BANGLADESH UNIVERSITY OF BUSINESS AND TECHNOLOGY

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Lab Report on:

Determination of the Young's Modulus by the flexure of a beam

Experiment NO: 9

Course Title: Physics Lab I

Course Code: PHY -102

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Signature of Teacher

Submission Date:

Experiment NO: 04

Experiment Name: Determination of the Young's Modulus by the flexure of a beam.

Apparatus:

1) Pin and Microscope
2. Meter Scale
3. Suitable weights
4. Slide calipers
5. Screw gauge
6. A long Metal beam
7. knife screw

Theory:

Provided the distortion of a body is not too great it has been found that the amount of distortion is directly proportional to the magnitude of the forces producing the distortion. The fact is know as "Hooke's" law. If a wire of natural length L is streched or compressed a distance x by a force F, experiment reveals that

$$F = kx \quad \text{-------} \quad (1)$$

where k is the constant whose value will depend on the material, the dimension of the wire and the units for measurement. The value of k is depend only on the material of the specimen and not on its dimension. It is called Young's Modulus of modulus of elascity for the material symbol Y.

If a force F be applied normally to a cross-sectional area A of the material in the ~~front~~ form of a wire, then F/A is called the tensile stress. x be the increase in length produced in an original length l as a result of this force, then x/l, is called the tensile strain.

$$\therefore \; Y = \frac{\text{tensile stress}}{\text{tensile strain}} = \frac{F/A}{x/l} = \frac{mg}{\pi r^2} \times \frac{l}{x} \text{ dynes/cm}^2$$

If a rectangular beam of breadth b and thickness d is supported near its two ends by two knife edges seperated by a distance l, and if a mass m acting at a point of the beam equidistant from the knife edges producess a depression x, then the Young's modulus is given by $Y = \frac{mgl^3}{4bd^3x}$

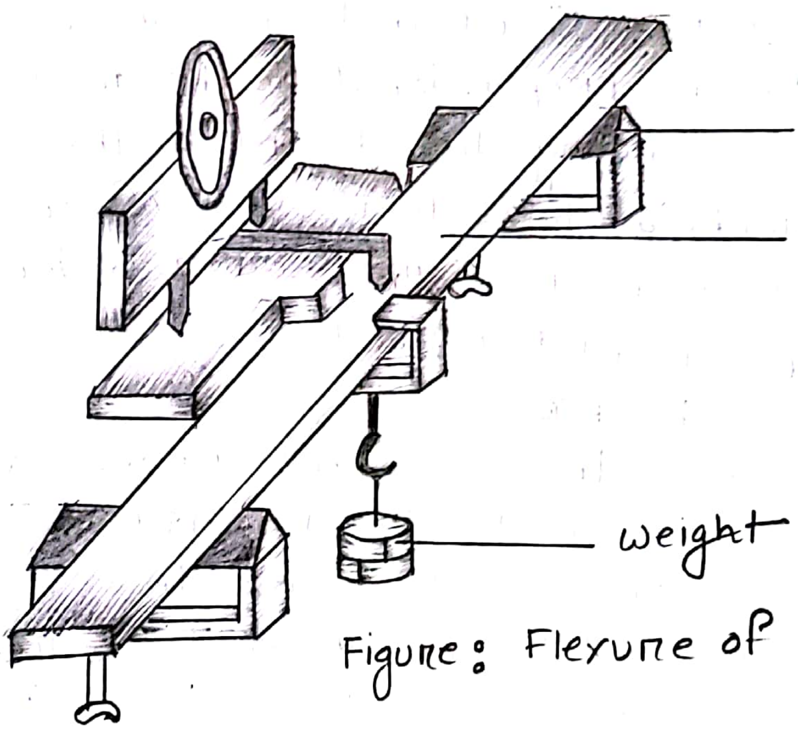

Figure: Flexure of a beam.

$$Y = \frac{mgl^3}{4bd^3x}$$
$$= \frac{1.5 \times 9.8 \times (0.78)^3}{4 \times 0.038 \times (0.0038)^3 \times 0.00403}$$
$$= 2.07 \times 10^{11}\ Nm^{-2}$$

Experiment No.: 04

Name of the Experiment:
Determination of the Young's Modulus by the flexure of a beam

Data Collection:

Length of the beam, l = ~~.....~~ 78.74 cm

Table 1: Data for load versus elongation

Additional Load on hanger (kg)	Readings for the elongation, x										Mean reading (cm)	Mean depression y_0 (cm)
	Load increasing					Load decreasing						
	LSR x (cm)	CSD N	LC (cm)	CSR $y = N \times L.C.$ (cm)	Total Reading =x+y cm	LSR x (cm)	CSD N	LC (cm)	CSR $y = N \times LC$ (cm)	Total Reading =x+y cm		
0	0	0		0	0	0.1	110		0.110	0.21	0.105	0.105
0.5	0.2	195		0.195	0.395	0.3	305		0.305	0.605	0.5	0.395
1.0	0.4	438	0.001	0.438	0.838	0.6	550	0.001	0.550	1.15	0.999	0.495
1.5	0.7	613		0.613	1.313	0.8	670		0.670	1.47	1.3915	0.4035
2.0	0.9	770		0.770	1.67	0.9	780		0.780	1.68	1.675	0.2775
2.5	1.1	975		0.975	2.075	1.1	975		0.975	2.075	2.075	0.4

Table 2: Measure the breadth, (b) of beam

No. of obs.	Main scale reading (M.S.R) cm	Vernier scale divisions (V.S.D)	Vernier constant (V.C) cm	Vernier scale reading (V.S.R) = (V.S.D X V.C) cm	Total breadth b (cm)	Mean Breadth b (cm)
1	3.70	03	0.002	0.006	3.706	
2	3.80	21	0.002	0.042	3.8421	3.8226
3	3.90	10	0.002	0.02	3.92	

Table 3: Measure the depth, (d) of beam

No. of obs.	Main scale reading (M.S.R) cm	Vernier scale divisions (V.S.D)	Vernier constant (V.C) cm	Vernier scale reading (V.S.R) = (V.S.D X V.C) cm	Total depth d (cm)	Mean depth d (cm)
1	0.3	40	0.002	0.08	0.380	
2	0.3	43	0.002	0.086	0.386	0.380
3	0.3	37	0.002	0.074	0.374	

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Calculation:

From the sheet we get,

Length of the beam (l) = 78.74 cm = 0.78 m

mean depression (x) = 0.4035 cm = 0.00403 m

breadth of the beam (b) = 3.8226 cm = 0.038 m

depth of the beam (d) = 0.380 = 0.0038 m

~~given,~~ weigth of ~~the beam~~ (m) = 1.5 kg

we know,

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

$$= \frac{1.5 \times 9.8 \times (0.78)^3}{4 \times (0.038) \times (0.0038)^3 \times 0.00403}$$

$$= 2.07 \times 10^{11} \ Nm^{-2}$$

Result:

Young's modulus of the given material is $2.07 \times 10^{11} \, Nm^{-2}$

Precission:

1. First of all we have to find out the ~~point~~ equivalent reading of Main scale ~~readin~~ and circular scale, which we will count as 0.
2. After increasing 0.5kg in each steps, we have reset our circular, main scale. After reseting those scale we count every full rotation of our circular scale.
3. To find out the mean depression, we take the value which occurs frequently.
4. For 2.5 kg the load increasing data and load decreasing data ~~will be~~ was same.

References:

(i) Lab manual

(ii) Links → scribd.com