TASK DETAILS:

Experiment 7: Torsion Test

Objective:

The objective of this experiment is to apply torsional moment for bars with different material and find the corresponding modulus of rigidity or shear modulus.

Introduction:

Torsion, also known as torque, describes a moment that is acting upon an object around the same axis in which the object lies. A moment is a measurement of the propensity of a force to create motion around either a point or an axis, and is calculated as the force upon the object multiplied by the distance of the force from the chosen origin.

$M_T = F.\ R$

Where F is the force applied and R is the radius of disk (lever arm) in this experiment.

Torque applied can also be calculated using:

$$M_T = \frac{GJ}{L}\alpha$$

Where:

M_T = Torque

G = modulus of rigidity

L = length of the bar

J = polar moment of inertia of area; $\boldsymbol{J = \frac{\pi}{32}D^4}$ Where D is the diameter of bar cross section

α = the resultant torsion angle; $\boldsymbol{\alpha = \alpha_2 - \alpha_1}$

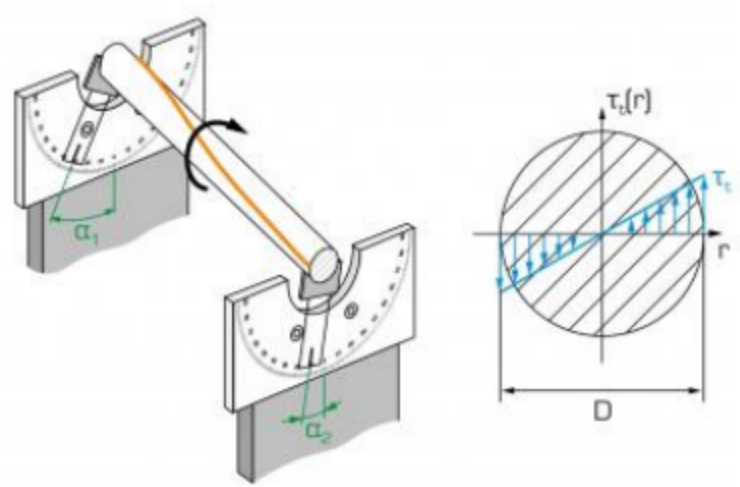

Figure 1. Torsion of a bar and measurement of the angles α 1 and α 2, right: shear stresses on the circular section

The **shear modulus or modulus of rigidity, G,** describes the material's response to shear stress. It is a coefficient of elasticity of a substance, expressing the ratio between the force per unit area (shearing stress) that laterally deforms the substance and the shear (shearing strain) that is produced by this force. The shear modulus is a measure of the ability of a material to resist transverse deformations and is a valid index of elastic behavior only for small deformations, after which the material is able to return to its original configuration.

Members in torsion are encountered in many engineering applications. The most common application is provided by transmission shafts, which are used to transmit power from one point to another.
Example: The ductile material will break at 90 degrees, while the brittle material break at 45 degrees.

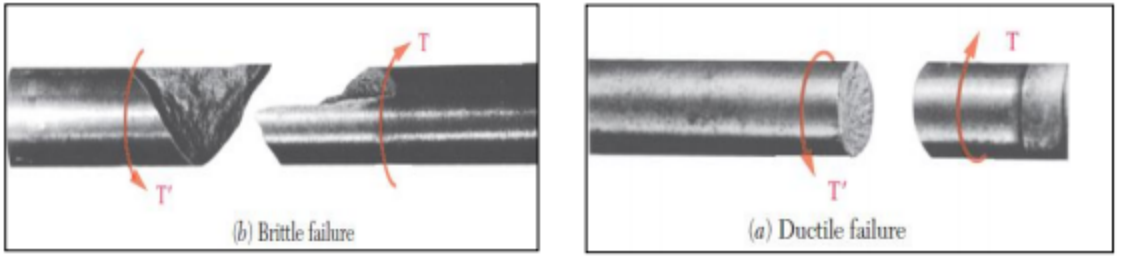

Figure 2. Brittle and ductile failure by torsion

Modulus of rigidity calculation steps:

1. Measure the dimensions of the bar.
2. Apply torque (torsion moment) on the bar and increase it gradually.
3. Record the torque and the twist angle.
4. Plot the torque versus twist angle.
5. The linear part of this curve can be used to measure the modulus of rigidity for the bar material.

