Rigidity Modulus

Experiment No: ______________ **Date: __________________**

Aim:

To determine the rigidly modulus of the given wire by Barton's apparatus (Static Method).

Apparatus Required:

a) Barton's apparatus
b) Vernier callipers
c) Micrometer
d) Slotted weights (500gm)
e) Meter scale
f) Spirit Level

Theory:

Let 'D' be the diameter of the cylinder, to which tortional couple is applied by a suspending equal loads on the two pans attached, each of value 'm' grams.

Then, twisting couple = mgD

If $\propto$ is the twist indicated by the pointer in degrees on the scale S, then **Twist** in radians;

$$\theta = \frac{\pi}{180} \times \propto$$

Restoring couple for a twist θ radians; $c\theta = \frac{\pi\eta r^4}{2l} \times \theta$

Where 'l' is the length of the wire from torsion head to the pointer and 'r' the radius of the wire. Let C = Restoring couple per unit angular twist.

At equilibrium, twisting couple = restoring couple i.e.,

$$MgD = \frac{\pi\eta \;\; {}^4\theta}{2l}$$

Or $$\eta = \frac{MgD \times 2l}{\pi r^4 \theta} = \frac{MgD \times 2l}{\pi r^4 \times \left(\frac{\pi}{180}\right) \times \propto}$$

Or $$\boxed{\boldsymbol{\eta = \frac{360\, l\, g\, D}{\pi^2\, r^4} \left(\frac{M}{\propto}\right)}}$$

Procedure:

a) Measure the diameter of the rod in two mutually perpendicular directions at several places with the help of screw gauge, hence find mean radius (r) of the rod.

b) Find the diameter and hence radius(R) of the cylinder by vernier calliper or measure the circumference $2\pi R$ of the cylinder by thread. From the circumference find out the radius (R) of the pulley.

c) For zero weight on the hanger, adjust the pointer so that read zero on the respective circular scales.

d) Measure the distance '*l*' of the pointer from the fixed end A of the rod.

e) Gently place 0.5 kg slotted weight on the hanger. Wait for few minutes and note down the reading of the pointer.

f) Increase the load in steps of 0.5 kg slotted weight on the hanger. Wait for few minutes and note down the reading of the pointer on the scale at each step. Let it be X_1 (say).

g) Now decrease the load in steps of 0.5 kg till the zero loads is reached. Note down the reading of the pointer on the scale at each step. Let bit be X_2 (say). Find the mean of loading and unloading i.e. $\theta = \frac{X_1+X_2}{2}$. Angle of twist for zero loads is $\theta_0 = 0$. The twist for 0.5 kg, 1.0 kg, 1.5 kg etc is $\theta_1,\ \theta_2,\ \theta_3$ respectively.

h) Plot a graph load (M) versus angle of twist (θ). The nature of the graph nis a straight line as shown in figure. The slope of the straight line gives $\frac{\Delta M}{\Delta \theta}$.

i) Repeat the steps (d) to (g) by changing the position of the pointer for three to four different lengths (*l*).

j) Calculate the angle of twist for a give load 2 kg (say) by making proper subtraction and note the mean angle of twist for 2 Kg (Table – 1).

Precautions:

a) Pulley should be frictionless.

b) Load should be increased or decreased gradually and gently and should never exceed the maximum permissible limit.

c) As the radius of the rod of course in fourth power, it should be measured accurately in two mutually perpendicular directions.

Observation:

Pitch of micrometer: __________________ cm

Least count of micrometer: _____________ cm

Least count of Vernier callipers: _________ cm

Table – 1: (Radius of the wire using micrometer)

No. of Obs.	ICSR (I)	NCR (N)	FCSR (F)	Diff. (I - F)	PSR (cm) [Pitch×N]	CSR (cm) [(I – F)×L.C.]	Total (cm)	Mean (cm)
1								
2								
3								
4								

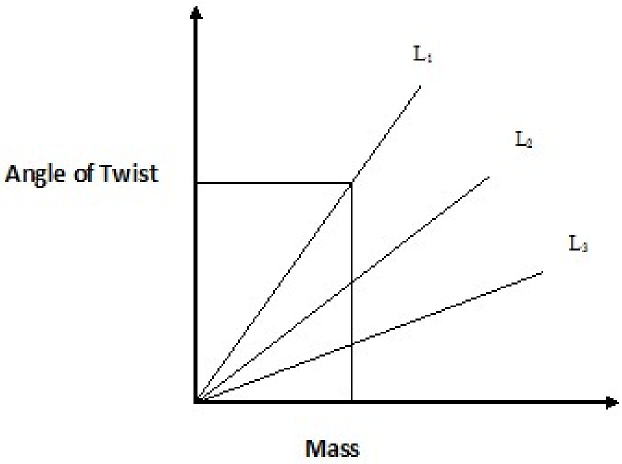
Table – 2: (Diameter of the cylinder using vernier-calliper)

No of Obs.	MSR (cm)	V.C.	VSR (cm)	Total (cm)	Mean (cm)
1					
2					
3					
4					

Table – 3: (Angle of Twist)

No of Obs.	Length in cm	Load in kg	Load increasing: Position of the pointer on scale θ_1 in degree	Load increasing: Change in position of the pointer on scale $\Delta\theta_1$ in degree	Load decreasing: Position of the pointer on scale θ_2 in degree	Load decreasing: Change in position of the pointer on scale $\Delta\theta_2$ in degree	Mean $\propto = \frac{d\theta_1 + d\theta_2}{2}$ in degree
1	L_1	0					
2		0.5					
3		1.0					
4		1.5					
5		2.0					
6	L_2	0					
7		0.5					
8		1.0					
9		1.5					
10		2.0					
11	L_3	0					
12		0.5					
13		1.0					
14		1.5					
15		2.0					

Graph:



Calculation:

Put the value of D, l, r and $\frac{m}{\alpha}$ from the graph in equation, $\eta = \frac{360\, l\, g\, D}{\pi^2\, r^4}\left(\frac{M}{\propto}\right)$

$\eta_1 = \frac{360\, l\, g\, D}{\pi^2\, r^4}\left(\frac{1}{Slope}\right)$ For L_1

$\eta_2 = \frac{360\, l\, g\, D}{\pi^2\, r^4}\left(\frac{1}{Slope}\right)$ For L_2

$\eta_3 = \frac{360\, l\, g\, D}{\pi^2\, r^4}\left(\frac{1}{Slope}\right)$ For L_3

Standard value:

Rigidity modulus of the copper wire = 4.55×10^{11}

Rigidity modulus of the steel wire = $7.9\ to\ 8.9\ \times 10^{11}$

% of Error:

Conclusion:

The value of rigidity modulus of the given wire was found to be ___________________ with ______________ % of error.

Marks Awarded

Planning and Execution (2)	Result and Report (6)	Viva (2)	Total (10)

Signature of the Faculty

Signature of the student:

Regd No:

Group:

Branch: