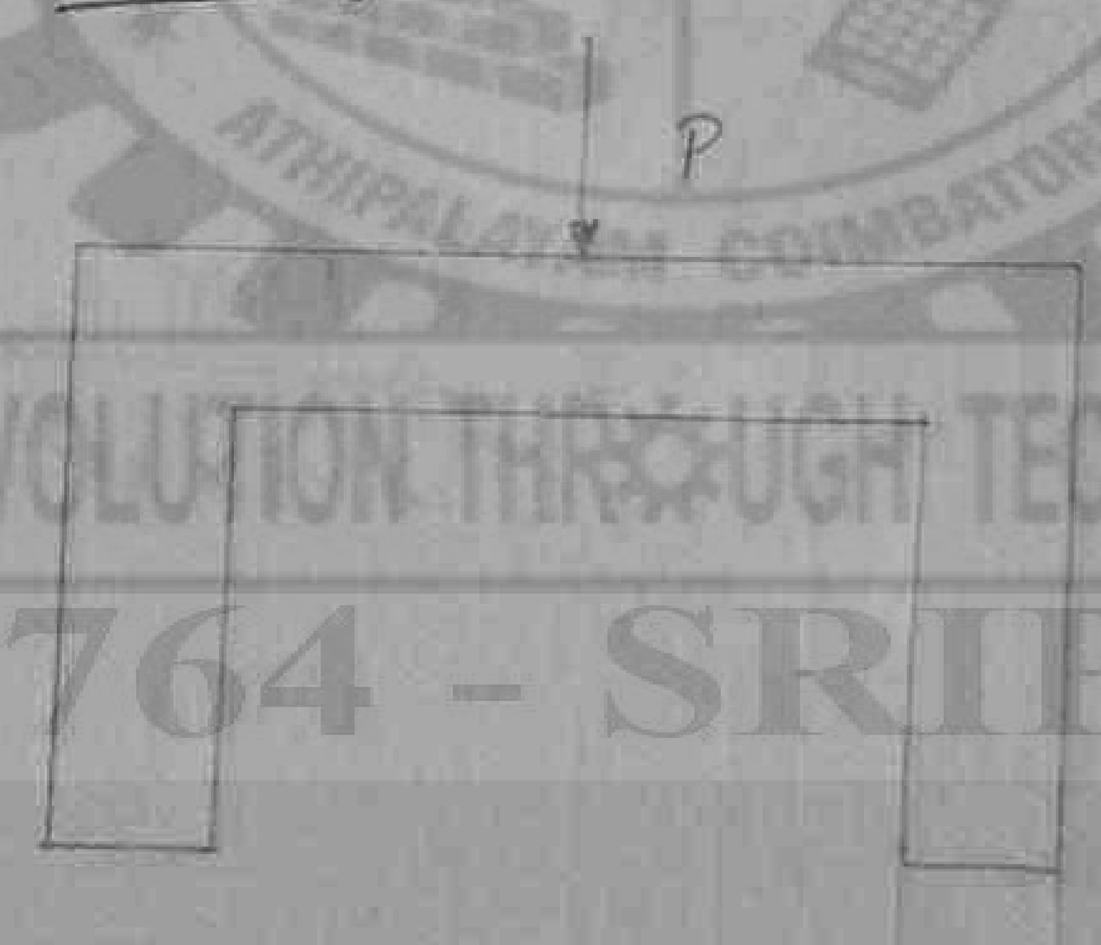
Beams:

Generally beam is a horizontal member carrying vertical loads.

A Beam is provided to support floor, roof slabs.

Axial load :

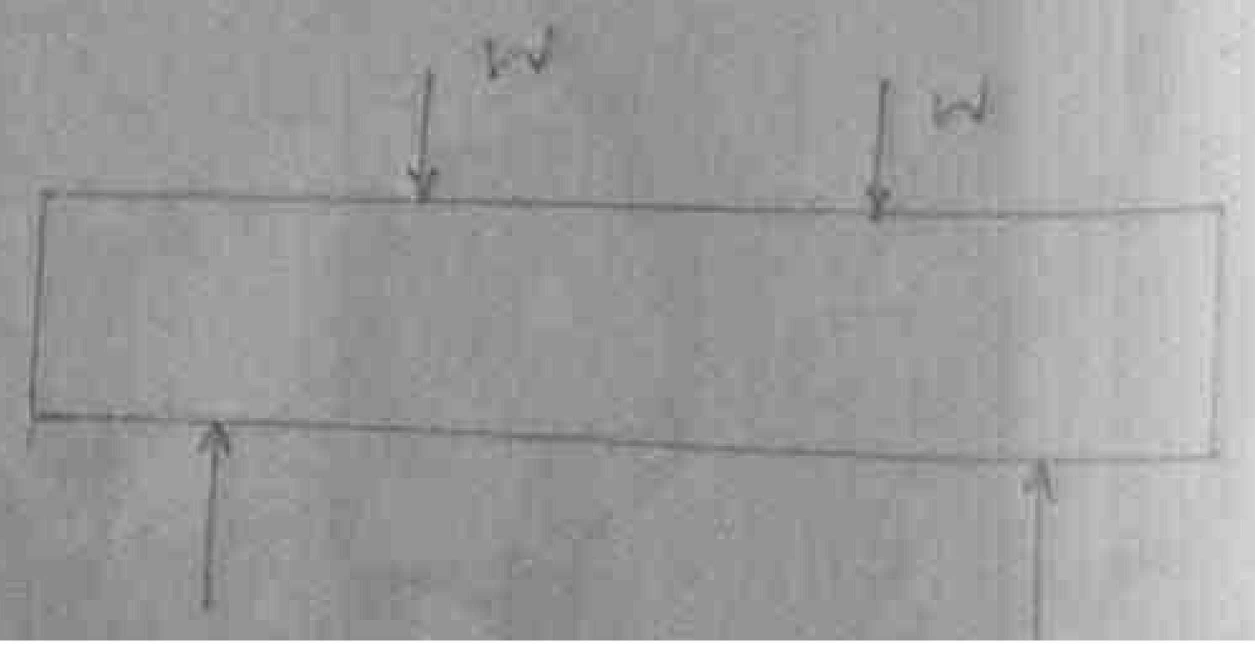
Transverse load :



Types of load on Beams :

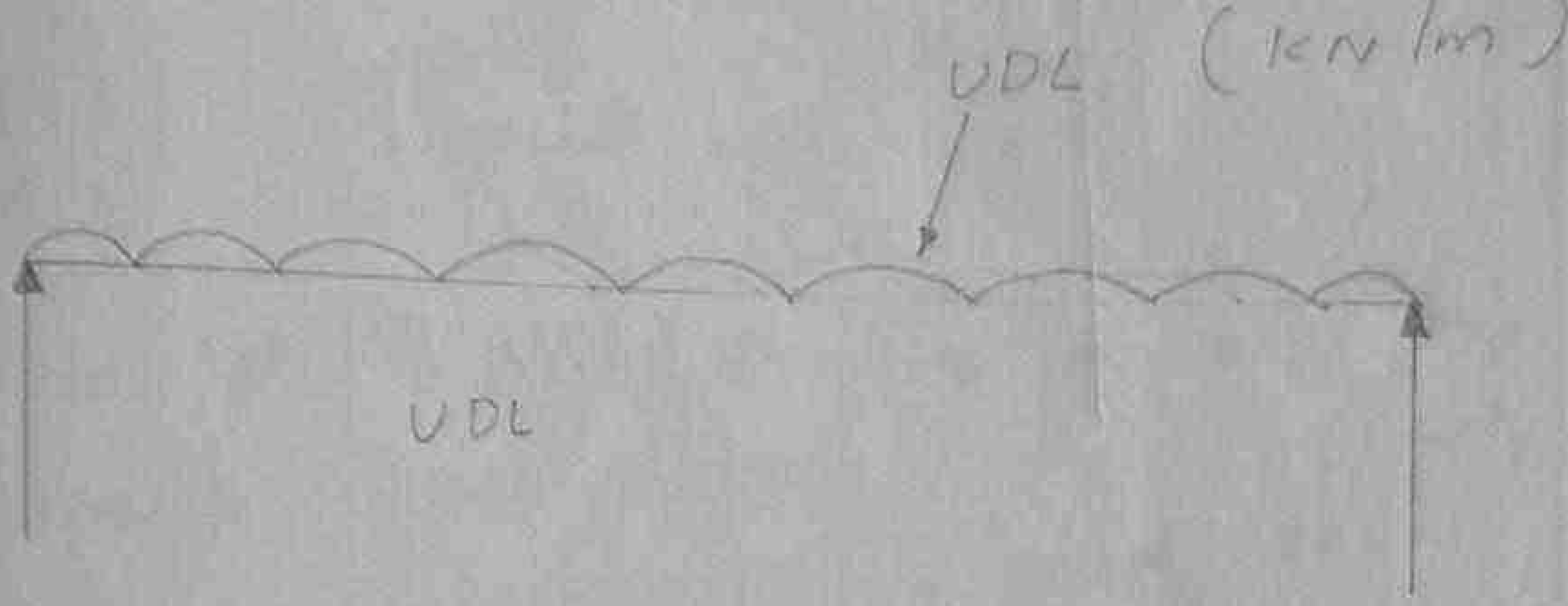
1). point load.
2). uniformly distributed load.
3). uniformly varying load.

Point load.

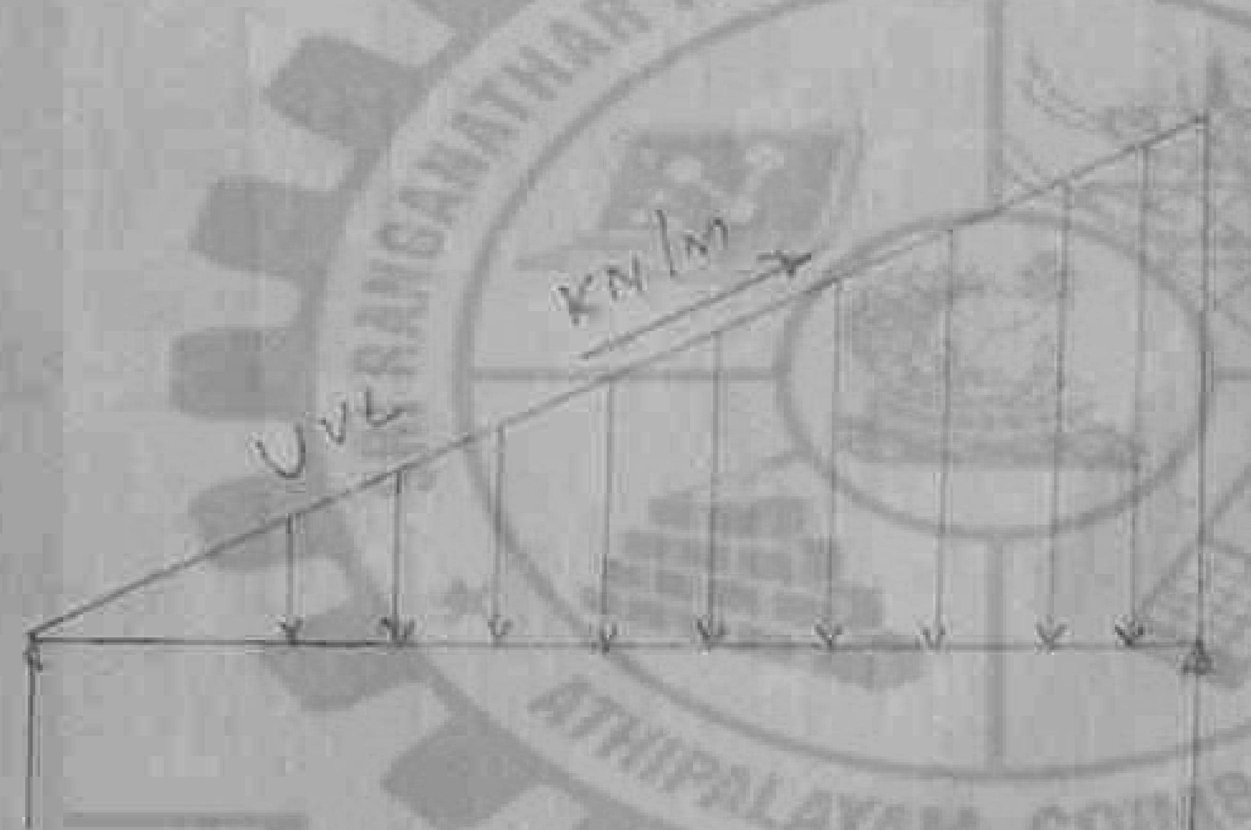


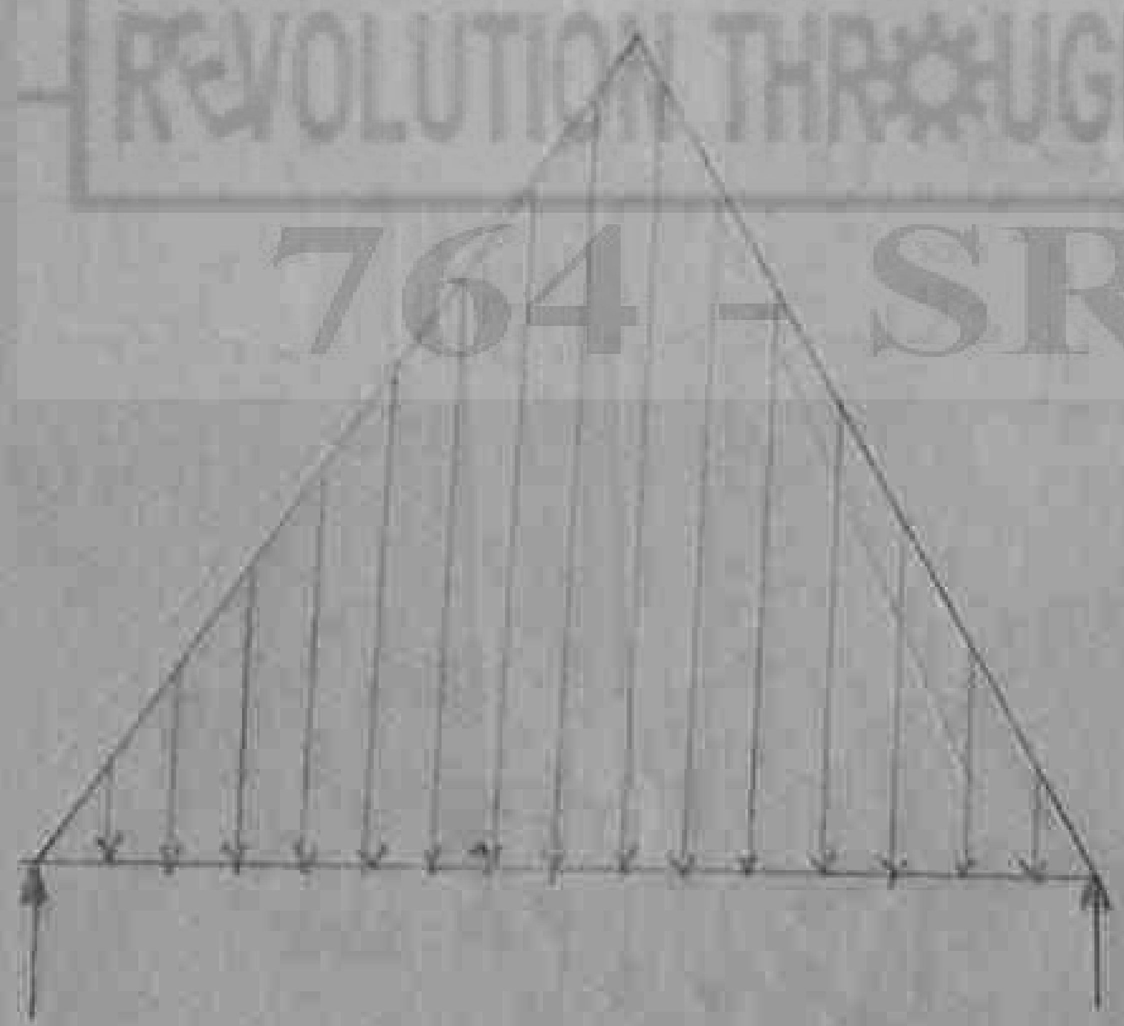
→ load acting on the particular point.

Uniformly distributed load :-



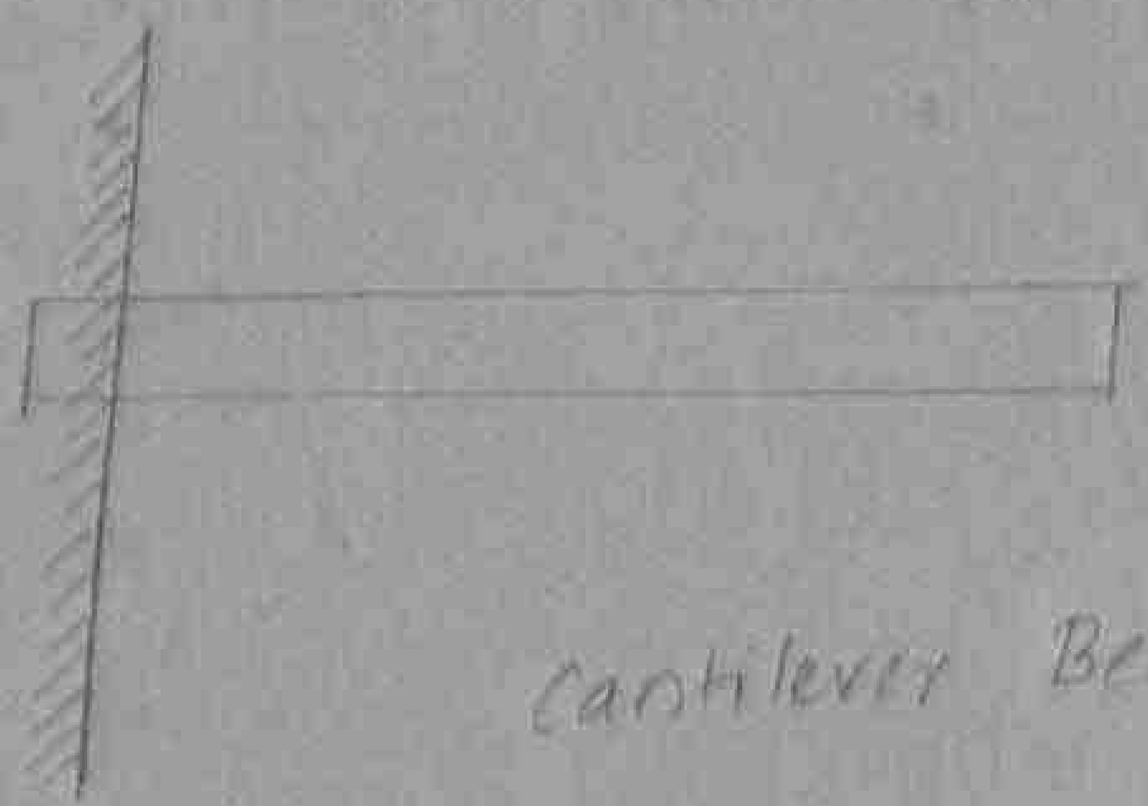
UVL – uniformly varying load :-





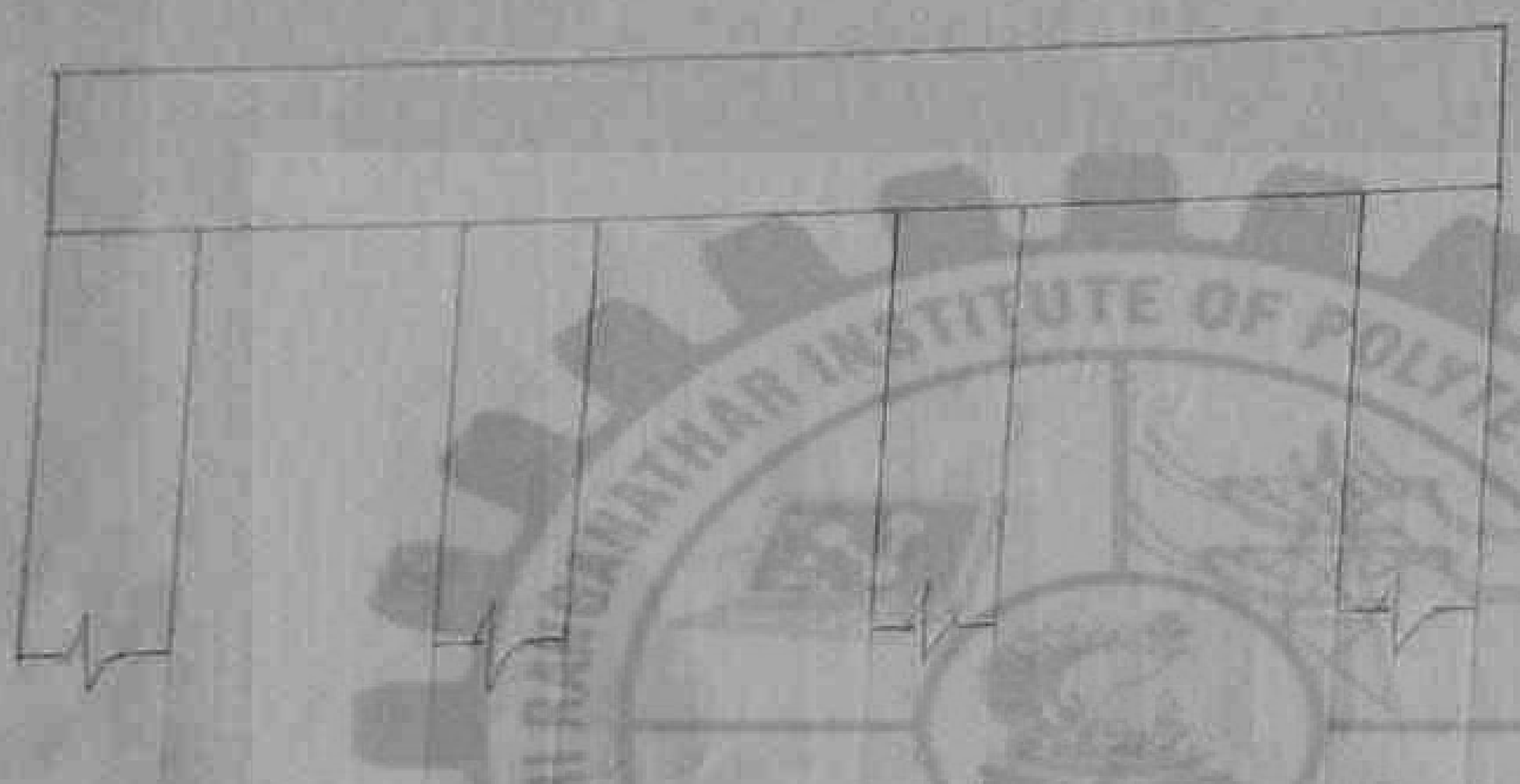
Types of Beam :

1. Simply Supported beam.



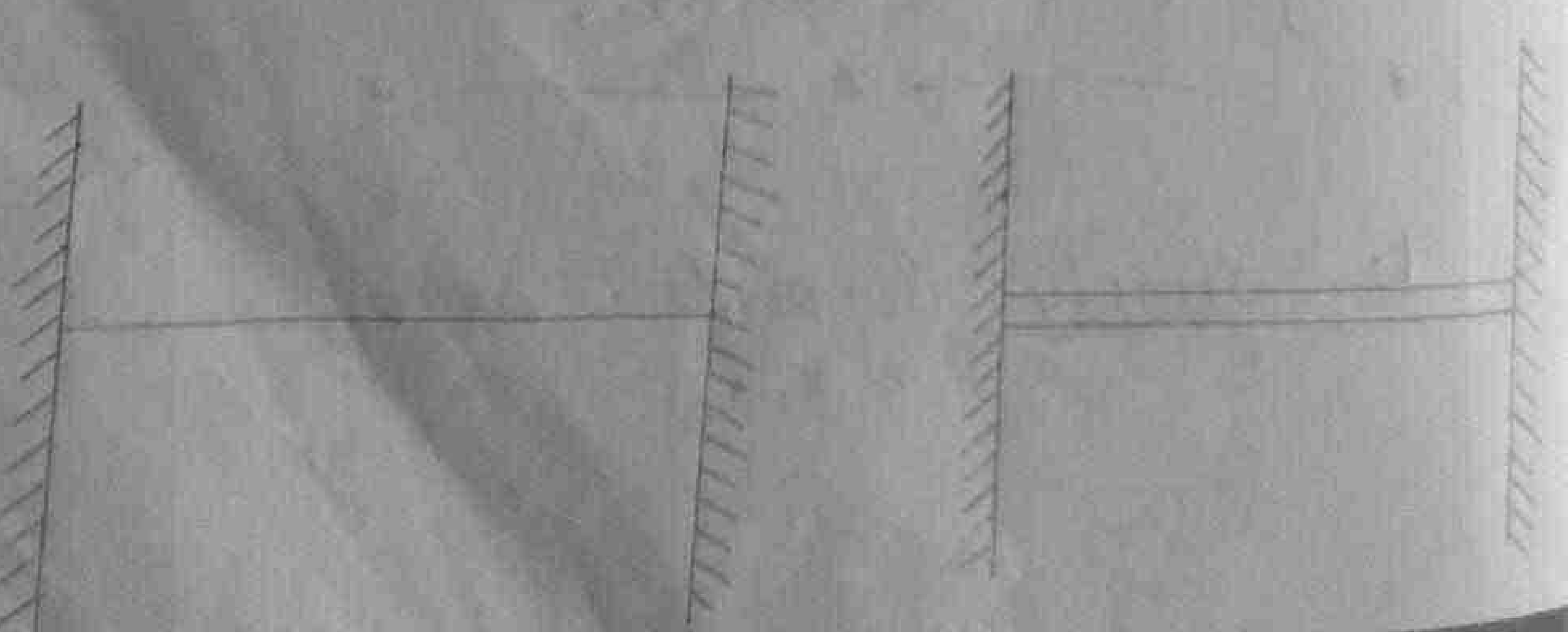
Cantilever Beam.

3). Continous Beam :



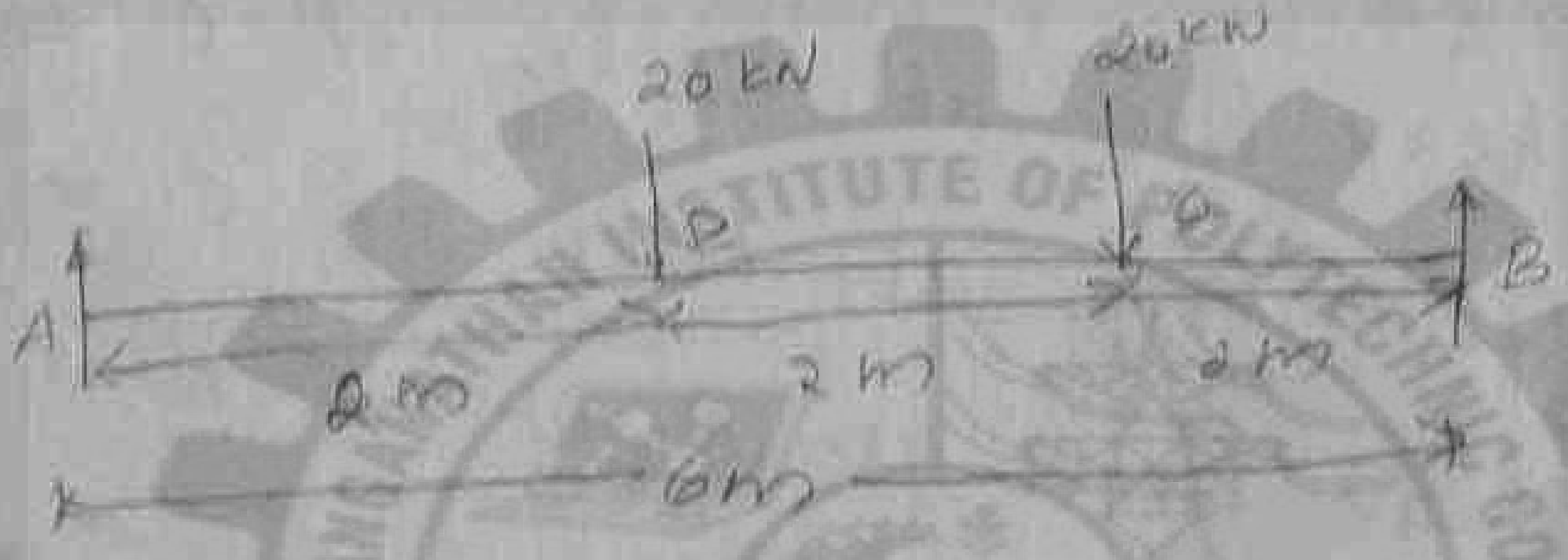
4). Over hanging Beam

5). Fixed beam.



Ques. Sketch the S.F.D (Shear force diagram) and BMD (Bending moment diagram) for SS (simply supported) span of 6m carries two point 20kN each at mid third points.

Ans.



Step - 1 : To find Total load

$TL = 20 + 20 = 40\,kN$

Step - 2 : To find reaction : RA, RB.

Taking moment about A,

$= -(20\times2) - (20\times4) \cancel{-(20\times6)} + RB\times6 = 0$

$-40 - 80 + 6RB = 0$

$-120 + 6RB = 0$

$RB = \frac{120}{6} = 20\,kN$

Step : 3 → To find RA :

$\boxed{RA + RB = T.L}$

$RA + 20 = 40.$

$RA = 40 - 20$

$$\boxed{RA = 20 kN}$$

~~Step : 4~~
~~Shear force~~ calculation :-

Step : 4

Shear force calculation :

Shear force at B = -20 kN

Shear force at Right of C = -20 kN.

Shear force at left of C = -20 + 20 = 0 kN.

Shear force at Right of D = -20 + 20 = 0 kN.

Shear force at Right of D = -20 + 20 + 20 =

SF at left of D = -20 + 40

= 20 kN.

Shear force at A = 20 kN.

