η by Barton's Apparatus

OBJECT: To determine the modulus of rigidity of material of a wire/rod by statical method using Barton's apparatus.

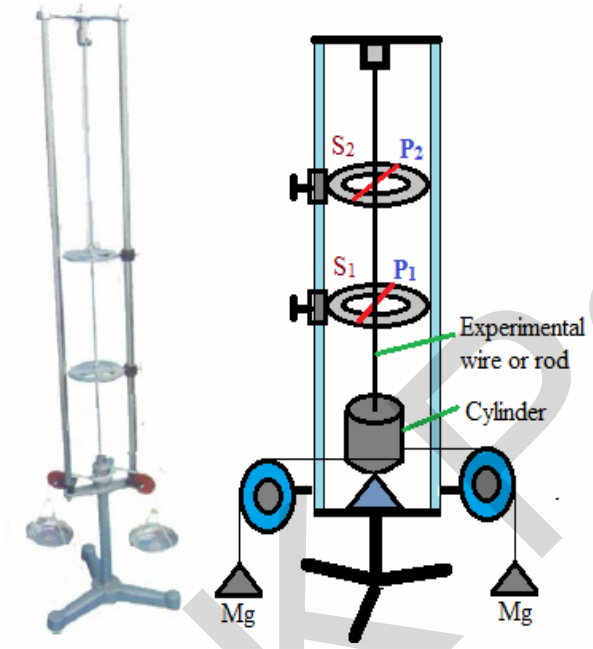
Apparatus used: Barton's apparatus, 500gm weights, screw gauge, Vernier calipers and meter scale.

Formula: The following formula is used for the determination of modulus of rigidity (η).

$$\eta = \frac{360\,M\,g\,D}{\pi^2 r^4}\frac{(l_1 - l_2)}{(\theta_1 - \theta_2)}$$

Where M: load suspended on each cord, g: acceleration due to gravity,
D: Diameter of heavy cylinder, r: radius of experimental rod,
$(l_1 - l_2)$: Distance between two circular scales,
$(\theta_1 - \theta_2)$: Difference between deflections measured in circular scales

Figure:



Procedure:

(1) Fix the both scales and pointers at different places such that pointers should indicate 0-0 on scales in absence of load (*note: at least pointer on one side must indicate zero*). Now measure distance between scales. This will provide the value of (l_1-l_2).

(2) Place equal masses (start from 0gm in interval of 500gm) on each pan and read deflection on both scale and on both side. The scale which is nearer to cylinder will provide θ_1 value while other will give θ_2 value.

(3) Go on increasing masses on each pan by equal amounts (from 0 to 2.5kg in interval of 0.5kg) and note the corresponding deflections on both scales on both sides.

(4) Go on increasing masses on each pan by equal amounts (from 0 to 2.5kg in interval of 0.5kg) and note the corresponding deflections on both scales on both sides.

(5) Now decreases the masses on pans in the same interval and note the corresponding readings on scales for the case of load decreasing.

(6) Take mean of all four readings of θ_1 which is noted for the case of load increasing and decreasing. Similarly, do it also for θ_2.

(7) After it, calculate θ_1-θ_2 for each masses. Using these values, find the angle of twist (θ_1-θ_2) for 1.5kg (it can be obtained by taking difference between 1st & 4th, 2nd &5th and 3rd &6th).

(8) Find out the least count of screw gauge and zero error in it. Using screw gauge, measure the diameter of wire. Its half will provide the value of radius (r) of wire/experimental rod.

(9) Find out the least count and zero error of Vernier calipers. Using Vernier calipers, measure the diameter of cylinder (D).

(10) Put all the values in the formula and calculate it by log method.

Observations:

(1) Distance between two circular scales $(l_1 - l_2)$ =……..cm

(2) ***Table for angle of twist***

S .N.	Load on each pan	Reading of first pointer P_1				θ_1	Reading of second pointer P_2				θ_2	$\theta_1 - \theta_2$	$\theta_1 - \theta_2$ For 1.5 kg	Mean $\theta_1 - \theta_2$ For 1.5 kg
		Load increasing		Load decreasing			Load increasing		Load decreasing					
		a	b	c	d									
1.	0					A					A′	A-A′		
2	500					B					B′	B-B′		
3	1000					C					C′	C-C′		
4	1500					D					D′	D-D′		
5	2000					E					E′	E-E′		
6	2500					F					F′	F-F′		

(3) Least count of screw gauge= $\frac{pitch}{Number\ of\ \text{divisions on circular scale}}$ =……..cm

(4) Zero error in screw gauge=……..cm

(5) ***Table for diameter of experimental rod or wire***

Sr. no.	M.S. (cm)	C.S. (div)	un-corrected diameter (d= MS + CS x LC) (cm)	Mean un-corrected diameter (d: cm)	corrected diameter (D_w=d± zero error) (cm)
1.					
2.					
3.					
4.					
5.					
6.					

(6) *Radius of wire (r)=D_w/2=…..…..cm*

(7) Least count of Vernier calipers = $\frac{value\ \text{of one division on main scale}}{Number\ of\ \text{divisions on vernier scale}}$ ……..cm

(8) Zero error in Vernier calipers=……..cm

(9) ***Table for diameter of cylinder:***

Sr. no.	M.S. (cm)	V.S. (div)	un-corrected breadth (T= MS + VS x LC) (cm)	Mean un-corrected breadthr (d: cm)	corrected breadth (D=T± zero error) (cm)
1.					
2.					
3.					
4.					
5.					
6.					

Calculation: $\eta = \frac{360\ M\ g\ D}{\pi^2\ r^4} \frac{(l_1 - l_2)}{(\theta_1 - \theta_2)}$

(Put all the values in the above formula and solve it with log method)

Results: The modulus of rigidity of given experimental rod/wire material = …….N/m^2

Precautions:

1. There should be friction in pulleys.
2. The cord wounded on cylinder should be thin and strong.
3. Load should be increased and decreased gently.
4. Load should not exceed the limit of elasticity.
5. To avoid the backless error, the circular scale of screw gauge should be moved in one direction in measurement of diameter of experimental rod/wire.