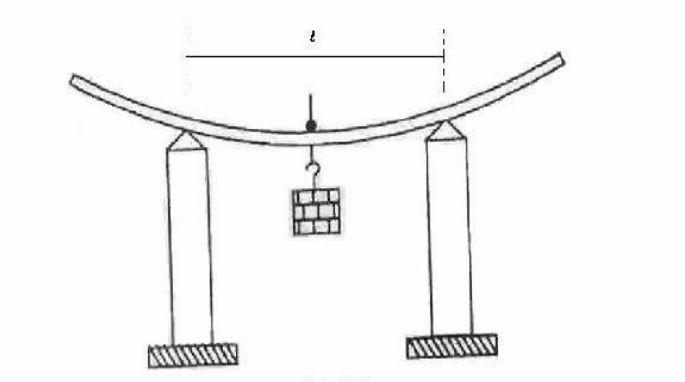
UNIT – I PROPERTIES OF MATTER

TOPIC – VII NON UNIFORM BENDING

Non – Uniform Bending

The given beam is symmetrically supported on two knife edges as shown in Fig.2. A weight hanger is suspended by means of a loop of thread from the point C exactly centre between the knife edges. A pin is fixed vertically at *C* by wax.



YOUNG'S MODULUS - NON-UNIFORM BENDING

Calculation of Depression 'y'

Let AB represents a beam of length '*l*', supported on two knife edges at *A* and *B* loaded with a weight W at the centre *C*. The reaction at each knife is (*W*/2) acting vertically upwards. The beam bends as shown in Fig. The depression being maximum at the centre. The bending is non – uniform. Let the depression by the load is '*y*'.

The portion *CA* of the beam may be considered as a cantilever of length (*l*/2), fixed at *C* and bending upwards under a load (*W*/2). In cantilever, the depression '*y*' produced by a load *W* is given by,

$$y = \frac{Wl^3}{3YAk^2} \quad \text{---------- (1)}$$

Hence, the elevation of *A* above *C* or the depression of *C* below *A* is given by,

$$y = \frac{\left[\frac{W}{2}\right]\left[\frac{l}{2}\right]^3}{3YAk^2} \quad \text{---------- (2)}$$

$$\text{Depression } y = \frac{Wl^3}{48YAk^2} \quad \text{---------- (3)}$$

Equation (3) denotes the depression by non – uniform bending and is proportional to the value of '*l*' and inversely proportional to the Young's modulus of the material.

Calculation of Young's Modulus 'Y'

A travelling microscope is focused on the tip of the pin such that the horizontal cross wire coincides with the tip of the pin. The reading in the vertical transverse scale of the microscope is noted. Weights are added in equal steps of mass m kg and the corresponding readings are noted. Similarly, readings are noted while unloading. The results are tabulated in the table 2.1

Load 'm' in kg	***Microscope Reading***			***Depression 'y' for 'm' kg***
	Loading	***Unloading***	***Mean***	

Table.2.1 Calculation of Depression (y) in Non-uniform Bending

The mean depression '*y*' is found for a load of m kg. The length of the beam '*l*' between the knife edges is measured. The breadth '*b*' and the thickness '*d*'of the beam is measured with a vernier calipers and screw gauge, respectively.

Then, depression $y = \frac{Wl^3}{48YAk^2}$

or $Y = \frac{Wl^3}{48yAk^2}$ ---------- (4)

since $W = mg$ and $Ak^2 = \frac{bd^3}{12}$, the Young's modulus '*Y*' is given as,

$$Y = \frac{Wl^3}{48y\left[\frac{bd^3}{12}\right]}$$

Young's modulus $Y = \frac{mgl^3}{4bd^3y}$ Nm^{-2} ---------- (5)

By knowing the mass (*m*), length (*l*), breadth (*b*) and thickness (*d*) of the beam and depression (*y*), the Young's modulus (*Y*) is determined.