TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
PULCHOWK CAMPUS

# A LAB REPORT
ON

Behaviour of Beam in Torsion / SIMPLE BENDING TEST / Column Behaviour & Buckling

10 July '23

Lab No.: 1, 2, 3

Experiments Date: 080 - 02 - 14

Submission Date: ~~080-02-28~~ / ~~2080-03-17~~

2080-03-25


SUBMITTED BY:

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## (1) TITLE:

THE ELASTIC FLEXURE BEHAVIOUR OF STEEL BEAMS

## (2) OBJECTIVES:

(a) To establish load-deflection characteristic, bending moment-deflection characteristic, inverse of moment of inertia-deflection characteristic and cube of span length-deflection characteristic curve of given beams.

(b) To compare theoretical value of proportionality constant with practical value.

## (3) INTRODUCTION:

The axis of the loaded beam bends in a curve, which is known as a deflection curve. Deflection of a point on the axis of the beam is the distance between its position before loading and after loading. The deflection of a simply supported beam with central load is given by.

$$\delta = \frac{W\cancel{3}L^2 x}{16EI} - \frac{Wx^3}{12EI} \quad \text{— (1)}$$

At center of the beam,

$x = \frac{L}{2}$ deflection will be maximum

$$\delta = \frac{WL^3}{48EI} \quad \text{— (2)}$$



Where,

W = ~~trans~~ traverse load

L = span of the beam

E = Modulus of elasticity

I = Moment of inertia of the cross-section of the beam

Again, at center,

Bending moment (M) = $\frac{WL}{4}$, therfore from equation (2),

$$\delta = \frac{ML^2}{12EI} \quad \text{—— (3)}$$

If E, I and L maintained constant, the from equation (2),

$$\delta = K_1 W \quad —(4)$$

And from equation (3),

$$\delta = K_2 M \quad —(5)$$

Similarly, if E, I and W maintained constant, then from equation (2),

$$\delta = K_3 L^3 \quad —(6)$$

Likewise if E, W & I maintained constant, then from equation (2),

$$\delta = \frac{K_4}{I} \quad —(7)$$

Where $K_1, K_2, K_3$ and $K_4$ are constants.

From these equations, it is clear that deflection is directly proportional to transverse load, bending moment and cube of span length; and inversely proportional to moment of inertia of the section. If graph between deflection and load/bending moment/cube of span length/ inverse of moment of inertia are drawn, then these will be straight lines upto elastic limit.

(4) PROCEDURE:

(1) Fixed the support at the required span length.

(2) The both supports were maintained at same level with the help of dial gauge.

(3) The beam was placed over the supports.

(4) The load hanger was placed at the ~~m~~ center of the span.

(5) Dial gauge was set at the middle of span.

(6) Initial reading of the dial gauge was taken.

(7) Loads of load hanger was placed and successive dial gauge readings were noted.

(8) After optimum load again readings were taken in descending orders.

(9) Average deflection was calculated.

(10) The whole process was repeated for different span length and thickness of the beam.

(11) Deflection V/s load/bending moment/cube of span length/inverse of moment of inertia curves were drawn.

## (5) OBSERVATION AND CALCULATION:-

For 5mm thick beam with width 25mm

| Load (N) | Span length (l) = 900mm | | Average | Average Deflection (mm) | Theoretical value (mm) |
|---|---|---|---|---|---|
| | Increasing | Decreasing | | | |
| 0 | 8.00 | 7.93 | 7.96 | - | - |
| 5 | 6.67 | 6.63 | 6.65 | 1.310 | 1.389 |
| 10 | 5.30 | 5.25 | 5.28 | 2.680 | 2.777 |
| 15 | 3.92 | 3.90 | 3.91 | 4.050 | 4.166 |
| 20 | 2.52 | 2.52 | 2.52 | 5.440 | 5.554 |

For 3mm thick beam with width 25mm

| Load (N) | Span length (l) = 900mm | | Average Reading | Average Deflection (mm) | Theoretical value (mm) |
|---|---|---|---|---|---|
| | Increase | Decrease | | | |
| 0 | 8.30 | 8.43 | 8.36 | - | - |
| 1 | 7.02 | 6.83 | 6.93 | 1.430 | 1.286 |
| 2 | 5.78 | 5.86 | 5.80 | 2.560 | 2.571 |
| 3 | 4.75 | 4.49 | 4.62 | 3.740 | 3.857 |
| 4 | 3.42 | 3.44 | 3.43 | 4.930 | 5.143 |
| 5 | 2.24 | 2.24 | 2.24 | 6.120 | 6.429 |

For 5mm thick ~~spo~~ beam of width ~~8~~ 25mm

| Load (N) | Span length (l) = 800mm | | Average Reading | [(I)-i] Average Deflection (mm) | Theoretical value (mm) |
|---|---|---|---|---|---|
| | Increase | Decrease | | | |
| 0 | 9.05 | 9.04 | 9.045(I) | - | - |
| 5 | 8.05 | 8.03 | 8.04 | 1.005 | 0.975 |
| 10 | 7.08 | 7.02 | 7.05 | 1.995 | 1.950 |
| 15 | 6.03 | 6.01 | 6.02 | 3.025 | 2.926 |
| 20 | 5.02 | 5.02 | 5.02 | 4.025 | 3.901 |

For 3mm thick beam of width 25mm

| Load (N) | Span length (l) = 800mm | | Average ~~Read~~ Reading | Average Deflection (mm) | Theoretical value (mm) |
|---|---|---|---|---|---|
| | Increasing | Decreasing | | | |
| 0 | 6.81 | 6.81 | 6.81 | - | - |
| 1 | ~~5~~ 5.90 | 5.93 | 5.915 | 0.895 | 0.900 |
| 2 | 5.07 | 4.97 | 5.02 | 1.790 | 1.806 |
| 3 | 4.19 | 4.08 | 4.135 | 2.675 | 2.709 |
| 4 | 3.17 | 3.16 | 3.165 | 3.645 | 3.612 |
| 5 | 2.41 | 2.41 | 2.41 | 4.400 | 4.515 |

For 5 mm thick beam of width 25mm

| Load (N) | Span length (l) = 1000mm | | Average Reading | Average Deflection (mm) | Theoretical value (mm) |
|---|---|---|---|---|---|
| | Increasing | Decreasing | | | |
| 0 | 9.27 | 9.09 | 9.18 | - | - |
| 5 | 7.31 | 7.19 | 7.25 | 1.930 | 1.905 |
| 10 | 5.47 | 5.38 | 5.42 | 3.760 | 3.810 |
| 15 | 3.56 | 3.49 | 3.52 | 5.660 | 5.714 |
| 20 | 1.76 | 1.76 | 1.76 | 7.420 | 7.619 |

