Experiment - 6

* **Aim:-**

To find the Young's modulus of the given material bar by non-uniform bending using pin and microscope method.

* **Apparatus:-**

Pin and Microscope arrangment, scale, vernier callipers, Screw gauge, weight hanger, Material bar or rod.

* **Theory:-**

Young's Modulus is named after Thomas Young, 19th Century, British Scientist. In Solid mechanics, Young's modulus is defined as the ratio of the longitudial stress over longitudinal strain, in the range of elasticity the Hook's law holds.

If a wire of length L and area of cross-section a be streched by a force F and if a change (increases) on length l is produced then,

Young's Modulus = $\frac{\text{Normal Stress}}{\text{Longitudinal Stress}}$

$$\Rightarrow \frac{F/a}{l/L}$$

* Non Uniform Bending Using Pin and Microscope

Here the given beam (meter scale) is Supported Symmetrically on two knife edges and loaded at is centre.
In Non uniform bending (central Loading), the Youngs modulus of the material of the Bar is given by

$$Y = \frac{mgl^3}{48Ie}$$

wher I is the moment of Inertia of the bar.
For rectangular bar,

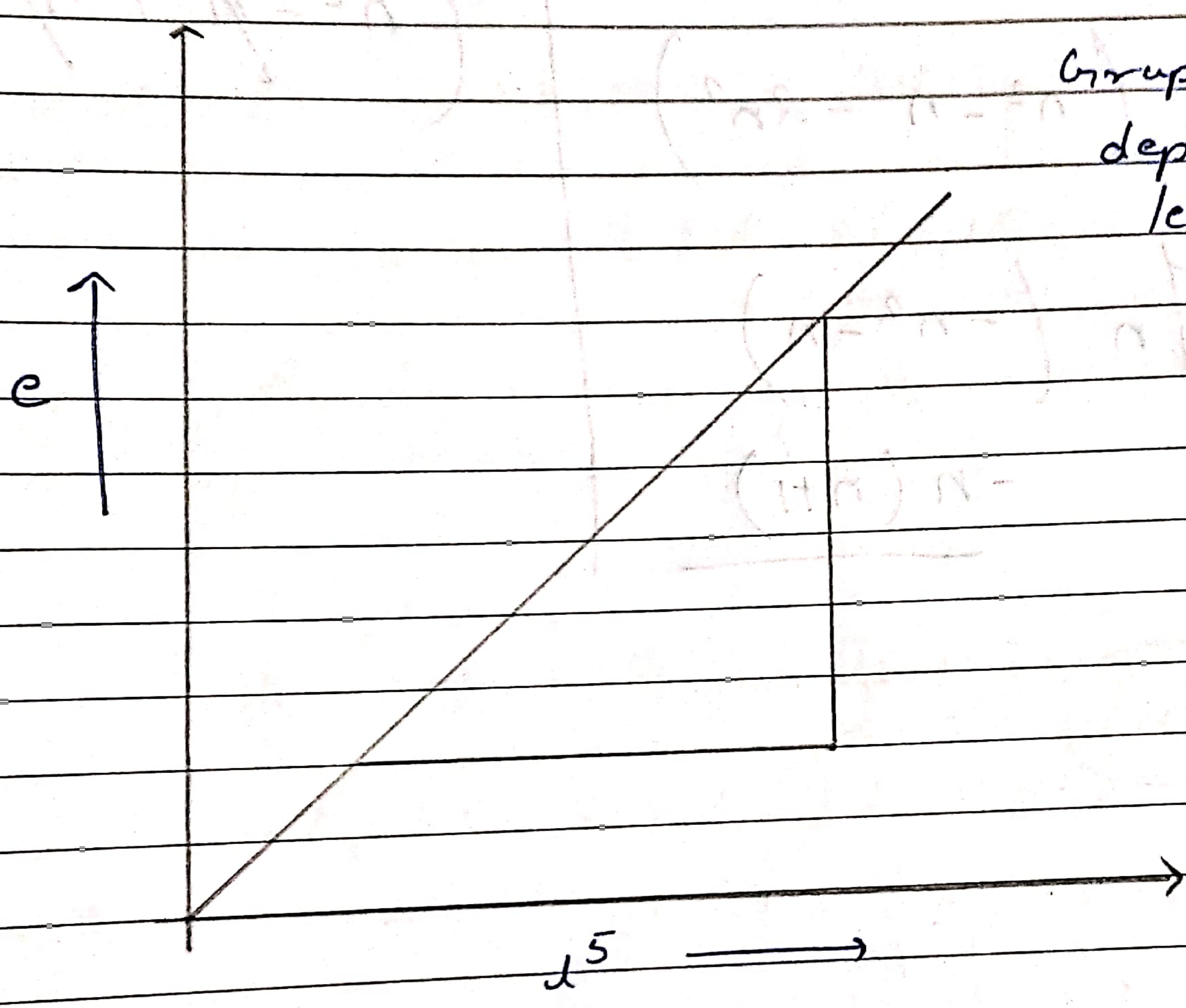
$$I = \frac{bd^3}{12}$$

In non uniform bending, the Young's Modulus of the material of the bar is given by:-

$$Y = \frac{mgl^3}{4bd^3e}$$

$m \rightarrow$ mass loaded for depression.
$g \rightarrow$ Acceleration due to gravity.
$l \rightarrow$ Length between knife edges.
$b \rightarrow$ Breath of the bar using vernier Calipers.
$d \rightarrow$ Thickness of the bar using Screw gauge.
$e \rightarrow$ Depression of the bar.

* Graph:-



Graph between depression and length.

* Procedure :-

1) Non-uniform Bending: The given bar is Supported symmetrically on two knife edges. The length l of bar between the knife edges is measured.

2) A pin is fixed vertically at the midpoint of the bar with its pointed end upwards. The Slotted weights ~~has~~ are added one by one on both the hangers and removed one by one a number of times.