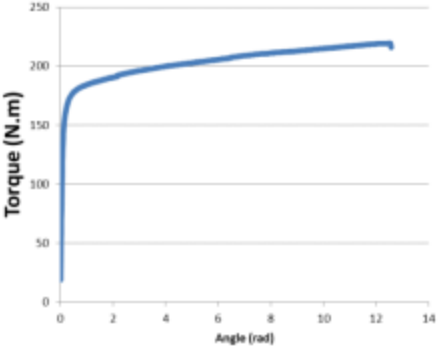

Figure 3. Torque vs. twist angle

Equipments:

1. 2 bars made by 2 different materials: round bar with full cross-section
2. 2 movable support blocks with clamping chuck for mounting of bars, 1 fixed and 1 movable support
3. 2 movable angle indicators clampable to the bar
4. Mass disk (pulley)
5. Hook and weights
6. Storage system to house the components
7. Experimental setup in frame SE 110.29

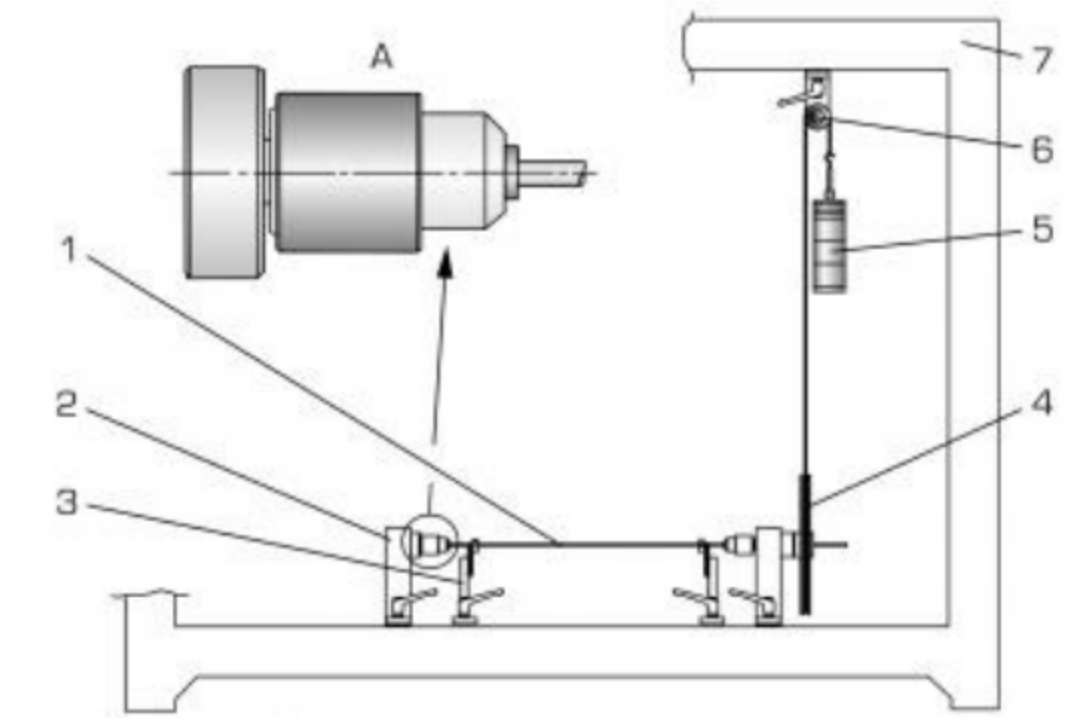

Figure 4. Experimental setup in frame SE 110.29

Procedure:

1. Set the apparatus as shown below.
2. Select test bar and mount it.
3. Set torsion length and adjust scale pointer to value of 0 degree.
4. Attach weight.
5. Read and record the two torsional angles.
6. Increase the loads and repeat the experiment.
7. Repeat the experiment for the second test bar.

Figure 5. Torsion of bar apparatus SE 110.29

TASK 1

Data:

L (length) = 695 mm

R (radius of the disk) = 110 mm

D (diameter of solid bar) = 6 mm

Material A

Load F (N)	Torque M_T (N.mm)	α_2 (degree)	α_1 (degree)	α (degree)	α (rad)

Material B

Load F (N)	Torque M_T (N.mm)	α_2 (degree)	α_1 (degree)	α (degree)	α (rad)