For 3mm thick beam of width 25mm

| Load (N) | Span length ($l$) = 1000mm | | Average Reading | Average Deflection (mm) | Theoretical value (mm) |
|---|---|---|---|---|---|
| | Increasing | Decreasing | | | |
| 0 | 8.09 | 8.68 | 8.38 | - | - |
| 1 | 6.74 | 7.25 | 6.98 | 1.400 | 1.764 |
| 2 | 5.03 | 4.93 | 4.98 | 3.400 | 3.527 |
| 3 | 3.71 | 3.49 | 3.60 | 4.780 | 5.291 |
| 4 | 2.22 | 1.7 | 1.96 | 6.420 | 7.055 |
| 5 | 0.17 | 0.17 | 0.17 | 8.210 | 8.818 |

CALCULATION

(a) For span of 800mm

For 5mm thick beam with width of 25mm

$$\delta_1 = \frac{W_1 l^3}{48EI} = \frac{5 \times (0.8)^3 \times 12}{48 \times (2.1 \times 10^{11}) \times 0.005^3 \times 0.025} = 0.975\,mm$$

$$\delta_2 = \frac{W_2 l^3}{48EI} = \frac{10 \times (0.8)^3 \times 12}{48 \times (2.1 \times 10^{11}) \times 0.005^3 \times 0.025} = 1.950\,mm$$

$$\delta_3 = \frac{W_3 l^3}{48EI} = \frac{15 \times (0.8)^3 \times 12}{48 \times 2.1 \times 10^{11} \times 0.005^3 \times 0.025} = 2.926\,mm$$

$$\delta_4 = \frac{W_4 l^3}{48EI} = \frac{20 \times 0.8^3 \times 12}{48 \times 2.1 \times 10^{11} \times 0.005^3 \times 0.025} = 3.901\,mm$$

Bending Moment Calculation:

At centre,

$$B.M._1 = \frac{W_1 l}{4} = \frac{5 \times 800}{4} = 1000\ N\text{-}mm$$

$$BM_2 = \left(\frac{WL}{4}\right)_2 = \frac{10 \times 800}{4} = 2000\ N\text{-}mm$$

$$BM_3 = \left(\frac{WL}{4}\right)_3 = \frac{15 \times 800}{4} = 3000\ N\text{-}mm$$

$$BM_4 = \left(\frac{WL}{4}\right)_4 = \frac{20 \times 800}{4} = 4000 \text{ N-mm}$$

For 5mm,

$$I = \frac{0.005^3 \times 0.025}{12} = 2.604 \times 10^{-10} \text{ m}^4$$

~~(b)~~ For span of 800mm length, 3mm ~~width~~ thickness

Bending Moment Calculation at centre,

$$BM_1 = \left(\frac{Wl}{4}\right)_1 = \frac{1 \times 800}{4} = 200 \text{ N-mm}$$

$$BM_2 = \left(\frac{Wl}{4}\right)_2 = \frac{2 \times 800}{4} = 400 \text{ N-mm}$$

$$BM_3 = \left(\frac{Wl}{4}\right)_3 = \frac{3 \times 800}{4} = 600 \text{ N-mm}$$

$$BM_4 = \left(\frac{Wl}{4}\right)_4 = \frac{4 \times 800}{4} = 800 \text{ N-mm}$$

$$BM_5 = \left(\frac{Wl}{4}\right)_5 = \frac{5 \times 800}{4} = 1000 \text{ N-mm}$$

(b) For span of 900 mm length, 5mm ~~width~~ thickness

$$BM_1 = \left(\frac{Wl}{4}\right)_1 = \frac{5 \times 900}{4} = 1125 \text{ N-mm}$$

$$BM_2 = \left(\frac{Wl}{4}\right)_2 = \frac{10 \times 900}{4} = 2250 \text{ N-mm}$$

$$BM_3 = \left(\frac{Wl}{4}\right)_3 = \frac{15 \times 900}{4} = 3375 \text{ N-mm}$$

$$BM_4 = \left(\frac{Wl}{4}\right)_4 = \frac{20 \times 900}{4} = 4500 \text{ N-mm.}$$

For 3mm width,

$$BM_1 = \left(\frac{Wl}{4}\right)_1 = \frac{1 \times 900}{4} = 225 \text{ N-mm}$$

$$BM_2 = \left(\frac{Wl}{4}\right)_2 = \frac{2 \times 900}{4} = 450 \text{ N-mm}$$

$$BM_3 = \left(\frac{Wl}{4}\right)_3 = \frac{3 \times 900}{4} = 675 \text{ N-mm}$$

$BM_4 = \left(\frac{Wl}{4}\right)_4 = \frac{4 \times 900}{4} = 900$ N-mm

$BM_5 = \left(\frac{Wl}{4}\right)_5 = \frac{5 \times 900}{4} = 1125$ N-mm

(c) For span of 1000 mm length

For 5mm thickness.

$BM_1 = \left(\frac{Wl}{4}\right)_1 = \left(\frac{5 \times 1000}{4}\right) = 1250$ N-mm

$BM_2 = \left(\frac{Wl}{4}\right)_2 = \left(\frac{10 \times 1000}{4}\right) = 2500$ N-mm

$BM_3 = \left(\frac{Wl}{4}\right)_3 = \frac{15 \times 1000}{4} = 3750$ N-mm

$BM_4 = \left(\frac{Wl}{4}\right)_4 = \frac{20 \times 1000}{4} = 5000$ N-mm

For 3mm thickness,

$BM_1 = \left(\frac{Wl}{4}\right)_1 = \frac{1 \times 1000}{4} = 250$ N-mm

$BM_2 = \left(\frac{Wl}{4}\right)_2 = \frac{2 \times 1000}{4} = 500$ N-mm

$BM_3 = \left(\frac{Wl}{4}\right)_3 = \frac{3 \times 1000}{4} = 750$ N-mm

$BM_4 = \left(\frac{Wl}{4}\right)_4 = \frac{4 \times 1000}{4} = 1000$ N-mm

$BM_5 = \left(\frac{Wl}{4}\right)_5 = \frac{5 \times 1000}{4} = 1250$ N-mm

SUB/REF

For 5mm thick beam with width 25mm

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$l = 900mm$ $b = 25mm$ $d = 5mm/3mm$

For 5mm

| Load(N) | Increase | Decrease | Avg |
|---|---|---|---|
| 0 | 8.00 | 7.93 | 7.96 |
| 5 | 6.67 | 6.63 | 6.65 |
| 10 | 5.30 | 5.25 | 5.28 |
| 15 | 3.92 | 3.90 | 3.91 |
| 20 | 2.52 | 2.52 | 2.52 |

For 3mm

| Load(N) | Increase | Decrease | Avg |
|---|---|---|---|
| 0 | 8.30 | 8.43 | 8.36 |
| 1 | 7.02 | 6.83 | 6.93 |
| 2 | 5.78 | 5.86 | 5.80 |
| 3 | ~~3~~ 4.75 | 4.49 | 4.62 |
| 4 | 3.42 | 3.44 | 3.43 |
| 5 | 2.24 | 2.24 | 2.24 |