Step : 5

Bending moment calculation :

BM at A = 0

BM at B = 0

BM at C = (RB×4) - 20×2

= 20×4 - 20×2

= 80 - 40 = 40 kNm

BM at D = (RA×2)

= (20×2)

= 40 kNm

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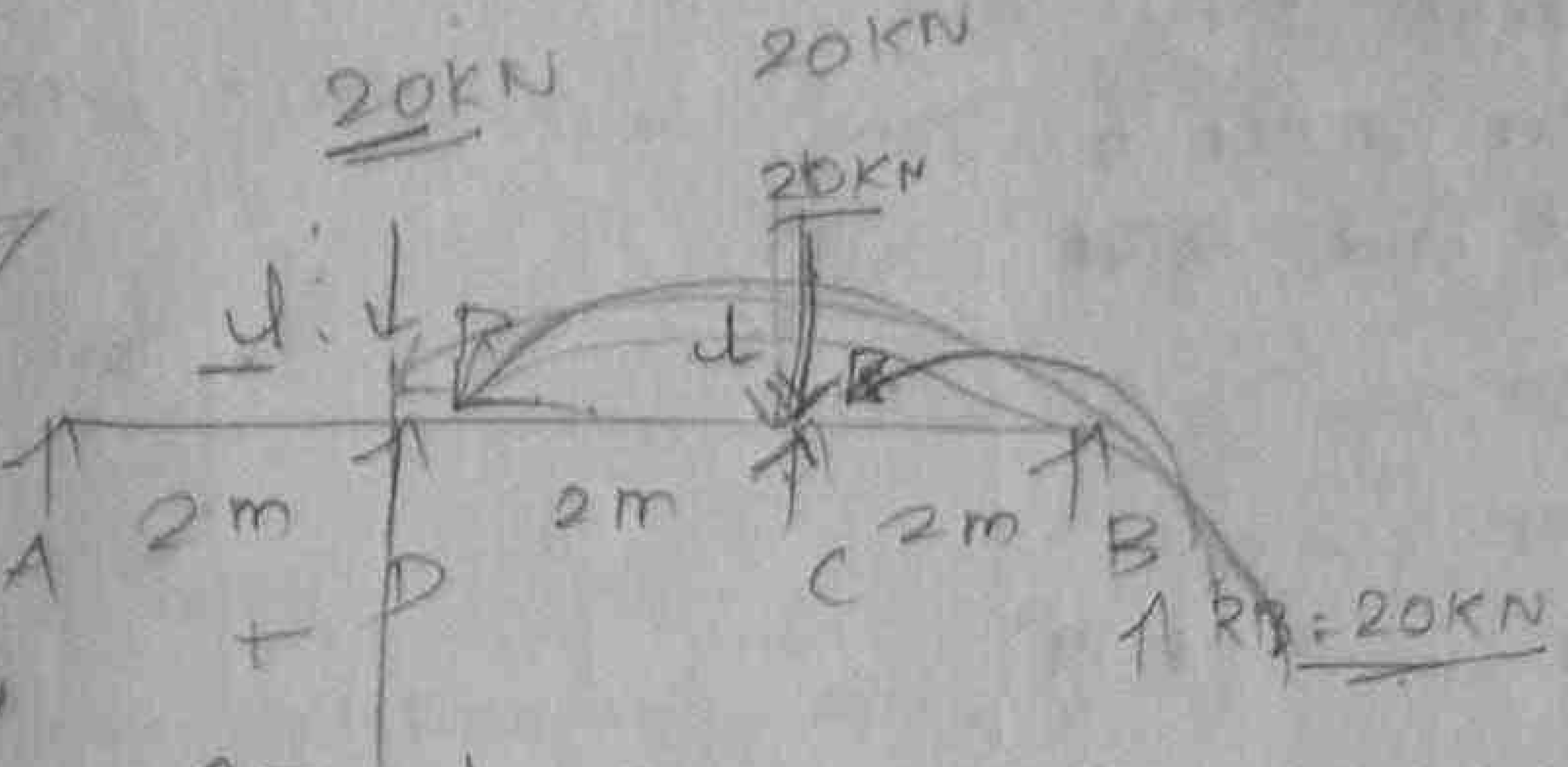
Friday

step 4 →



SF at B = −20 kN

SF at (R) of C = −20KN

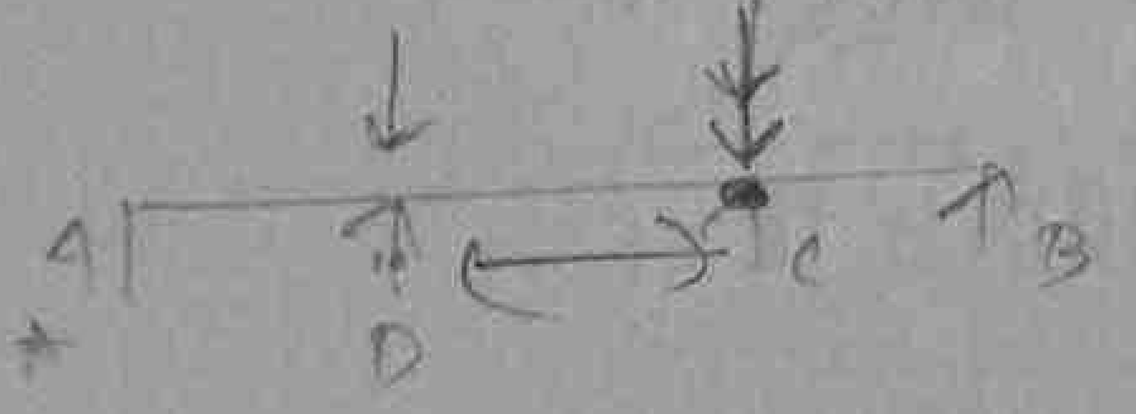
L of C = −20+20

SF at R of D = −20+20
= 0

SF at L of D = −20+20+20
= −20+40
= 20 kN

SF at A = +20 kN.

Bending Moment diagram.

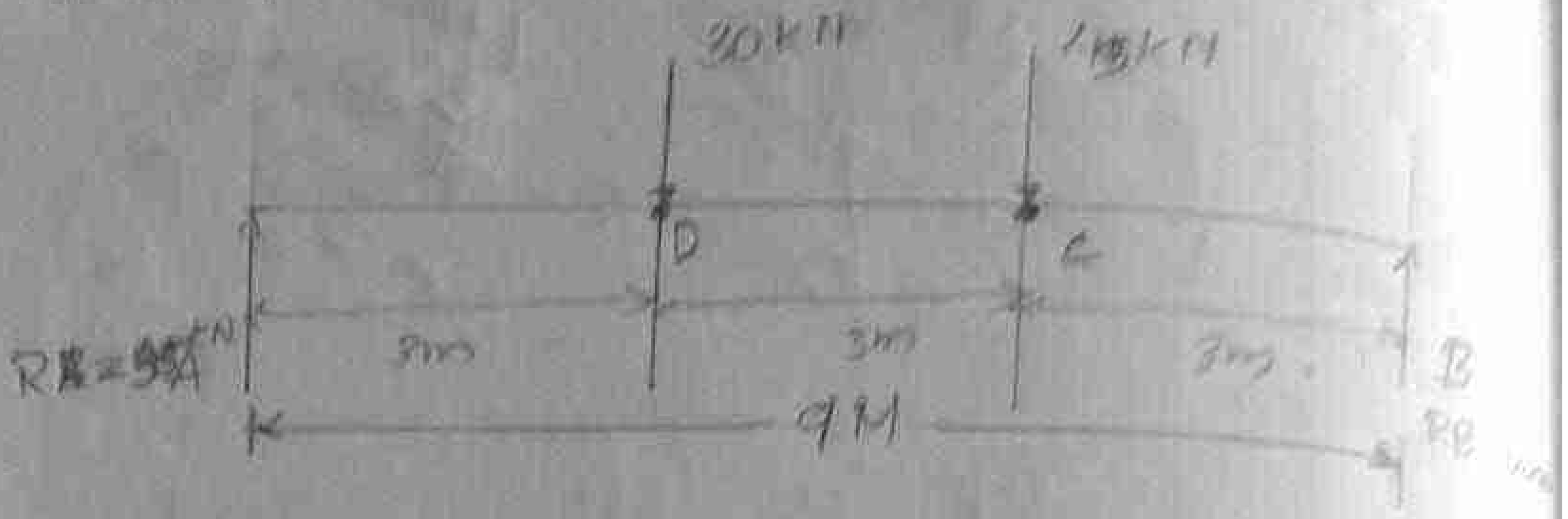


BM at A, B = 0

BM at C = (RB × 4) − 1 lo
= (20×4) − 20×2
= 80 − 40
= 40 kN m
= (RA×2) − 20×2 = 40 kN

Que: 2. Sketch S.F.D and B.M.D for a station of span 9m carries two point load, 30 kN, 45 kN each at mid third points?

Ans-



Step : 1 : To find Total load.

$TL = 30 + 45 = \underline{\underline{75\ kN}}$

Step : 2 : To find Reaction RA and RB.

Taking moment about A,

$= -(30 \times 3) - (45 \times 6) + (RB \times 9) = 0.$

$= -90 - 270 + 9RB = 0$

$= -360 + 9RB = 0$

$RB = \frac{360}{9} = \cancel{36.6\ kN}\ \underline{\underline{40\ kN}}$

Step : 3 : To find RA :-

$\boxed{RA + RB = TL}$

$RA + \cancel{36.6} = \cancel{70}\ 40 = 75$

$RA = \cancel{70 - 36.6}\ 75 - 40$

$\cancel{RA = 33.4\ kN}$ $\boxed{RA = 35\ kN}$

Step : 4 : shear force calculation :

Shear force at B = 40 kN.

Shear force at right of C = -40 kN

Shear force at left of C = -40 + 40 = 0 kN

Shear force at Right of D = -40 + 40 = 0 kN

Shear force at left of D = -40 + 40 + 30

= -40 + 70

= 30 kN.

Shear force at A = 35 KN

Step : 5 : Bending moment calculation.

BM At A = 0

BM at B = 0

BM at C = (RB x 4) - 45 x 3

= (40 x 4) - 45 x 3

= 160 - 135 = 25 KNM

BM at D = (RA x 2)

= (35 x 2)

= 70 KNM.

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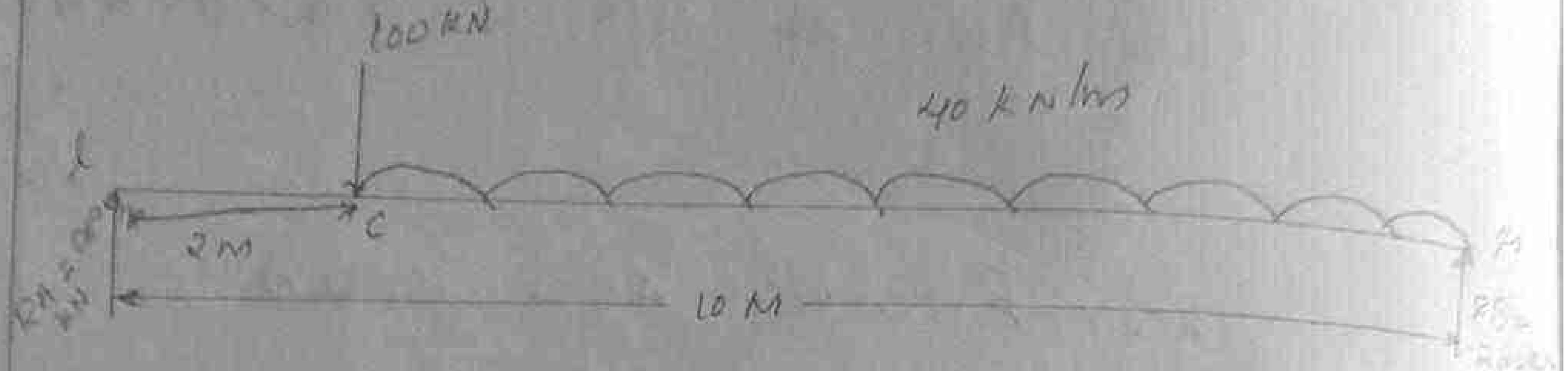
Que 3. A simply supported beam of span of 10m carries a concentrated of 100 kN at 2m from the left support and a UDL of 40 kN/m over entire length. Sketch S.F.D & B.M.D indicating values at salient points.



Step :- 1

Total load = UDL + PL

$= (40 \times 10) + 100$

$= 400 + 100$

$= 500$ kN

Step : 2

To find the reaction : RB

$-(\overset{w \times l}{100 \times 2}) - (\overset{w \times l \times l/2}{40 \times 10 \times 5}) + 10\,RB = 0$

$-200 - 2000 + 10\,RB = 0$

$-2200 + 10\,RB = 0$

$10\,RB = 2200$

$RB = \frac{2200}{10}$ $\quad RB = 220$ kN

Step : 3

To find the reaction : RA

RA + RB = TL

$RA + 220 = 500$

$RA = 500 - 220$

$RA = \underline{280\ kN}$

Step : 4

Shear force calculation

S.f at B = -220 kN

S.f at right of C = $-220 + (40 \times 8)$

$= -220 + 320$

$= \underline{100\ kN}$

S.f at left of C = $-220 + (40 \times 8) + 100$

$= -220 + 320 + 100$

$= \underline{200\ kN}$

S.f at A = $\underline{280\ kN}$

Step : 5

Bending moment calculation

B.M at A = 0

B.M at B = 0

B.M at C = $RB \times 8$

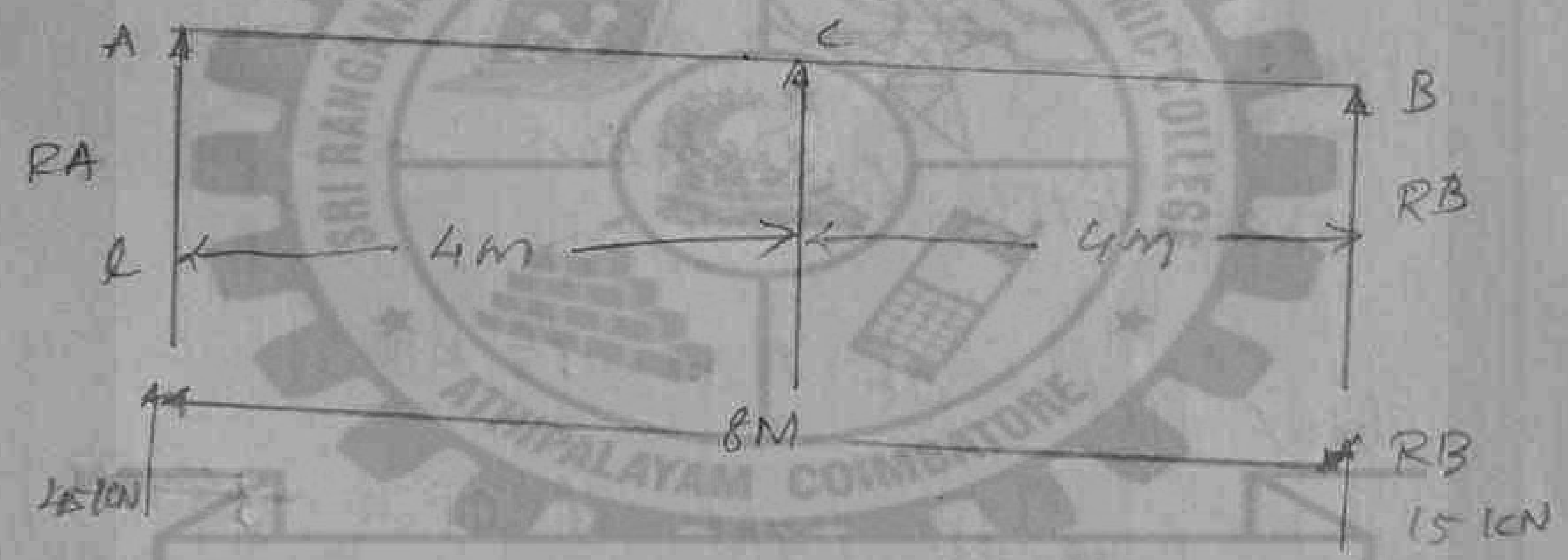
$= (-40 \times 8 \times 4) + RB \times 8$

$= -1280 + 220 \times 8$

$= -1280 + 1760$

$= \underline{480\ kNm}$

Que: 5. A simply supported beam of 8m length carries an UDL of 5KN/m for a distance of 4m from left support. The rest of the beam of 4m carries a UDL of 10 KN/m. Draw S.F.D & B.M.D?



Draw S.F.D & B.M.D Diagram :-

Step : 1 - Total load :-

$$= (5\times4) + (10\times4)$$

$$= 20 + 40$$

$$T.L = 60\,kN$$

Step : 2

$$= -\left(5\times4\times\frac{4}{2}\right) - \left(10\times4\times\frac{4}{2}\right) + RB\times8 = 0.$$

$$-(5\times4\times2) - (10\times4\times2) + RB\times8 = 0$$

$$-40 - 80 + 8RB = 0.$$

$8RB = 120$

$RB = \frac{120}{8}$

$\boxed{RB = 15\,KN.}$

Step : 3 :-

To find RA :-

$RA + RB = T.C$

$RA + 15 = 60$

$RA = 60 - 15$

$\boxed{RA \Rightarrow 45\,KN.}$

Step : 4

Shear force calculation :-

Shear force at $B = -15\,KN$

Shear force at right of $C = -15 + (10 \times 4)$

$= -15 + 40$

$= 25\,KN$

Shear force at left of C,

$= -15 + (10 \times 4)$

$= -15 + (40) + (20)$

$= -15 + 60 = 45\,KN.$

Shear force at $A = 45\,KN$.

Steps : 5

Bending moment :-

BM at $A = 0$

B.M at $B = 0$.

B.M at C $\Rightarrow$ (RB × 4)

(10 × 4 × 4/2) + RB × 4

= (40 × 2) + RB × 4

= 80 + (15 × 4)

= 80 + 60

= 140 kNm

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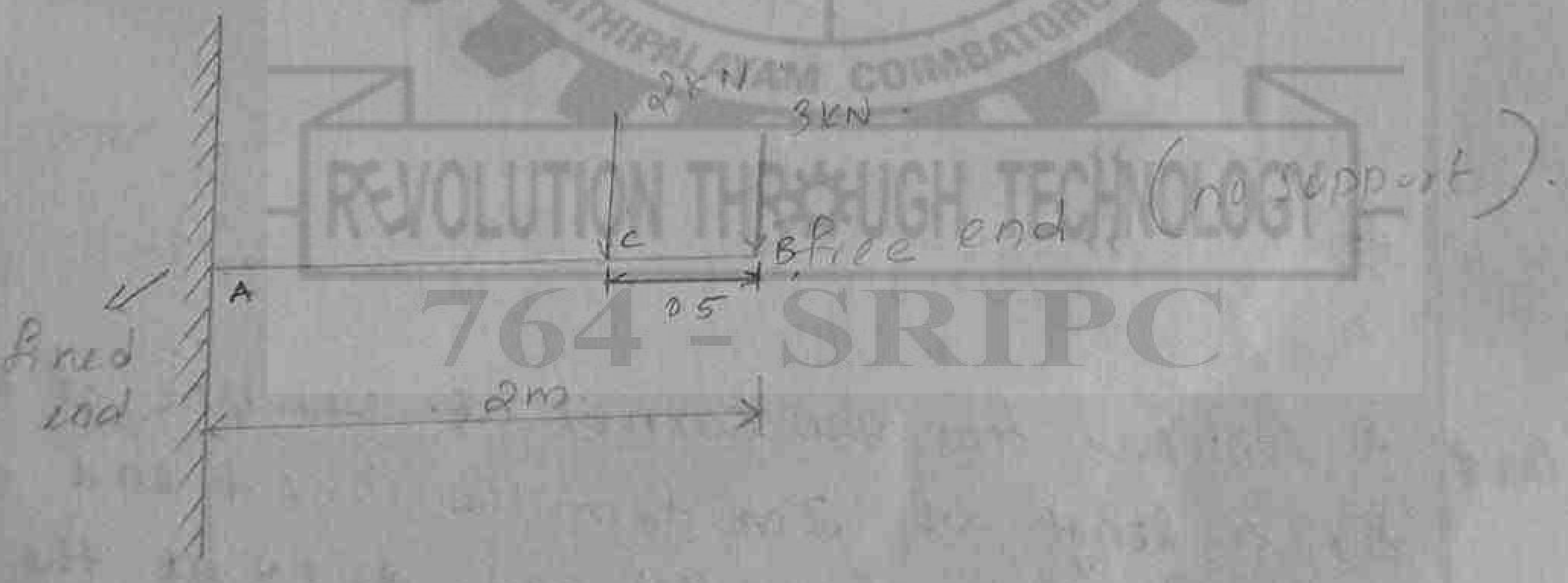
Qu: 6. A cantilever beam 2m long carries a load of 3 kN at its free end and another point load 2 kN at a distance of 0.5m from the free end. draw S.F.D and ~~free end~~ B.M.D.



Step :- 1 (load)

SF :-

SF at B = 3 kN

SF at C = 3 + 2 = 5 kN

SF at A = 5 kN

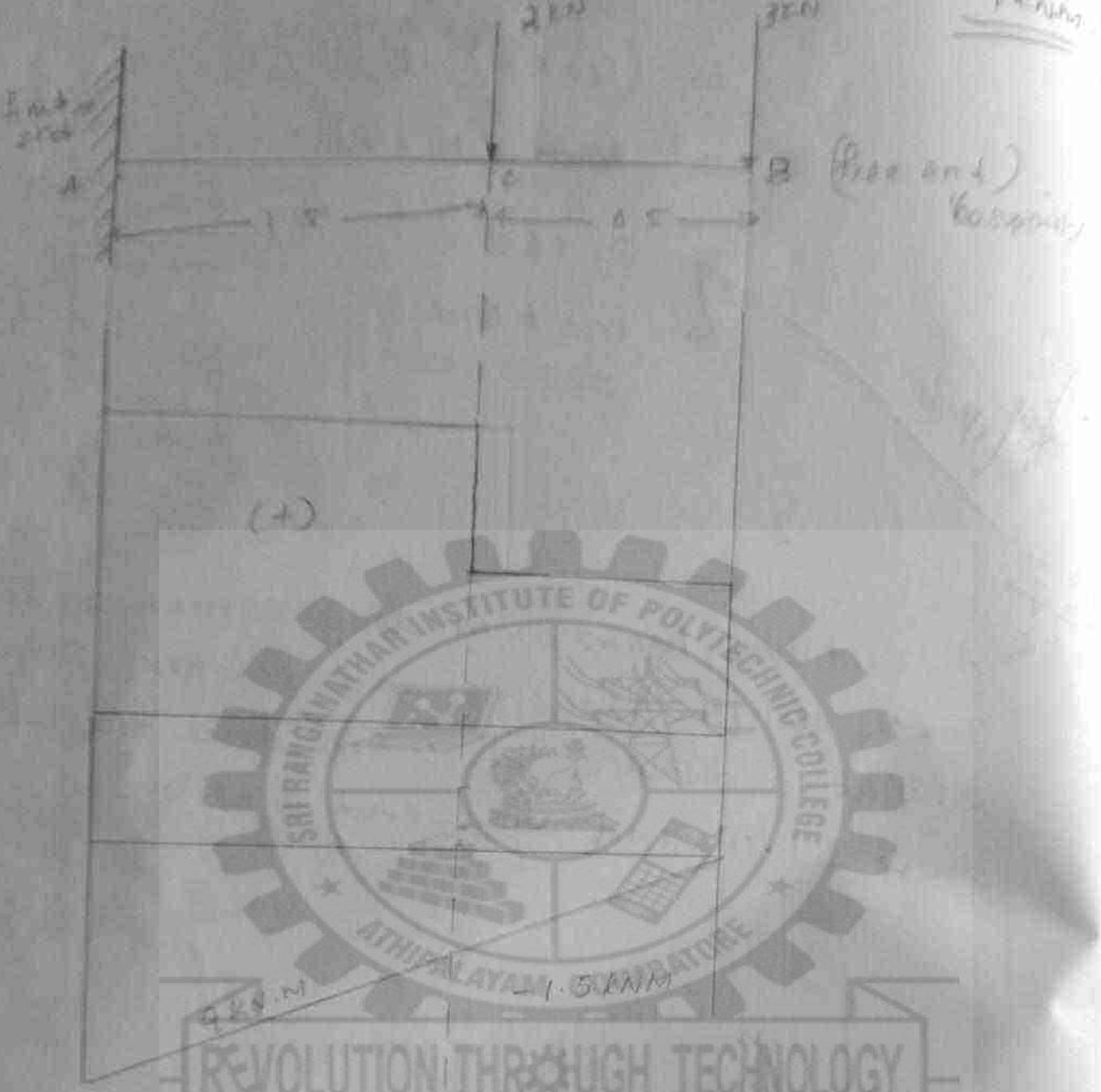
BM :-

BM at B = 0

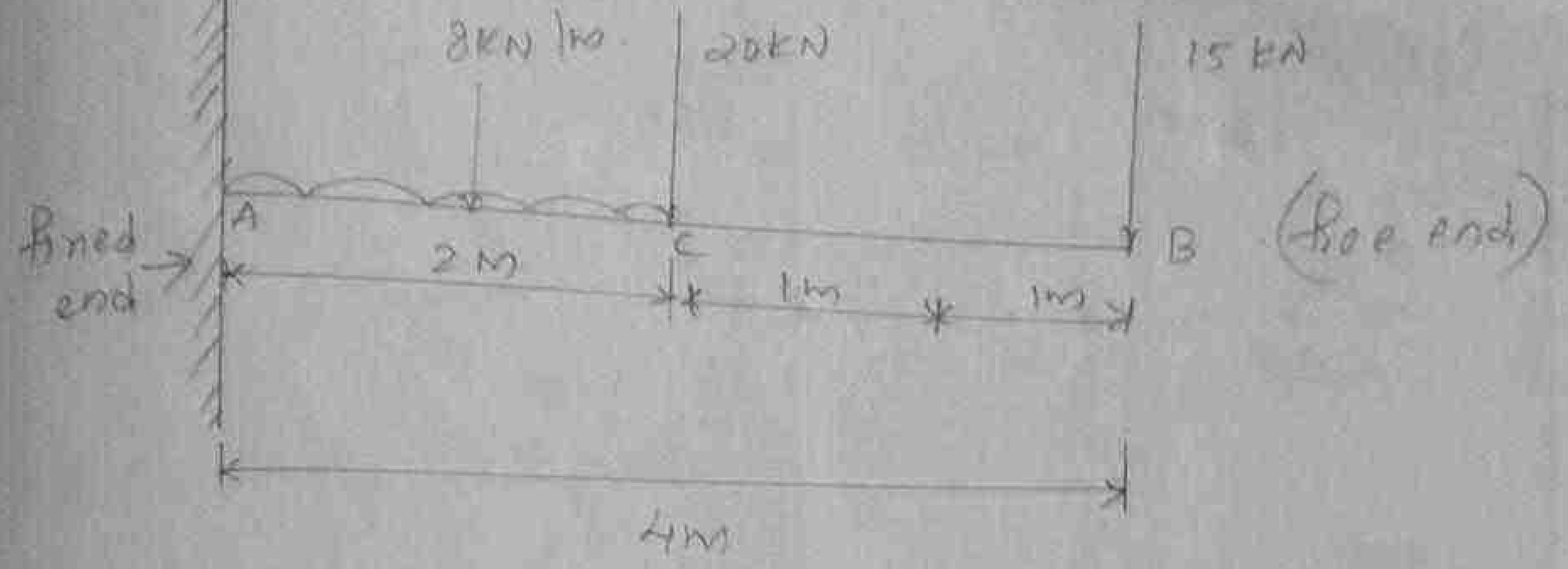
BM at C →

BM at A → $-(2\times1.5)-(3\times2) = -3-6$

$= -9$ kNm



Q.7 A cantilever 4m span carries at UDL of 8 kN/m for a length of 2m from the fixed end and 2 point loads of 15 kN and 20 kN at the free end and 2m from the free end respectively. Draw S.F.D and B.M.D and find the maximum shear force and bending moment?



Sf :-

Sf at B = 15KN.

Sf at Right of C ⟹ 15 KN.

Sf at left of C ⟹ 15 + 20 ⟹ 35 KN.

Sf at A ⟹ (8×2) + 15 + 20 ⟹

⟹ 16 + 15 + 20

⟹ 51 KN

B.M :-

B.M B = 0.

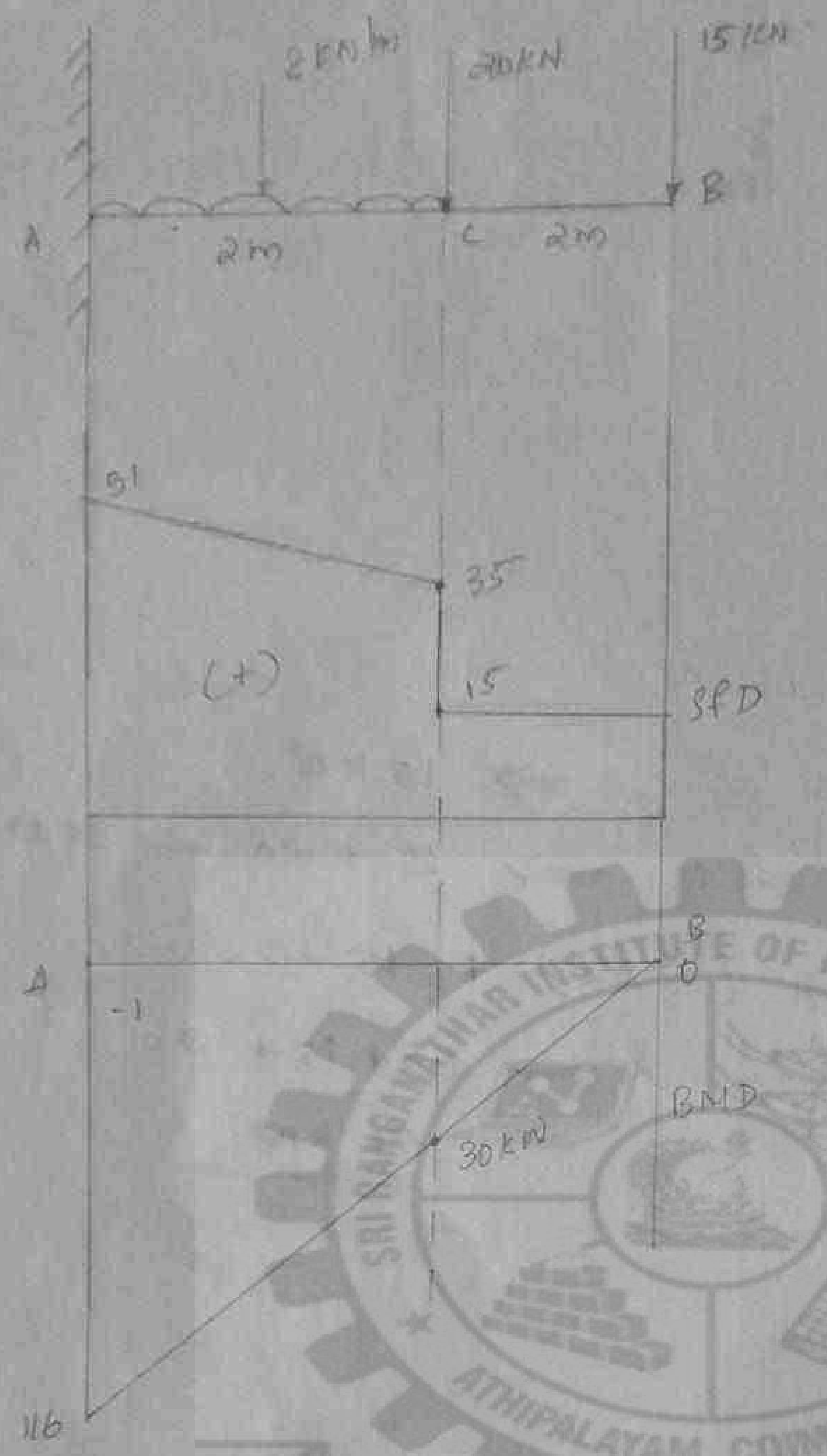
B.M at C ⟹ − 15×2 ⟹ − 30 kN.m.

Bm at A ⟹ − 15×4 − 20×2 − (8×2×1)

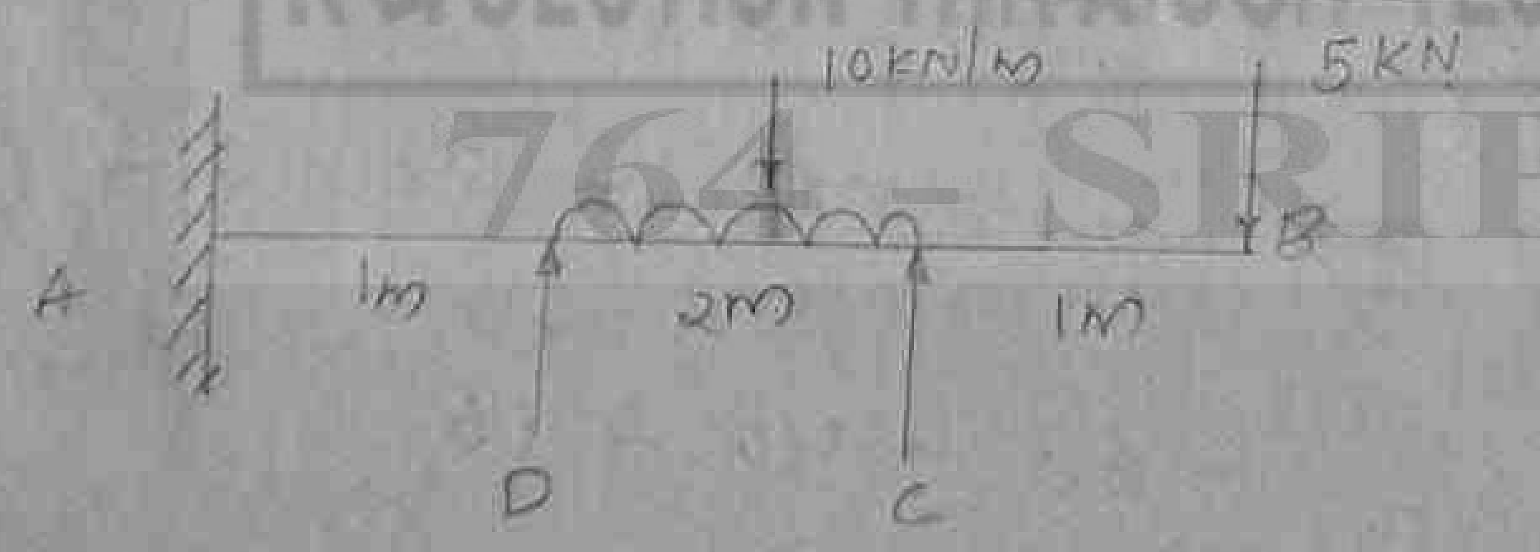
2/2 = 1

= − 60 − 40 − 16.

= − 116 kN.M.



Que:



Sf at B = 5KN.

Sf at C = 5KN.

Sf at D = (10×2) + 5

= 20+5 = 25 kN.

BMD :-

BM at B = 0.

