EXPERIMENTAL INVESTIGATION OF TORSIONAL STRENGTH

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ABSTRACT

The present work is aimed at "Experimental investigation of torsional strength". The two sensors, strain gauge and the rotary potentiometer are used in this machine. The strain gauge is used to measure the torque developed in the experiment while the rotary potentiometer to measure the angle of twist. The international research paper on "Design and Development of Economical Torsion Testing Machine" by Glenn E. Valley from England helped to complete the project work successfully. It provided the direction in which the project is to be carried out.

Keywords – Torsion ,strain guage ,Potentiometer.

I. INTRODUCTION

Torsion refers to twisting of a straight member under the action of turning moment or torque which tends to produce a rotation about the longitude axis. Steering rods, propeller shafts, axles, drive shafts of automobiles are some example of members subjected to torsion.

Shear stress acting on the cross-sectional planes and on the longitudinal planes gives rise to diagonal tensile and diagonal compressive stresses of the same magnitude as the shear stresses. These tensile and compressive stresses are oriented at 45 degree to the longitudinal axis and are obviously maximum at the surface of the shaft in torsion.

Torsion equation-

$$T/J = f/R = G \times \theta / L$$

Where, T=moment of resistance or applied torque, J=second moment of area is a measure of beams ability to resist torsion, f=shear stress, R=radius of shaft, G=modulus of rigidity, θ=angle of twist, L=longitudinal length of shaft

II. EXPERIMENTAL SET UP

The prime mover gets power through electricity switch board via Dimmerstat. Dimmerstat varies the voltage across motor so that variable speed can be obtained. By varying the Dimmerstat knob low speed is obtained at prime mover shaft. Through sprocket and chain arrangement another speed reduction is obtained. The one end of specimen which is tightly gripped in lathe chuck became rotating. As specimen is held fixed on other side it gets twisted, and torsion phenomena occurs. The reading of torque from strain gauge indicator and angle of twist from rotary potentiometer is taken.

Figure 1 : Experimental set up

III. STRAIN GUAGE CALIBRATION

The fabricated C channel is attached on the strain gauge shaft with the help of two screws as shown in photograph. On the other side of 'C' channel weight panel is attached. The weights are added *progressively in the weight pan and corresponding reading of strain gauge indicator is noted down. The indicator shows reading in terms of millivolt and by attaching weight and calculating corresponding torque the strain gauges were calibrated.*