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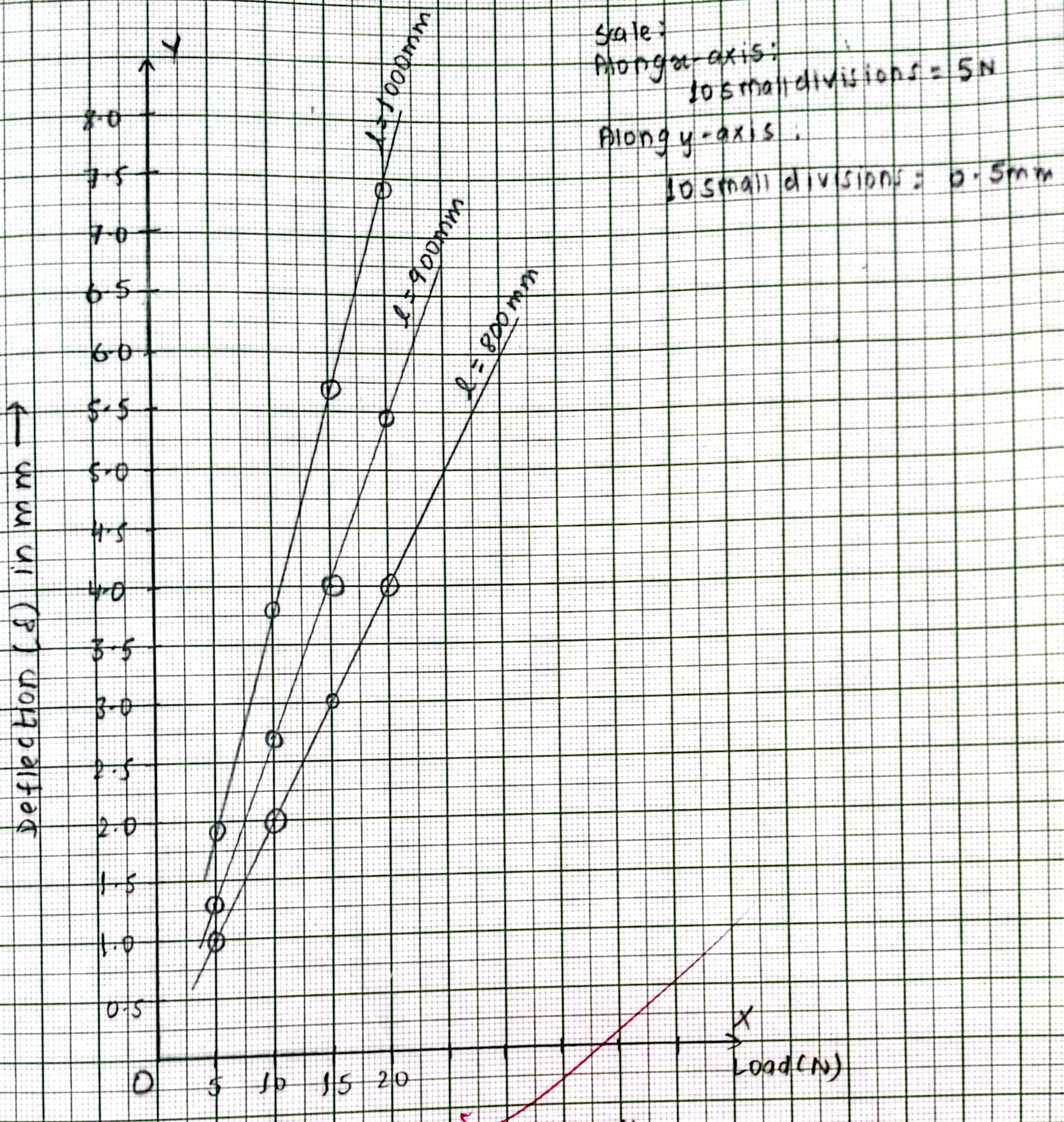
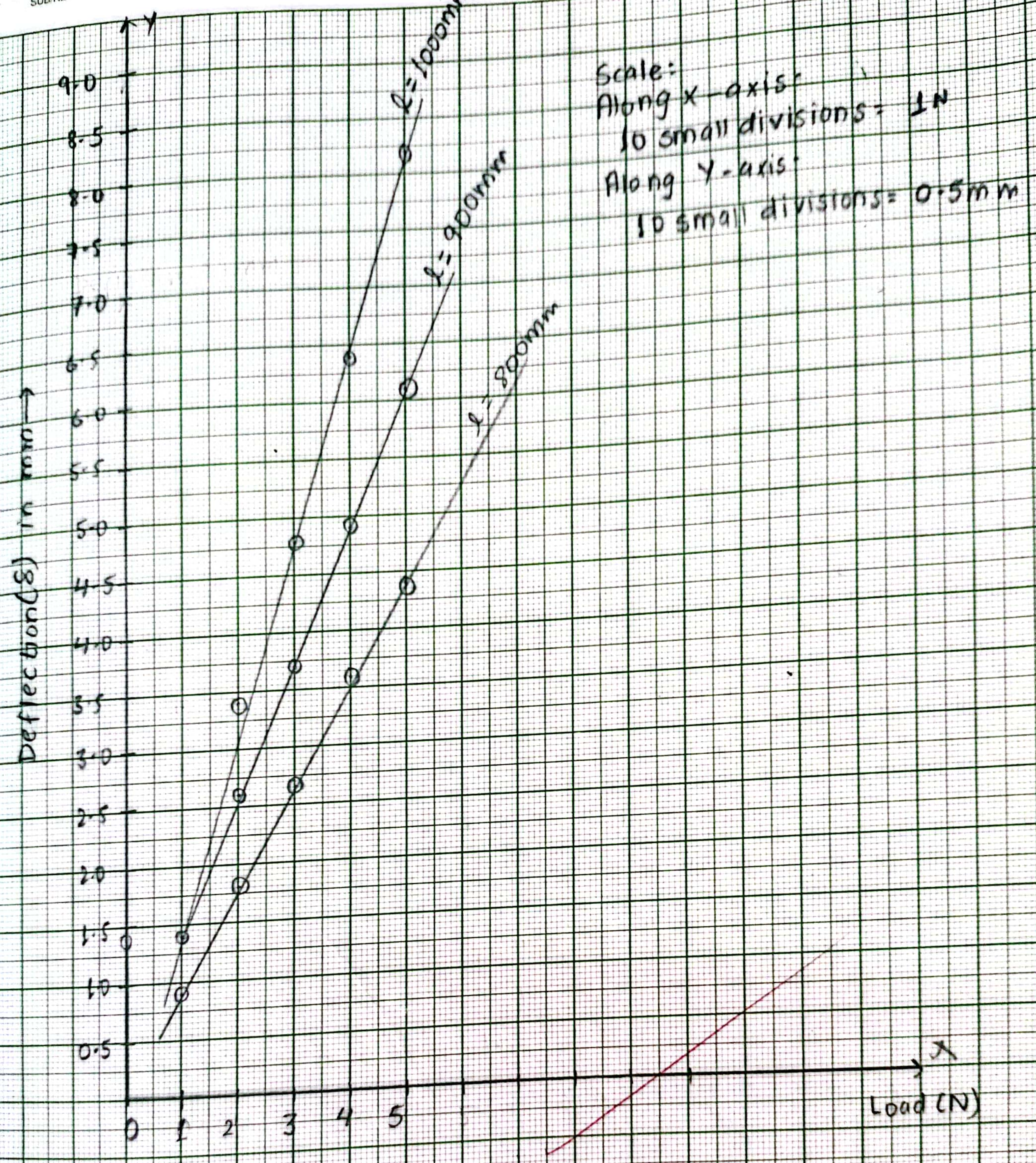
For 5mm thick beam with width 25mm

