• Paper-I.

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(1) Horizontal torsion apparatus for rod.

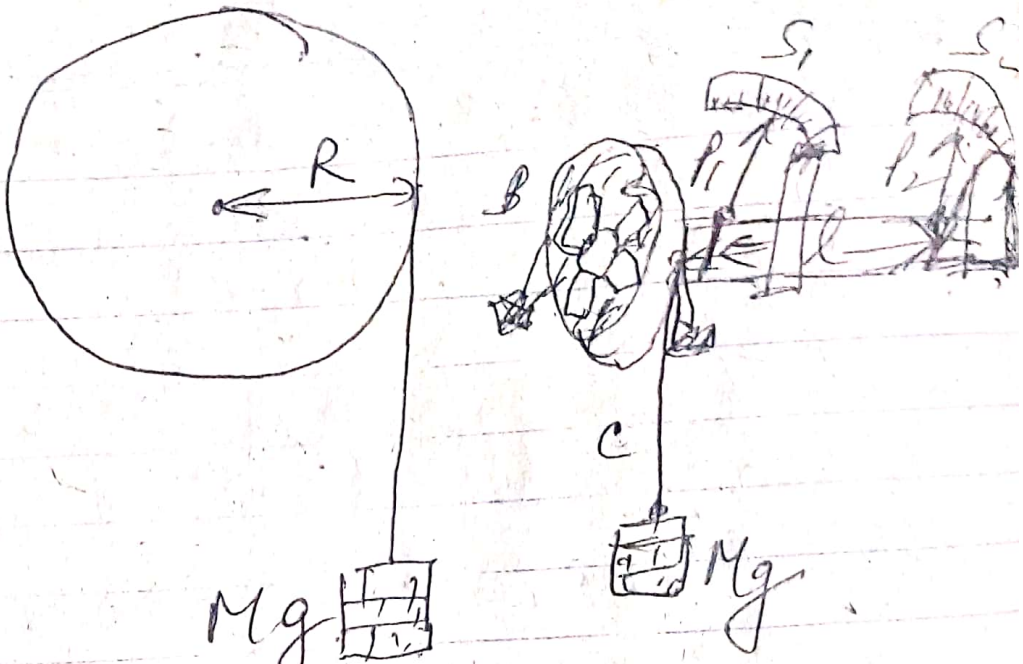

Fig (1).

For the determination of modulus of rigidity to the materials of rods, the horizontal apparatus due to Searle is shown in the fig (1). The apparatus consists of the specimen rod about 50 cm. long and reading 0.25 cm. One end of the rod is firmly fixed to a block A and the other end is attached to a steel axle which is fixed to the pulley B.

A cord is wound round the pulley and to the free end a load is suspended. This produces a couple, which tends to twist the rod about its own axis.

Let R be the radius of the pulley and M be the mass suspended to the free end of the cord. The moment of the couple acting on the rod due to the load of mass M

$$= Mg \cdot R$$

If l is the length between the two pointers. P_1 and P_2 and θ_1 and θ_2 be the corresponding twists produced (measured in radians) respectively, then

$$Mg \cdot R = \frac{n\pi r^4 (\theta_2 - \theta_1)}{2l},$$

where r is the radius of the rod.

In practice, we measure θ_1 and θ_2 in degrees, converting these into radians, we have

$$Mg \cdot R = \frac{n\pi r^4 (\theta_2 - \theta_1)}{2l} \cdot \frac{\pi}{180}$$

[$\because 180^\circ = \pi$ radians]

$$\therefore n = \frac{360 \cdot Mg \cdot l \cdot R}{\pi^2 r^4 (\theta_2 - \theta_1)}$$

Hence, with the help of this formula, the value of n for the material of the rod can be determined.

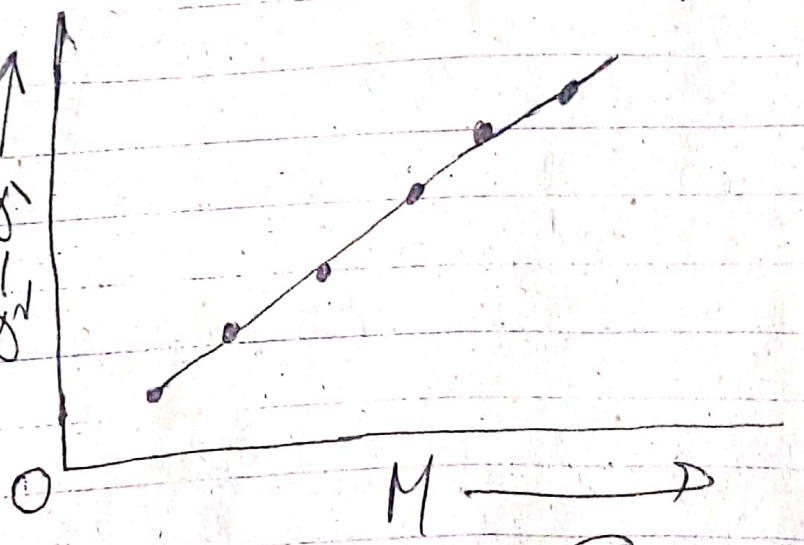

fig. (2)

In experiment, a series of weights are used and the observations of two pointers P_1 and P_2 are noted. A graph is then plotted between M as abscissa and corresponding twist $(\theta_2 - \theta_1)$ in the rod as ordinate. The slope of

the straight line, so obtained, gives the average value of $\frac{(\theta_2 - \theta_1)}{M}$. Now, measuring l, R and r, the modulus of rigidity of the material of the rod can be determined.

The apparatus suffers from two main defects:

(i) The centres of the scales S_1 and S_2 may not lie on the axis of the rod. Thus, the resulting error cannot be removed by the use of a single-end pointer.

(ii) There is only one pulley in the apparatus, by means of which only a single force can be applied to the end of the rod. A side pull is exerted on the rod by this force and thus introduces friction between the bearing and the rod, which hinders the rod from twisting freely.