Introduction to the Experiment

The purpose of torsion testing usually parallels that of uniaxial tension tests. From the experiment, the shear elastic modulus (G), shear proportional stress (τ_p), shear yield stress (τ_y), and the Stress-Strain behavior in general, can be obtained. However, in contrast to uniaxial tension tests, the stresses are not distributed uniformly over the cross section.

Torsion loading results in twisting of one section of a body with respect to a contiguous section. During the test the angle of twist ϕ and the applied torque T are measured as the test proceeds. For a circular cross-section, in the absence of the other loads, pure shear stress state exists at each point. Torsional elastic shear stresses vary linearly from zero at the axis of twist to a maximum at the extreme fibers. Thus, in a solid circular bar, when the surface fibers reach the yield shear stress they are, in a sense, supported by elastic interior fibers. Consequently, the elastic resistance of the remainder of the section masks the effect of yielding of the surface fibers during their early stage of yielding. Usually, it is not until considerable yielding has taken place that any noticeable effect of nonlinearity is apparent using a simple mechanical troptometer to measure the angle of twist ϕ

To test the material in torsion the proper test procedure is needed. It involves mounting a shaft into the testing machine, applying torque incrementally and measuring both the applied torque and the corresponding angle of twist. Using the appropriate formulae, relationships and the measured dimensions, we can determine the shear stress and shear strain on the shaft. Then, one can plot the torque vs. angle of twist, and shear stress vs. shear strain from which one can find the material properties previously mentioned.

Apparatus other than testing specimen:

1. Caliper

2. Troptometer

3. Torsion testing machine
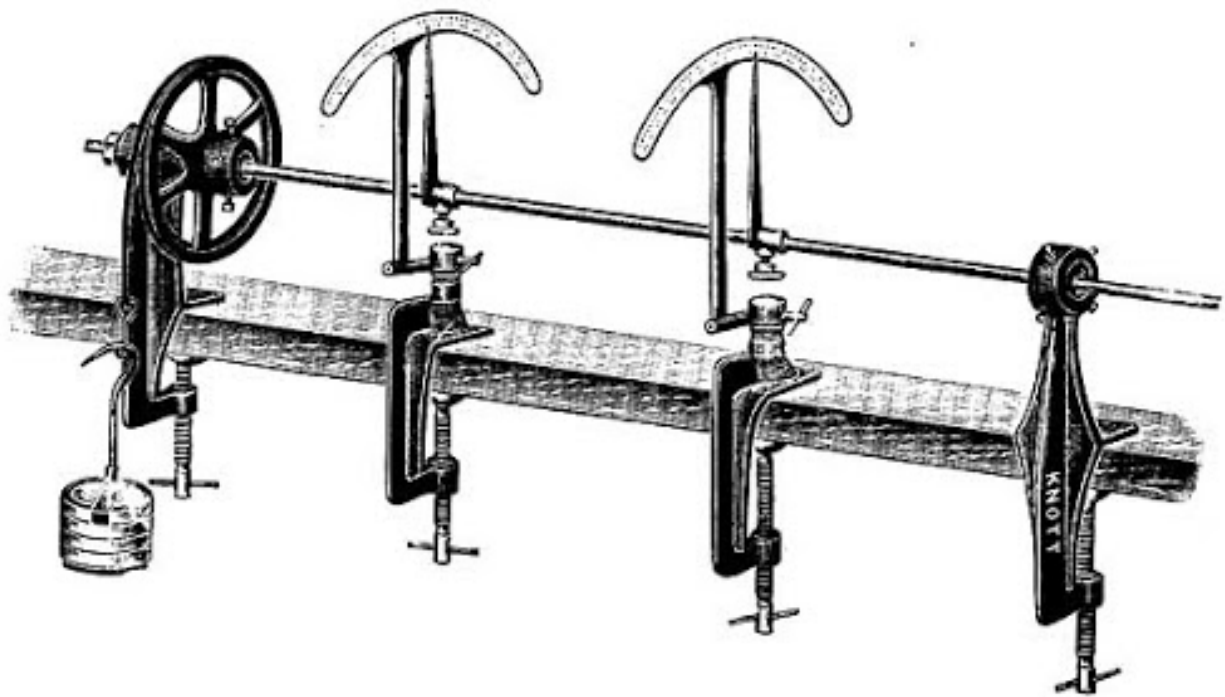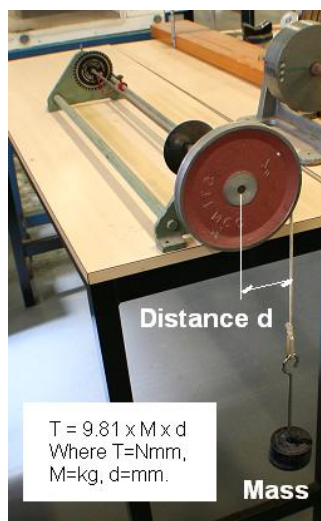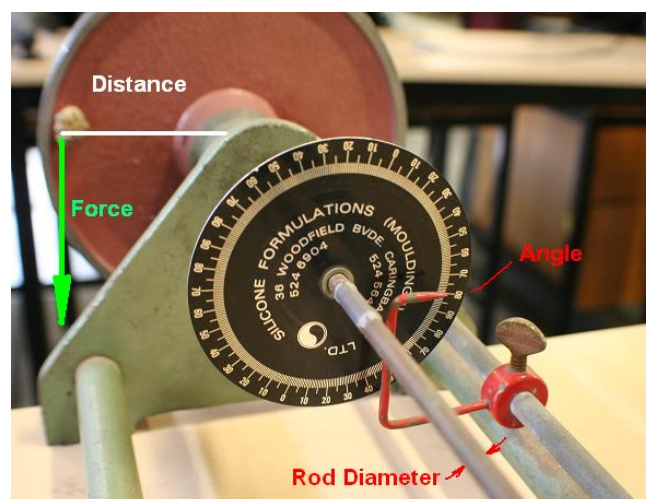
4. Measuring tape