BM at C = ... ⇒ −5 kN·M.

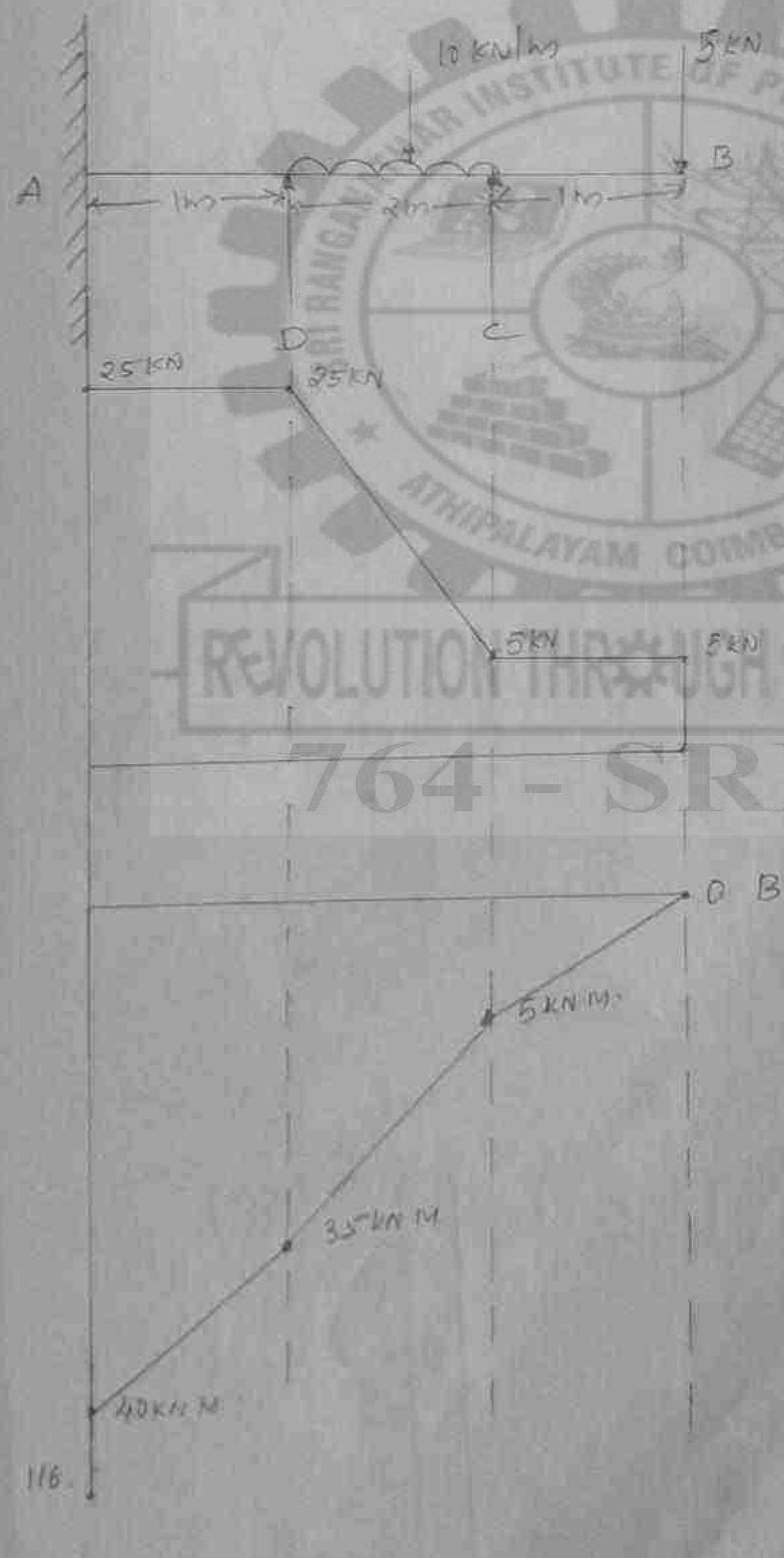
BM at D ⇒ −(5×3) − (10×2×1)

⇒ −15 − 20 ⇒ −35 KNM.

BM at A ⇒ −(5×4) − (10×2×1)

⇒ −20 −20 ⇒ −40KNM.

* Draw S.F.D and B.M.D diagram for the beam show in the figure.



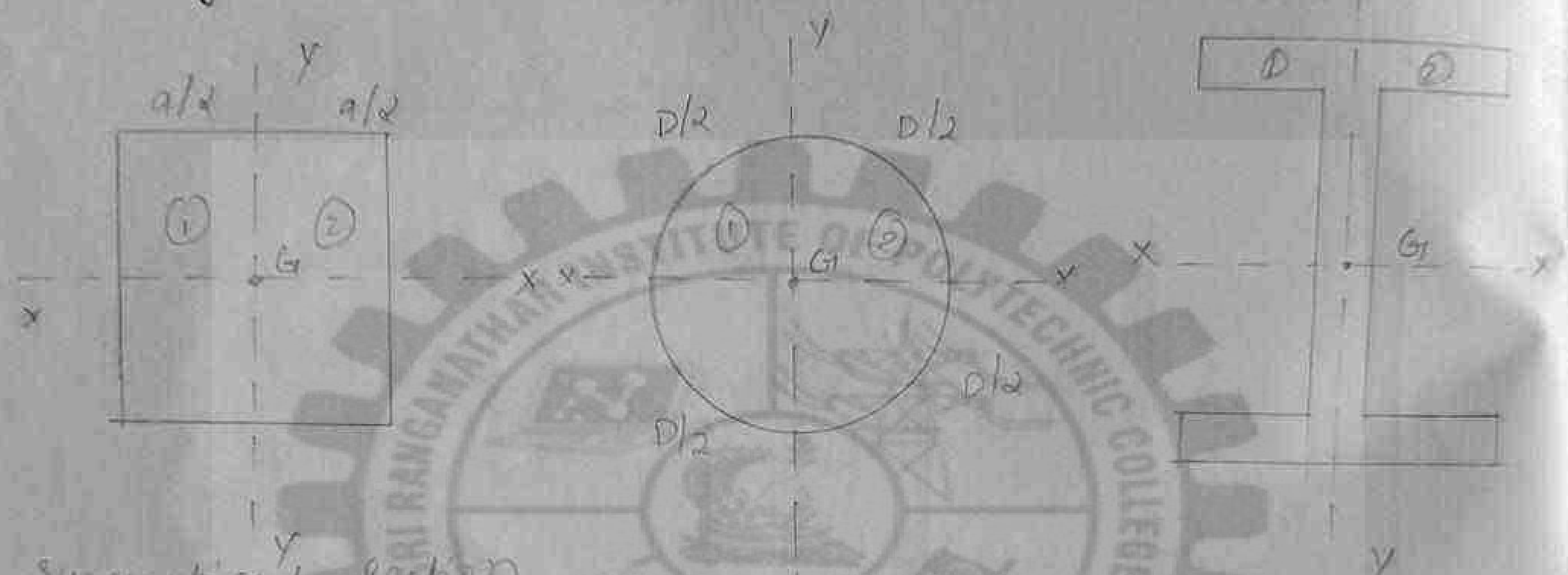
116.

24/9/22
Saturday

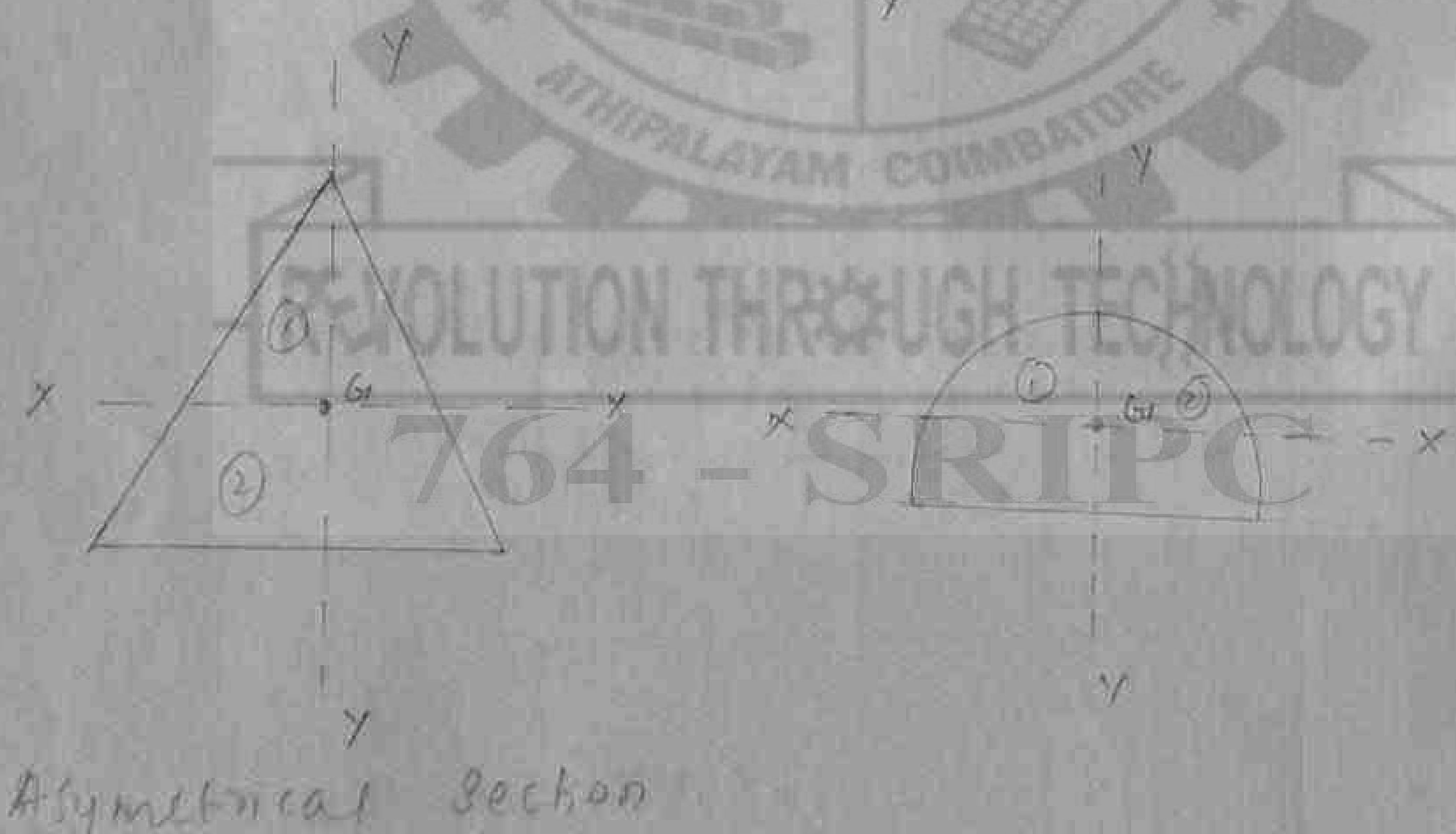
Unit - II

Geometrical Properties Of Section :-

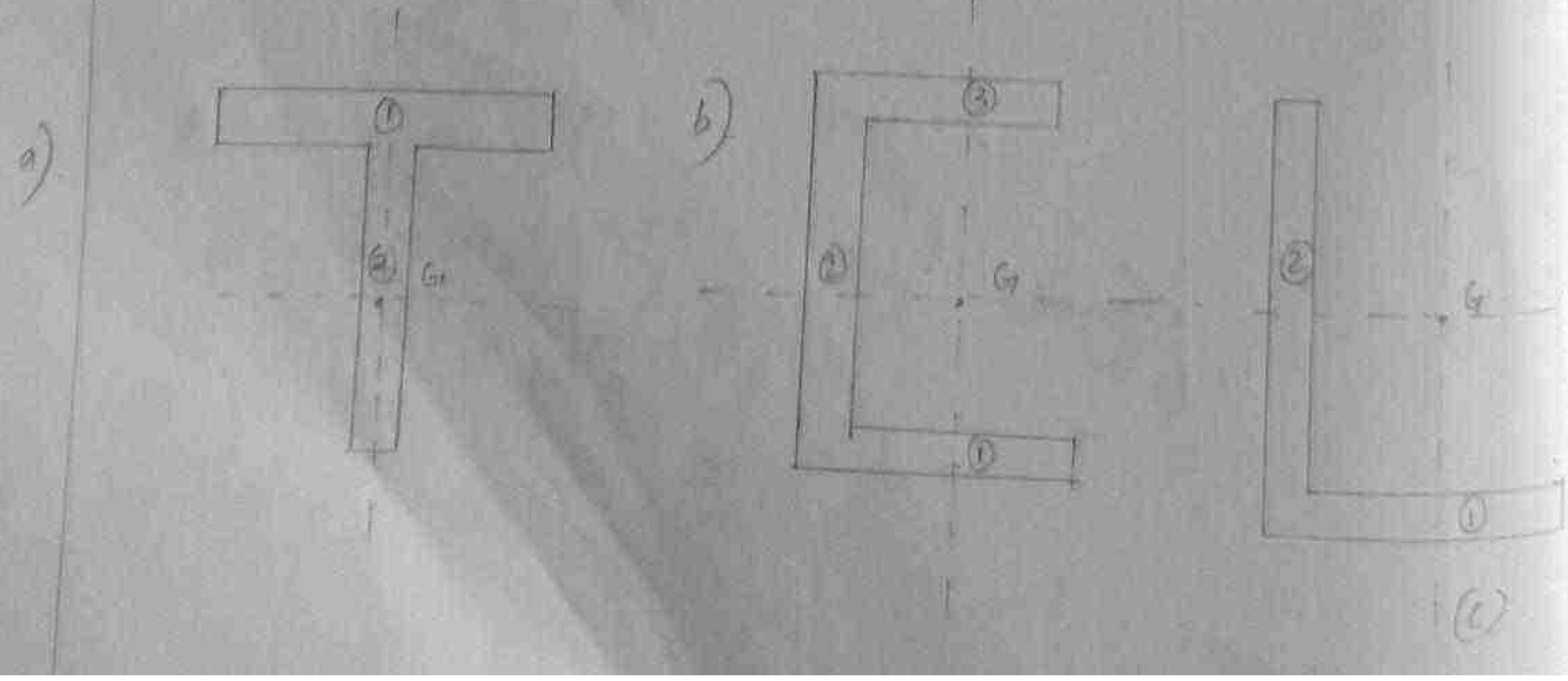
1) Symmetrical Section (equal ~~section~~ shapes)
2) Asymmetrical Section (unequal shape).
3) Antisymmetrical Section (2 or more than 2 sections)

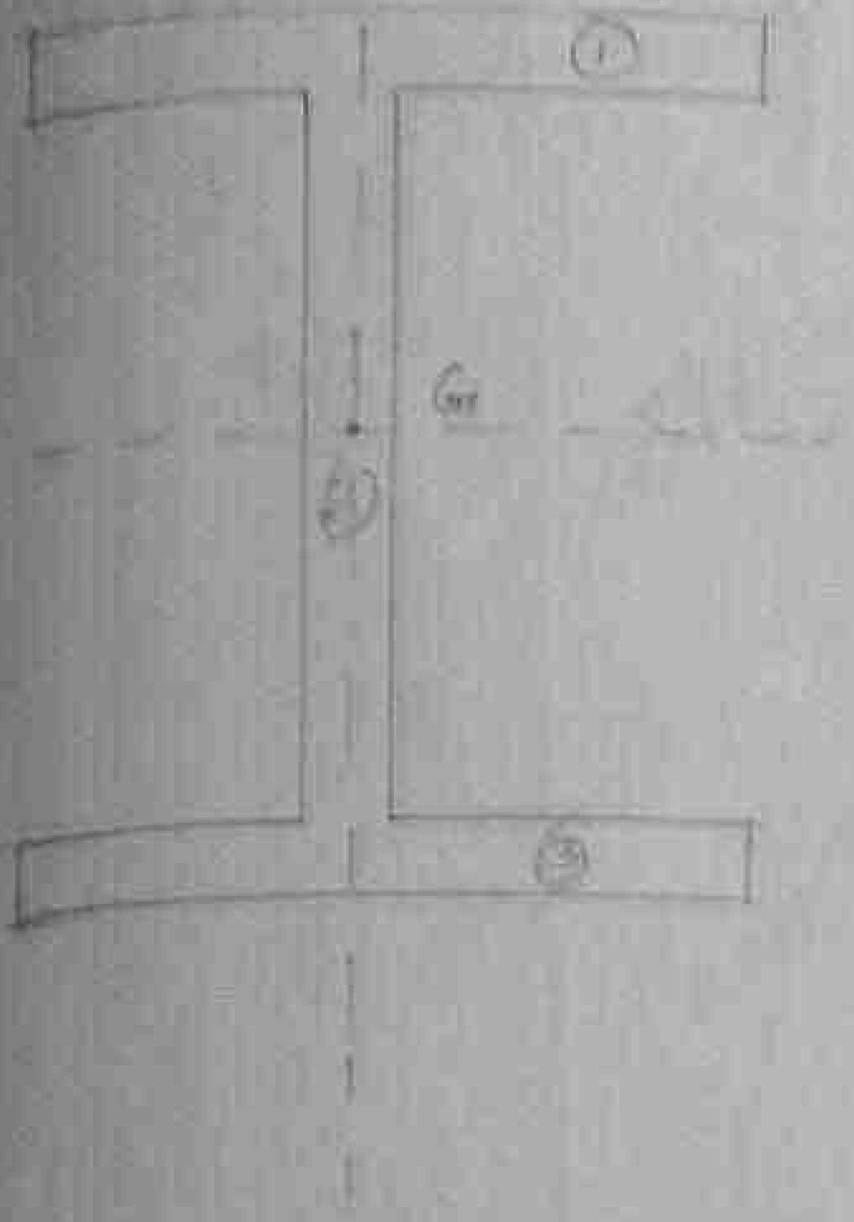


Symmetrical Section



Asymmetrical Section

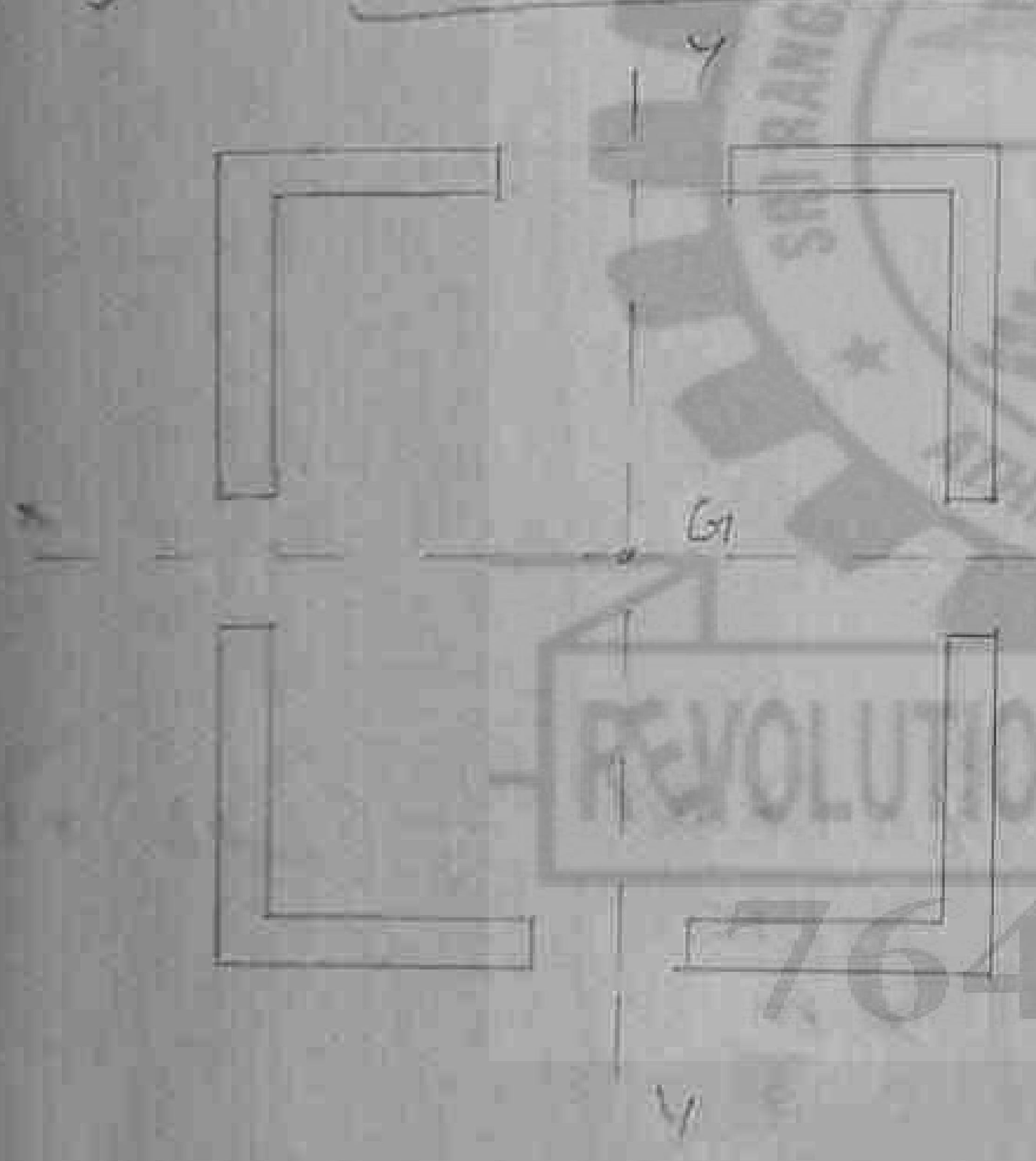




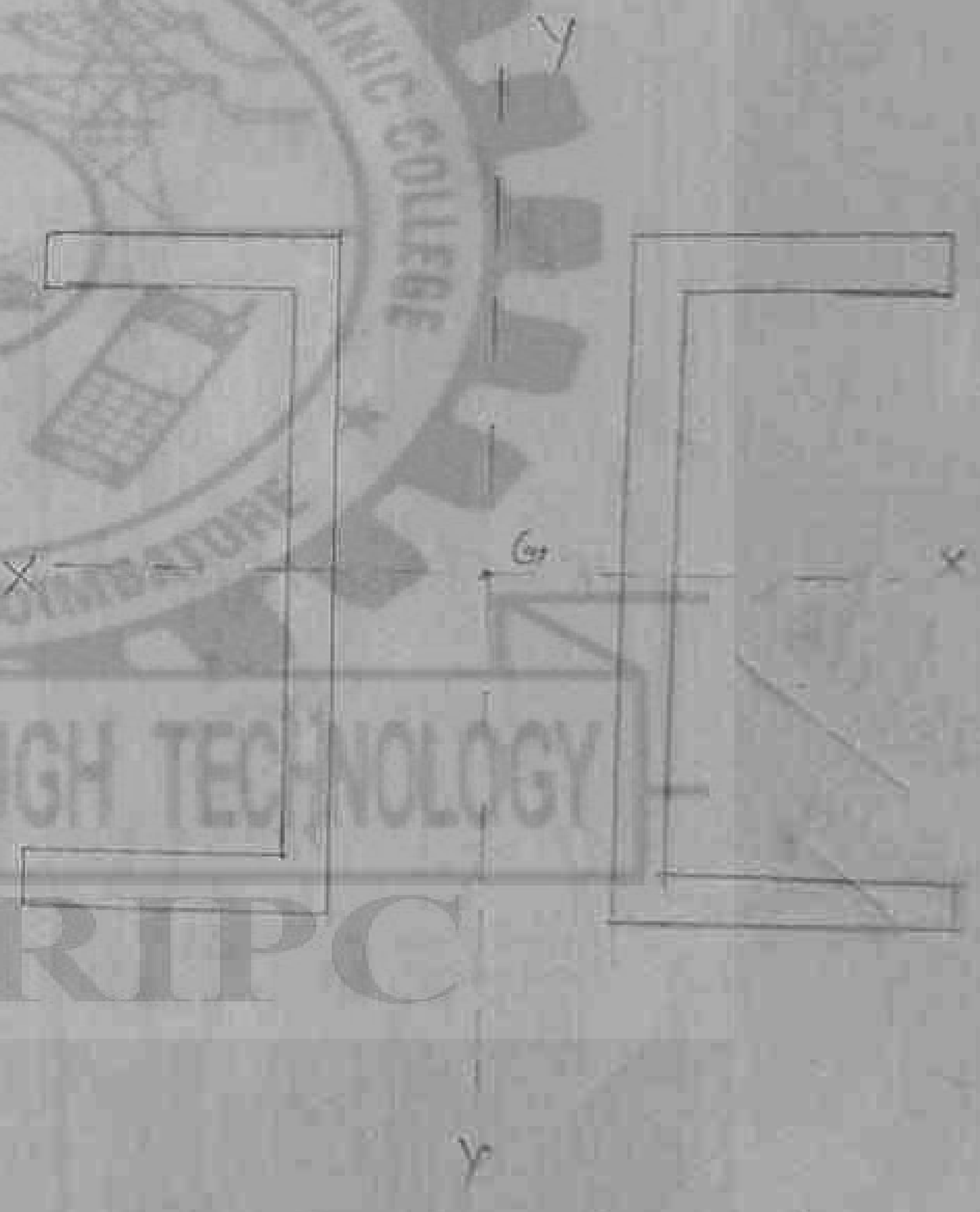
Anti Symmetrical Section

4). Build up Section

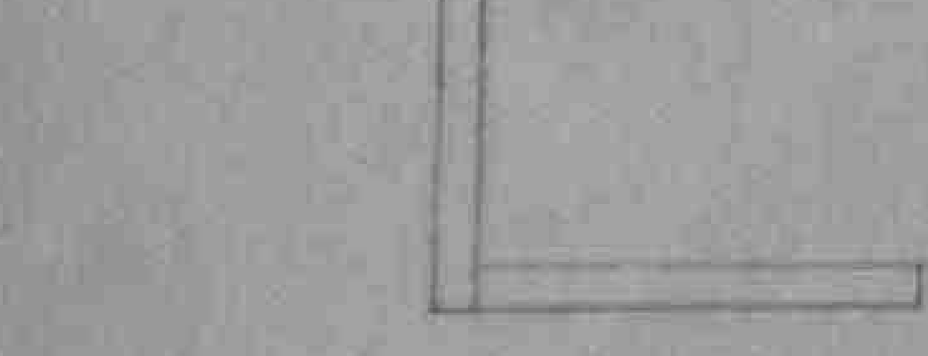
i). Four (L) Section :



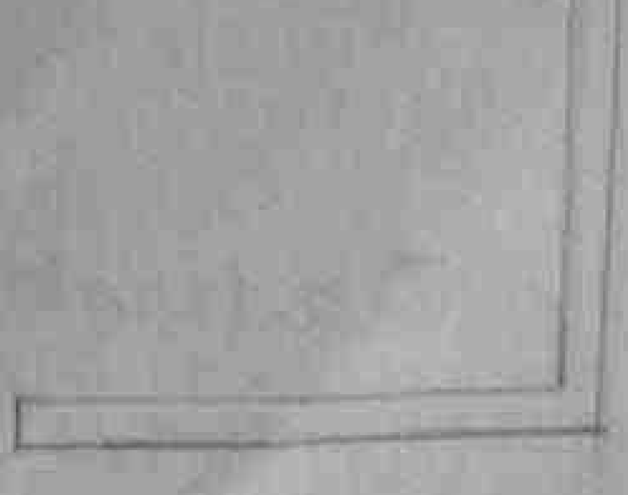
1) Four (L) Section.



2) Double Channel.

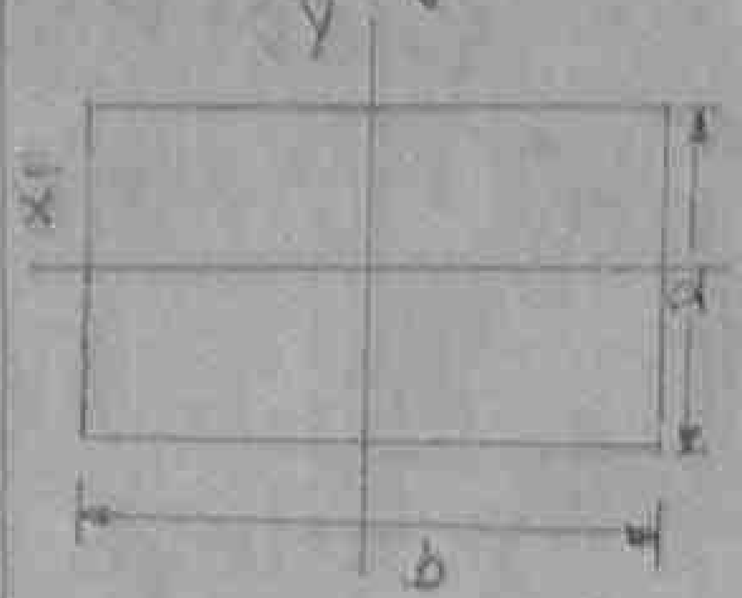
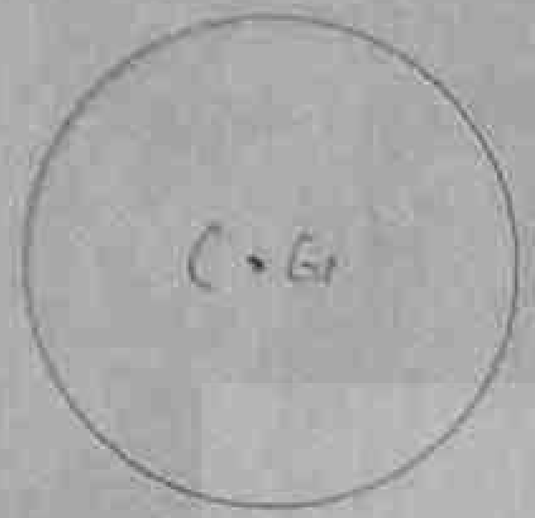
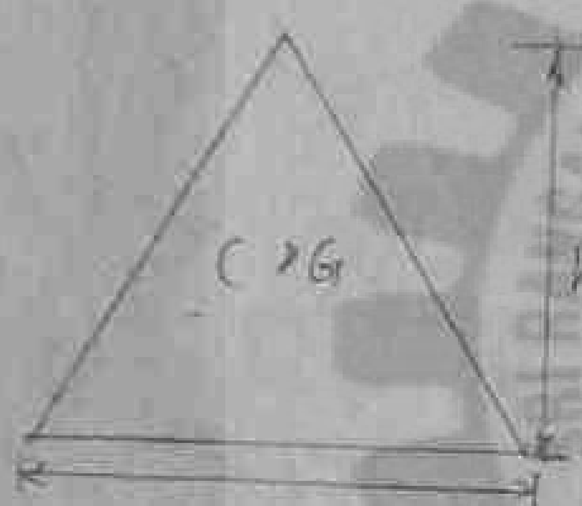
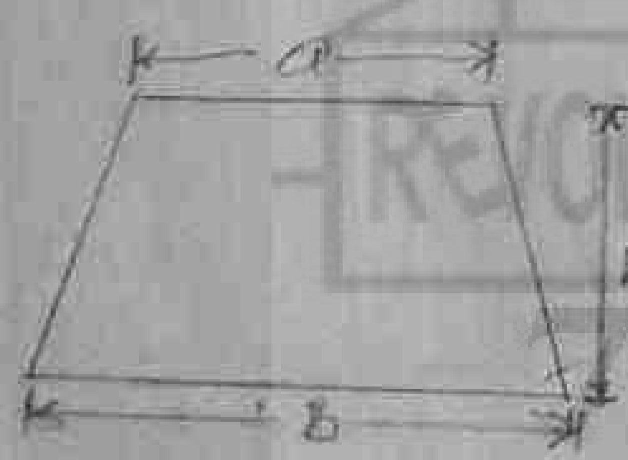
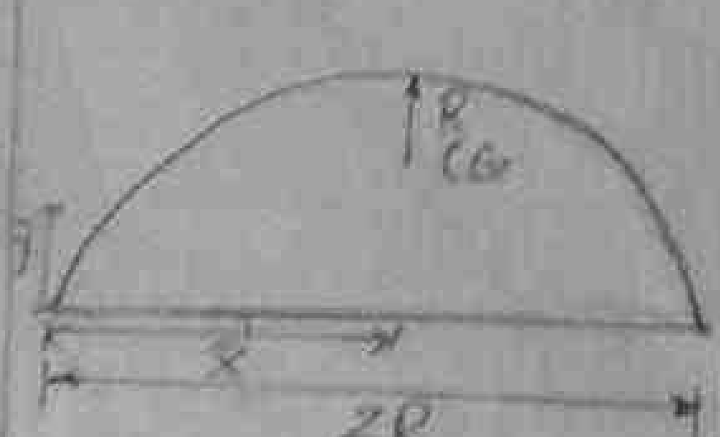
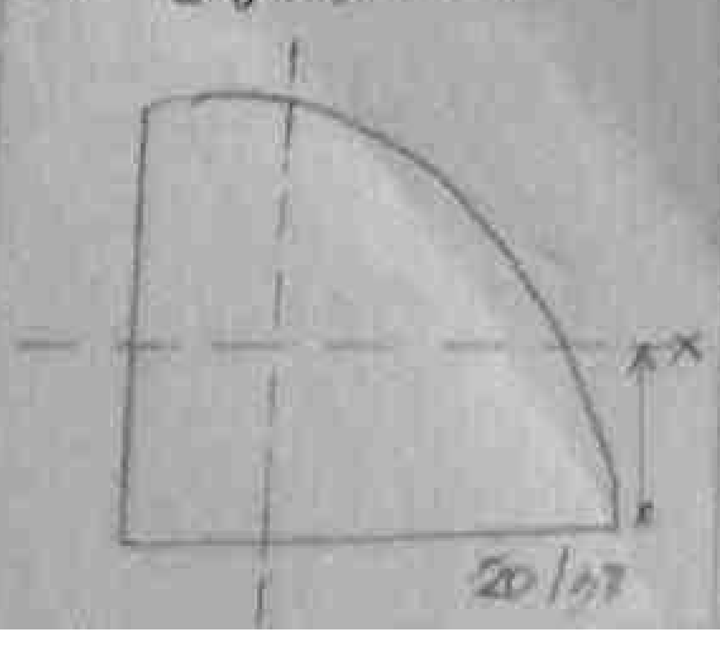


Z - Section



Inverted Section

26/9/22
Monday

Shape	$\bar{x}$	$\bar{y}$	Area
1. Rectangle : 	$\bar{x} = b/2$	$\bar{y} = d/2$	bd.
2. circle : 	$\bar{x} = d/2$	$y = d/2$	$\pi d^2/4$.
3. Triangle : 	$\bar{x} = b/2$	$y = h/3$	$1/2\ bh$.
4. Trapezium : 	$\bar{x} = b/2$	$\bar{y} = \frac{b+2a}{b+a} \times \frac{h}{3}$.	$\frac{1}{2}(a+b) \times h$.
5. Semi circle . 	$\bar{x} = R$.	$\bar{y} = \frac{4R}{3\pi}$	$\frac{\pi d^2}{8}$
6. Quadrant . 	$\bar{x} = \frac{2D}{3\pi}$ Q=(0.4243)	$y = \frac{2D}{3\pi}$ Q=(0.4243)	$\pi/16\ d^2$.

