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ME818 Lab 3

* Objective: To perform torsion test and determine
  a) Torque-Twist relationship for an aluminium circular shaft
  b) Compare the result with theoretical ~~results~~ predictions

* Experimental Methods

Instruments used are:

a) Torsion Setup:- This machine helps us measure the angle of twist and torsion exerted by the ~~setup~~ specimen. A sensor measures the twist values and load cells measure torque values. The setup includes an output monitor to display the readings.

b) Vernier Calipers: A measuring device used to measure diameter of specimen

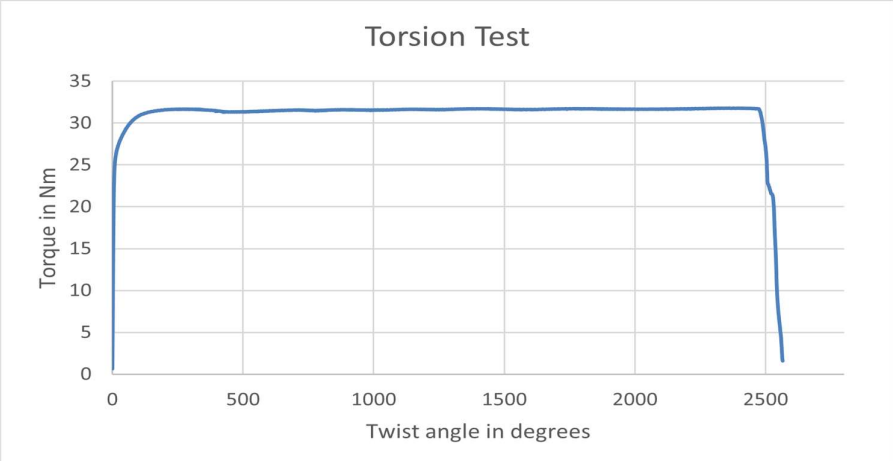
c) Aluminium specimen: A solid circular rod of aluminium of a dog-bone shape but with ends being flattened in an elliptical shape so that the specimen does not rotate but only twist during the experiment.

We stop the experiment when the specimen breaks

* Results

Limiting Torsion is the value of torque after which rod twists without any increase in torque, i.e. slope of graph is 0. At this point, rod cannot resist any further change in torque. This value is called limiting torque (T_L) for the shaft

Yield point is the torsion value after which specimen starts undergoing plastic deformation. We can find this point by observing the point till which torque vs twist graph is linear.



From the graph - T_y (yield point) = 25.105 Nm
T_L (at saturation) = 31.605 Nm

$T_L = 4/3 T_y \left(1 - (\theta_y/\theta)^3/4\right) \Rightarrow T_{L,th} = 4T_y/3 = 33.473$ Nm

T_y = Torsion at yield point
θ_y = Angle of twist at yield point

In the linear region

$$G_{exp} = \frac{TL}{J\theta} = \frac{12.4867 \times 0.1}{9.8174 \times 10^{-10} \times 0.048154}$$

$$= 86.4 \text{ GPa}$$

Theoretical Shear Modulus of Aluminium = 24 GPa

% error = $\frac{86.4 - 24}{24} \times 100 = 10\%$

% error on limiting torque = $\left|\frac{31.605 - 33.473}{33.473}\right| \times 100 = 5.58\%$

* Conclusions and Observations

Final Results - $T_{L,exp}$ = 31.605 Nm
$T_{y,th}$ = 33.473 Nm
G_{exp} = 86.4 GPa
% error on Shear Modulus = 10%
% error on limiting torque = 5.58%

Shear modulus of Aluminium is quite low, however it has a large plastic region which fails at around 2500 degrees. The specimen fails at the point of contact with the set screws. Therefore failure is not actually due to torsion, it is due to normal force at the ends of the specimens and due to defects.