3) The slotted weights are added one by one on the weight hangers and removed one by one a number of times.

4) The adjusted so that the image of the tip of the pin coincides with the point of intersection of cross wires.

5) From the microscope reading, the mean depression (e) for a given mass is found. The value of $\frac{l^3}{e}$ is calculated and hence calculated the Young's modulus of the given material bar.

* Observations and Calculations:-

Value of 1 m.s.d = 1/20

Number of division on the vernier (n) = 50

Least count of the Microscope = 1/1000 = 0.001 cm.

S.No	Distance (l) cm	Load (M) kg	Microscope Reading	Depression (e) cm	Mean cm	Y
1)	60	50	$x_0 = 5.2$			
		100	$x_1 = 5.4$	5.4 − 5.2 = 0.2		
		150	$x_2 = 5.6$	5.6 − 5.4 = 0.2	0.2	1.1×10^{10}
		200	$x_3 = 5.8$	5.8 − 5.6 = 0.2		
2)	55	50	$x_0 = 5.1$			
		100	$x_1 = 5.3$	5.3 − 5.1 = 0.2		
		150	$x_2 = 5.5$	5.5 − 5.3 = 0.2	0.2	1.1×10^{10}
		200	$x_3 = 5.7$	5.7 − 5.5 = 0.2		
3)	50	50	$x_0 = 5.1$			
		100	$x_1 = 5.2$	5.2 − 5.1 = 0.1		
		150	$x_2 = 5.3$	5.3 − 5.2 = 0.1	0.1	1.1×10^{10}
		200	$x_3 = 5.4$	5.4 − 5.3 = 0.1		
4)	45	50	$x_0 = 5.1$			
		100	$x_1 = 5.2$	5.5 − 5.1 = 0.1		
		150	$x_2 = 5.3$	5.3 − 5.2 = 0.1	0.1	1.1×10^{10}
		200	$x_3 = 5.4$	5.4 − 5.3 = 0.1		

$$Y = \frac{mgl^3}{4bd^3e}$$

From for $m = 50g = 0.05\,kg$

$g = 9.8\,m/s^2$

$l = 60\,cm = 0.6\,m$

$b = 1\,cm = 0.01\,m$

$d = 0.5\,cm = 0.005\,m$

$e = 0.2\,cm = 0.002\,m$

$$Y = \frac{0.05 \times 9.8 \times 0.6 \times 0.6 \times 0.6 \times 10^{12}}{4 \times 0.01 \times 0.005 \times 0.005 \times 0.005 \times 0.002 \times 10^{12}}$$

$$Y = \frac{105840 \times 10^{12}}{1000 \times 10^{+4}}\ N/m^2$$

$$Y = 10584 \times 10^{8}\ N/m^2$$

$$Y = 1.0584 \times 10^{10}\ N/m^2$$

$$\boxed{Y = 1.1 \times 10^{10}\ N/m^2}$$ Ans

* **Result:-**

Young's modulus of the given material using non uniform bending method 1.1×10^{10} N/m^2.