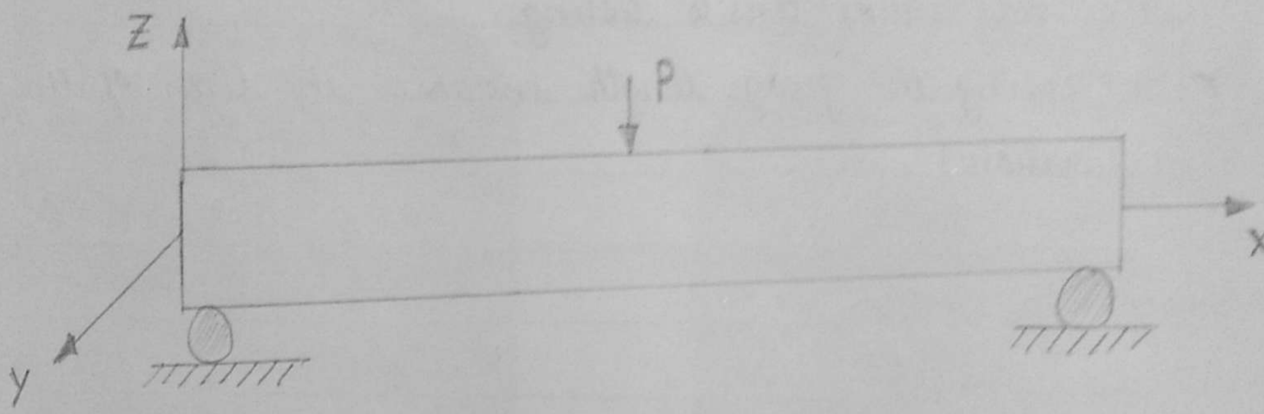

SCHEMATIC DIAGRAM SHOWING THE SETUP

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SHEAR AND BENDING IN BEAMS

A. TRANSVERSE TEST

- **Objective:** To find the modulus of elasticity of the given specimen.

- **Apparatus Required:**
  - 10 tons Universal Testing Machine (UTM)
  - Dial gauge to measure deflections
  - Scale or measuring tape

- **Theory:** An axis in the cross-section of a beam at half along which there is no longitudinal stress or strain is called Neutral Axis. All layers on one side of the neutral axis are in a state of tension while those on the opposite side are in compression. Radius of curvature of neutral surface of a beam subjected to pure bending, within elastic range is

$$\boxed{\frac{1}{\rho} = \frac{M}{EI}}$$

Radius of curvature is also $\frac{1}{\rho} = \frac{d^2y/dx^2}{\left(1 + \left(\frac{dy}{dx}\right)^2\right)^{3/2}}$

neglecting $\left(\frac{dy}{dx}\right)^2$, we have

$$\boxed{\frac{d^2y}{dx^2} = \frac{M}{EI}}$$

- Observation Table

TABLE: 1 LOADING

LOAD (KN)	DEFLECTION (mm)
9.810	0.050
14.715	0.070
19.620	0.090
24.525	0.110
29.430	0.130
34.335	0.150
39.240	0.170
44.145	0.195
49.050	0.220
53.955	0.240
58.860	0.255
63.765	0.270
68.670	0.300

TABLE: 2 UNLOADING

LOAD (KN)	DEFLECTION (mm)
68.670	0.300
63.765	0.300
58.860	0.299
53.955	0.280
49.050	0.260
44.145	0.240
39.240	0.210
34.335	0.190
29.430	0.170
24.525	0.150
19.620	0.125
14.715	0.105
9.810	0.080
4.905	0.060
0	0.020

Boundary conditions for a simply supported beam is at $x=0, y=0$ and as $x=L, y=0$

We get maximum deflection $y = \frac{Pl^3}{48EI}$ where $P = mg$

The maximum deflection is at the centre of the beam

$l \rightarrow$ length of unsupported beam

$I \rightarrow$ second moment of area about neutral axis

$$E = \frac{m'l^3}{bd^3}$$

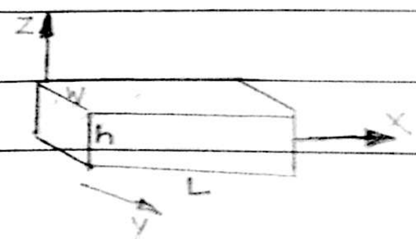
$m' \rightarrow$ slope of load vs. deflection graph

- **Procedure :**

1) Measured the dimensions of the specimen and held it on the supports on the UTM. Made sure that the specimen is symmetrically placed.
2) Mounted the dial gauge so that it touched the mid section of the beam.
3) The motor was started and the load was applied gradually.
4) The values of load and corresponding deflection on the dial gauge was noted.
5) The care that the elastic limit is not exceeded was taken.