$\bar{x}$ Formula :-

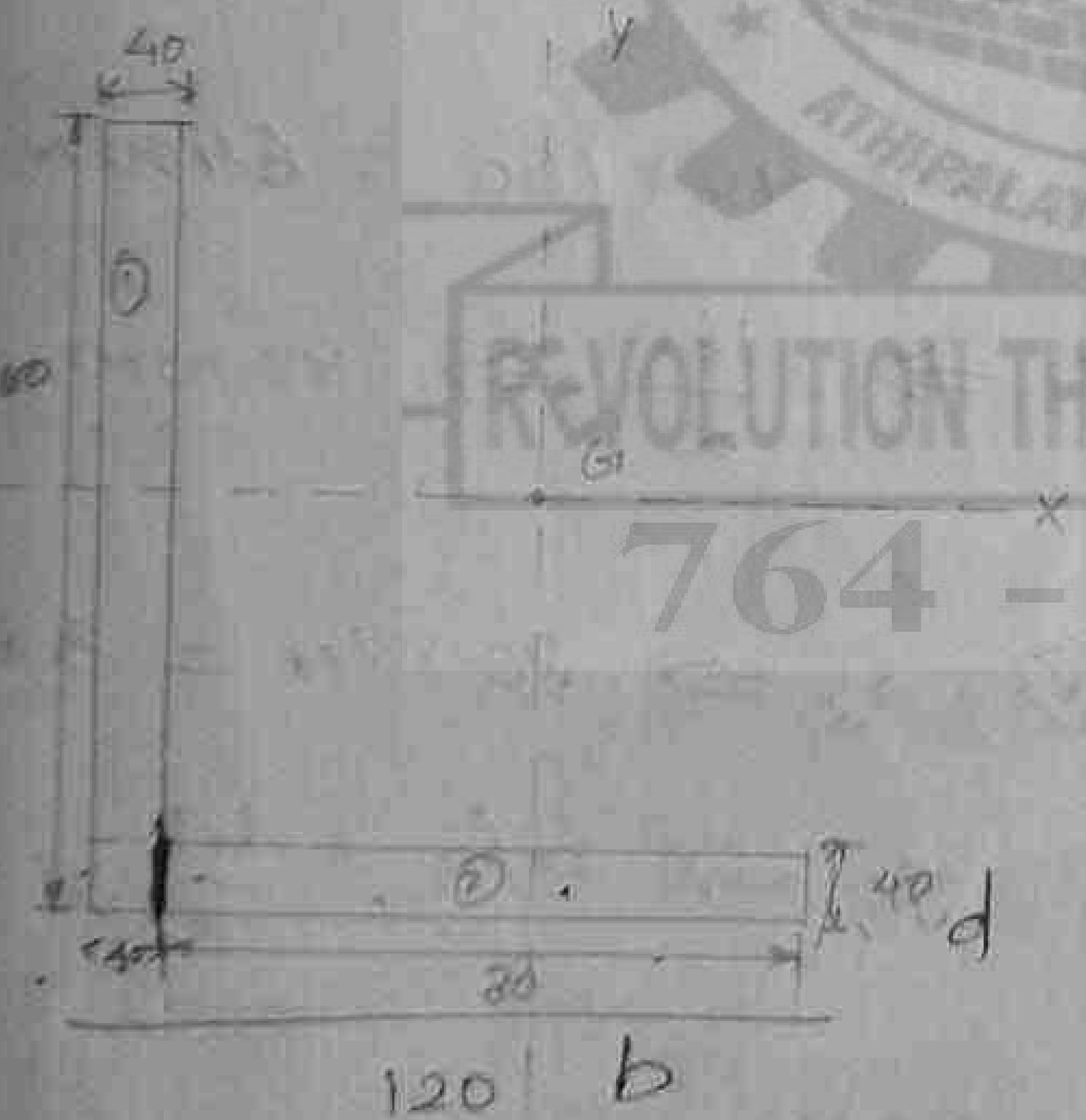
$$\bar{x} = \frac{\Sigma a_1 x_1}{\Sigma a}$$

$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3 + \cdots}{a_1 + a_2 + a_3 + \cdots}$$

$$\bar{y} = \frac{\Sigma a_1 y_1}{\Sigma a}$$

$$= \frac{a_1 y_1 + a_2 y_2 + a_3 y_3 + \cdots}{a_1 + a_2 + a_3 + \cdots}$$

Qu:1 Find out the position of centroid of L-section as showing figure?



Step : 1

b×d

Rectangle ① 160 × 40 mm

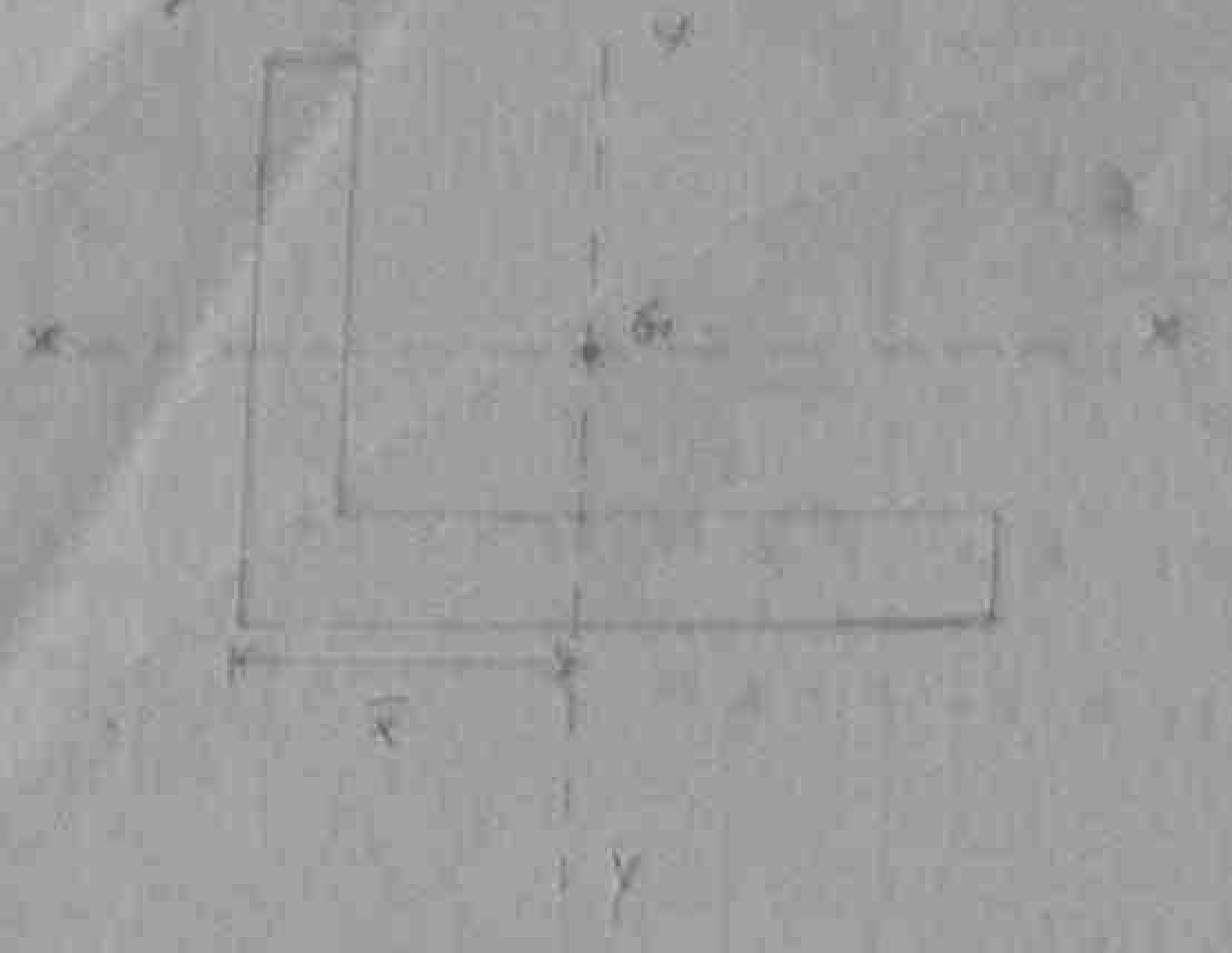
Rectangle ② 80 × 40 mm.

Let xx and yy major axis.

G centroid

$\bar{x}$ → centroidal distance from the base.

$\bar{y}$ → centroidal distance from the left edge.



Step : 2

To find centroidal distance $\bar{y}$

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

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

Area of Rectangle $a_1 \Rightarrow 40 \times 160 = 6400\ mm^2$

$y_1 = \frac{d}{2}$ $\quad y_1 \Rightarrow \frac{160}{2} \Rightarrow 80\ mm$

Area of Rectangle ② $a_2 \Rightarrow 80 \times 40 = 3200\ mm^2$

$y_2 \Rightarrow d/2 = \frac{40}{2} = 20\ mm.$

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

$$= \frac{6400 \times 80 + 3200 \times 20}{6400 + 3200}$$

$$= \frac{576000}{9600} = 60\ mm$$

Step : 3

$$\bar{x} = \frac{\Sigma a_1 x_1}{\Sigma a}$$

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

$$= 6400 mm^2$$

$x_1 \Rightarrow \frac{b}{2} \Rightarrow \frac{40}{2} = 20 mm$

$a_2 \Rightarrow 3200 mm^2$

$x_2 \Rightarrow \frac{b}{2} \Rightarrow 40 + \frac{80}{2}$

$= 40 + 40 = 80 mm$

$$\bar{x} = \frac{(6400 \times 20) + (3200 \times 80)}{(6400 + 3200)}$$

$$\bar{x} = \frac{128000 + 256000}{9600}$$

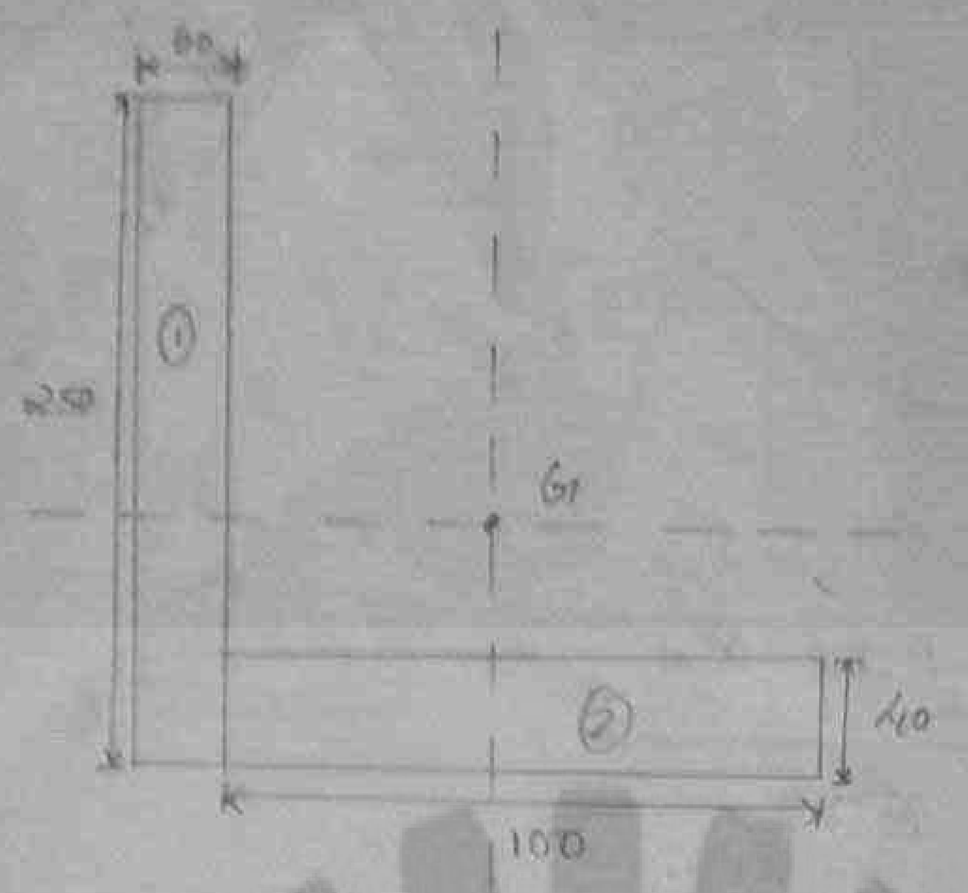
$$= \frac{384000}{9600} = 40 mm$$

Result :

$\bar{x} = 40 mm$

$y = 60 mm$

Que : 2



Step :- 1

Rectangle ① = (60 × 250)

Rectangle ② = (100 × 40)

G – centroid

XX , YY – major axis

Step :- 2

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

①.

Area of Rectangle ① = b×d ⇒ 60 × 25

$a_1 = 15000\ mm^2$

Centroid distance $y_1 = \frac{d}{2} \Rightarrow \frac{250}{2} = 125\ mm$

②.

Area = b×d = 100 × 40 ⇒ 4000 mm²

centroid distance $y_2 = d/2 \Rightarrow \frac{40}{2} = 20\,mm$.

$$\bar{y} = \frac{(15000 \times 125) + (4000 \times 20)}{(15000 + 4000)}$$

$$\bar{y} = \frac{1875000 + 80000}{19000}$$

$$\bar{y} = 102.89\,mm.$$

Step : 3 $\bar{x}$

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

①.

$a_1 \Rightarrow 15000\,mm^2$.

$x_1 \Rightarrow b/2 = 60/2 = 30\,mm$

②.

$a_2 \Rightarrow 4000\,mm^2$.

$x_2 \Rightarrow 60 + 100/2 = 60 + 50 = 110\,mm$

$$\bar{x} \Rightarrow \frac{(15000 \times 30) + (4000 \times 110)}{(15000 + 4000)}.$$

$$\frac{450000 + 440000}{19000}$$

$\bar{x} \Rightarrow$ ~~23.15 mm~~. $\bar{x} \Rightarrow 46.84\,mm.$

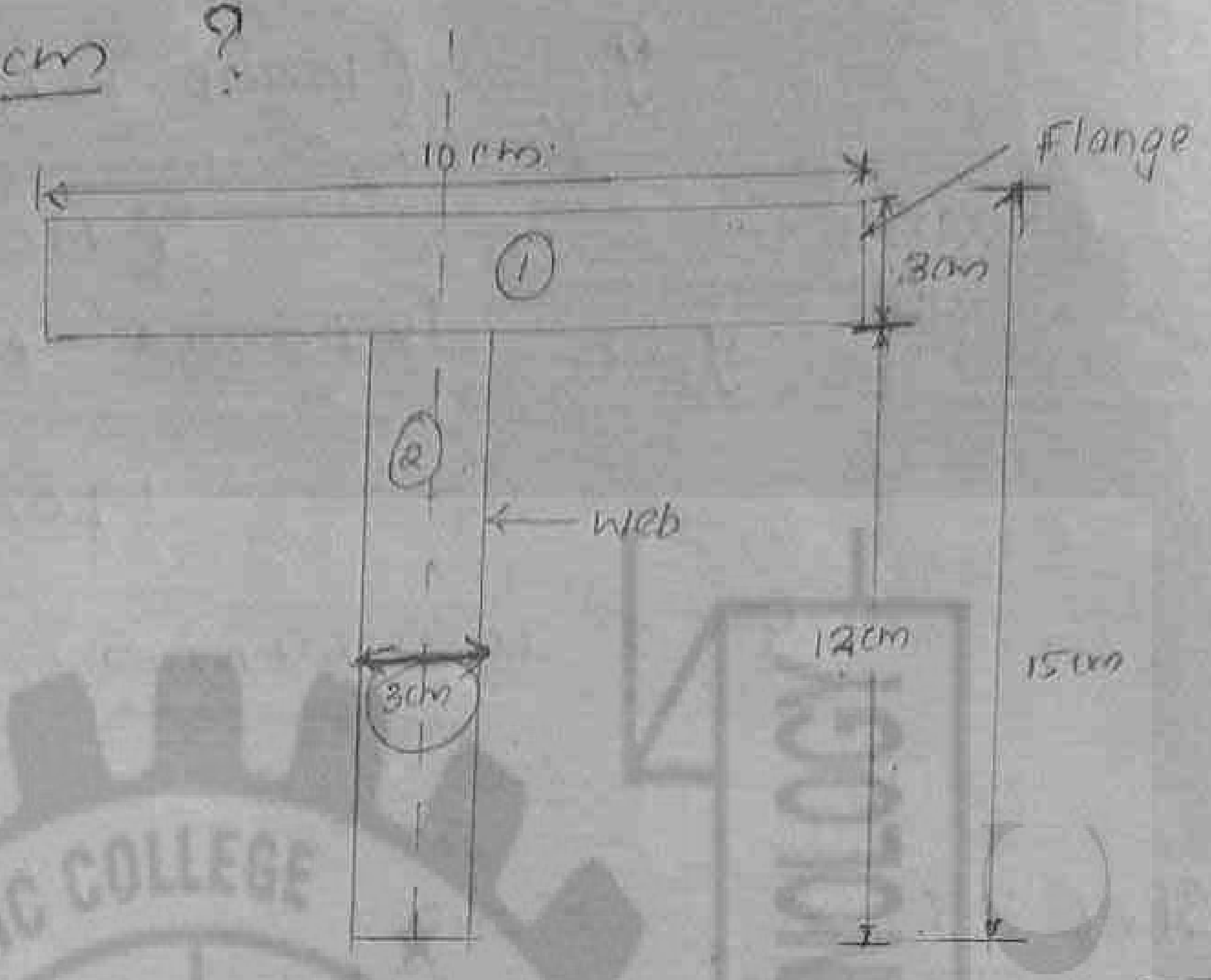
Result :

$\bar{x} = 46.84\,mm$.

$\bar{y} = 102.89\,mm$.

1/9/22 Friday

Que 13. Find the centroid of the T-Section size 10cm × 15cm × 3cm ?



— b

— (b)
(d)
y(d)

Step :- ①

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

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

Section ① ⟹ 10cm × 3cm

Section ② ⟹ 3cm × 12cm.

Step :- 2

$a_1 = b \times d \Rightarrow 10 \times 3 = 30\,cm^2$.

$a_2 = b \times d \Rightarrow 3 \times 12 = 36\,cm^2$.

Step ③ :-

To find centroidal axis ($\bar{y}$)

$y_1 \Rightarrow d/2 \Rightarrow 3/2 + 12 = 1.5 + 2 =$

$= 12 + 3/2 = 13.5\,cm$.

Scanned by TapScanner

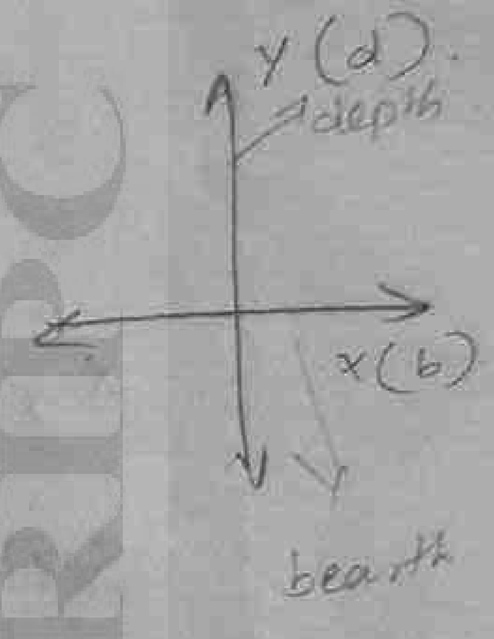
$y_2 = d/2 = 12/2 = \underline{\underline{6\,cm}}$

$$\bar{y} = \frac{(\overset{a_1}{30} \times \overset{y_1}{13.5}) + (\overset{a_2}{36} \times \overset{y_2}{6})}{\underset{a_1}{30} + \underset{a_2}{36}}$$

$$\bar{y} \Longrightarrow \frac{405 + 216}{66}$$

$$\bar{y} = \frac{621}{66} = \underline{9.40\,cm}$$

$$\bar{y} = \underline{\underline{9.40\,cm}}$$



Step: 4,

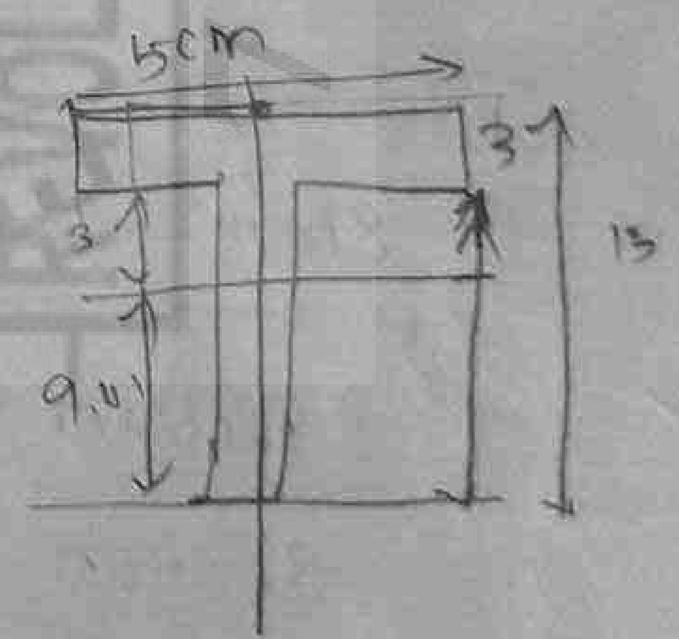
To find $(\bar{x})$

$a_1 = 30\,cm^2$, $a_2 = 36\,cm^2$

$\underline{x_1} = b/2 \Longrightarrow 10/2 = 5\,cm$

$x_2 = b/2 \Longrightarrow 10/2 = 5\,cm$

$$\bar{x} = \frac{(\overset{a_1}{30} \times \overset{x_1}{5}) + (\overset{a_2}{36} \times \overset{x_2}{5})}{\underset{a_1}{30} + \underset{a_2}{36}} = \frac{330}{66}$$



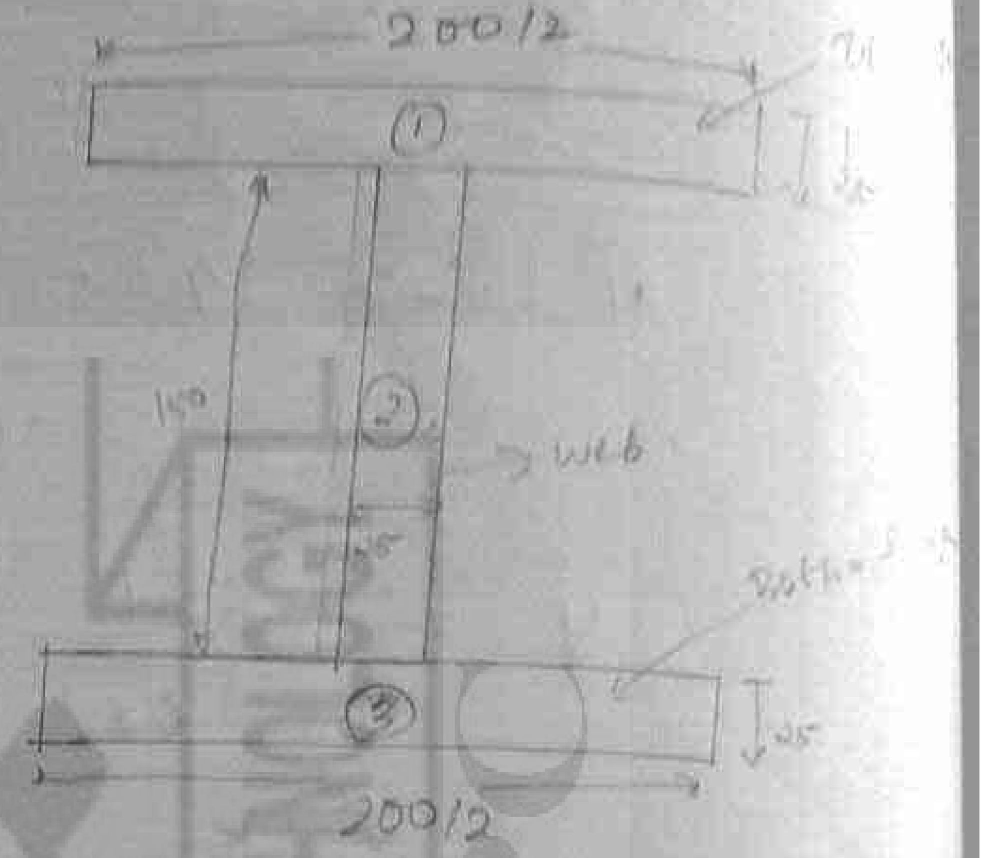
$\bar{x} \Longrightarrow \underline{\underline{5\,cm}}$

Result :- $\bar{x} = 5\,cm$

$\bar{y} = 9.40\,cm$

7/10/22
Friday

Que: 4. find the centroid of the given I section.



flange = 200 x 25 mm

web = 25 x 150 mm.

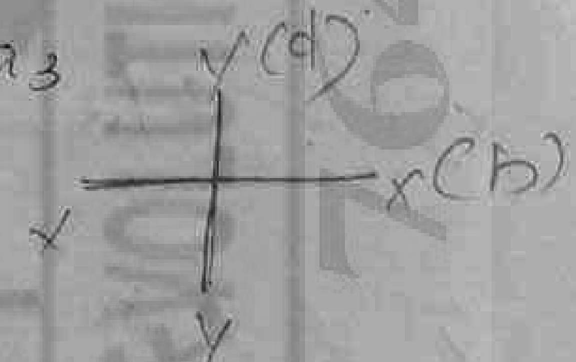
$\bar{x}, \bar{y}$

Section :-

$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

1) Horizon

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}$$



Step :- 1

Section ① = 200 x 25 mm^2 = 5000 mm^2

Section ② = 25 x 150 mm^2 = 3750 mm^2

Section ③ = 200 x 25 = ~~mm~~ 5000 mm^2.

Step :- 2

Area :-

$a_1 \Rightarrow b \times d \Rightarrow 200 \times 25 \Rightarrow 500\ mm^2$.

$a_2 \Rightarrow b \times d \Rightarrow 25 \times 150 \Rightarrow 3750\ mm^2$.

$a_2 \Rightarrow$

$a_3 \Rightarrow b \times d \Rightarrow 5000\,mm^2$.

Step :- 3

$\bar{y}$ (To find centroid distance).

$y_1 \Rightarrow d/2 \Rightarrow 25 + 150 + \frac{25}{2} = 187.5mm$

$y_2 \rightarrow d/2 \Rightarrow 25 + \frac{150}{2} \Rightarrow 100mm$.

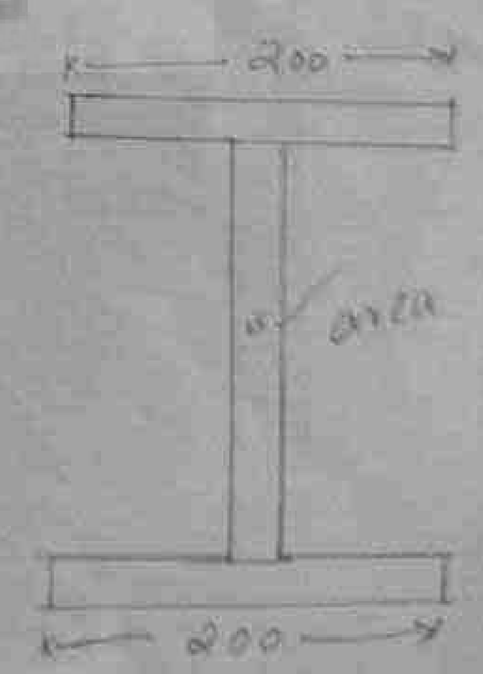
$y_3 \Rightarrow d/2 \Rightarrow 25/2 = 12.5mm$.

$$y = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}$$

$$= \frac{(5000 \times 187.5) + (3750 \times 100) + (5000 \times 12.5)}{5000 + 3750 + 5000}$$

$$= \frac{937500 + 375000 + 62500}{13750}$$

$$\bar{y} = 100\ mm.$$



$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

$x_1 \Rightarrow \frac{b}{2} = \frac{200}{2} = 100mm$.

$x_2 \Rightarrow 100\ mm$.

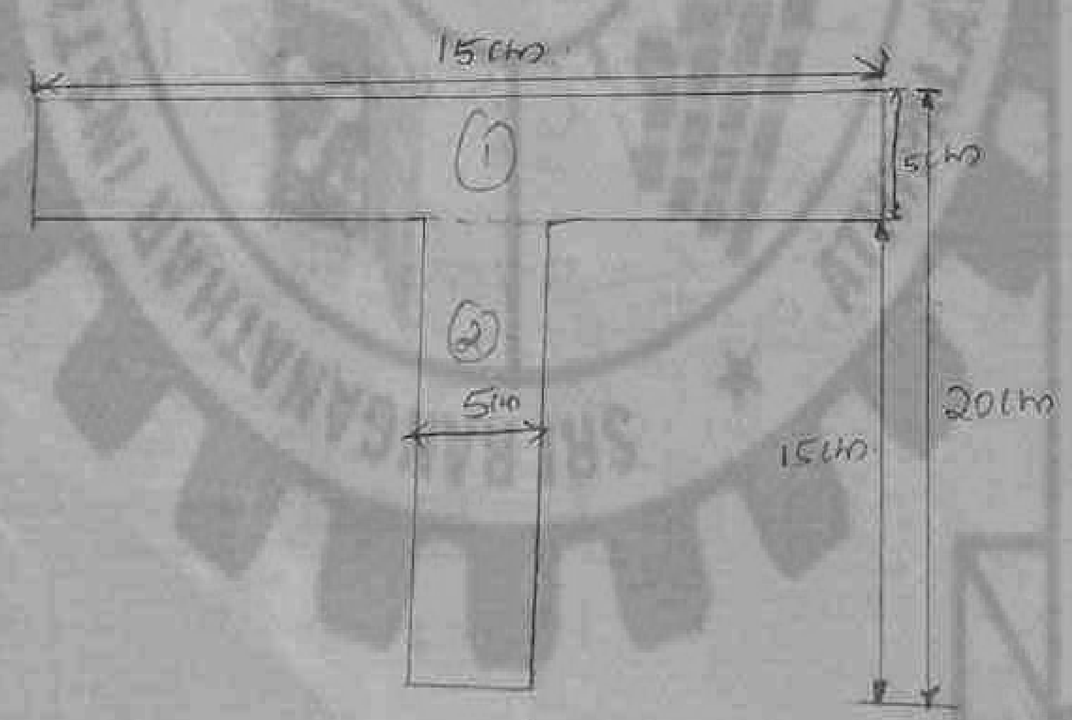
$$x_3 = b/2 \Rightarrow \frac{200}{2} = 100\,mm.$$

$$\bar{x} \Rightarrow \frac{(5000 \times 100) + (3750 \times 100) + (5000 \times 100)}{5000 + 3750 + 5000}$$

$$\bar{x} \Rightarrow \frac{500000 + 375000 + 500000}{13750}$$

$$\bar{x} \Rightarrow 100\,mm.$$

Que: 5.



