Teacher's Signature:___________
Date: ______________________

United International **University**

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Section: ______ Batch: _____________ Date: _______________________

Experiment No. 07

Name of the Experiment: Determination of the Young's modulus of the given material bar by non-uniform bending using pin and microscope method.

Theory:

Young's modulus is named after Thomas Young, 19th century, British scientist. In solid mechanics, Young's modulus is defines as the ratio of the longitudinal stress over longitudinal strain, in the range of elasticity the Hook's law holds (stress is directly proportional to strain). It is a measure of stiffness of elastic material.

If a wire of length L and area of cross-section 'a' be stretched by a force F and if a change (increase) of length '*l*' is produced, then

$$Young's\ modulus = \frac{Normal\ stress}{Longitudinal\ strain} = \frac{F/a}{l/L}$$

Non Uniform Bending Using Pin and Microscope

Here the given beam (meter scale) is supported symmetrically on two knife edges and loaded at its centre. The maximum depression is produced at its center. Since the load is applied only one point of the beam, the bending is not uniform throughout the beam and the bending of the beam is called non- uniform bending.

In non-uniform bending (central loading), the Young's modulus of the material of the bar is given by

$$Y = \frac{mgl^3}{48Ie} \qquad (1)$$

I is the moment of inertia of the bar.

For a rectangular bar**,**

$$I = \frac{bd^3}{12} \qquad (2)$$

Substituting (2) in (1), In non-uniform bending, the young's modulus of the material of the bar is given by,

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

Where m-Mass loaded for depression, g-Acceleration due to gravity, *l*-Length between knife edges, b-Breadth of the bar using Vernier calipers, d-Thickness of the bar using screw gauge, and e-Depression of the bar. Plot a graph e vs. l^3 (or e vs. m). From the graph l^3/e (or m/e) can be calculated.

Procedure for Simulation

1. Select the environment and material for doing experiment.
2. Choose mass, length, breadth and thickness of the material bar using sliders on the right side of the simulator.
3. Fix the distance between knife edges.
4. Focusing the microscope and adjusting the tip of the pin coincides with the point of intersection of the cross wires using left and top knobs on microscope respectively.
5. Readings are noted using the microscope reading for 0g. Zoomed part of microscope scale is available by clicking the centre part of the apparatus in the simulator. Total reading of microscope is MSR+VSR*LC. MSR is the value of main scale reading of the microscope which is coinciding excel with the zero of Vernier scale. One of the division in the Vernier scale coincides exactly with the main scale is the value of VSR. LC is the least count.
6. Weights are added one by one say 50g, then pin moves downwards while viewing through microscope. Again adjust the pin such that it coincides exactly with the cross wire.
7. The readings are tabulated and Y is determined using equation (3).

Apparatus:

- Rectangular beam
- Microscope or travelling microscope
- Suitable weights
- Slide calipers
- Screw Gauge
- Two strong knife-edges
- Meter scale etc.

Experimental Data:

Number of divisions on the Vernier =

Vernier constant of the microscope =

(A) Table for determining load versus depression data:

No. of obs.	Distance of the knife edges, l (cm)	Load, m (gm)	Readings of the microscope								Mean (cm.)	Depression for load, e (cm)	Mean e (cm)	l^3 (cm^3)	Mean l^3 (cm^3)
			Loading				Unloading								
			LSR x (cm)	V.S.R.	Value of V.S.R. y (cm)	Total, x+y (cm)	LSR x (cm)	V.S.R.	Value of V.S.R. y (cm)	Total, x+y (cm)					
1	10	50									X_o=	X_4-X_o=			
2	15	100									X_1=	X_5-X_1=			
3	20	150									X_2=	X_6-X_2=			
4	25	200									X_3=	X_7-X_3=			
5	30	250									X_4=				
6	35	300									X_5=				
7	40	350									X_6=				
8	45	400									X_7=				

Calculation:

Thickness of the material bar “d” = cm

Breadth of the material bar “b” = cm

Mean value of l^3/e = cm^2 or

Mean value of l^3/e (from e vs l^3 graph) = cm^2

Slope of e vs. m graph = cm/gm

Slope^{-1} = m/e = gm/cm

Load applied for depression “e” = cm

Young’s modulus of the material bar, $Y = \frac{mgl^3}{4bd^3e}$ = dynes/cm^2 = N/m^2.

Difference = [(Experimental Result - Theoretical Result)/Theoretical Result] x 100% =

Accuracy= 100% - % Difference =

Result:

The Young's modulus of the given material using non uniform bending method is, Y =

Discussions:

Q: What is stress and strain? Define longitudinal stress and longitudinal strain. How are they related to Young's Modulus? Derive the unit of Young's Modulus.

Q: In determining the Young's Modulus of the material using the formula given which quantities you think should be measured with caution and why?

Q: On what factors does the value of Y depend?

Q: Is it necessary to use a dead load here?

Q: Suppose, you are provided with two wires both made of copper but they are of different length and diameter. What do you think about their Young's Modulus? Will they be different or same? Why?

Q: Why do the readings for load increasing and load decreasing differ?

Q: Why is it necessary to wait a while before reading is taken after putting a load on the hanger?

Q: Which is more elastic, rubber or steel?

Q: What is the standard value of the *Young's Modulus* of the material used to perform the experiment?