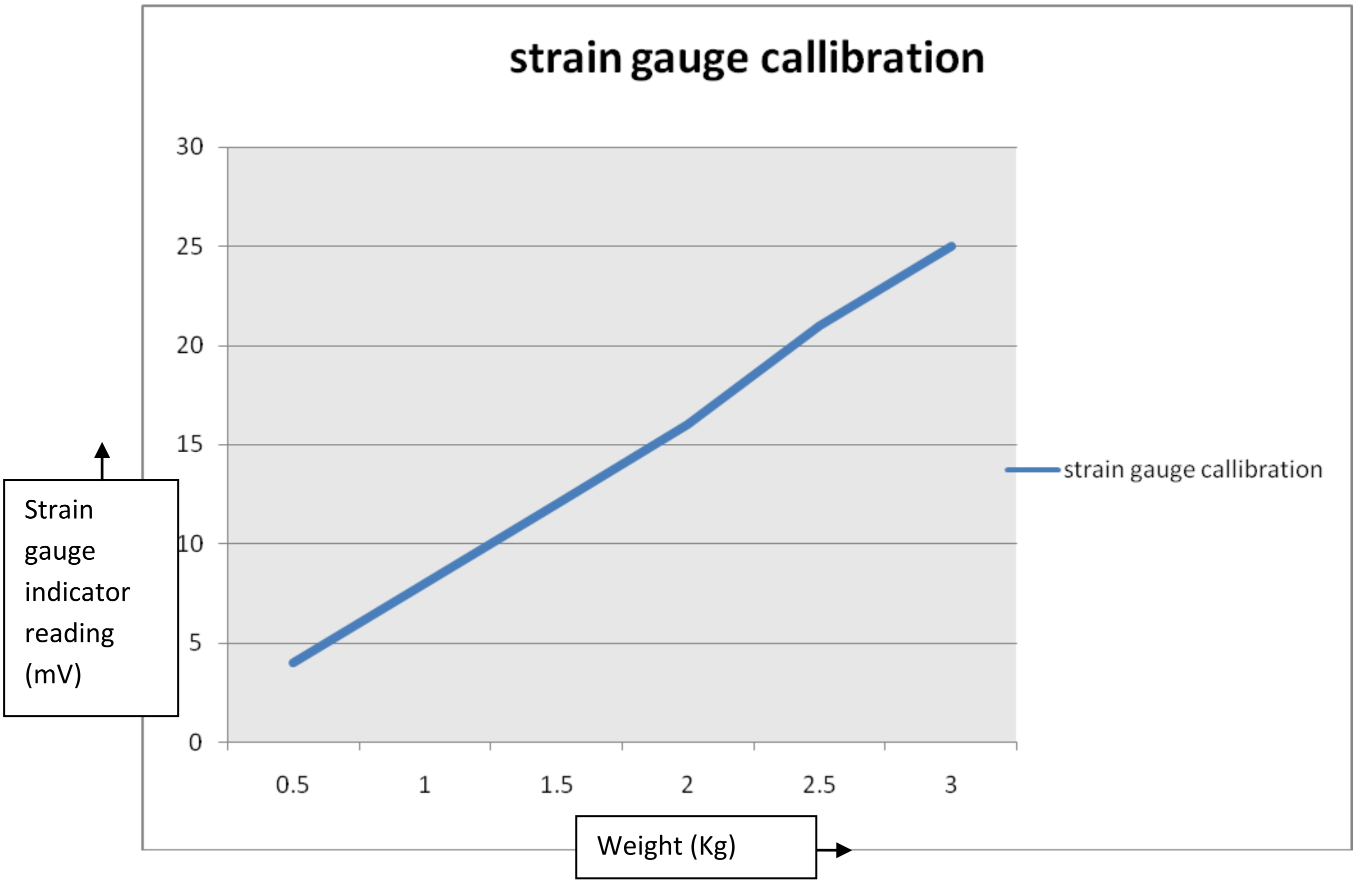
Figure 2 : Calibration of strain guage

III. Result and discussion

Table 1:Observation table for strain gauge calibration

Observation no.	Weight (Kg) [W]	Strain gauge indicator (mV)	Torque (Nm) [W×0.195×9.81]
1	0	0	0
2	0.5	4	0.956
3	1	8	1.912
4	1.5	12	2.86
5	2	16	3.825

6	2.5	21	4.78
7	3	25	5.738

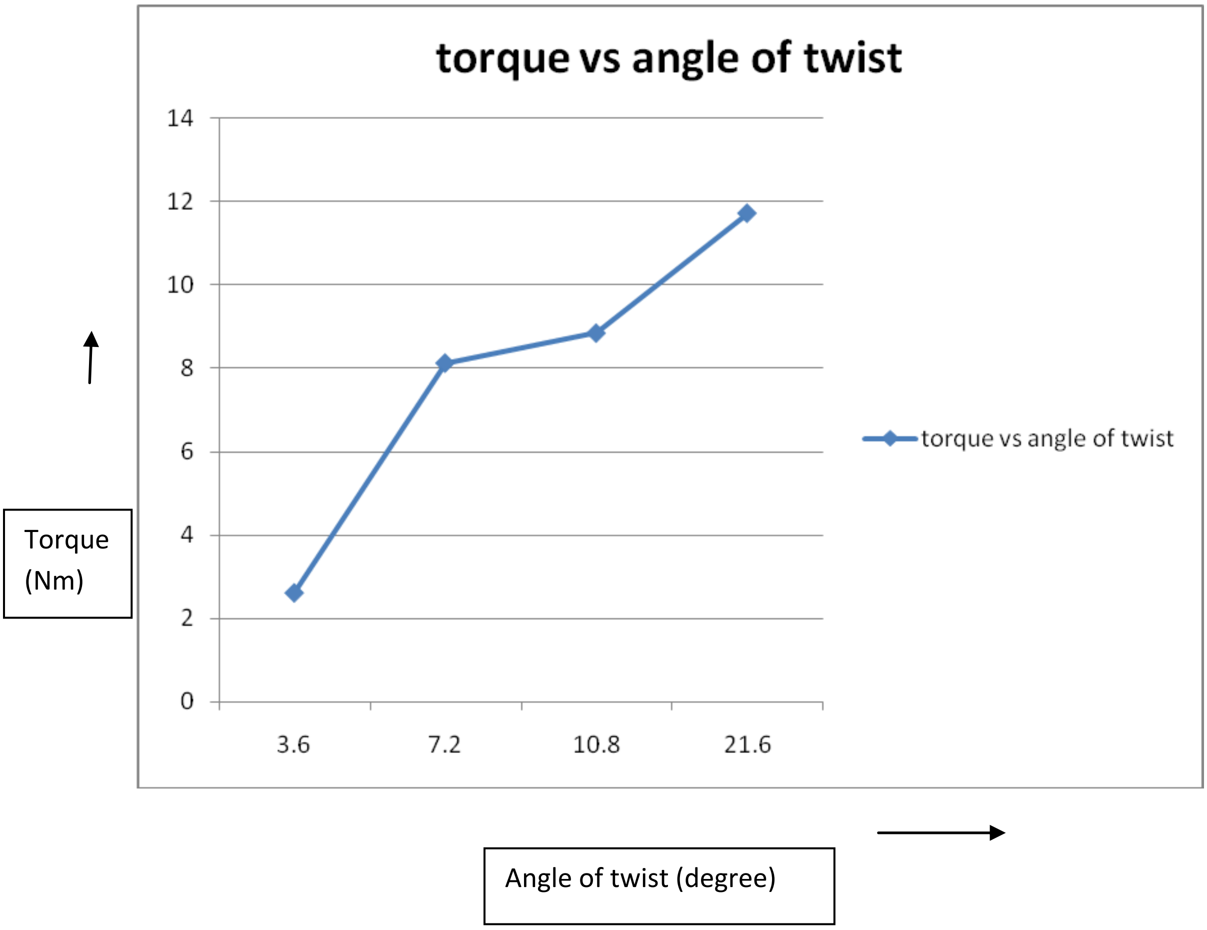


Graph 1: load v/s voltage

Table 2:Observation table for mild steel shaft

Sr. no.	Potentiometer reading [P]	Angle of twist (degrees) θ [36 ×P]	Strain gauge indicator reading (mV) [S]	Torque (Nm) [0.239×S]
1	0	0	0	0