Step - 1

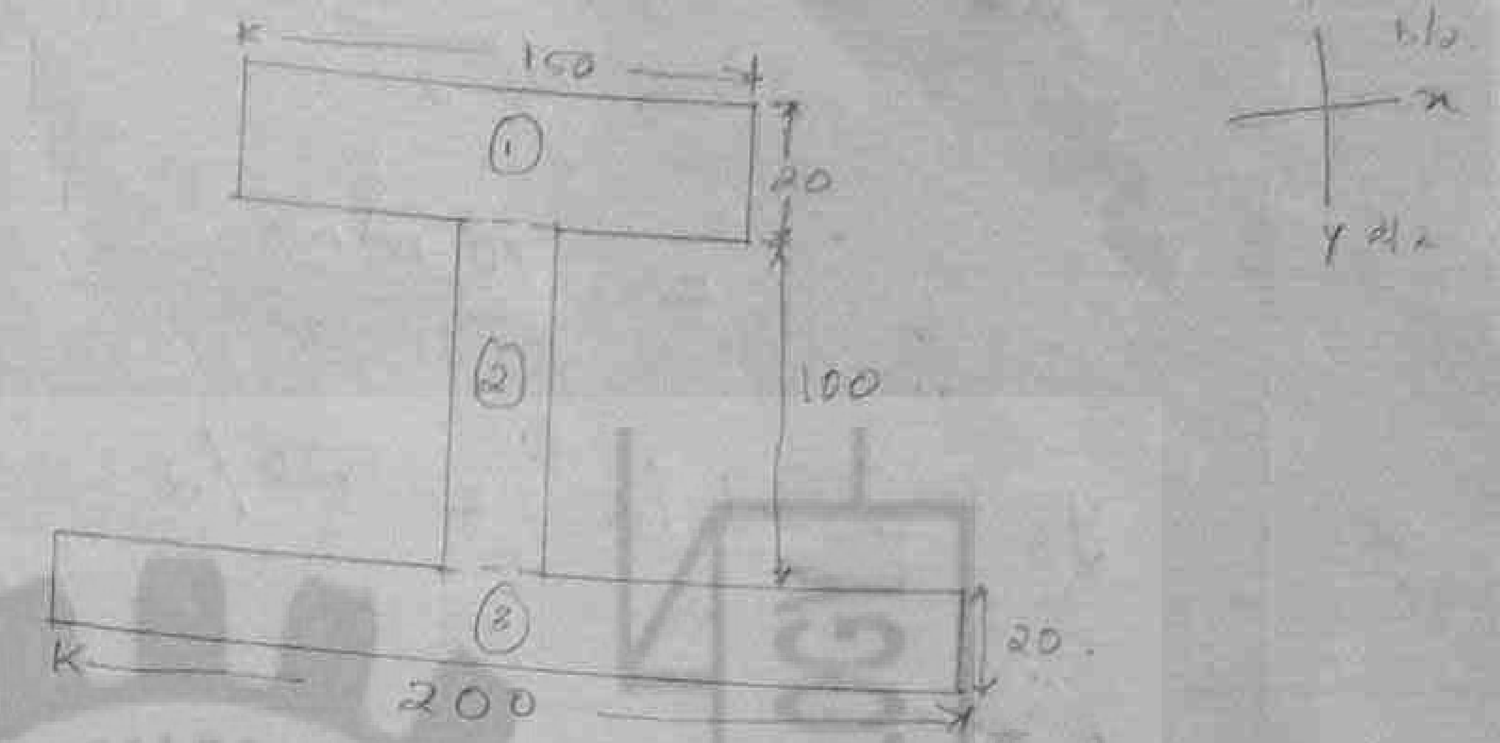
$$\bar{x} = \frac{a_1 x_1 + a_2 x_2}{a_1 + a_2}$$

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

Section 1 $\Rightarrow$ 15cm × 5 cm

Section 2 $\Rightarrow$ 15cm × 5cm

Qu: Determine the position of centroid of the I-Section shown in figure.



Step :- 1

Section (1) 150 mm x 20 mm

Section (2) 20 mm x 100 mm

Section (3) 200 mm x 20 mm

Step :- 2 centroid $\bar{x}$, $\bar{y}$

$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}$$

To find $\bar{y}$:-

area

$a_1 \Rightarrow b \times d = 150 \times 20 = 3000\,mm^2$.

$a_2 \Rightarrow b \times d = 100 \times 20 = 2000\,mm^2$.

$a_3 \Rightarrow b \times d = 200 \times 20 = 4000\,mm^2$.

$y_1 \Rightarrow d/2 \Rightarrow 20 + 100 + \frac{20}{2}$

$= 130\ mm.$

$y_2 = 20 + \frac{100}{2}$

$= 70\ mm.$

$y_3 = d/2 = 20/2 = 10\ mm.$

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

$$= \frac{(3000 \times 130) + (2000 * 70) + (4000 * 10)}{3000 + 2000 + 4000}$$

$$= \frac{390000 + \cancel{2070}\ 140000 + \cancel{4010}\ 40000}{9000}$$

$$\boxed{\bar{y} = 63.33\ mm}$$

Step :- 4.

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

$x_1 = b/2 \Rightarrow 150/2 \Rightarrow 75$

$= b/2 \Rightarrow \cancel{100}\ 20/2 \Rightarrow \cancel{50}\ 10.$

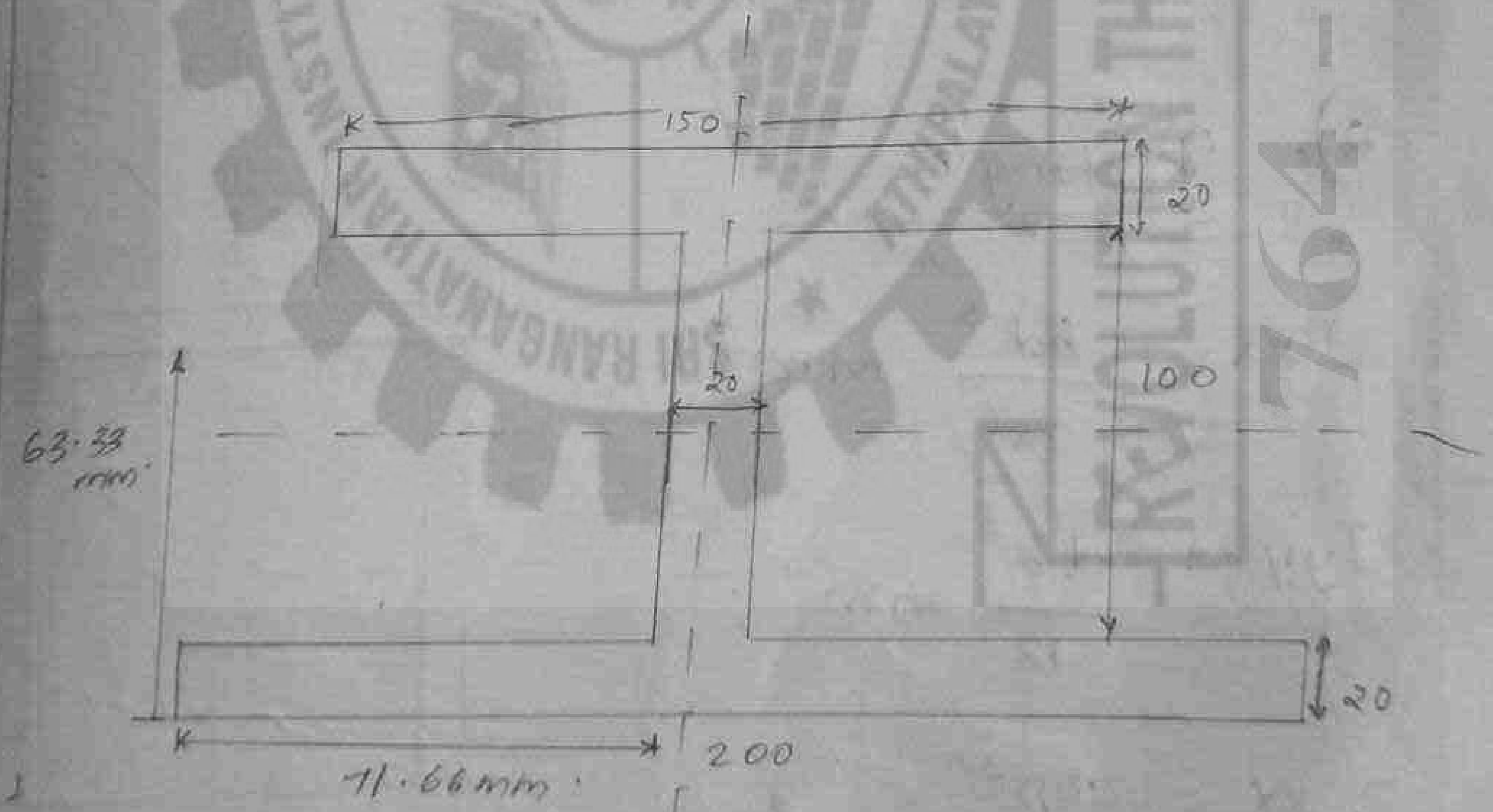
$x_3 \Rightarrow b/2 \Rightarrow \cancel{20/2} = \cancel{10}\ 200/2 = 100$

$$\bar{x} = \frac{(3000 \times 75) + (2000 \times 90) + (4000 \times 100)}{3000 + 2000 + 4000}$$

$$= \frac{225000 + 200000 + 400000}{9000}$$

$$= \frac{645000}{9000} = \underline{71.66 mm}$$

$$\boxed{\bar{x} = 71.66 mm}$$



$\bar{x}_1 = 150/2 = 75 + 25 = \underline{100 mm}$ (b/2)

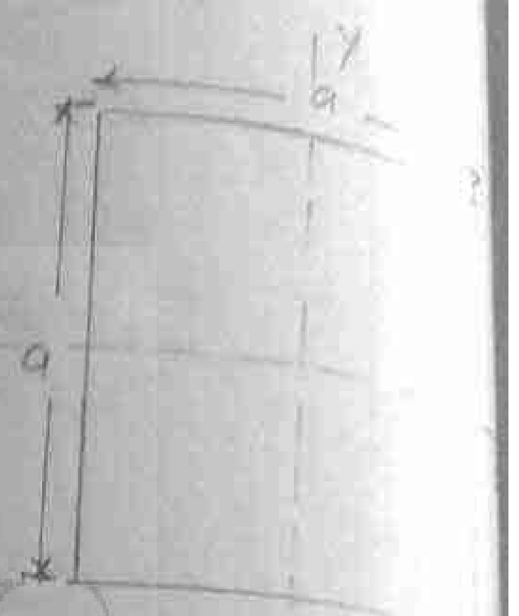
$x_2 = 20/2 + 90 = 10 + 90 = \underline{100 mm}$

$x_3 = 200/2 = \underline{100 mm}$

$$\bar{x} = \frac{(3000 \times 100) + (2000 \times 100) + (4000 \times 100)}{9000}$$

$\boxed{\bar{x} = 100 mm}$

MOMENT OF INERTIA SECTION MODULUS OF COMMON PLANE GEOMETRY SECTION.



Square :

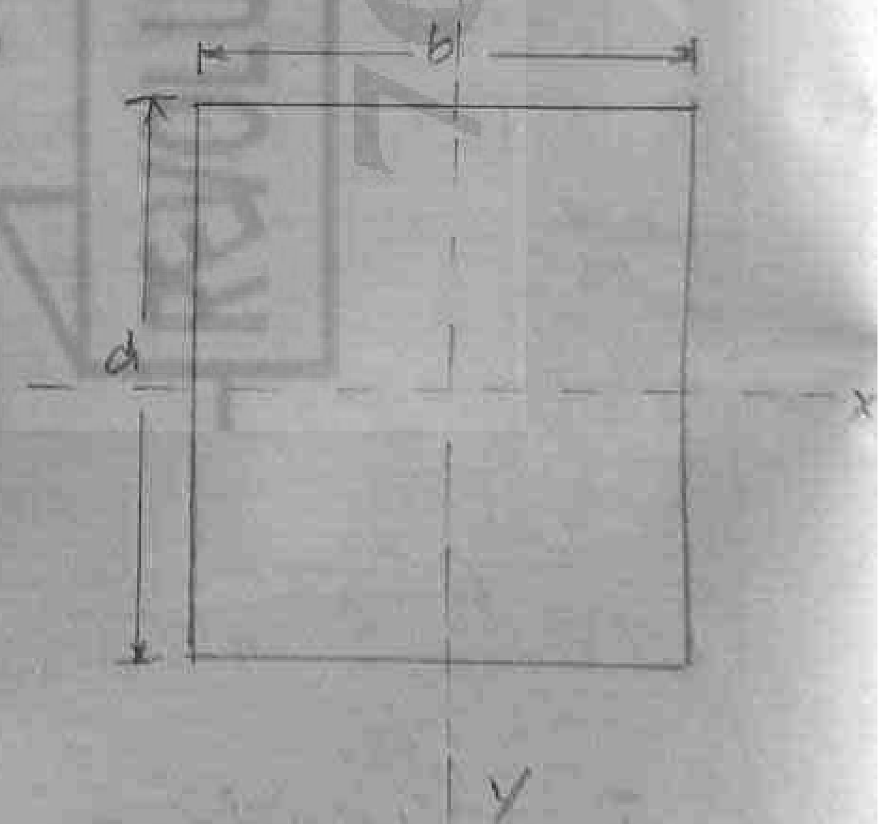
$$I_{xx} = I_{yy} = \frac{a^4}{12}\ mm^4.$$

$$I_{zz} = \frac{a^4}{6}\ mm^4.$$

$$Z_{xx} = Z_{yy} = \frac{a^3}{6}\ mm^3 //$$

$$r_{xx} = r_{yy} = \frac{a}{2\sqrt{3}}\ mm.$$

2). Rectangle :



$$I_{xx} = \frac{bd^3}{12}\ mm^4.$$

$$I_{yy} = \frac{db^3}{12}\ mm^4.$$

$$Z_{xx} = \frac{BD^2}{6}\ mm^3.$$

$$Z_{yy} = \frac{DB^2}{6}\ mm^3.$$

$$r_{xx} = \frac{D}{2\sqrt{3}}\ mm$$

$$\gamma_{yy} = \frac{B}{2\sqrt{3}} \text{ mm}.$$

3). Hollow Rectangular Section :-

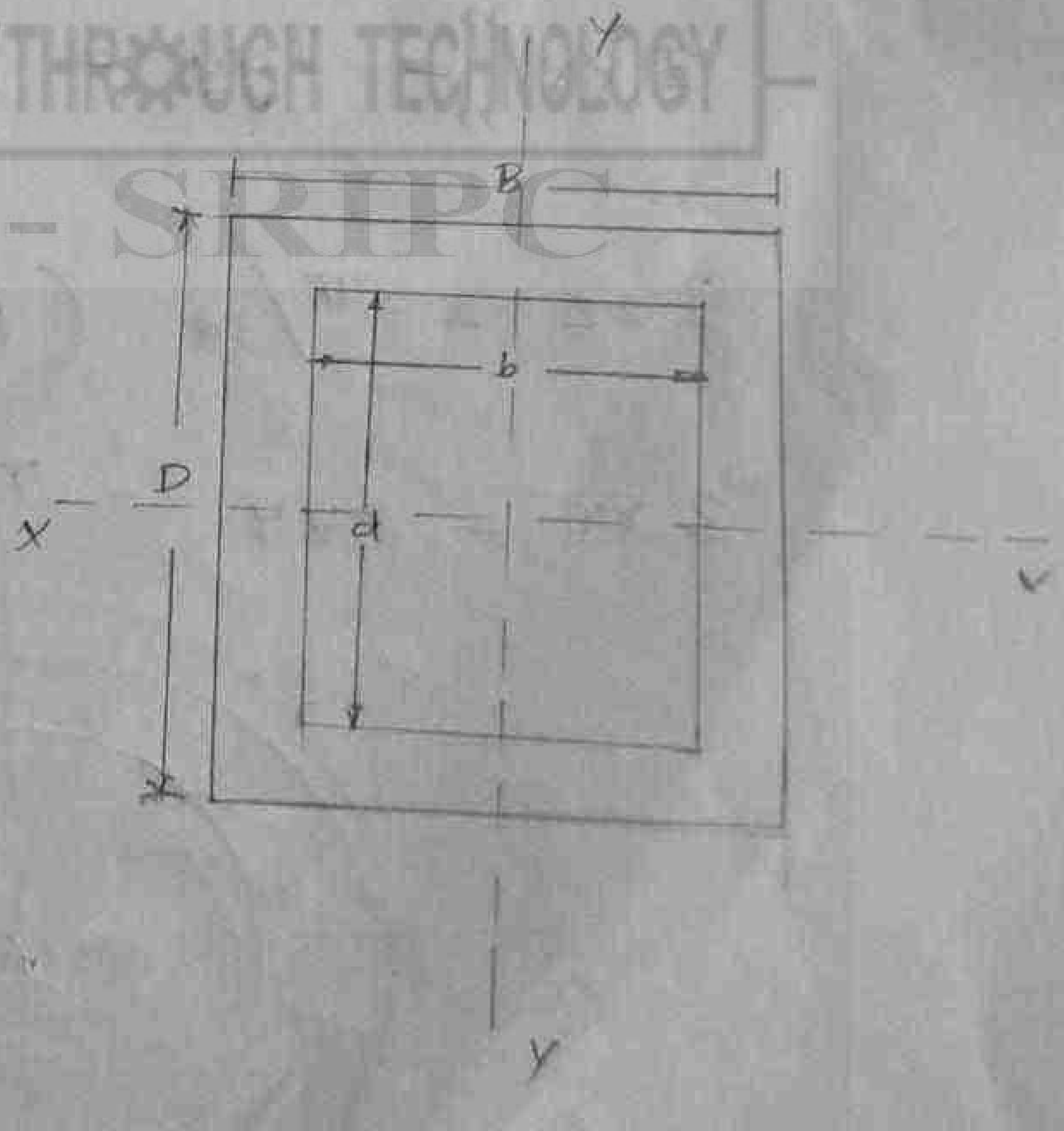
$$I_{xx} = \frac{BD^3}{12} - \frac{bd^3}{12} \text{ mm}^4$$

$$I_{yy} = \frac{DB^3}{12} - \frac{db^3}{12} \text{ mm}^4.$$

$$Z_{xx} = \frac{BD^3 - bd^3}{6D} \text{ mm}^3.$$

$$Z_{yy} = \frac{DB^3 - db^3}{6B} \text{ mm}^3.$$

4).



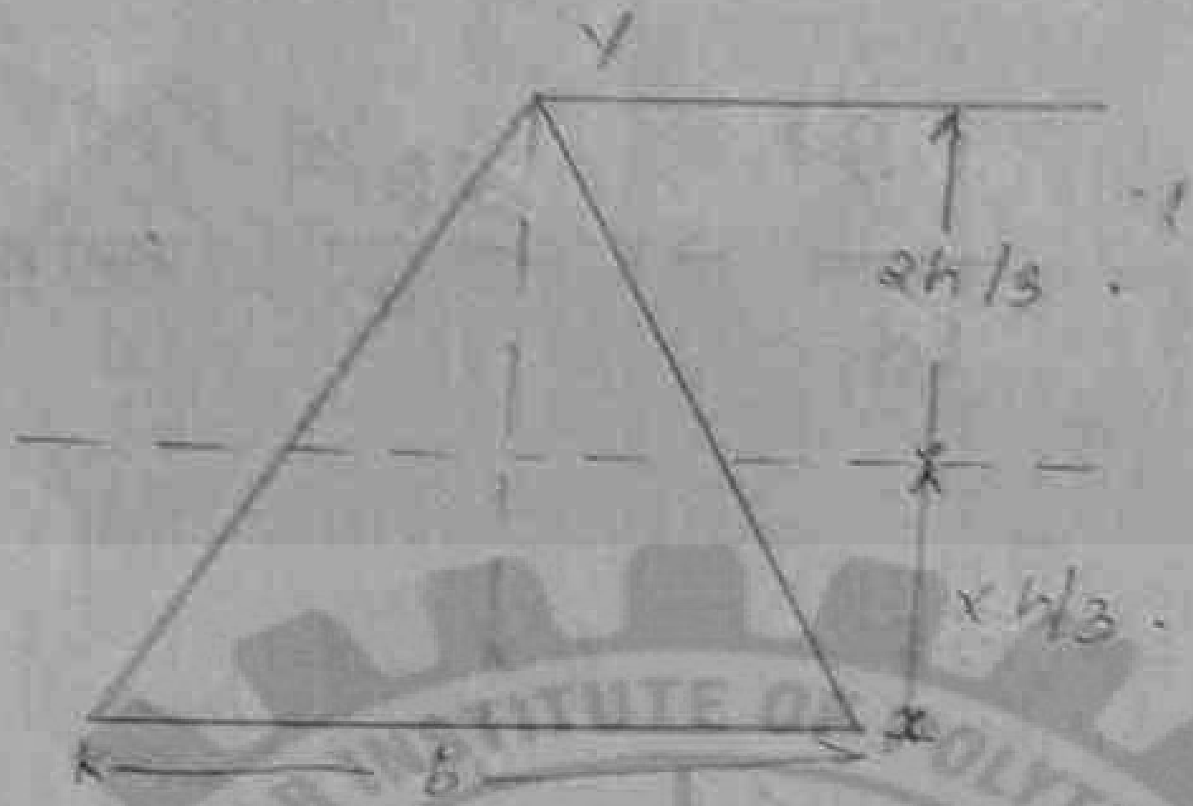
Imp

$A = mm^2$
$I = mm^4$
$Z = mm^3$

4). Triangular Section :

$$I_{xx} = \frac{bh^3}{36} \, mm^4 \qquad I_{yy} = \frac{hb^3}{48} \, mm^4$$

$$Z_{xx} = \frac{bh^2}{24} \, mm^3 \qquad r_{xx} = \frac{h}{3\sqrt{2}}.$$

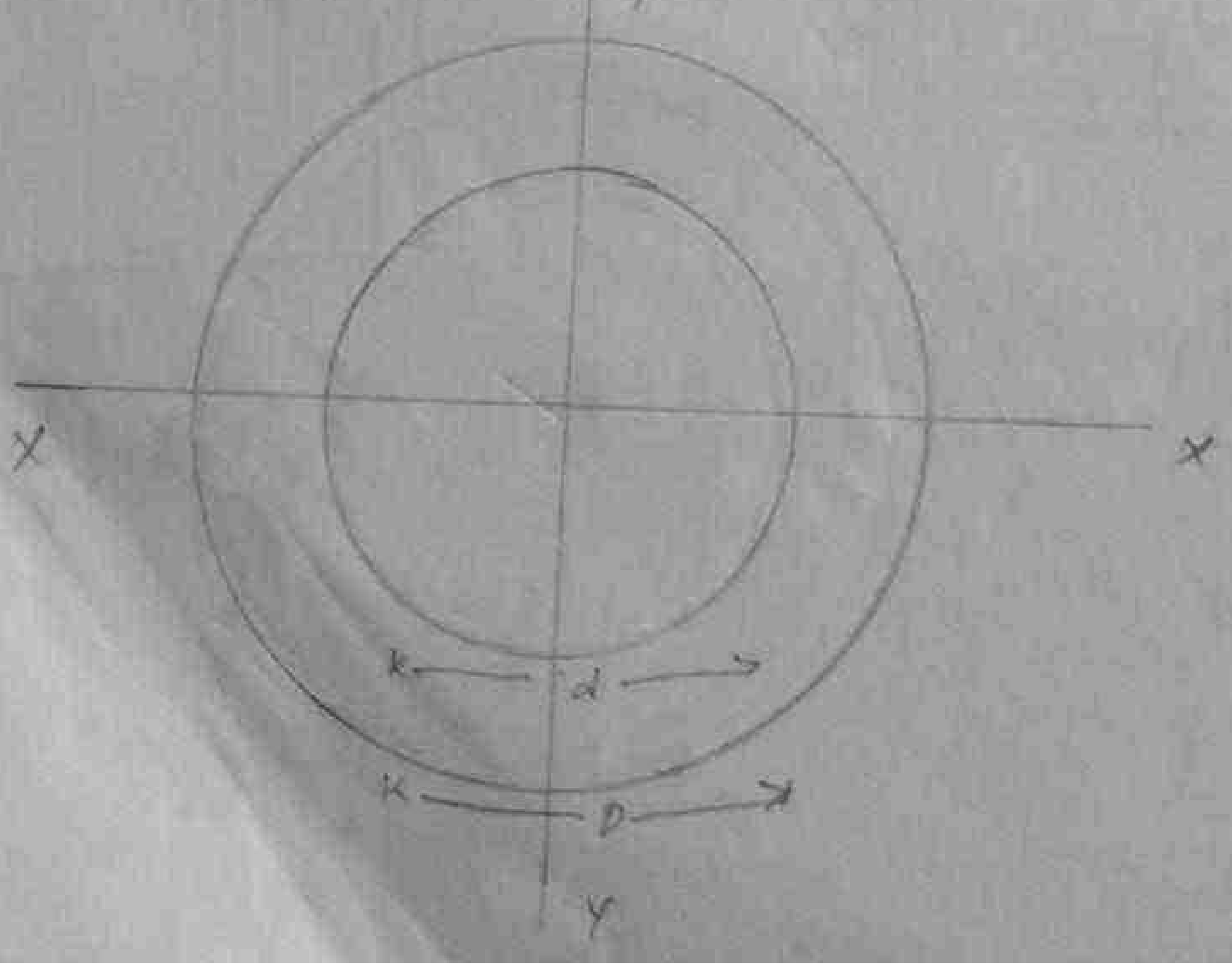


Hollow Circular Section.

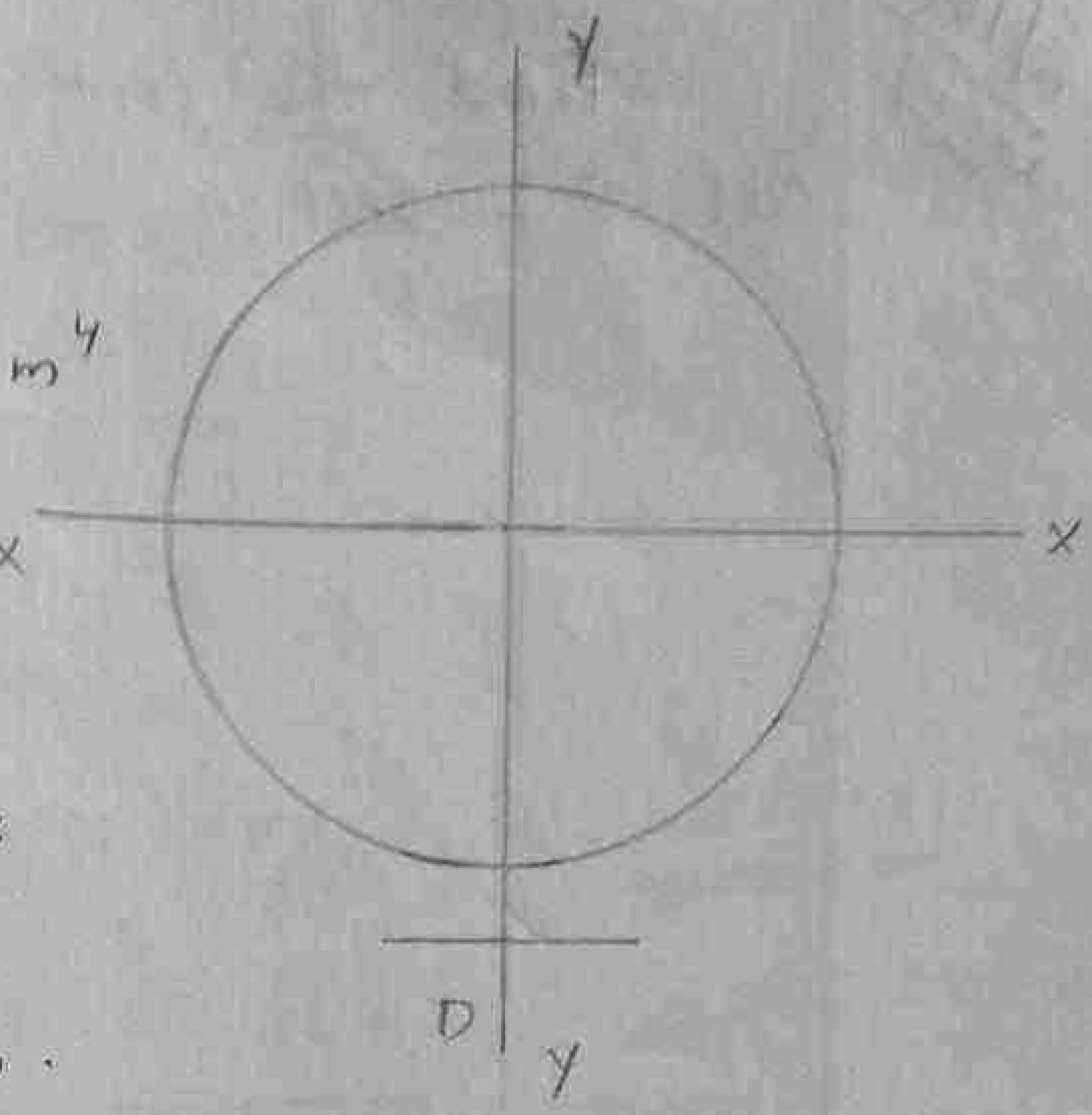
$$I_{xx} = I_{yy} = \frac{\pi}{64}\left(D^4 - d^4\right) mm^4.$$

$$I_{zz} = \pi/32 \left(D^4 - d^2\right) mm^4.$$

$$Z_{xx} = Z_{yy} = \pi/32D \left(D^4 - d^4\right) mm^3.$$



Circular Section.



$$I_{xx} = I_{yy} = \frac{\pi D^4}{64} \ mm^4$$

$$I_{zz} = \frac{\pi D^4}{32} \ mm^4$$

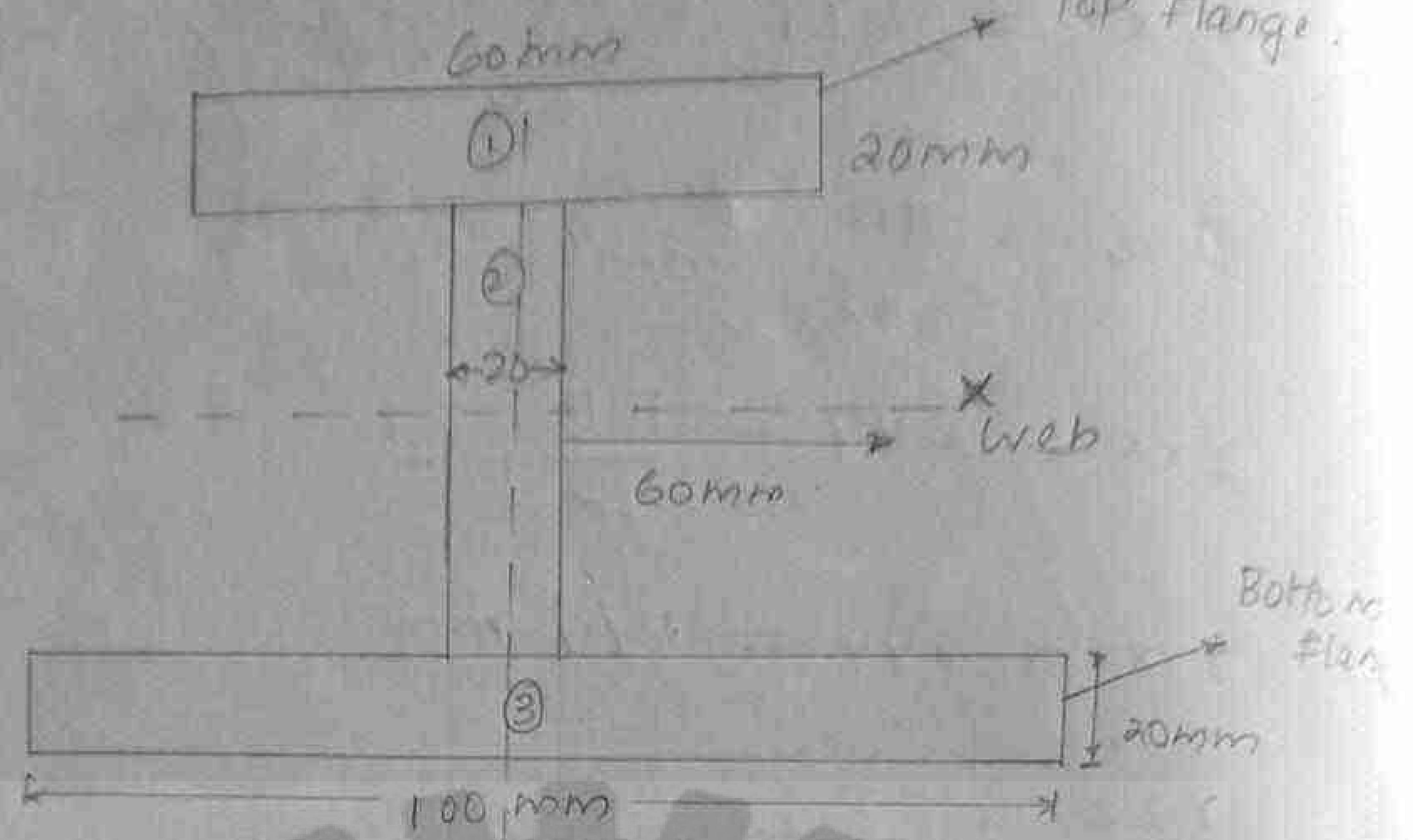
$$Z_{xx} = Z_{yy} = \frac{\pi D^3}{32} \ mm^3$$

$$r_{xx} = r_{yy} = D/4 \ mm.$$

$$r_{zz} = \frac{D}{2\sqrt{2}}$$

10/10/22
Monday.