- **Observation :**

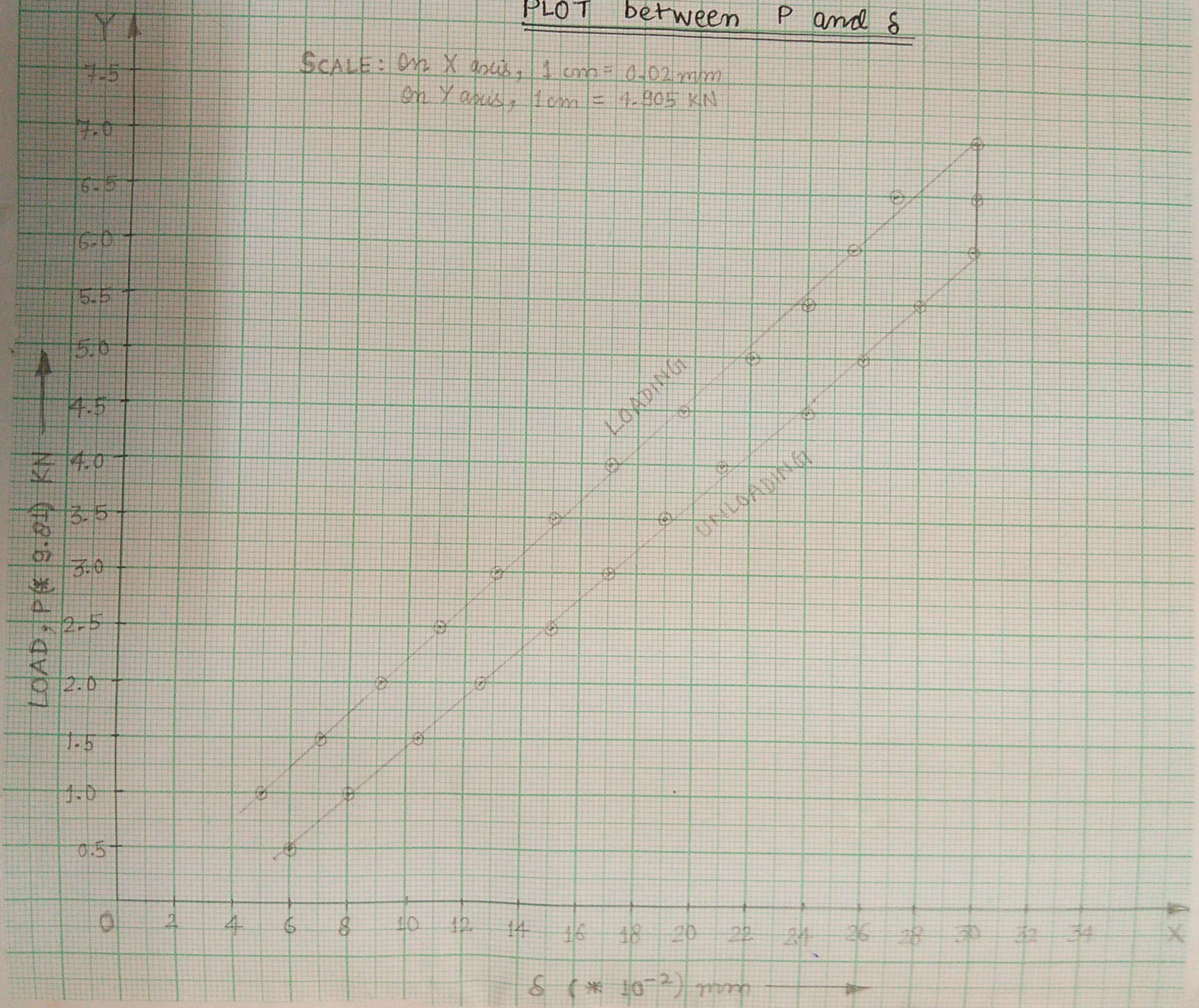
For the specimen, length = 300 mm
height = 55 mm
width = 55 mm