Figure 1: Torsion Apparatus

Figure 2: Torsion Apparatus Setup

(a) Lever

(b) Deflection Indicator

The assumptions made in this experiment include the following:

1. The torque is applied along the center of axis of the shaft.

2. The material is tested at steady state (absence of strain rate effects).

3. Plane sections remain plane after twisting (the circular section conforms to this condition).

Test Procedure:

1. Measure the diameter of the test specimen using the caliper (take an average of 5 measurements).

2. Slide the shaft into the Torsion Test Apparatus and tighten down the two fastening screws to the shaft.

3. Clean the clamps used to hold the shaft in place.

4. Insert the shaft into the right clamps. Tighten the clamp ensuring that the grip is very tight.

5. Adjust the Torsion Test Apparatus to the correct position pointing at 0 degree initially.

6. Measure the length between the Torsion Test Apparatus clamps Lt using the tape measure. This length is the effective length of the rod between which the Torsion takes place

7. Add weights to the lever gradually and note down the Apparatus reading of the deflection

8. After loading the lever,unload it by taking the masses off one by one and note down the Apparatus reading of the deflection.

9. Repeat this cycle 20 times to obtain sufficient data to find a good estimate of the Shear Modulus

10. Calculate the Stress and Strain with the recorded data and plot a Shear Stress vs Shear Strain Curve. **The slope of the Shear Stress vs Shear Strain curve gives the value of the Shear Modulus G**

Results :
Experimental Shear Modulus of Aluminium 6061 : 20.2659 ± 3.2629 GPa
Published Shear Modulus of Aluminium 6061 : 26 GPa

Discussion:

As we can see the Experimental value is less than the Published value. A part of this can be attributed to the fact that since we can not measure angles beyond a certain precision,we have taken a larger range of Strain to calculate the Shear Modulus.This means that the values that are obtained are not strictly confined to the proportionality limit and may exceed it.

Beyond the Proportionality Limit the Stress does not increase linearly with Strain and slope of Stress vs Strain graph decreases. Thus when we apply a Linear Fit, the slop of the Best Fit line is less than the slope of the Stress vs Strain graph in the Proportionality Limit. Due to this reason we obtain a value less than the Published value and not more than it.

Another observation we made was that the Precision of the Data given to us was higher than the Precision of the Torsion Apparatus.This suggests the use of a more precise apparatus than mentioned

Conclusion:

- We understood that Modulus of rigidity is the coefficient of the elasticity for a shearing force, it measure the stiffness of the particular materials in torsion test.

- Different type of material will have different elastic limit. The higher value of modulus of rigidity, G , the higher the torsion stiffness of material .

- If the material exceeds the elastic limit,permanent deformation will be occurring. On exceeding the proportionality limit the objective of this experiment will be defied.

- We learnt how Torsion Test can be used to calculate the Shear Modulus of a Material.

- Learning about the Errors that might persist during the Torsion Test and how to minimize them

- Using tools with limited technology and precision,the Torsion Test gives a decent esitmate of the Shear Modulus of a material