Find the centroidal distance of the UD - symmetrical I - section.



It symetrical about Y axis

Step :- 1

$\bar{x} = 50mm$

Section (1) 60mm x 20mm.

(2) 20mm x 60mm.

(3) 100mm x 20mm.

Step : 2 $\bar{x}, \bar{y}$

$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}$$

Area :

$a_1 \Rightarrow b \times d = 60mm \times 20mm \Rightarrow$

$1200\ mm^2$.

$a_2 \Rightarrow b \times d \Rightarrow 20 \times 60 \Rightarrow 1200\ mm^2$.

$a_3 \Rightarrow b \times d \Rightarrow 100 \times 20 \Rightarrow 2000\ mm^2$.

$y_1 \rightarrow$ centroidal distance.

$y_1 \Rightarrow d/2$

$$= 20 + 60 + 20/2 = \underline{\underline{90\ mm}}.$$

$y_2 \Rightarrow d/2$

$$= 20 + \frac{60}{2} = \underline{\underline{50\ mm}}.$$

$y_3 \Rightarrow d/2$

$$= 20/2 = \underline{\underline{10\ mm}}$$

$$\bar{y} \Rightarrow \frac{(1200 \times 90) + (1200 \times 50) + (2000 \times 10)}{1200 + 1200 + 2000}$$

$$\bar{y} = \frac{108000 + 60000 + 20000}{4400}$$

$$\boxed{\Rightarrow 42.72\ mm.}$$

Step : 3

To find $\bar{x}$

$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

$a_1 = 1200\ mm^2$.

$a_2 = 1200\ mm^2$

$a_3 = 2000\ mm^2$.

$x_1 = b/2 \Rightarrow 60/2 + 20 = 30 + 20$

$= 50\ mm$.

$x_2 = b/2 \Rightarrow 20/2 + 40 = 10 + 40$

$= 50\ mm$

$x_3 = b/2 \Rightarrow 100/2 = 50\ mm$

$$\bar{x} = \frac{(1200 \times 50) + (1200 \times 50) + (2000 \times 50)}{4400}$$

$\bar{x} = 50\ mm$.

PROCEDURE :

Step :- 1

To find centroidal distance $(\bar{x}, \bar{y})$.

$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}.$$

Step :- 2.

To find Radius of Gyration of each

Section :-

$\bar{x}_1 = \bar{x} - x_1$ $\qquad$ $\bar{y}_1 = \bar{y} - y_1$

$\bar{x}_2 = \bar{x} - x_2$ $\qquad$ $\bar{y}_2 = \bar{y} - y_2$

$\bar{x}_3 = \bar{x} - x_3$ $\qquad$ $\bar{y}_3 = \bar{y} - y_3$

Step :- 3.

To find moment of inertia about (x x axis).

$$I_{xx} = \frac{bd^3}{12} + a\bar{y}^2.$$

$$I_{xx} = \left[\frac{b_1 d_1^3}{12} + a_1 \bar{y}_1^2\right] + \left[\frac{b_2 d_2^3}{12} + a_2 \bar{y}_2^2\right]$$

$$+\left[\frac{b_3 d_3^3}{12} + a_3 \bar{y}_3^2\right].$$

Step : 4

To find moment of inertia about yy axis

$$I_{yy} \Rightarrow \left(\frac{d_1 b_1^3}{12} + a_1 \bar{x}_1^2\right) + \left(\frac{d_2 b_2^3}{12} + a_2 \bar{x}_2^2\right) + \left(\frac{d_3 b_3^3}{12} + a_3 \bar{x}_3^2\right)$$

Step : 5

$$I_{zz} = I_{xx} + I_{yy}$$

Step : 6.

To find Radius of Gyration r_{xx}, r_{yy}.

$$r_{xx} = \sqrt{\frac{I_{xx}}{A}}$$

$$r_{yy} = \sqrt{\frac{I_{yy}}{A}}$$

Step : 7.

To find section Modulus Z_{xx}, Z_{yy}.

$$Z_{xx} = \frac{I_{xx}}{y_{max}}$$

$$Z_{yy} = \frac{I_{yy}}{x_{max}}$$

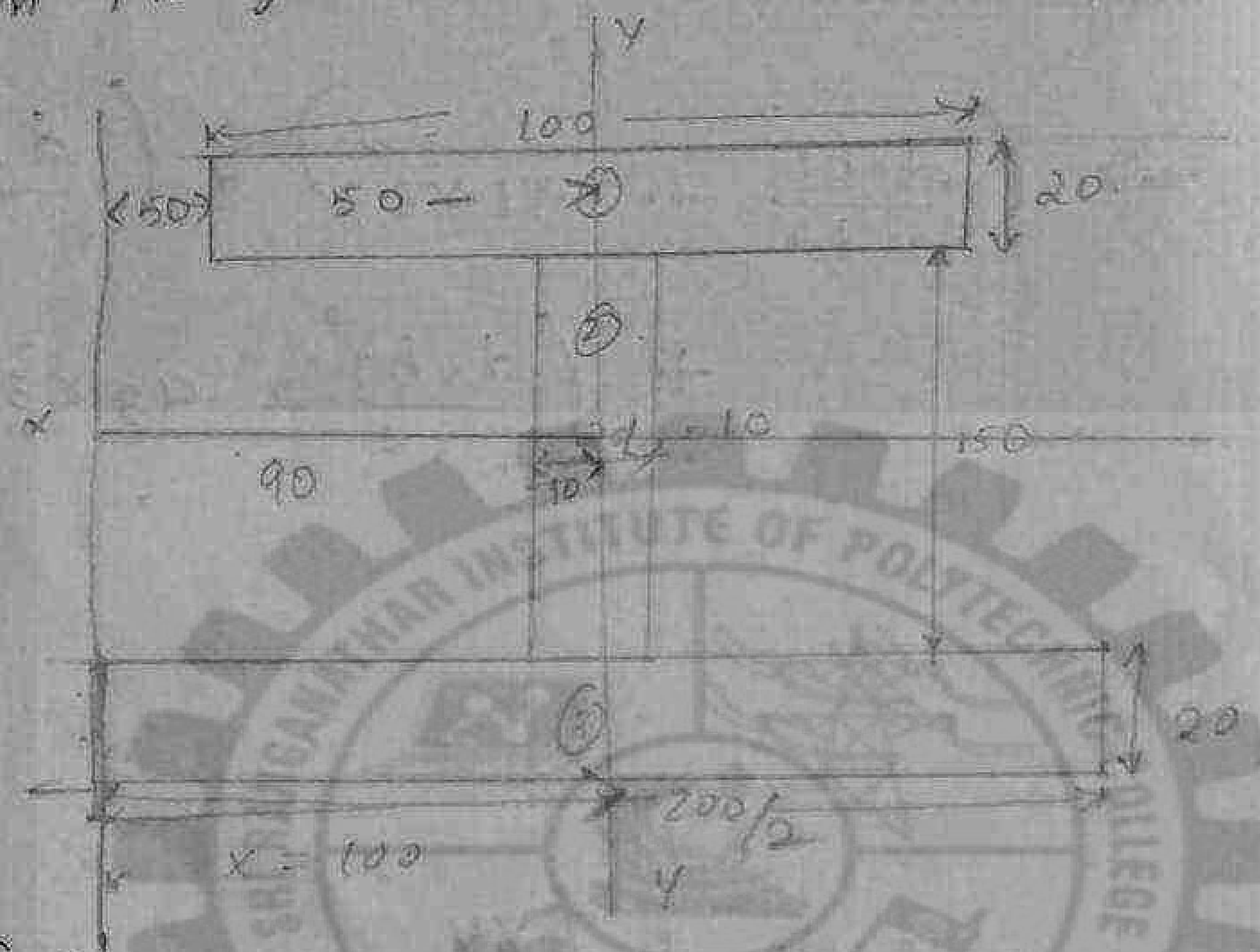
Sum

Que:1. Find the I_{xx}, I_{yy}, r_{xx}, r_{yy}, Z_{xx}, Z_{yy} for the I-section?

Top flange = 100 x 20 mm.

web dimensions = 20 x 150 mm.

Bottom flange = 200 x 20 mm.



step :-

To find centroidal distance $\bar{x}$, $\bar{y}$

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

$$\bar{y} = \frac{(2000 \times 180) + (3000 \times 95) + (4000 \times 10)}{2000 + 3000 + 4000}$$

$$= \frac{360000 + 285000 + 40000}{\cancel{9200}\ 9000}$$

$$= \frac{\cancel{361000}}{\cancel{1200}} = \frac{685000}{9000}$$

$a_1 = b \times d = 100 \times 20$
$= 2000 mm^2$

$a_2 = b \times d = 20 \times 150$
$= 3000 mm^2$

$a_3 = b \times d = 200 \times 20$
$= 4000 mm^2$

$y_1 = d/2 = 20 + 150 + 20/2$
$= 180 mm$

$y_2 = d/2 = 20 + 150/2$
$= 95 mm$

$y_3 = d/2 = 20/2 = 10 mm$

$\bar{Y} = 76.11 mm$

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

$x_1 = b/2 = 100/2$

$= 50+50 = 100mm$

$x_2 = b/2 = 20/2$

$= 10 + 90 = 100mm$

$x_3 = b/2 = 200/2$

$= 100 mm$

$$= \frac{(2000 \times 100) + (3000 \times 100) + (4000 \times 100)}{2000 + 3000 + 4000}$$

$$= \frac{200000 + 300000 + 400000}{9000}$$

$$= \frac{900000}{9000} = 100 mm$$

Step : 2

To find Radius of Gyration.

$\bar{x}_1 \Rightarrow \bar{x} - x_1 \Rightarrow 100 - 100 = 0.$

$\bar{x}_2 \Rightarrow \bar{x} - x_2 \Rightarrow 100 - 100 = 0.$

$\bar{x}_3 \Rightarrow \bar{x} - x_3 \Rightarrow 100 - 100 = 0.$

$\bar{y}_1 \Rightarrow \bar{y} - y_1 = 76.11 - 180 \Rightarrow -103.89mm$

$y_2 \Rightarrow \bar{y} - y_2 = 76.11 - 95 \Rightarrow -18.89mm.$

$y_3 \Rightarrow \bar{y} - y_3 = 76.11 - 10 \Rightarrow 66.11mm.$

To find MOI (Moment of Inertia) (xx axis)

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

$$= \left(\frac{b_1 d_1^3}{12} + a_1 \bar{y}_1^2\right) + \left(\frac{b_2 d_2^3}{12} + a_2 \bar{y}_2^2\right) + \left(\frac{b_3 d_3^3}{12} + a_3 \bar{y}_2^2\right).$$

$$\Rightarrow \left[\frac{100 \times 20^3}{12} + 2000 \times (-103.89)^2\right] +$$

$$= (66666.66 + 21586264.2) +$$

$$\cancel{(5625000 + 1070496.3)} +$$

21652930.86

$$\left[\frac{20 \times 150^3}{12} + 3000 \times (-18.89)^2\right]$$

$$= (5625000 + 1070496.3) +$$

$$\left[\frac{200 \times 20^3}{12} + 4000 \times (66.11)^2\right]$$

$$= \left[133333.33 + 17482128.4\right]$$

$= 45963888.89$

$I_{xx} = 45.96 \times 10^6 \ mm^4$

Step :' 4 I_{yy}

$$I_{yy} = \left(\frac{d_1 b_1^3}{12} + a_1 \bar{x}_1^2\right) + \left(\frac{d_2 b_2^3}{2} + a_2 \bar{x}_2^2\right) + \left(\frac{d_3 b_3^3}{12} + a_2 \bar{x}_3^2\right).$$

$$= \left(\frac{20 \times 100^3}{12} + (2000 \times 0)\right) + \left(\frac{150 \times 20^3}{12} + (3000 \times 0)\right) + \left(\frac{20 \times 200^3}{12} + (4000 \times 0)\right)$$

$$= \left(1666666.66 \cancel{+ 2000}\right) + \left(100000 \cancel{+ 3000}\right) + \left(1333333.33 \cancel{+ 4000}\right).$$

$$= 1668666.66 + 100000 + 1333333.33$$

$$= 1509999.99$$

$$= 150.09 \times 10^8$$

Step :- 5

To find the polar moment of Inertia

$$I_{zz} = I_{xx} + I_{yy}$$

$$= 45.96 \times 10^6 + 15.09 \times 10^6$$

$$= 61.05 \times 10^6$$

Step :- 6

Radius of Gyration

$$r_{xx} = \sqrt{\frac{I_{xx}}{A}} = \sqrt{\frac{45.96 \times 10^6}{9000}} \Rightarrow 71.46 \text{ mm}$$

$$r_{yy} = \sqrt{\frac{I_{yy}}{A}} = \sqrt{\frac{15.09 \times 10^6}{9000}} \Rightarrow 40.94 \text{ mm}$$

Step :- 7

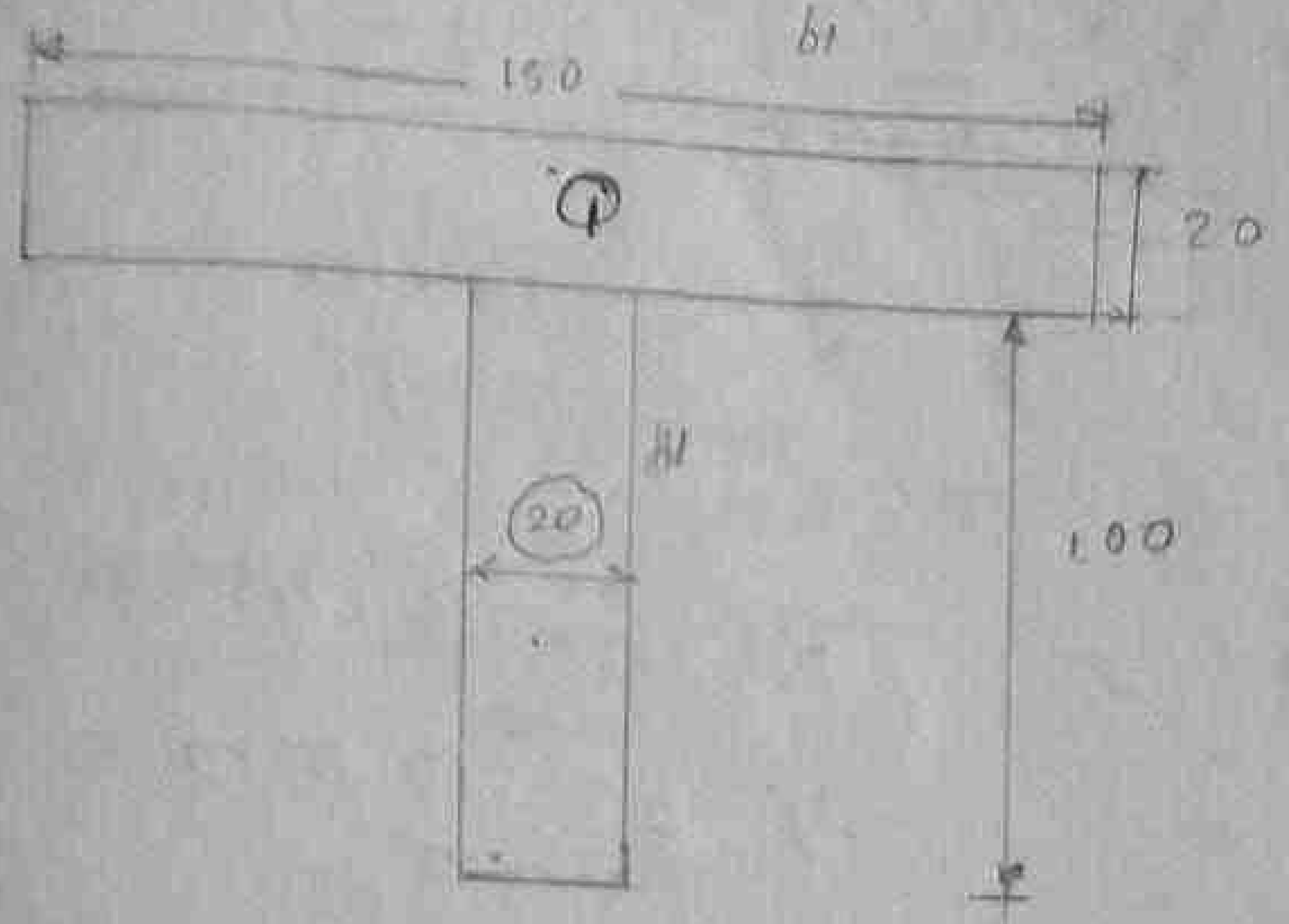
Section modulus :

$$Z_{xx} = \frac{I_{xx}}{y_{max}} = \frac{45.96 \times 10^6 \text{ mm}^4}{113.89 \text{ mm}}$$

$$= 403547.28 \text{ mm}^3$$

$$Z_{yy} = \frac{I_{yy}}{y_{max}} = \frac{15.09 \times 10^6}{113.87}$$

$$= 132496.26 \text{ mm}^3$$



Step :- 1 $\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 + a_2}$

To find centrodial distance $\bar{x}$, $\bar{y}$.

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

Step : 2

$a_1 = b \times d = 150 \times 20 = 3000$

$a_2 = b \times d = 20 \times 100 = 2000$

$$\bar{y} = \frac{(3000 \times 110) + (2000 \times 50)}{3000 + 2000} \quad 100000$$

$$= \frac{330000 + 100000}{5000}$$

$$= \frac{430000}{5000} = 86$$

Step : 3

$y_1 = d/2 = 100 + 20/2 = 110\ mm$

$y_2 = d/2 = 100/2 = 50\ mm$

$\bar{y} = 86\ mm$

Step : 4

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

$x_1 = b/2 = 150/2$

$x_1 = 75\ mm$

$x_2 = \frac{150}{2} = 75\ mm$

$$= \frac{(3000 \times 75) + (2000 \times 75)}{3000 + 2000}$$

$$= \frac{225000 + 150000}{5000}$$

$= \frac{375000}{5000} = 75\ cm$

$= \bar{x} = 75\ cm$

Result = $\bar{x} = 75\ cm$

$\bar{y} = 70\ mm$

Step :- 2.

Radius of Gyration :

$\bar{x}_1 = \bar{x} - x_1 \Rightarrow 75 - 75 = 0$

$\bar{x}_2 = \bar{x} - x_2 \Rightarrow 75 - 75 = 0$

$\bar{y}_1 = \bar{y} - y_1 \Rightarrow 86 - 110 = -24\ mm$

$\bar{y}_2 = \bar{y} - y_2 \Rightarrow 86 - 50 = 36\ mm$

Step : 3 Moment of Inertia

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

$= \left(\frac{b_1 d_1^3}{12} + a_1 \bar{y}_1^2\right) + \left(\frac{b_2 d_2^3}{12} + a_2 \bar{y}_2^2\right)$

$\Rightarrow \left(\frac{150 \times 20^3}{12} + (3000 \times (-24)^2\right)$

$+ \left(\frac{20 \times 100^3}{12} + (2000 \times (36)^2\right.$

$$\left(\frac{150\times 8000}{12}+3000\times 576\right)+\left(\frac{20\times 1000000}{12}\cancel{+1296}\right)$$

$$\cancel{+1296)}$$

$$= \frac{\overset{100000}{\cancel{1200000}}+1728000}{\cancel{12}} = \cancel{\frac{2922000}{12}}$$

$$= \cancel{244000} \qquad = 1666666.66 \; \cancel{+1296} \; +2592000$$

$$= \cancel{1828000} + \cancel{1667962.6}$$

$$=$$

$$= (100000+1728000)+(1666666.66+2592000)$$

$$I_{xx} = \underline{6.08\times 10^{6}\ mm^{4}}$$

$$I_{yy} \Rightarrow \left(\frac{b_1^3 d_1}{12}+a_1\bar{x}_1^2\right)+\left(\frac{b^3 d^2}{12}+a_2\bar{x}_2^2\right)$$

$$\Rightarrow \left(\frac{150^3\times 20}{12}+(3000\times 0)\right) + \left(\frac{20^3\times 100}{12}+(200\times 0)\right)$$

$$\overset{3375000}{} \qquad \overset{8000}{}$$

$$= 5625000 + 0 + 66666.66 + 0$$

$$= \underline{5.69\times 10^{6}\ mm}$$

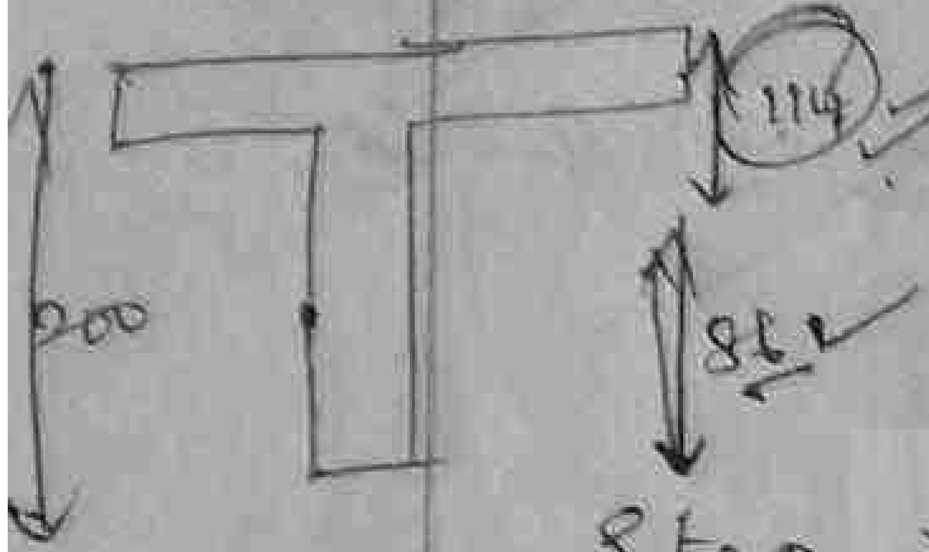
Step : 4

Polar moment of Inertia.

$$I_{zz} = I_{xx} + I_{yy}$$

$$= (6.08 \times 10^6 + 5.69 \times 10^6)$$

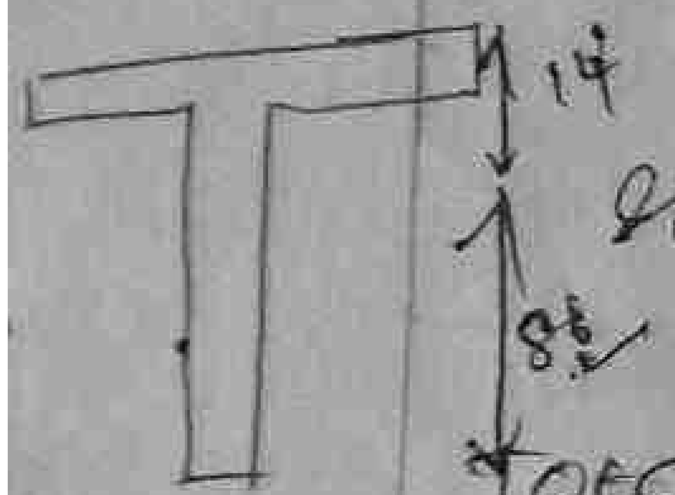
$$= 11770000.$$



$$= 11.77 \times 10^{-6}\ mm^4$$

Step : 6

Radius of gyration.



$$r_{xx} = \sqrt{\frac{I_{xx}}{A}} = \sqrt{\frac{6.08 \times 10^6}{5000}}$$

6080000 / 5000 = 1216

Total $a_1 + a_2 = 3000 + 2000 = 5000$

$\Rightarrow$ 34.871

34.871 mm.

$$r_{yy} = \sqrt{\frac{I_{yy}}{A}} = \sqrt{\frac{5.69 \times 10^6}{5000}}$$

5690000 / 5000 = 1138

Total $a_1 + a_2 = 3000 + 2000 = 5000$

$\Rightarrow$ 33.73 mm

Step :- 7.

Section modulus.

$$Z_{xx} = \frac{I_{xx}}{} = \frac{6.08 \times 10^6}{}$$

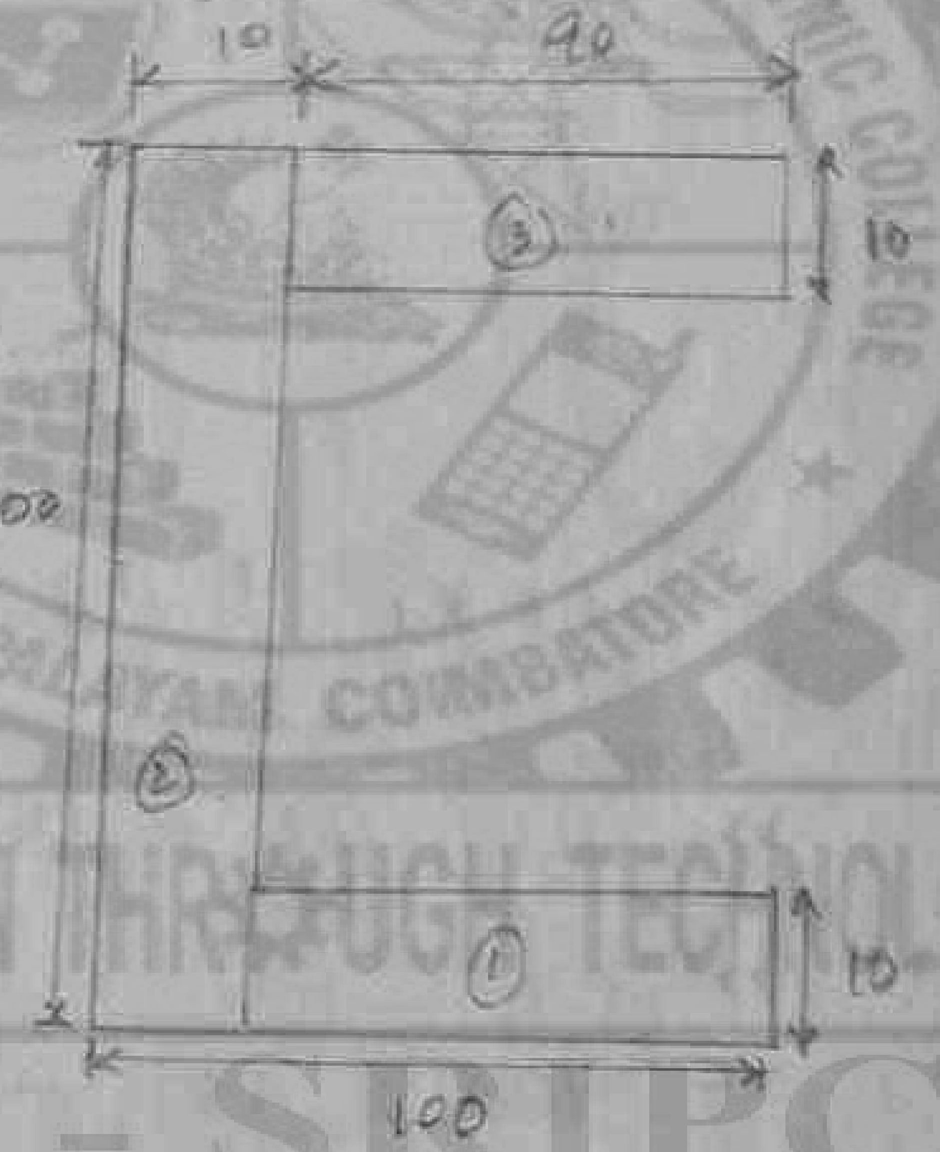
~~Z = 70~~ $Z_{xx} = 178823.52\ mm^3$

$$Z_{yy} = \frac{I_{yy}}{y_{max}}$$

$$= \frac{7.29 \times 10^6}{86}$$

$=$

Que: Find the values of I_{xx}, I_{yy}, I_{zz}, r_{xx}, r_{yy}, Z_{xx}, Z_{yy}



Step :-1

$\bar{x}, \bar{y}$ -

$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}$$

$a_1 = b \times d \Rightarrow 90 \times 10 = 900\ mm^2$.

$a_2 = b \times d \Rightarrow 10 \times 300 = 3000\ mm^2$.

$a_3 = b \times d \Rightarrow 90 \times 10 = 900\ mm^2$.

$\bar{x}, \bar{y}$

$\bar{y}_1 \Rightarrow d/2 \Rightarrow 10/2 = 5mm.$

$\bar{y}_2 = d/2 \Rightarrow 300/2 = 150mm.$

$\bar{y}_3 = ~~d+~~ 290 + 10/2 \Rightarrow 290+5$

$\Rightarrow 295mm$

$x_1 \Rightarrow b/2 \Rightarrow 10 + 90/2 = 10 + 45 = 55 mm$

$x_2 \Rightarrow b/2 \Rightarrow 10/2 = 5mm$

$x_3 \Rightarrow b/2 \Rightarrow 10 + 90/2 = 10 + 45$

$= 55mm.$

$$\bar{x} = \frac{a_1 x_1 + a_2 x_2 + a_3 x_3}{a_1 + a_2 + a_3}$$

$$= \frac{900 \times 55 + 3000 \times 5 + 900 \times 55}{900 + 3000 + 900}$$

$$= \frac{49500 + 15000 + 49500}{4800}$$

$$= \frac{114000}{4800} = 23.75$$

$$\boxed{\bar{x} = 23.75}$$

$$\bar{y} = \frac{a_1 y_1 + a_2 y_2 + a_3 y_3}{a_1 + a_2 + a_3}$$

$$= \frac{900 \times 5 + 3000 \times 150 + 900 \times 295}{900 + 3000 + 900}$$

$$= \frac{4500 + 450000 + 265500}{4800}$$

$$= \frac{720000}{4800} = \underline{\underline{150}}.$$

$$\boxed{\bar{Y} = 150}$$

Result $= \bar{X} = 23.75$

$\bar{Y} = 150$

Step :- Radius of gyration

$\bar{x}_1 = \bar{x} - x_1 \Rightarrow 23.75 - 55$

$= \underline{\underline{-31.25}}.$

$\bar{x}_2 = \bar{x} - x_2 \Rightarrow 23.75 - 5$

$= \underline{\underline{18.75}}.$

$\bar{x}_3 = \bar{x} - x_3 \Rightarrow 23.75 - 55$

$= \underline{\underline{-31.25}}.$

$\bar{Y}_1 = \bar{Y} - Y_1 \Rightarrow 150 - 5$

$= \underline{\underline{145}}.$

$\bar{Y}_2 = \bar{Y} - Y_2 \Rightarrow 150 - 150$

$= \underline{\underline{\cancel{145}\ 0}}.$

Step : 3

Moment of Inertia.

