KOENIGS METHOD

1 OBJECTIVE

To determine the Young's modulus of material of given bar by Koenigs method.

2 REQUIREMENTS

Bar (metal/wooden), knife edges, mirrors, scale, telescope

3 INTRODUCTION

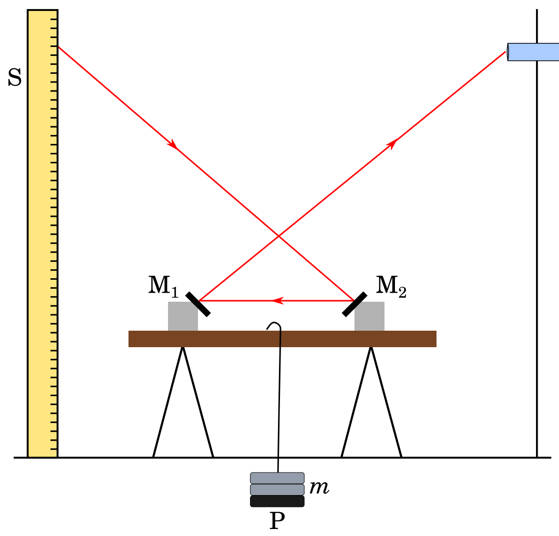


Figure 1: The experimental setup

The experimental arrangement is as shown in the figure. The bar is mounted on a knife edge which carries the load on a pan P. At the ends of the bar two mirrors M_1 and M_2, almost normal to the bar, but slightly displaced, are fixed to enable a scale S to be seen in the telescope T, the light from S having suffered 2 reflections.

The telescope carries a crosswire in the eye-piece and the apparatus is arranged so that scale divisions as seen in the telescope coincides with crosswire. If now the bar is loaded with say 0.5 or 1 kg, as a result of the depression produced, the scale division viewed in the telescope will be altered by the particular divisions. One can determine the Young's modulus using the relation:

$$Y = \frac{3WL^2(2D+\alpha)}{2bd^3x} \tag{1}$$

where,

$$\begin{aligned} W &= mg \text{ where m is load in kg} \\ l &\rightarrow \text{ distance between the knife edges in m} \\ D &\rightarrow \text{ distance between scale and the more remote mirror } M_2 \text{ in m} \\ \alpha &\rightarrow \text{distance between the mirrors in m} \\ b &\rightarrow \text{breadth of the bar in m} \\ d &\rightarrow \text{ Thickness of the bar in m} \end{aligned}$$

4 PROCEDURE

1. Arrange the apparatus as shown in figure.
2. Adjust the telescope to get a clear image of the scale on the mirror M_1.
3. Place the 0.5 kg load in the pan bar and take the scale readings which coincides with crosswire. Note the value.
4. Repeat the above step by adding equal loads upto 3.5 kg and note the corresponding depression.
5. Find the values of l, D and α using a meter scale, and values of b and d using a screw gauge.
6. Plot a graph of load versus depression. The slope of the graph gives the value of $\left(\frac{m}{x}\right)$. Substituting it in the equation, Y can be obtained.

5 OBSERVATIONS

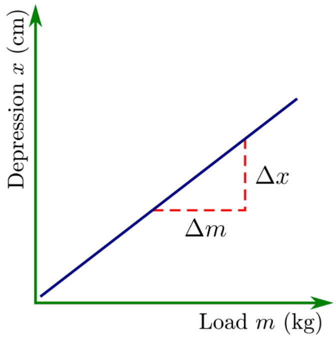
Sl.no.	Load m (kg)	Reading of scale in mirror (cm)			Depression x (cm)
		Load increase	Load decrease	Average	

Distance between the knife edged, l = __________
Distance between scale and the mirror, M_2 =__________
Distance between mirrors, α = __________
Breadth of the bar, b =__________
Thickness of the bar, d =__________

6 CALCULATIONS

The plot of load versus depression gives a straight line. The slope of this line is given by

$$\text{slope} = \frac{\Delta x}{\Delta m}$$



From equation (1),

$$Y = \frac{3Wl^2(2D+\alpha)}{2bd^3x} = \frac{3mgl^2(2D+\alpha)}{2bd^3x}$$

$$\therefore Y = \frac{3gl^2\,(2D+\alpha)}{2bd^3x}\left(\frac{m}{x}\right)$$

$$\Rightarrow Y = \frac{3gl^2\,(2D+\alpha)}{2bd^3x}\left(\frac{1}{\text{slope}}\right)$$

7 RESULT

The Young's modulus of the bar is ____________________ Pa.