THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

EEE3112 ELECTRICAL ENGINEERING PRACTICE – MECHANICAL COMPONENT LABORATORY
LAB. INSTRUCTION SHEET No.:1

1.0 Title

PURE TORSION

2.0 Objective

To illustrate the theory of torsional stresses and twisting in a solid circular shaft

3.0 Theory

For more detailed treatment of the theory, consult standard textbooks on Strength of Materials

Consider a cylindrical solid shaft of length *l*, and diameter *d* and having shear modulus *G*. Let this shaft be subjected to a pure torsion caused by a couple *T* applied so that the axis of the couple coincides with the axis of the shaft. The state of stresses at any point in the shaft, is one of pure shear, and strain is such that one cross-section of the shaft rotates to another.

If θ is the angle of twist through which one end of the shaft rotates relative to the other, it can be shown that:

$$\frac{T}{J} = \frac{G\theta}{l} = \frac{2\tau}{d}$$

where: T = Torque, Nm
J = Polar second moment of area, m^4
τ = Shear stress, N/m^2
G = Shear modulus, N/m^2
θ = Angle of twist, rad
l = Length of shaft, m
d = Shaft diameter, m

4.0 Equipment/Apparatus

a) Standard 1.7 kNm Torsion Testing Machine for manual or powered straining and with self-indicating Weighing Mechanism and Sliding Saddle
b) 360^{O} machine mountable angle of twist indicator/protractor
c) A number of pre-prepared specimens

5.0 Procedure

a) Attach the angle indicator at the headstock of the machine.
b) Mark out a suitable test length on the test piece, say 100 – 150 mm.
b) Securely clamp the specimen in two sets of jaws of the machine. Make sure the sliding saddle is securely locked on the machine bed.
d) Clamp the moving jaws of the angle indicator to the test piece.
e) Select a suitable load scale using the handle located below the dial face.
f) Make sure the machine chuck is disengaged, start the machine
g) Note the "zero" readings on the angle of twist and torque.
h) Engage the chuck to rotate "forward".
i) At suitable load intervals (not exceeding 10Nm), take corresponding angle of twist readings.

j) Continue until the specimen fails completely.
k) Take particular note of the following:
(i) Torque and angle of twist around the yield point.
(ii) Torque and angle of rapture.
l) Repeat the above procedure for other specimens of either different materials or dimensions.

6.0 Results/Points of Discussion

a) Tabulate your results
b) For each specimen, plot T against θ, and hence calculate:
(i) G for each shaft, in the elastic region, and deduce what its material could be.
(ii) The average total work done in twisting each shaft to yielding over the test length
(iii) The average energy per unit volume over the test length
(iv) The maximum shear stress at yielding.
(v) The shear stress at rapture.

c) Compare the theoretical and experimental yield and rapture stresses
d) Discuss your results and draw suitable conclusions.

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