Scanned by CamScanner

PLOT between P and δ

SCALE: On X axis, 1 cm = 0.02 mm
On Y axis, 1 cm = 4.905 KN



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Calculations :

$$I_y = \frac{1}{12} W h^3 = \frac{1}{12} \times 55 \times (55)^3 \ mm^4$$

$$\Rightarrow \boxed{I_y = 7.626 \times 10^5 \ mm^4}$$

calculating E for both loading and unloading at $P = 29.43$ kN

For loading δ at 29.43 kN = 0.13 mm

$$\therefore E_1 = \frac{29.43 \times 10^3 \times (300)^3 \times (10^{-3})^3}{48 \times 0.13 \times 10^{-3} \times 7.626 \times 10^5 \times (10^{-3})^4} \ N/m^2$$

$$= 16.7 \times 10^{10} \ N/m^2$$

$$\boxed{E_1 = 167 \ GPa}$$

For unloading, δ at 29.43 kN = 0.17 mm

$$\therefore E_2 = \frac{29.43 \times 10^3 \times (300)^3 \times (10^{-3})^3}{48 \times 0.17 \times 10^{-3} \times 7.626 \times 10^5 \times 10^{-12}} \ N/m^2$$

$$= 12.769 \times 10^{10} \ N/m^2$$

$$\boxed{E_2 = 127.69 \ GPa}$$

$$\therefore E_{average} = \frac{E_1 + E_2}{2}$$

$$\boxed{E_{average} = 147.345 \ GPa}$$

Result :

The average value of E is 147.345 GPa

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Discussions :

- The load should show linear relationship with displacement and our plot of load vs displacement shows the linear

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relationship too.

From the table, $E_{mild\ steel} = 205\ GPa$

$$\therefore \%\ error = \frac{205 - 147.345}{205} \times 100\%$$

$$= 28.124\%$$

SHEAR AND BENDING IN BEAMS.

B. SHEAR TEST

- **Objective:** To find the shear strength of the given material.

- **Apparatus Required:**
  - 10 tons Universal Testing Machine (UTM)
  - Shear Test attachments and specimen.
  - Micrometer.

- **Specifications:** In this experiment, the specimen provided was subjected to double shear. This increases the load which it can withstand. Bolts are often used in double shear thus increasing safety.

Breaking Load = P (found from experiment)

$$\text{Shear Strength} = \frac{P}{2A}$$

A → Area of cross section.

- **Procedure:**

1) Measurement of the diameter of the specimen using micrometer was taken.
2) The specimen was fitted in the shearing attachments.
3) The shearing attachments onto the UTM were installed.
4) The motor was started and the load was applied gradually.
5) The load was increased upto the failure of the specimen due to shear.

6) The load reading was noted down when the specimen got sheared off.

Observations and calculations:

$d_{top} = 9.40\ mm$

$d_{bottom} = 9.40\ mm$

$d_{middle} = 9.47\ mm$

$\therefore$ Diameter of the specimen, $d = 9.423\ mm$ (Average)

Cross sectional area $= \frac{\pi d^2}{4} = \frac{\pi \times (9.423)^2}{4}\ mm^2$

$= 69.738\ mm^2$

$\therefore$ Shear strength $= \frac{P}{2A}$

Here, Break load, $P = 66.46275\ KN$

$\therefore$ shear strength $= \frac{66462.75}{2 \times 69.738}\ \frac{N}{mm^2}$

$= 476.517\ \frac{N}{mm^2}$

$= 476.517\ MPa$

Result:

The value of shear strength as obtained from the experiment is 476.517 MPa

Discussions:

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➤ For shear test, the shear load was double shear. Thus the load acting on each of the shear planes is P/2

➤ The load should not be increased after fracture or error after yielding starts in the material.