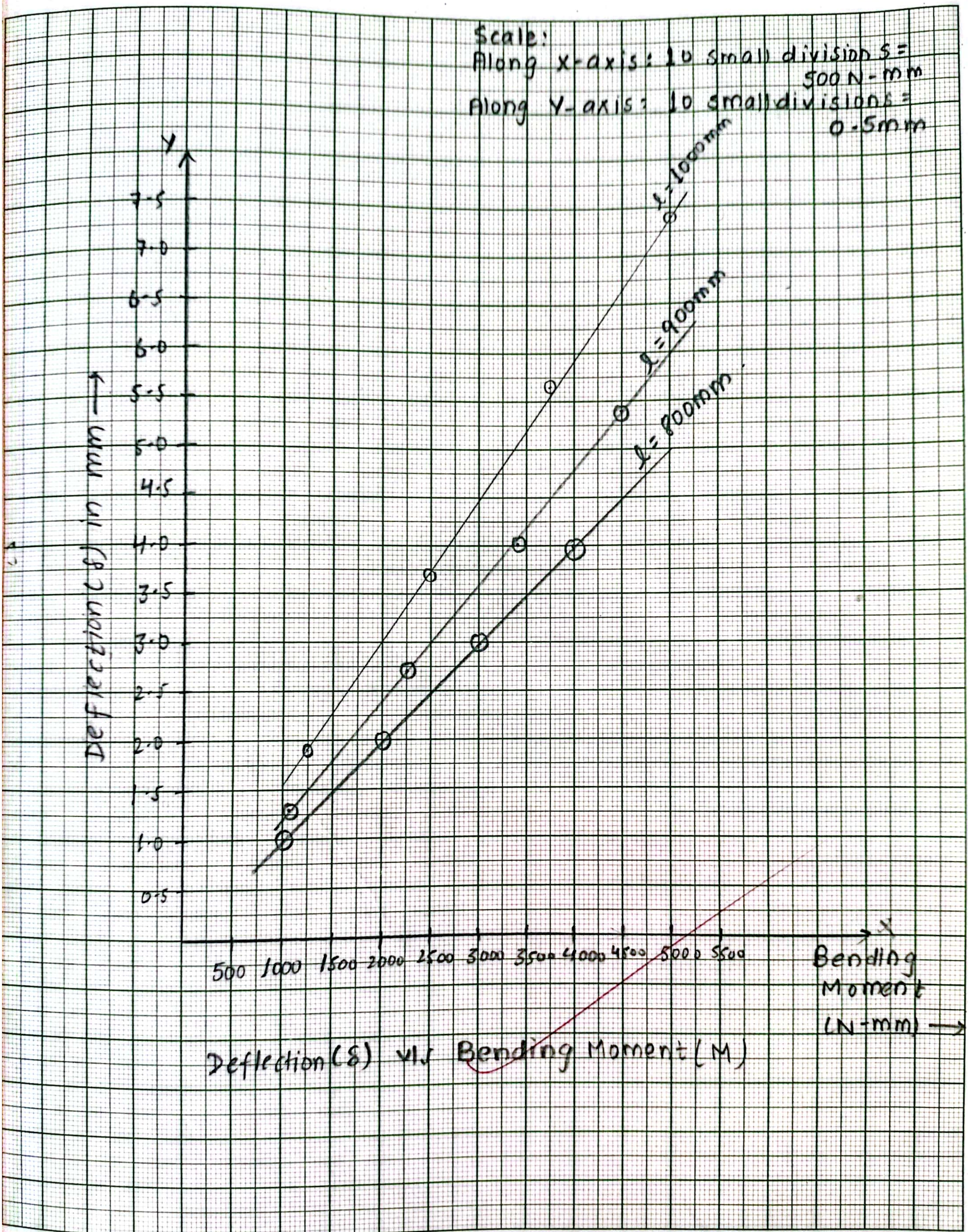



~~Def~~ Deflection (δ) v/s Loading

For 3mm thickness beam



SUB/REF. For 5mm thick steel beam of width 25mm. NO DATE




Deflection (δ) v/s Bending Moment (M)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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For 3mm thickness beam

(Deflection (δ) v/s Bending Moment (M))

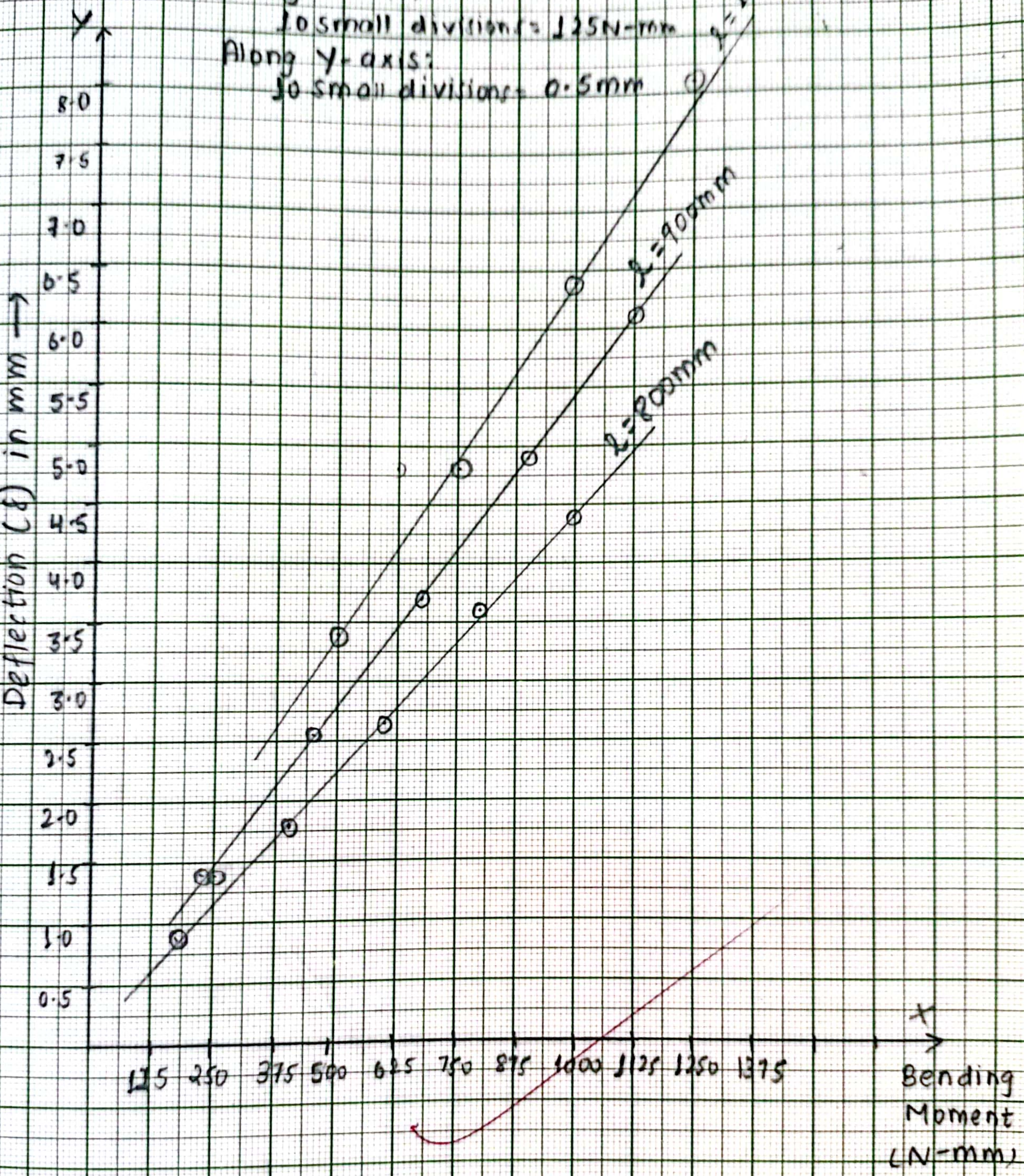
Scale:

Along X-axis:

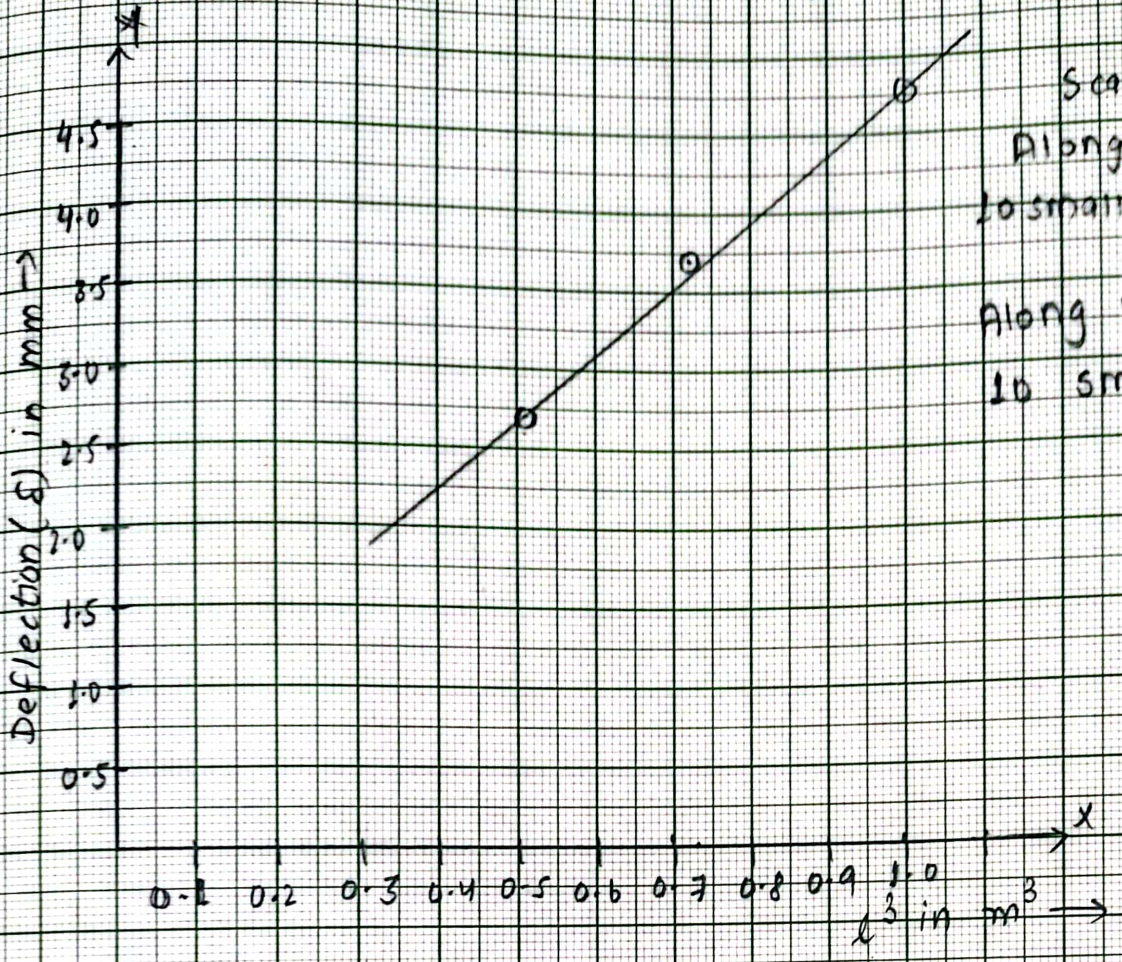
10 small divisions = 125 N-mm

Along Y-axis:

10 small divisions = 0.5 mm

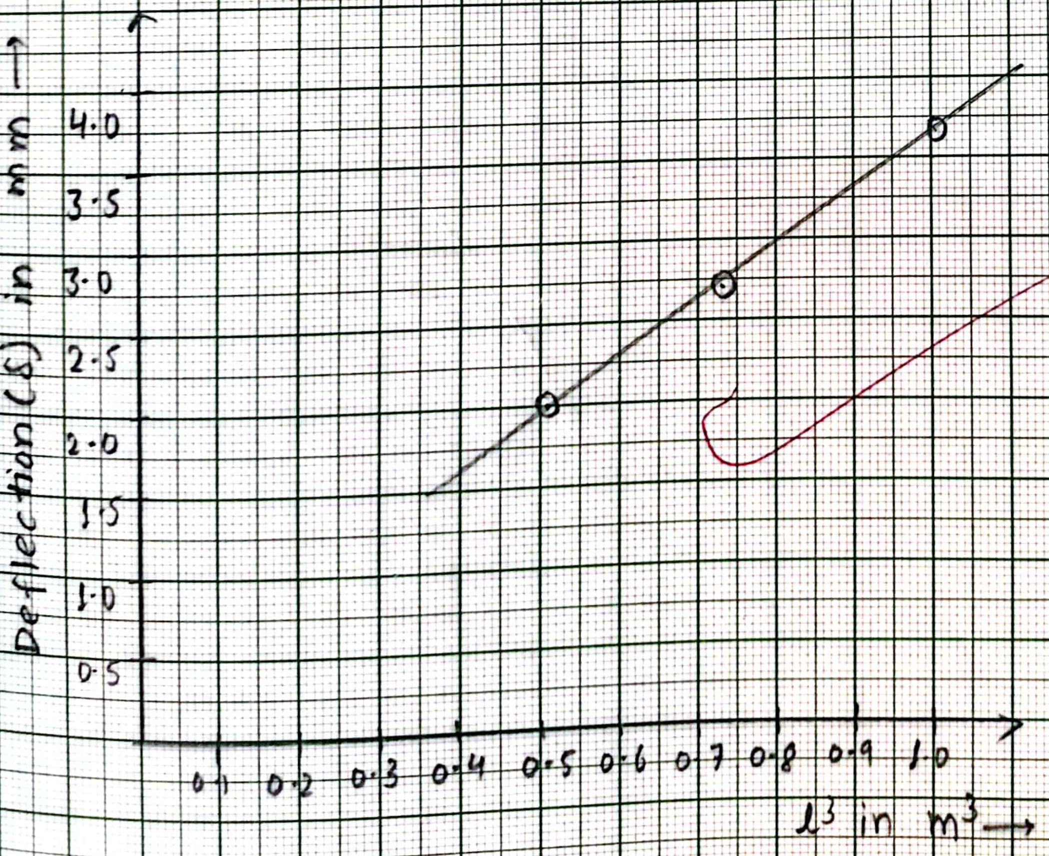


For 3mm thick and (taking load 3N)
(Deflection v/s length$^3$)




Scale:
Along X-axis:
10 small divisions = 0.1 $m^3$
Along Y-axis:
10 small divisions = 0.5 mm.

For 5mm thick and taking load 10N



## CONCLUSION

From the experiment, we were able to experimentally calculate the deflection produced in a simply supported beam due to load at its centre and compare it with value obtained from theoretical computation. Also, we obtained the relationship between deflection and load/bending moment/ cube of length span/Inverse of moment of inertia.

## Discussion:

This experiment was conducted with extreme caution and precision. However, some error were introduced because of instrumental incompetency, inaccurate reading etc. Tackling all these setbacks, we were able to calculate and practically observe the deflection produced by a point load in simply supported beam. Nevertheless, the sources of error can be minimized by using proper and precise instruments, digital meters, etc.

**TITLE:** BEHAVIOUR OF BEAM IN TORSION

**OBJECTIVE:**

To determine modulus of rigidity of given material.

**THEORY:**

Hooke's law states that, "upto elastic limit, shear stress is proportional to the shear strain".

i.e. $\tau \propto \theta$

or, $\tau = C\theta \Rightarrow C = \frac{\tau}{\theta}$ — (i)

where, C is called modulus of rigidity, $\theta$ is the shear strain & $\tau$ is shear stress.

Also, we have,

$$\frac{T}{I_p} = \frac{\tau}{R} = \frac{C\theta}{L} \quad \text{— (ii)}$$

where, T = Maximum Twisting torque
$\tau$ = Shear stress
$\theta$ = Angle of Twist
C = Modulus of Rigidity
$I_p$ = Polar Moment of inertia
R = Radius of the shaft
L = Length of the shaft

From, equation (ii), we have,

$$\frac{T}{I_p} = \frac{C\theta}{L} \Rightarrow C = \frac{TL}{I_p\theta} \quad \text{— (iii)}$$

But $T = WR'$ where W = Applied load
R' = lever Arm

$$\therefore C = \frac{WR'L}{I_p \times \delta/R'} \quad \text{— (iv)}$$

Let, $\frac{R'^2 L}{I_p} = K \quad \therefore C = \frac{KW}{\delta}$

$\delta = \frac{KW}{C}$ — (v) which is of form $y = mx$.

So, slope (m) = K/C, on plotting the graph $\delta$ - W, we can obtain straight line passing through origin. From graph, $C = \frac{K}{\text{slope}}$ — (vi)

The testing machine connected to a dial gauge gives direct reading of angular deformation with multiple of its conversion factor in mm. The testing specimen with its standard size matched in the machine is placed in testing machine and clamped. The load was applied to the normal of its longitudinal axis and load is increased and corresponding deformation is recorded. Then every load should be removed and reading should be taken by which the twisting of material can be seen.

PROCEDURE

(a) The specimen was clamped on testing machine & measuring gauge was removed with magnetic roler from the load plate.

(b) The load was taken off and counter weight of 20N was unlocked. The load plate was placed on support column.

(c) The specimen was clamped on specimen holder of load plate.

(d) The counter weight of 20N was suspended and end of the specimen was clamped in column specimen holder.

(e) The measurements were taken as follows:-

(i) The average load of 20N was compensated with counter weight.

(ii) The measuring gauge was placed diametrically opposite of the load (i.e. opposite to 90°, not to 0°).

(iii) The load weight was placed at 90°, with increment of 2N at each time.

(iv) The load and hanger was removed and remaining deformation was measured.

(v) The load was increased successively and deformation was recorded in observation table.

(vi) The load and the hanger were removed and remaining deformation was read.

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| Load(N) | Deflection($\delta$) |
|---|---|
| 0 | 0 |
| 2 | 0.12 |
| 4 | 0.25 |
| 6 | 0.38 |
| 8 | 0.51 |
| 10 | 0.66 |
| 12 | 0.80 |
| 14 | 0.93 |
| 16 | 1.07 |
| 18 | 1.20 |
| 20 | 1.34 |

Length of Specimen, L = 24mm
Diameter of specimen, D = 5.5mm
Lever Arm (R') = 100mm

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OBSERVATION

Specimen type = Mild steel

Level arm (R') = 100mm

Length of specimen (L) = 24mm

Diameter of specimen (D) = 5.5mm

Area = 23.76 $mm^2$.

Least count of dial gauge = 0.01mm

| S.N. | Applied load W (N) | Deflection, δ (mm) | Modulus of Rigidity (C) $N/mm^2$ $C = \frac{WR'L}{I_p\,\delta R'}$ |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 2 | 2 | 0.12 | 44525.55 |
| 3 | 4 | 0.25 | 42744.53 |
| 4 | 6 | 0.38 | 42182.10 |
| 5 | 8 | 0.51 | 41906.40 |
| 6 | 10 | 0.56 | 40477.78 |
| 7 | 12 | 0.80 | 40073.00 |
| 8 | 14 | 0.93 | 40216.63 |
| 9 | 16 | 1.07 | 39948.16 |
| 10 | 18 | 1.20 | 40073.00 |
| 11 | 20 | 1.34 | 39873.63 |

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# Deflection(δ) v/s Load(W)