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

$$I_{xx_1} = \left(\left(\frac{b_1 d_1^3}{12} + (a_1 \bar{y}_1^2)\right)\right) + \left(\frac{b_2 d_2^3}{12} + (a_2 \bar{y}_2^2)\right)$$

$$+ \left(\frac{b_3 d_3^3}{12} + (a_3 \bar{y}_3^2)\right).$$

$$= \left(\frac{\overset{90}{\cancel{100}} \times 10^3}{12} + (900 \times 145^2)\right) + \left(\frac{\cancel{300 \times 10^3}\ 10 \times 300^3}{12} + \right.$$

$$\left.(3000 \times \overset{0}{\cancel{150}}{}^2)\right)$$

$$+ \left(\frac{90 \times 10^3}{12} + (900 \times \overset{2}{\cancel{215}} -145^2)\right).$$

$$= \left(7500 + 18922500\right) + \left(22500000 + 0\right)$$

$$+ \left(\overset{7500}{\cancel{90000}} + 18922500\right)$$

$$= 18930000 + 22500000 + \cancel{18922500}\ 18930000$$

$$= 60360000$$

$$I_{xx} = 60.36 \times 10^6$$

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$Xyy \Rightarrow \left(\frac{b_1^3 d_1}{12} + a_1 x_1^{-2}\right) + \left(\frac{b_2^3 d_2}{12} + a_2 x_2^{-2}\right) + \left(b_3^3 d_3 + a_3 x_3^{-2}\right).$

$\Rightarrow \left(\frac{90^3 \times 10}{12} + \left(900 \times -31.25^2\right)\right) +$

$\left(\frac{10^3 \times 300}{12} + \left(3000 \times 18.75^2\right)\right) +$

$\left(\frac{90^3 \times 10}{12} + \left(900 \times -31.25^2\right)\right).$

$= \left(607500 + \left(878906.25\right)\right) +$

$\left(250000 + \cancel{56250}\right) +$ ~~3164062500~~ 1054687.5.

$\left(607500 + 878906.25\right)$

$= \left(1486406.25 + \cancel{306250} + 1486406.25\right)$ 1079687.5 ~~3164312500~~ +

$= \underline{4.05 \times 10^6 \ mm^4}$

Step : 4

polar moment of Inertia.

$I_{zz} = I_{xx} + I_{yy}$

$= \left(60.36 \times 10^6 + 4.05 \times 10^6\right)$

$= \underline{64.41 \times 10^6}$

Step : 6

Radius of Gyration.

$$r_{xx} = \sqrt{\frac{I_{xx}}{A}} = \sqrt{\frac{60.36\times10^6}{4800}}$$

$$\Rightarrow \underline{112.138\ mm}$$

$$r_{yy} = \sqrt{\frac{I_{yy}}{A}} = \sqrt{\frac{4.05\times10^6}{4800}}$$

$$\Rightarrow \underline{29.04\ mm}$$

Step : 7

Section modulus.

$$Z_{xx} = \frac{I_{xx}}{Y_{max}} = \frac{60.36\times10^6}{150}$$

$$= \underline{402400\ mm^3}$$

$$Z_{yy} = \frac{I_{yy}}{Y_{max}} = \frac{4.05\times10^6}{150}$$

$$= \underline{27000\ mm^3}$$

To find the Torque.

$$P = \frac{2\pi N T}{60}$$

$$375 \times 10^3 = \frac{2\pi\ 210\ T}{60}$$

$$T = \frac{375 \times 10^3 \times 60}{2 \times \pi \times 210}$$

$$T = 17.05 \times 10^3 \text{ N mm}.$$

Shear stress $= T = \frac{\pi}{16}(D^3)\ \tau_{max}$.

$$17.05 \times 10^3 = \frac{\pi}{16} D^3 \times 50$$

$$D^3 = \frac{17.05 \times 10^3 \times 16}{\pi \times 50}$$

$$D^3 = 1736.698739$$

$$D = (1736.698739)^{1/3}$$

$$D = 12.02 \text{ mm}$$

Result

least value of shaft $= 12.02$ mm

angle of twist $= \frac{T}{IP} = \frac{G\theta}{l}$

$$= \frac{17.05 \times 10^3}{Jp} = \frac{80 \times 10^3 \times \frac{\pi}{180}}{3000}$$

$$Jp = \frac{17.05 \times 10^3}{0.465}$$

$$Ip = 36666.66.$$

4. $Jp = \frac{\pi}{32} D^4$ — $36666.66 = \frac{\pi}{32} D^4$.

$D^4 = \frac{36666.66}{\pi/32}$

$D = (~~364730116~~\ 373483.5319)^{(1/4)}$

$D \approx 24.72$ mm

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14/10/21
Friday

Unit - IV

Stresses in Beams And Shafts

Power Transmitted by Shaft :-

$$\boxed{P = \frac{2\pi N T}{60} \ Nm/sec}$$

$\boxed{\text{Shear stress :- } (\tau_{max})}$ Tou

$$\boxed{T = \frac{\pi}{16} D^3 \tau_{max}}$$

To find angle of twist

angle of twist rotation = θ
max shear stress tion = τou.

$$\boxed{\frac{T}{J_P} = \frac{G\theta}{l}}$$

Que: 1 Find the power transmitted by a shaft 50mm dia at 150 mm RPM if the maximum permissible stresses $80 N/mm^2$?

Given :-

dia (d) = 50mm

speed (N) = 150 rpm

$\tau_{max} = 80 N/mm^2$.

To find :-

power (P) = ?

$$P = \frac{2\pi N T}{60} \ Nm/sec$$

Torque :

$T = \pi/16 \ D^3 \times \tau_m$

$= \pi/16 \ (50)^3 \times$

$T \Rightarrow 1.96 \times 10^6 \ Nm$

$P = \frac{2 \times \pi \times 150 \times 1.46 \times 10^6}{60}$

$P \Rightarrow 1.84725 \times 10^9$

30.78×10^6 KW.

Qn. 2. Mild steel shaft 80 mm dia transmits 100 kW at 240 RPM. Calculate the maximum intensity of stress induced and the angle of twist in degree for length of 5m take $G = 80\ GN/m^2$.

Given :-

dia (d) = 80 mm

power (P) = 100 kN = 100×10^3 W

speed (N) = 240 RPM

length (l) = 5m

Modulus of Rigidity (G) = ~~80~~ 80 GN/m^2 = $80 \times 10^3\ N/mm^2$.

To find :-

Max intensity of shear stress τ_{max}.

angle of twist (θ)

power $P = \frac{2\pi N T}{60}$

$100 \times 10^3 = \frac{2\pi \times 240 \times T}{60}$

100×10^3 ~~$\times 10^9$~~ $= 25.13\ T$

$T = \frac{100 \times 10^3}{25.13}$

$T \Rightarrow 3979.30\ 76$ ~~39912.57~~

~~$= 39.91 \times 10^3$~~

$\boxed{T \Rightarrow 3979.30\ Nm}$

$\boxed{= 3.97 \times 10^6\ Nmm.}$

$$T = \frac{\pi}{16} \times D^3 \times \tau_{max}$$

$$3.97 \times 10^6 = \pi/16\,(80^3) \times \tau_{max}$$

$$\tau_{max} = \frac{3.97 \times 10^6}{\pi/16 \times 80^3}$$

$$= \frac{3970000}{\pi/16 \times 512000}$$

$$= \cancel{39.490 \times 10^3} = 39.4032026$$

100.5310.5649

$$\boxed{\tau_{max} \Rightarrow 39.\cancel{5}9\ N/mm^2}$$

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~~τ_{max}~~

2. To find angle of twist (θ).

$$\frac{T}{I_P} = \frac{G\theta}{l}$$

$$I_P = \pi/32\,(D^4).$$

$$\frac{Tl}{GI_P} = \theta.$$

$$\theta = \frac{3.979 \times 10^6 \times 5000}{80 \times 10^3 \times \frac{\pi}{32}(80)^4}$$

$\Rightarrow 0.061$ Radius

$\Rightarrow 0.061 \left(\frac{180}{\pi}\right)$

$\Rightarrow$.

14/10/22
Friday

UNIT - IV

STRESS IN BEAMS AND SHAFTS.

Power Transmitted by shaft :-

$$\boxed{P = \frac{2\pi NT}{60} \text{ Nm/sec}}$$

Shear stress :- τ_{max}.

$$\boxed{T = \pi/16 \; D^3 \; \tau_{max}}$$

To find angle of twist.

$$\boxed{\frac{T}{I_P} = \frac{G\theta}{l}}$$

Que:1 Find the power transmitted by a shaft 50mm dia at 150 rpm. If the maximum permissible stresses 80 N/mm² ?

Given :-

dia (d) = 50mm

speed (N) = 150 rpm

τ_{max} = 80 N/mm².

Torque :- $T = \pi/16 \; D^3 \times \tau_{max}$

$= \pi/16 \; (50)^3 \times 80$

$T \Rightarrow 1.96 \times 10^6$ NM.

$$\therefore P = \frac{2 \times \pi \times 150 \times 1.96 \times 10^{6}}{60}$$

$$= \underline{30.78 \times 10^{6} \text{ kw.}}$$

Que:2.

A mild steel shaft 80 mm dia transmits 100kw at 240 rpm. calculate the maximum intensity of stress induced and the angle of twist in degree for length of 5m. Take $G = 80$ GN/m²

Given :-

Dia $(d) = 80$ mm

power $(P) = 100$ kw $= 100 \times 10^{3}$ N.

Speed $(N) = 240$ Rpm.

Length $(l) = 5$m.

Modulus of rigidity $(G) = 80$ GN/m²

$= 80 \times 10^{3}$ N/mm².

To find :-

max intensity of shear stress τ_{max} angle of twist (θ).

$$\text{Power } P = \frac{2\pi N T}{60}$$

$$100 \times 10^{3} = \frac{2\pi \times 240 \times T}{60}$$

$$100 \times 10^{3} = \frac{1507.96 \times T}{60}$$

$$100 \times 10^{3} = 25.13\, T.$$

$$T = \frac{100 \times 10^7}{25.13}$$

$$T = \underline{3978.87 \times 10^3 \text{ NM}}$$

$$T = \underline{\underline{3.97 \times 10^6 \text{ Nm}}}$$

$$\tau_{max} = T = \pi/16 \times D^3 \times \tau_{max}$$

$$3.97 \times 10^6 = \pi/16 \times 80^3 \times \tau_{max}$$

$$\tau_{max} = \frac{3.97 \times 10^6}{\pi/16 \times 80^3}$$

$$\tau_{max} = \cancel{39.49} \frac{3970000}{\pi/16 \times 512000}$$

$$= 39.4032226$$

$$\tau_{max} \Rightarrow 39.49 \text{ N/mm}^2$$

To find angle of twist, θ.

$$\frac{T}{I_P} = \frac{G\theta}{l} \qquad I_P = \pi/32 (D^4)$$

$$\frac{Tl}{GI_P} = \theta$$

$$\theta = \frac{3.979 \times 10^6 \times 5000}{80 \times 10^3 \times \pi/32 \times (80)^4}$$

$$= 0.061 \text{ Radius}$$

$$\theta = 0.061 (180/\pi)$$

$$\theta = \underline{\underline{3^\circ 32' 27''}}$$

Que: 3 A Solid circular Steel shaft has to transmit 375 kW at 210 RPM. The maximum shear stress is not to exceed 50 N/mm², and the angle of twist must not be more than 1° in a length of 3m. Select suitable diameter, take G = 80 kN/mm².

Ans. GIVEN :-

Power (P) = 375 kW = 375×10^3 W.

Speed (N) = 210 RPM

Angle of twist (θ) = 1°

Shear stress (τ_{max}) = 50 N/mm².

Length = 3m.

G = 80 kN/mm² = 80×10^3.

Step - 1

$$P = \frac{2\pi N T}{60} = 375 \times 10^3$$

$$= \frac{2\pi \times 210 \times T}{60}$$

$$T = \frac{375 \times 10^3 \times 60}{2\pi \times 210}$$

$$T = \underline{\underline{17.05 \times 10^3}}.$$

Step - 2.

$$\frac{T}{I_P} = \frac{G\theta}{l}.$$

$$\frac{17.05 \times 10^3}{I_P} \quad +$$

$$= \frac{80 \times 10^3 \times \pi/180}{3000}$$

$$\frac{17.05 \times 10^3}{I_P} = \frac{1396.26}{3000}$$

$$\frac{17.05 \times 10^3}{I_P} = 0.465$$

$$I_P = \frac{17.05 \times 10^3}{0.465}$$

$$I_P = 36633.48903$$

$$I_P = \pi/32 \; D^4$$

$$37065.21 = \pi/32 \; (D)^4$$

$$D^4 = \frac{36633.48}{\pi/32}$$

$$D = (373145.6552)^{1/4}$$

$$D = \underline{\underline{24.71 mm}}$$

$$T = \pi/16 \times D^3 \times \tau_{max}$$

$$17.05 \times 10^3 = \pi/16 \times D^3 \times 50$$

$$D^3 = \frac{17.05 \times 10^3}{\pi/16 \times 50}$$

$$D = 1736.69^{1/3}$$

$$D = 12.02\,mm$$

Dia of shaft = 12.02

Que: Find the maximum torque that can be applied safely to a circular solid shaft 300 mm dia the permissible angle of twist is 1.5° in a length of 7.5m and shear stress is not exceed 42 N/mm² and $G = 84.4\ kN/mm^2$.

Ans. Given :-

Diameter $(D) = 300\ mm$.

Angle of twist $(\theta) = 1.5°$.

length $(l) = 7.5\ m = 7500.0\ mm$.

Shear stress $= \tau_{max} = 42\ N/mm^2$.

$$G = 84.4\ kN/mm^2.$$

$$= 84.4 \times 10^3\ N/mm^2.$$

$$\text{Torque} = T = \pi/16 \times D^3\ \tau_{max}.$$

$$T = \pi/16 \times 300^3\ 42.$$

$$T = 222.66 \times 10^{6}$$

$$\frac{T}{J_P} = \frac{G\theta}{l}$$

$$\frac{T}{\pi/32 \times 300^{4}} = \frac{84.4 \times 10^{3} \times 1.5 \times \pi/180}{1500}$$

$$T = \frac{84.4 \times 10^{3} \times 1.5\pi/180 \times \pi/32 \times 300^{4}}{1500}$$

$$T = 234.279 \times 10^{6} \text{ N/mm}$$

maximum torque $= 234.279 \times 10^{6}$ N/mm.

28/10/22
Friday

Problem :

Que : Determine the maximum power transmitted by a hollow circular shaft of 200 mm external diameter and 160 mm internal diameter which is transmitting power at 80 RPM. The angle of twist in a length 3m was found to be 0.7°.

$G = 0.8 \times 10^5 \ N/mm^2$.

Given :-

Speed (N) = 80 Rpm

Diameter (external) = 200 mm

Diameter (internal) = 160 mm

Angle of twist (θ) = 0.7°

Length (l) = 3m = 3000 mm

G (modulus of rigidity) = $0.8 \times 10^5 \ N/mm^2$

To find

Power (P) = ?

$$P = \frac{2\pi N T}{60}$$

$$\frac{T}{I_P} = \frac{G\theta}{l}$$

$$I_P = \pi/_{32} \left(D^4 - d^4\right)$$

$$\frac{T}{J_P} = \frac{G\theta}{l}$$

$$\frac{T}{2356194490} = \frac{0.8 \times 10^5 \times 10^\circ \times \pi/180}{10000}$$

$$T = \frac{(0.8 \times 10^5) \times (10^\circ \times \pi/180) \times (2356194490)}{10000}$$

$$= 3289.86 \times 10^6 \ \text{Nmm}.$$

02/11/22
Wednesday

4th unit (IInd half)

Bending Equation

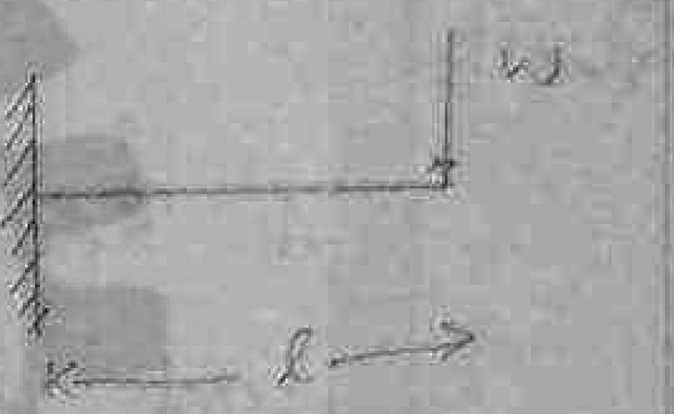
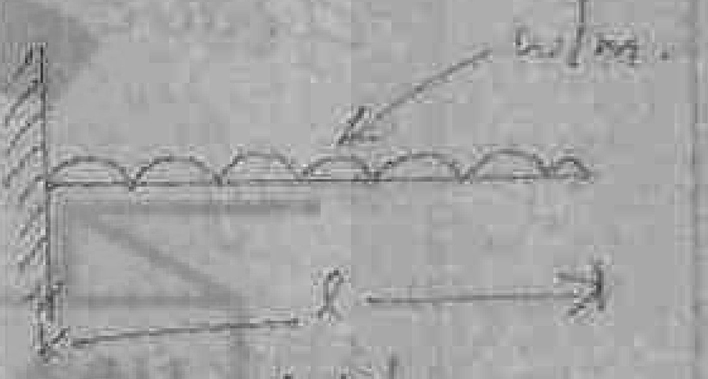
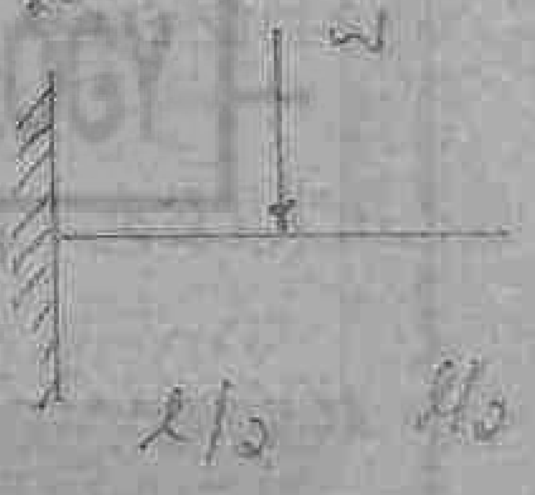
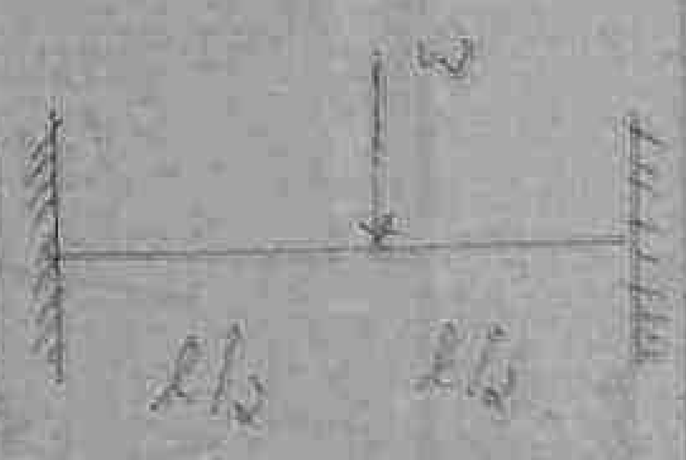
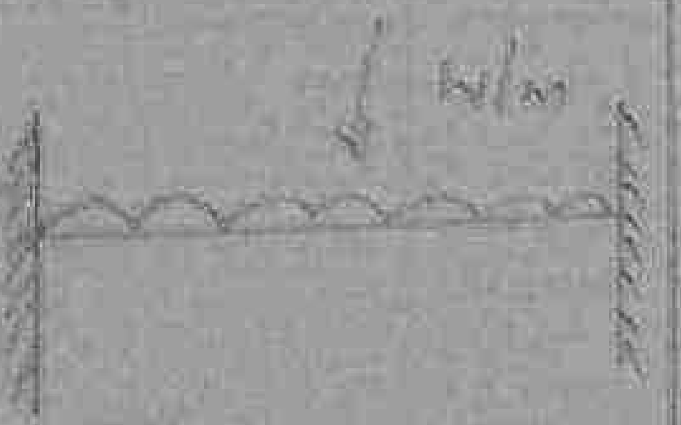
Imp

$$\boxed{\frac{M}{I} = \frac{\sigma}{y}}$$ → Moment of resistance

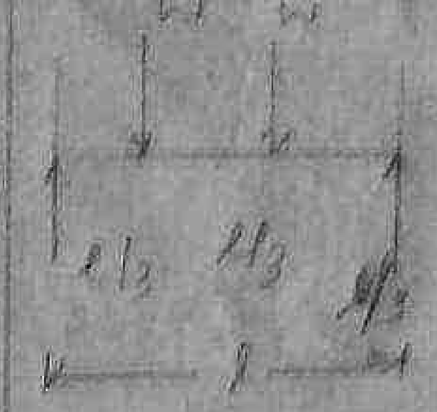
The max bending moment 'M' for standard cases.

$KN = N \times 10^3$.

$N = KN / 10^3$.

S.No	Type of Beam	Max BM = M	Figure
1.	A cantilever Beam with point load at the free end.	$\boxed{wl}$	
2.	A cantilever with UDL over entire length of the Beam.	$\boxed{\frac{wl^2}{2}}$	
3.	A cantilever Beam with point load at mid of span.	$\boxed{\frac{wl}{2}}$	
4.	Simply supported Beam with point load at mid span.	$\boxed{\frac{wl}{4}}$	
5.	A simply supported Beam with ~~point load~~ UDL throughout of the span.	$\boxed{\frac{wl^2}{8}}$	

Scanned by TapScanner

6.	Simply Supported Beam two equal loads at equal distance (a) of the Span.	Wa	
7.	Simply Supported Beam with unsymmetrically loaded.	$\frac{Wab}{l}$	

PROBLEMS

$MI \Rightarrow$ moment of inertia

Que:1

A Beam of Symmetricall Section is 350 mm deep and has a 'MI' of ~~a deep~~ 131.6×10^6 mm^4. about its principal anis. To what radius it may be bend. If the maximum Stress is not to enceed 126 N/mm^2. ~~Take~~

Take $E = 2 \times 10^5$ N/mm^2. what would be the moment of resistance at this Stress?

Given :-

$d = 350$ mm (diameter).

$M.I = 131.6 \times 10^6$ mm^4 (moment of inertia).

$E = 2 \times 10^5$ N/mm^2. (young's modulus).

To find :-

Radius (R)

Moment of inertia (M.I).

1). Radius of curvature (R).

$$\frac{\sigma}{y} = \frac{E}{R}$$

$d = 350$

$$R = \frac{Ey}{\sigma}$$

$y = \frac{d}{350}$

$Y = d/2$

$= 350/2 = \frac{350mm}{2} = 175\,mm$.

$y = 175\,mm$.

$$R = \frac{2 \times 10^5 \times 175}{126}$$

$R = 277.77 \times 10^3\ N/mm$

$R = 277.77\,mm$.

2). To find the moment of Resistance.

m = moment of Inertia.

$$\frac{M}{I} = \frac{\sigma}{y}$$

$$M = I\frac{\sigma}{y}$$

$$\frac{mm^4 \times N/mm^2}{mm} = N/mm^3.$$

$$m = \frac{131.6 \times 10^6 \times 126}{175}$$

$= 94.75 \times 10^6\ N/mm^3$

Que: When a Rectangular beam 300 mm beam is simply supported over a span of 4m that uniformly distributed load the beam can carry if the bending stress not to be exceed 120 MPA take $I = 225 \times 10^4$ mm⁴

Given :-

Rectangular Beam

$D = 300$ mm

$l = 4m = 4000$ mm

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

$\sigma_b = 120$ MPa

To find :-

Udl = ?

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

$D/2 = 300/2$

$y = 150$

$$\frac{M}{225 \times 10^4} = \frac{120}{150}$$

$M = 1.8$ kNm

$= 1.8 \times 10^6$ Nmm

$$M = \frac{wl^2}{8}$$

$$1.8 \times 10^6 = \frac{w(4000)^2}{8}$$

$$w = \frac{1.8 \times 10^6 \times 8}{(4000)^2}$$

$w = 0.9 \ kN/m$.

Que: A beam of Symmetricall Section depth 400mm. and $I = 193 \times 10^6 \ mm^4$ is simply supported over a span = 8m. What UDL ~~make~~ may it carry. If the bending stresses not to enceed $120 \ N/mm^2$?

what concentrated load may be carried by the beam at the center with these same permissible stess.

Given :-

depth(d) = 400 mm

$I = 193 \times 10^6 \ mm^4$.

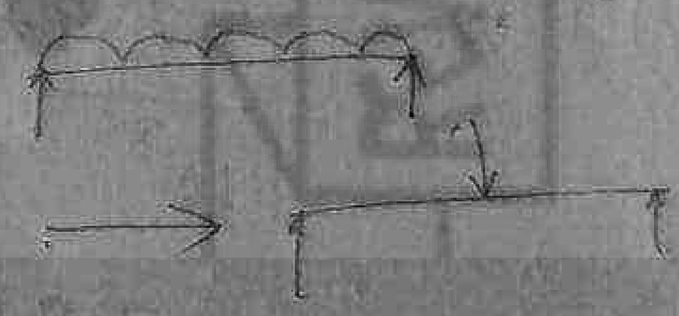
span(l) = 8 m = 8000mm.

bending stress (σ_b) = $120 \ N/mm^2$.

To find :

UDL →

p.t (conc. load) →



$y = d/2$
$= 400/2$
$= 200$.

1). Moment of Resistance.

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

$$\frac{M}{193 \times 10^6} = \frac{120}{200} \qquad M = \frac{193 \times 10^6 \times 120}{200}$$

$$M = 115.8 \times 10^6 \ N\,mm.$$

1). <u>UDL</u> <u>S.S</u>

$$M = \frac{wl^2}{8}$$

$$115.8 \times 10^6 = \frac{w \times (8000)^2}{8}$$

$$w = \frac{115.8 \times 10^6 \times 8}{(8000)^2}$$

$$= 14.475 \text{ KNm}.$$

2). Point load :-

$KN = N \times 10^3$.
$N = KN / 10^3$.

$$M \Rightarrow \frac{wl}{4}$$

$$\cancel{11.5 \times 8} \; 115.8 \times 10^6 = \frac{w (8000)}{4}$$

$$w = \frac{57.9 \cancel{\times 10^6}}{10^3}$$

$$M = 57.9 \text{ KN}.$$

7/11/22
Monday

5th Unit

PIN JOINTED FRAMES

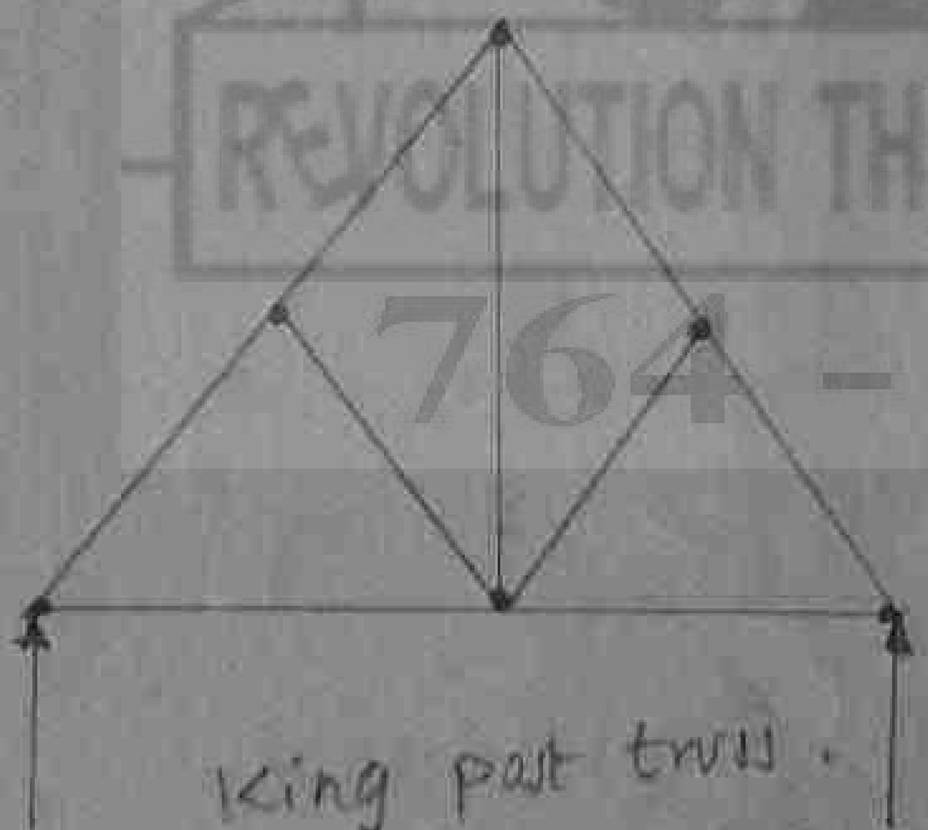
FRAMES :-

The builds up structures made up of several members angles, channels, pipe etc. To resist external loads is known as frames.

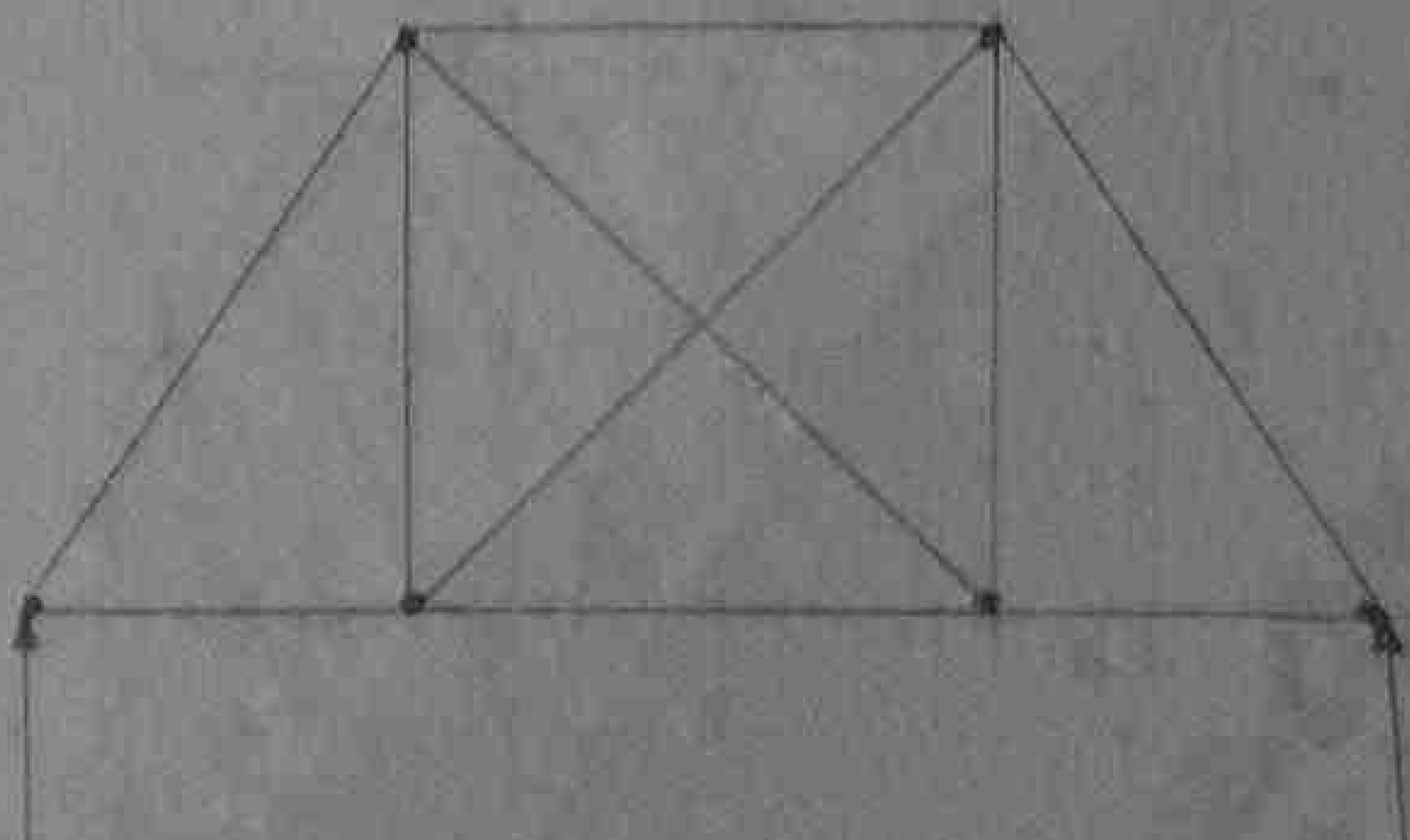
Truss :-

Trusses are made by series of triangles.