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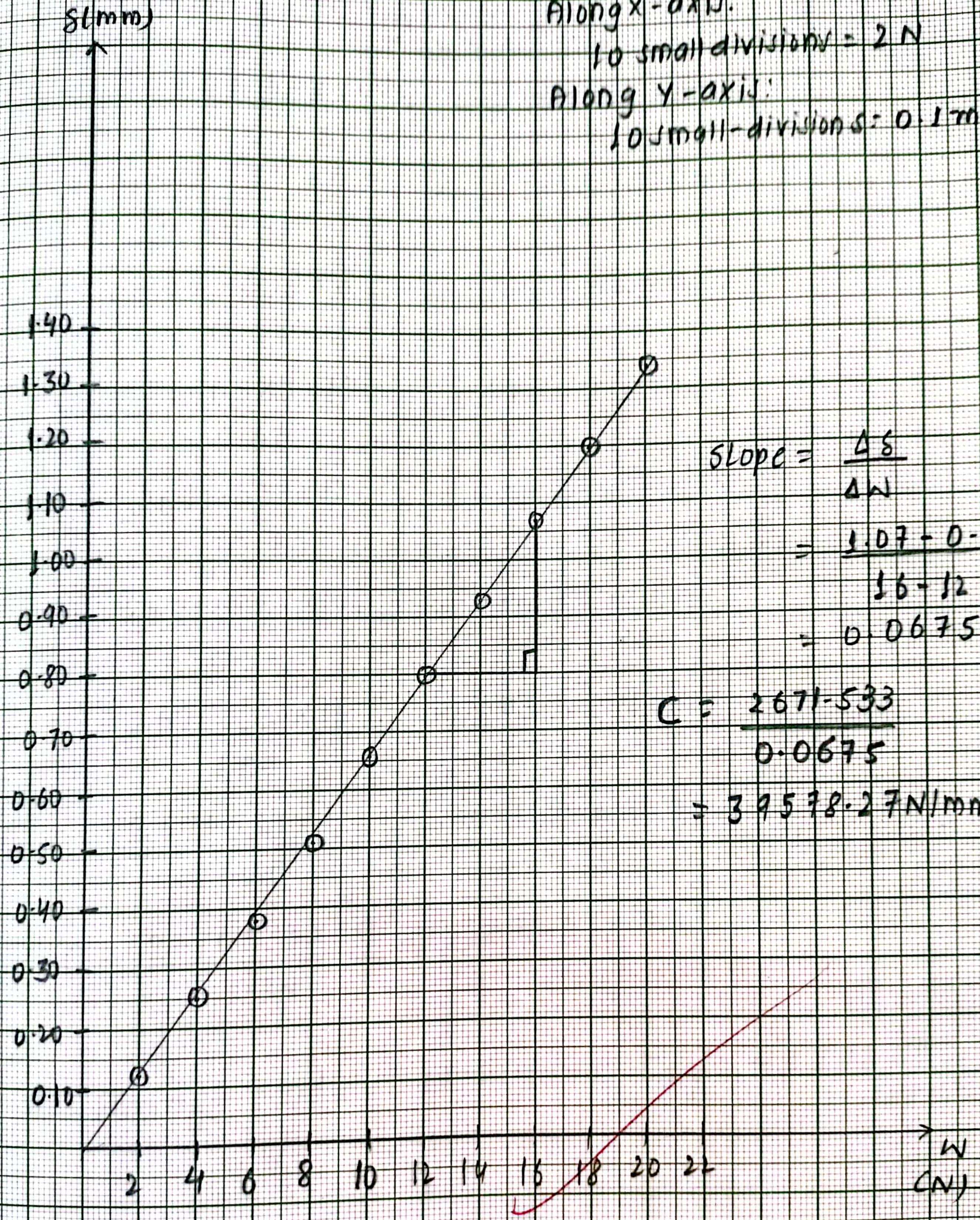
Scale:
Along X-axis:
10 small divisions = 2 N
Along Y-axis:
10 small divisions = 0.1 mm




$$\text{Slope} = \frac{\Delta\delta}{\Delta W}$$

$$= \frac{1.07 - 0.80}{16 - 12}$$

$$= 0.0675$$

$$C = \frac{2671.533}{0.0675}$$

$$= 39578.27 \, N/mm^2$$

Calculation :-

$$C = \frac{W R'^2 L}{I_p \delta} \quad ; \quad I_p = \frac{\pi R^4}{2} \quad \left\{ I_p = I_x + I_y \; ; \; I_x = I_y = \frac{\pi R^4}{4} \right\}$$

(1) $C = \frac{W R'^2 L}{I_p \delta} = \frac{100^2 \times 2\;4 \times 2}{\frac{\pi \times 2.75^4}{2} \times 0.12} = 44525.55 \text{ N/mm}^2$

(2) $C = \frac{2671.533 \times 4}{0.25} = 42744.53 \text{ N/mm}^2$

(3) $C = \frac{2671.533 \times 6}{0.38} = 42182.10 \text{ N/mm}^2$

(4) $C = \frac{2671.533 \times 8}{0.51} = 41906.40 \text{ N/mm}^2$

(5) $C = \frac{2671.533 \times 10}{0.66} = 40477.78 \text{ N/mm}^2$

(6) $C = \frac{2671.533 \times 12}{0.80} = 40073.00 \text{ N/mm}^2$

(7) $C = \frac{2671.533 \times 14}{0.93} = 40216.63 \text{ N/mm}^2$

(8) $C = \frac{2671.533 \times 16}{1.07} = 39948.16 \text{ N/mm}^2$

(9) $C = \frac{2671.533 \times 18}{1.20} = 40073.00 \text{ N/mm}^2$

(10) $C = \frac{2671.533 \times 20}{1.34} = 39873.63 \text{ N/mm}^2$

Average Modulus of Rigidity, $C_{avg} = 41202.08 \text{ N/mm}^2$.

RESULTS AND CONCLUSION

From this experiment, the average modulus of rigidity was obtained to be 41202.08 N/mm². This experiment was a practical demonstration of how beams behave in torsion and we measured shear stress developed due to torsion on beams. On plotting the graph, the modulus of rigidity was obtained to be 39578.27 N/mm².

DISCUSSION.

Despite extreme caution, the graphical and experimental value were found to be deviating. Also, the standard value of modulus of rigidity is 79GPa. while calculated value of modulus of rigidity of specimen (mild steel) was 41.2 GPa. This significant error can be attributed to device failure, handling error, inexperiency, etc. It is advisable to perform the experiment with proper instruments and extreme caution.

## TITLE: COLUMN BEHAVIOUR AND BUCKLING

OBJECTIVES:-

(a) To draw axial load transverse deflection curves and find out critical load.

(b) To verify Euler Formula of critical load.

INTRODUCTION:

When a long slender column subjected to direct compressive load, they bend suddenly, deflect laterally and buckle even if load is centered. Sudden buckling is the characteristics of instability and therefore buckling under axial load is considered to be a stability problem.

$$P_{cr} = \frac{\pi^2 EI}{L_e^2}$$

where, $P_{cr}$ = Critical load

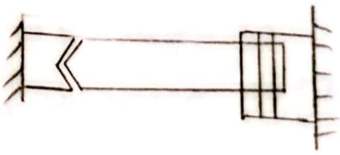
$E$ = Modulus of Elasticity

$I$ = Least Moment of Inertia

$L_e$ = Effective length of column

Effective length ($L_e$) vary with end conditions.

| End conditions | Effective length |
|---|---|
| (1) Both end hinged | $L_e = L$ |
| (2) Both end fixed | $L_e = L/2$ |
| (3) One end hinged & other fixed | $L_e = \frac{L}{\sqrt{2}}$ |



LABORATORY SETUP

The equipment used in this experiment was WP 120 buckling device. The test device mainly consists of basic frame, guide columns and load cross bars. The basic frame contains bottom mounting for rod specimen consisting of hydraulic force measuring device for measuring testing force and attachment socket which can hold pressure pieces for realizing various storage conditions.

SAFETY:

(1) Do not over load the device above 2000N.
(2) Never deflect more than 6mm.
(3) The test can be concluded when the load does not change.

PROCEDURE:

(1) The test device was set up in horizontal position and thrust piece with V-notch or guide bush of load cross bar was inserted into attachment socket. It was fastened with clamping screw.
(2) Top long thrust piece with V-notch inserted & firmly held.
(3) Load cross bar was clamped on guide column (with 5mm approx.) specimen was aligned so that its buckling direction pointed direction of lateral guide column.
(4) Low non-measurable force was applied and measuring guage was aligned at middle of specimen.
(5) The specimen was slowly subjected to load using load nut.
(6) Deflection was noted from measuring guage at every 0.25mm upto 1mm and then at every 0.5mm upto 5mm.
(7) Load v/s lateral deflection curve with average value was drawn.

OBSERVATION

Length of specimen = 650mm = 0.65m

Breadth = 20mm

Modulus of elasticity = 210000 $N/mm^2$

| Deflection (mm) | 0 | 0.25 | 0.5 | 0.75 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Load (N) | 100 | 200 | 260 | 300 | 350 | 400 | 450 | 500 | 525 | 550 | 560 | 575 | 590 |

Both end hinged

CALCULATION:

Effective length, $l_e = l = 0.65$ m

Critical load $(P_{cr}) = \frac{\pi^2 EI}{l_e^2}$

$$= \frac{\pi^2 \times 2.1 \times 10^{11} \times 0.02 \times 0.04^3}{12 \times 0.65^2}$$

$$= 523.264 N$$

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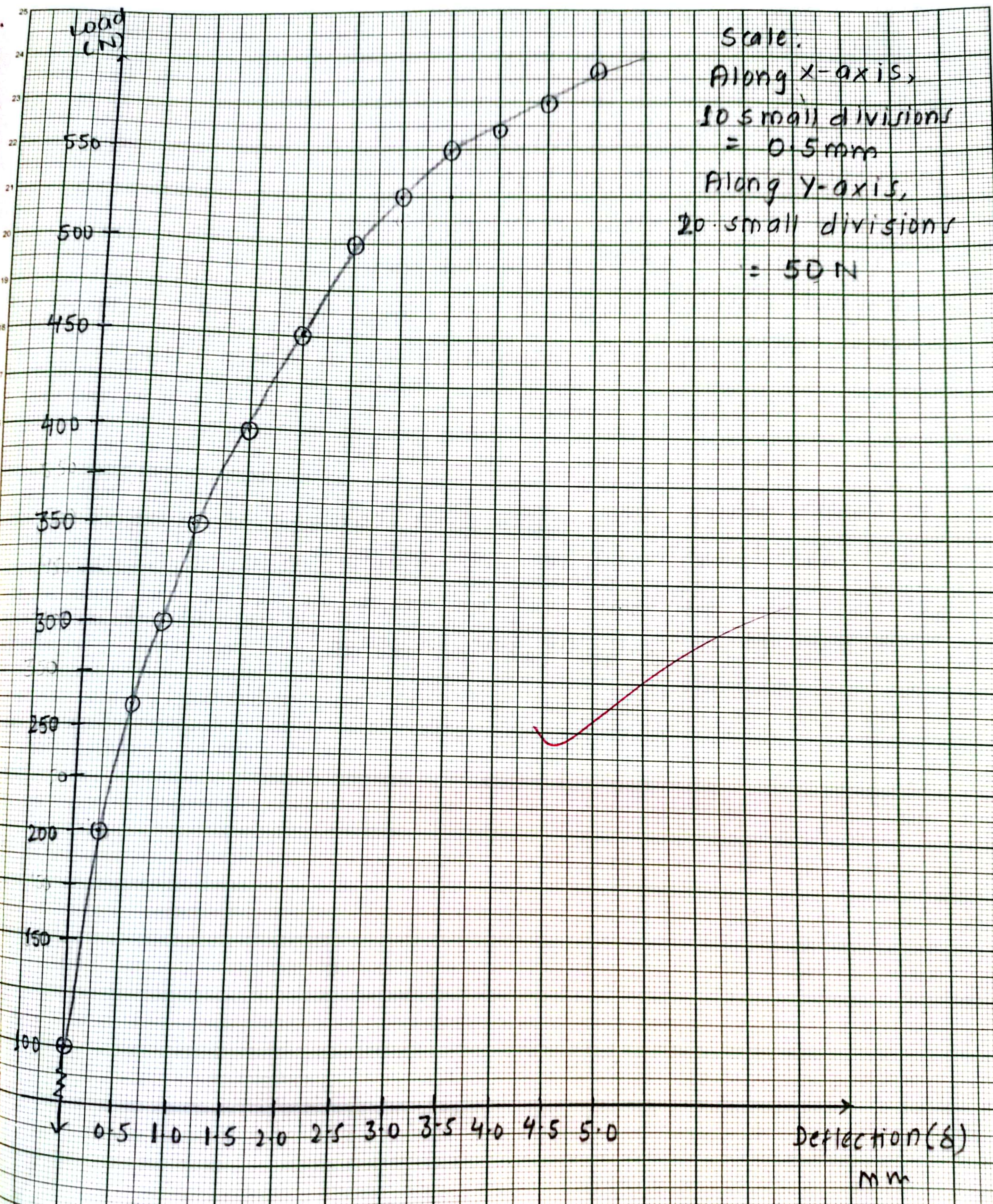
Title: Column Behaviour and Buckling

Length of specimen = 650mm

Modulus of elasticity = 210000 N/mm²

| Deflection (mm) | Load (N) |
|---|---|
| 0 | 100 |
| 0.25 | 200 |
| 0.5 | 260 |
| 0.75 | 300 |
| 1.0 | 350 |
| [illegible] | [illegible] |
| 1.5 | 400 |
| 2.0 | 450 |
| 2.5 | 500 |
| 3.0 | 525 |
| 3.5 | 550 |
| 4.0 | 560 |
| 4.5 | 575 |
| 5.0 | 590 |

Load(N) V/S Deflection(δ) 078BCE178



## RESULT AND CONCLUSION

From this experiment we identified the relationship between load and the corresponding deflection. The deflection of column was found to increase steeply for large values of loads initially but later on, even small load was enough for large deflection. Also, the critical load of column beyond which buckling and lateral deflection can occur was also determined for end conditions. It was found that end conditions can very well affect the load that the column can bear for some amount of deflection. Experiment shows that column hinged on both side bear minimum load for some deflection.

## DISCUSSION

The plot of obtained data was quite different from standard graph. This might have been the result of instrumental error, handling inefficiency, etc. Discrete caution and proper instrumentation is advisable.