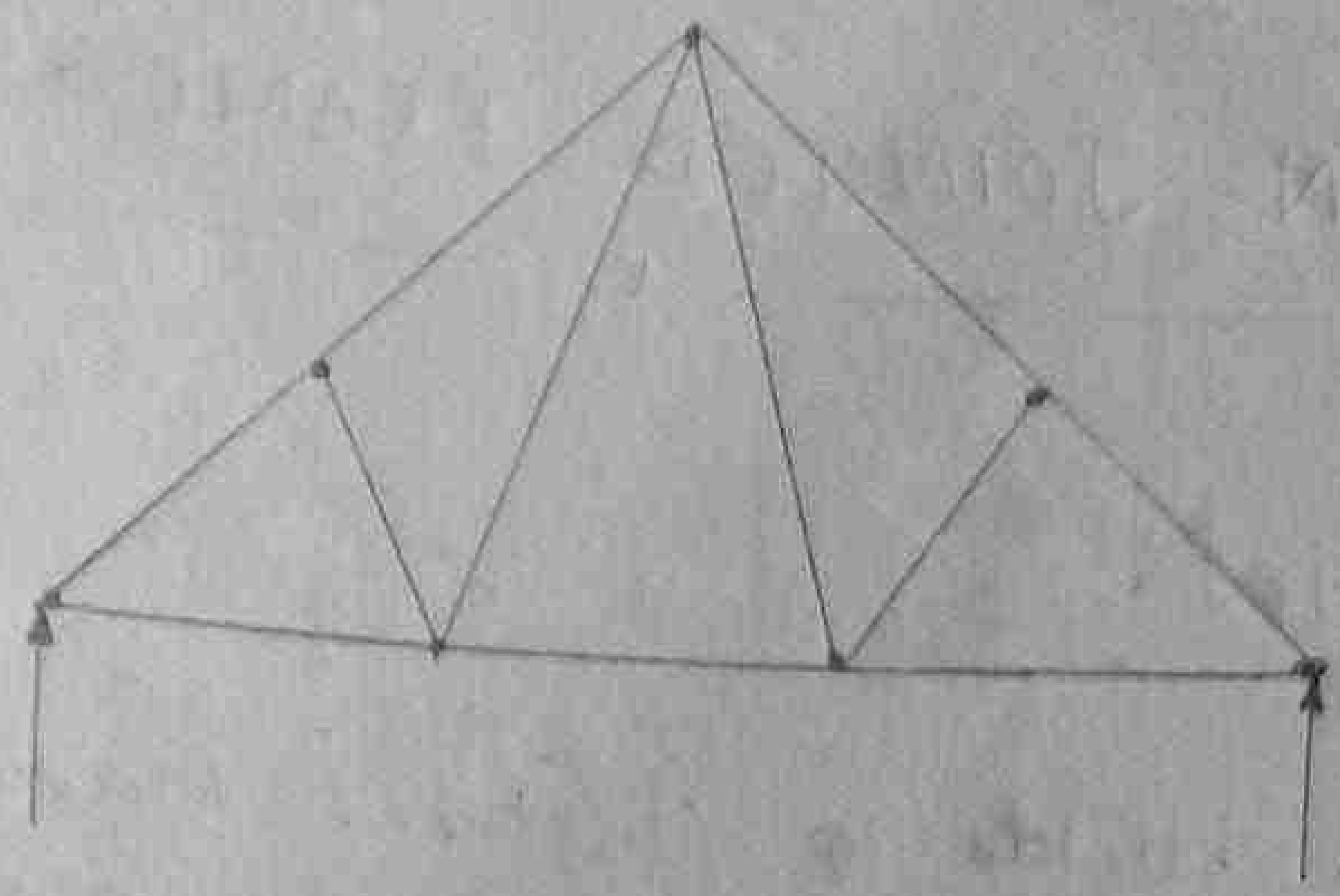
Types of Truss :-



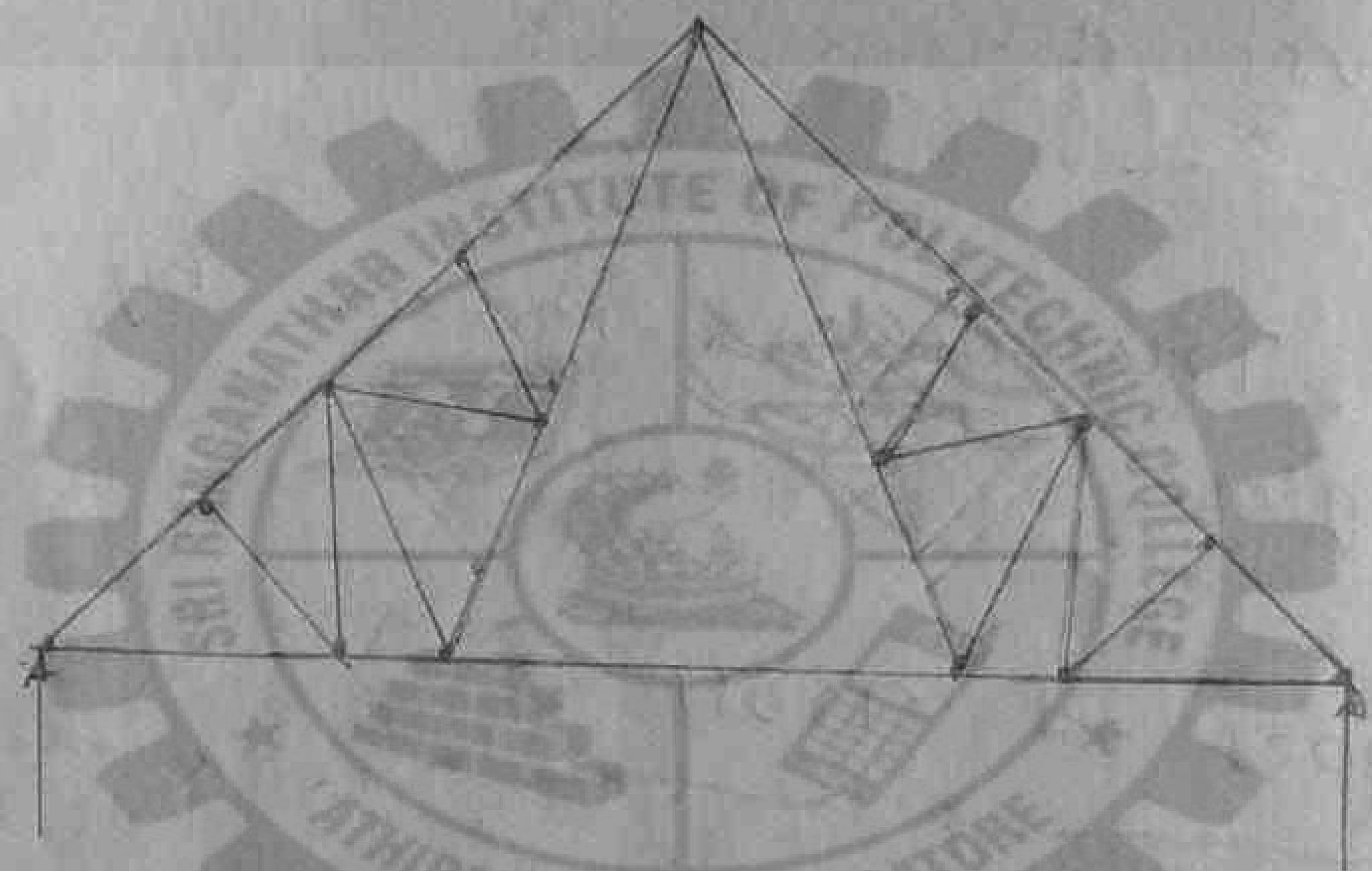
King post truss.
(upto 8m)



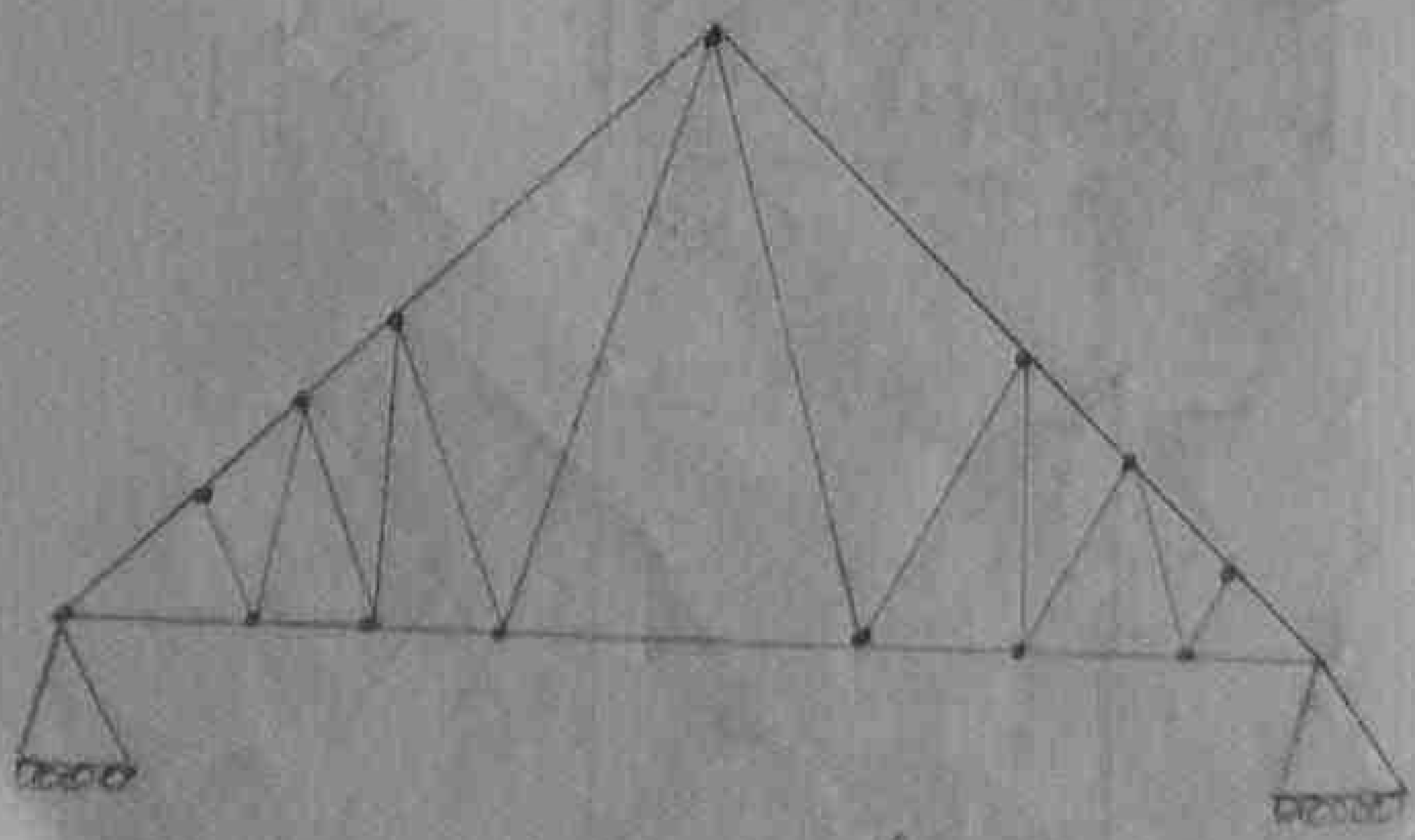
Queen post truss (up to 10m).



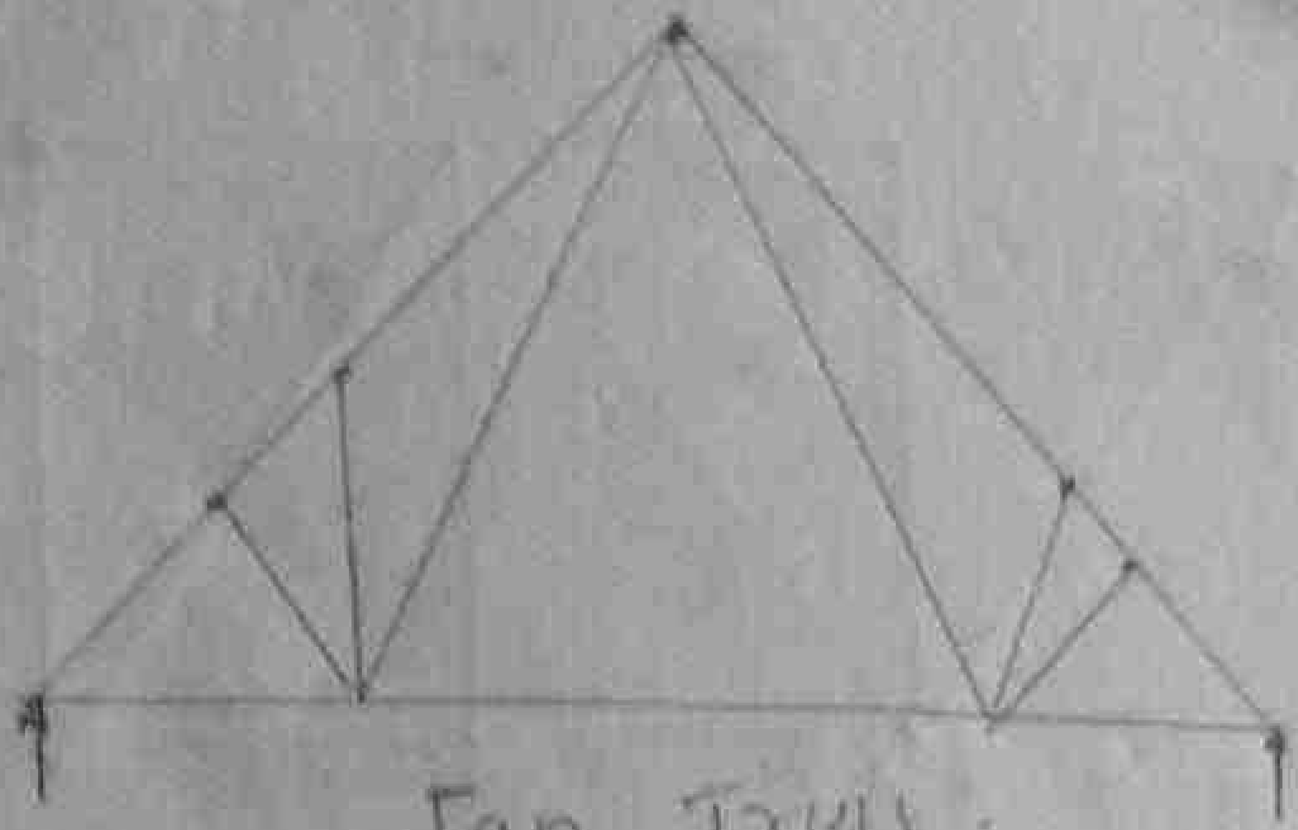
Fink Truss : (8 to 10m).



Compound Fink Truss.

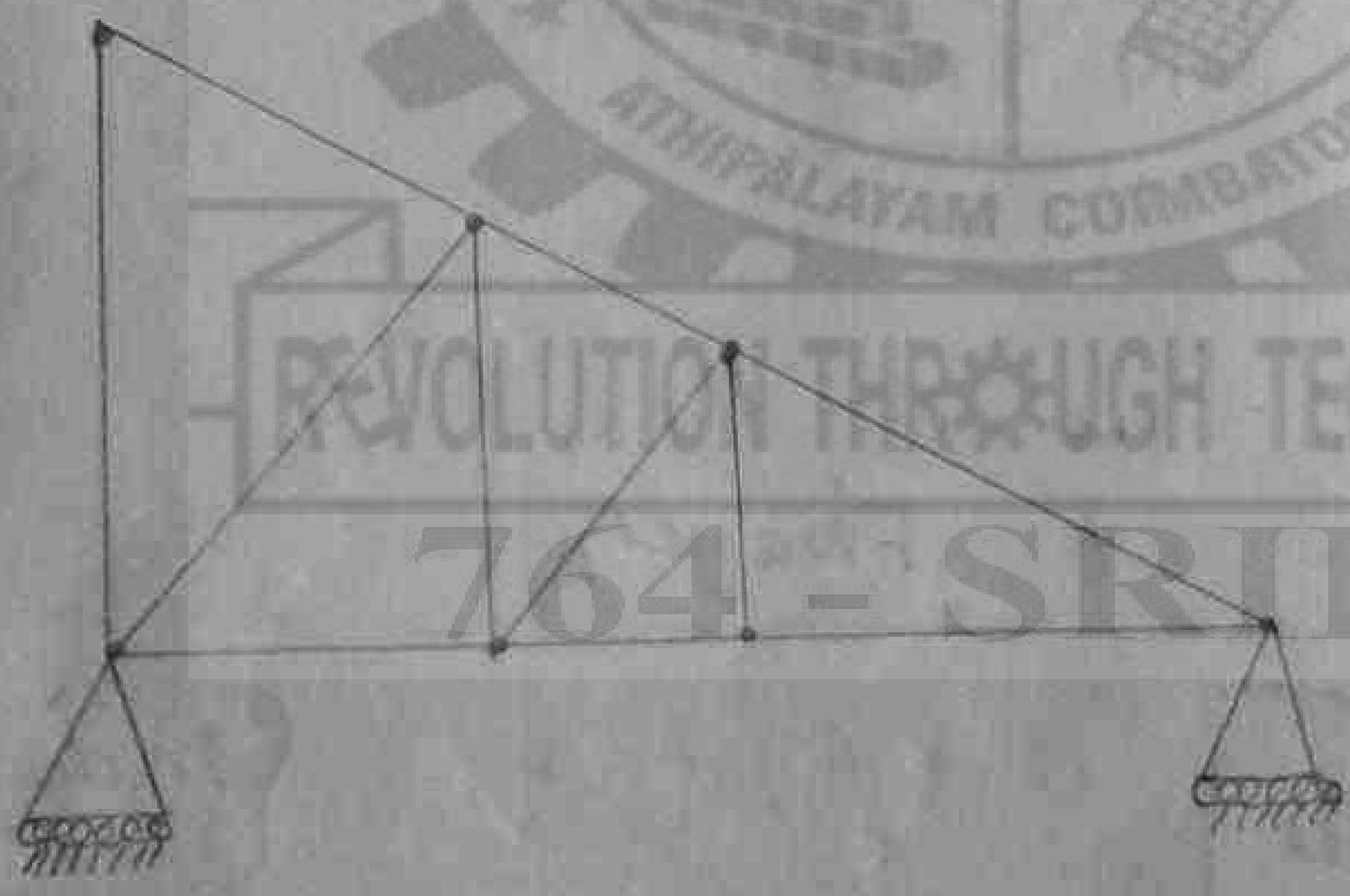


Pratt Truss (10 to 30m).

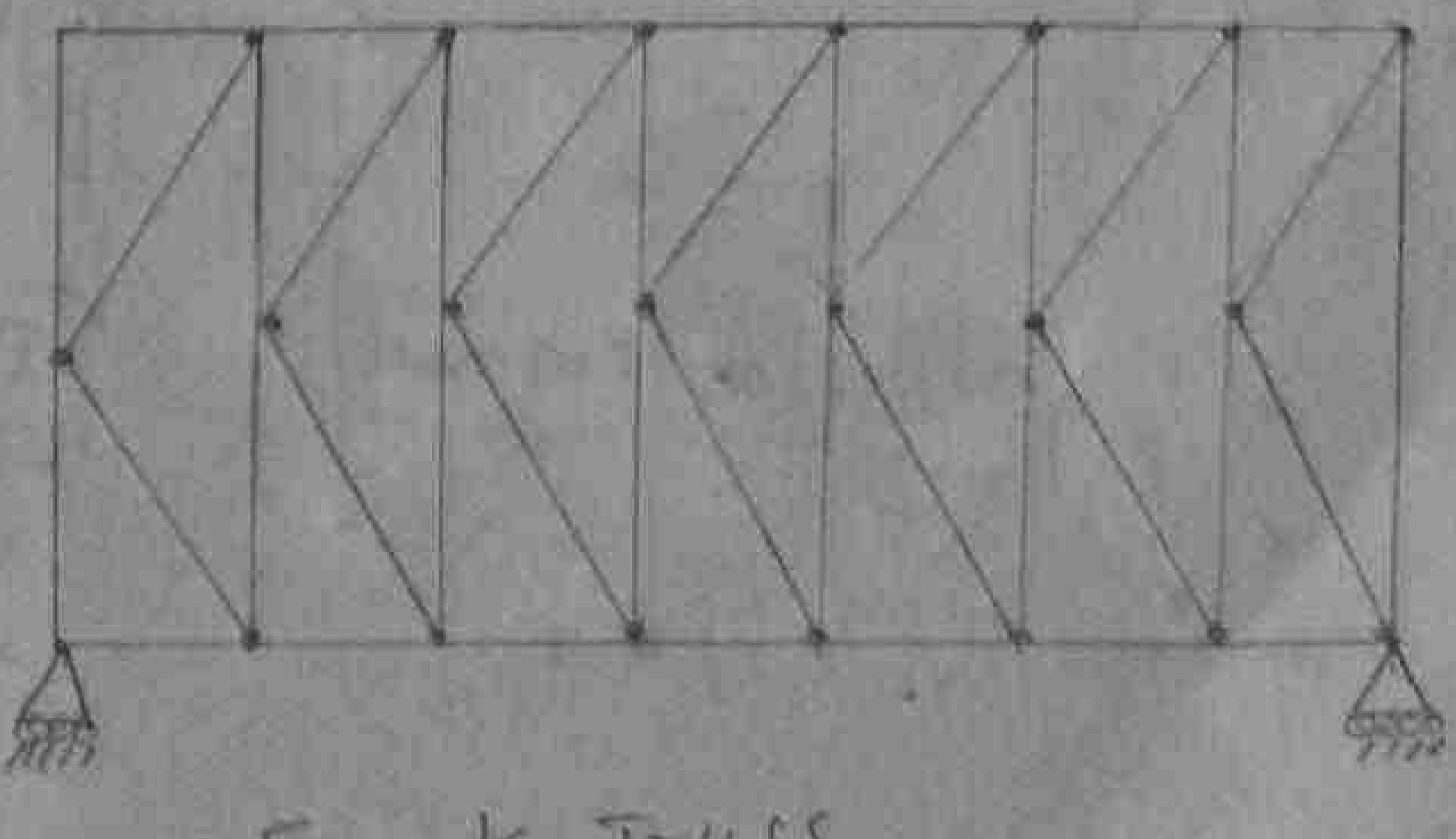


Fan Truss.

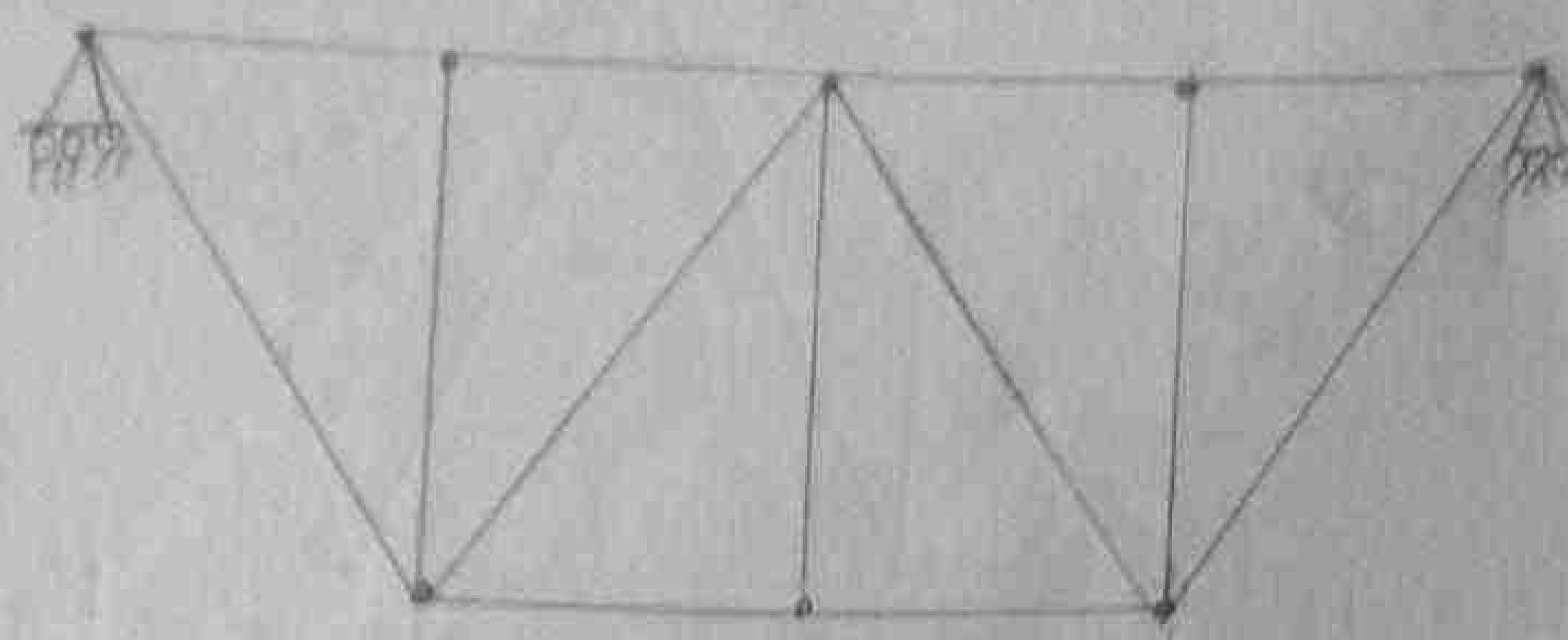
For Through Bridges.



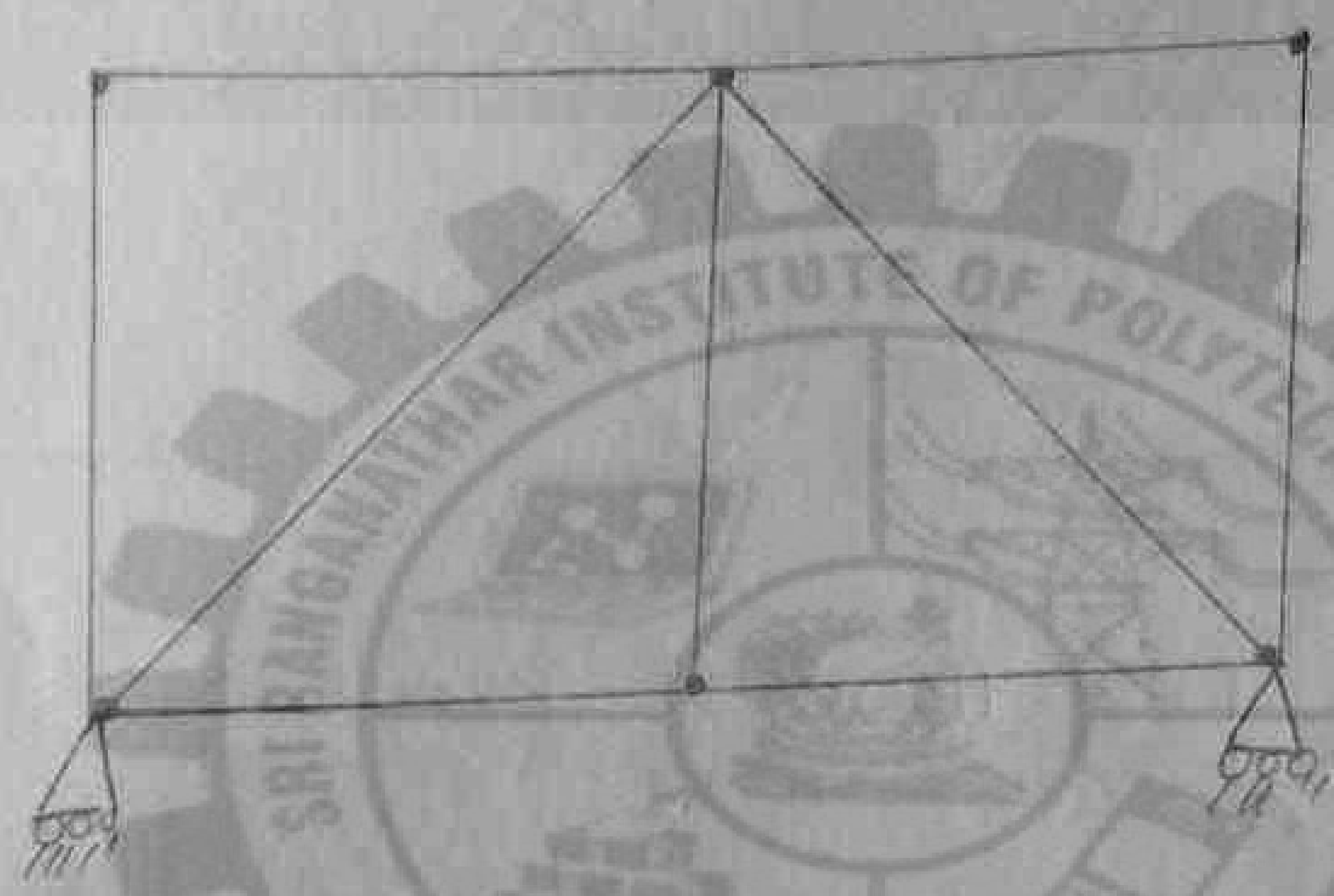
North Light Truss.



For K Truss.



For Deck Bridge.



N Truss

Frames :-

Frames

- Determinate Frames
  - perfect frames
    - $M = 2j - 3$
  - imperfect frames
    - $M \neq 2j - 3$.
      - Deficient frames
        - $M < 2j - 3$.
      - Redundant Frames.
        - $M > 2j - 3$.
- indeterminate Frames.

Qn 1.

Give data :-

Dia of Rod (d) = 20mm.

Gauge length (l) = 200 mm.

Yield load (Py) = 85 KN = 85×10^3.

Ultimate load (Pu) = 120 KN = 120×10^3.

Breaking load (PB) = 90 KN = 90×10^3.

final length = 205.6 mm.

Neck diameter = 14.5 mm.

To find :-

i). Yield stress (σ_y)

ii). Breaking stress

iii). ultimate stress.

iv). % elongation & constraction.

Solution :-

$$\text{Area} = \frac{\pi d^2}{4} = \frac{\pi \times 20^2}{4} = \underline{314.15 \text{ mm}^2}$$

i). Yield stress (σ_y) = $\frac{\text{load at yield point}}{\text{original ~~length~~ area}}$

$$\sigma_y = \frac{P_y}{A}$$

$$= \frac{85 \times 10^3}{314.15} = \underline{270.57 \text{ N/mm}^2}$$

$\sigma_y = 270.57 \text{ N/mm}^2$.

ii). nominal Breaking stress (σ_B) = $\frac{\text{load at breaking point}}{\text{original ~~length~~ area}}$

$$\sigma_y = \frac{P_B}{A}$$

$$= \frac{90 \times 10^3}{314.15} = \underline{286.48 \text{ N/mm}^2}$$

Actual Breaking Stress $= \frac{\text{load at breaking } (P_B)}{\text{waist area}}$

waist area $= \frac{\pi d_1^2}{4} = \frac{\pi \times 14.5^2}{4} = 165.12\ mm^2$.

Actual breaking stress $= \frac{P_B}{\text{waist area}} = \frac{90 \times 10^3}{165.12}$

$= 545.05\ N/mm^2$.

iii). Ultimate stress $= \frac{\text{Ultimate load}}{\text{Area.}}$

$= \frac{P_U}{A} = \frac{120 \times 10^3}{314.15}$

$= 381.98\ N/mm^2$.

iv). % of elongation

$= \frac{\text{~~Total length~~ final length} - \text{original length}}{\text{original length}} \times 100$

$= \frac{205.6 - 200}{200} \times 100$

$= 2.8\ \%$.

v). % of contraction in area

$= \frac{\text{original area} - \text{waist area}}{\text{original area}} \times 100$

$= \frac{314.15 - 165.12}{314.15} \times 100$

$= 47.4\ \%$.

Results

Yield stress = 270.57 N/mm^2.

nominal Breaking stress = 286.48 N/mm^2.

actual breaking stress = 545.05 N/mm^2.

Ultimate stress = 381.98 N/mm^2.

% of elongation = 2.8 %.

% of contraction = 47.4 %.