2	0.1	3.6	11	2.629
3	0.2	7.2	34	8.126
4	0.3	10.8	37	8.843
5	0.6	21.6	49	11.711



Graph 2: Torque v/s angle of twist for mild steel

This graph of torque Vs angle of twist is proportional to the shear stress-strain

Table 3:Result for mild steel

SR. NO.	Torque	Angle of twist	Modulus of rigidity(GPa)	Mean modulus of rigidity	Shear stress(τ) (N/mm^2)	Shear strain(γ)
1	2.629	3.6	65.806	72.57	61.99	0.00094
2	8.126	7.2	101.701		191.6	0.00188
3	8.843	10.8	73.94		208.51	0.00282
4	11.711	21.6	48.843		276.14	0.00565

For brass shaft

Length of specimen = 200 mm

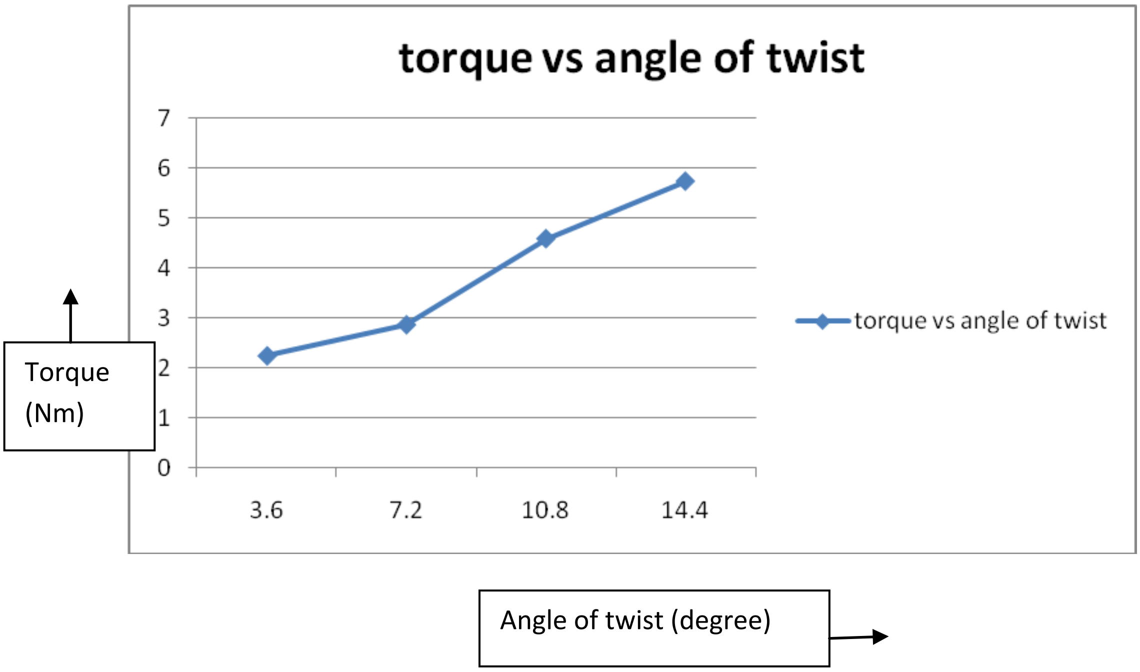
Diameter of specimen = 6 mm

Let, r1= radius of specimen= 3 mm

Table 4:Observation table for brass shaft

Sr. no.	Potentiometer reading [P]	Angle of twist (degrees) θ [36 ×P]	Strain gauge indicator reading (mV) [S]	Torque (Nm)
1	0	0	0	0
2	0.1	3.6	47	2.2466

3	0.2	7.2	60	2.868
4	0.3	10.8	96	4.588
5	0.4	14.4	120	5.736



Graph 3: Torque v/s angle of twist for brass

Second moment of area=J=$\pi d^4/32 = \pi \times 6^4/32 = 127.23$ mm^4

Table 5: Result for brass

SR. NO.	Torque	Angle of twist	Modulus of rigidity(GPa)	Mean modulus of rigidity	Shear stress(τ) (N/mm^2)	Shear strain(γ)
1	2.2466	0.0628	56.22	41.49	52.97	0.000942
2	2.868	0.125	35.6		67.62	0.00187
3	4.588	0.1884	38.36		108.18	0.00282
4	5.736	0.2518	35.801		135.23	0.00377

For aluminium shaft

Length of specimen = 200 mm

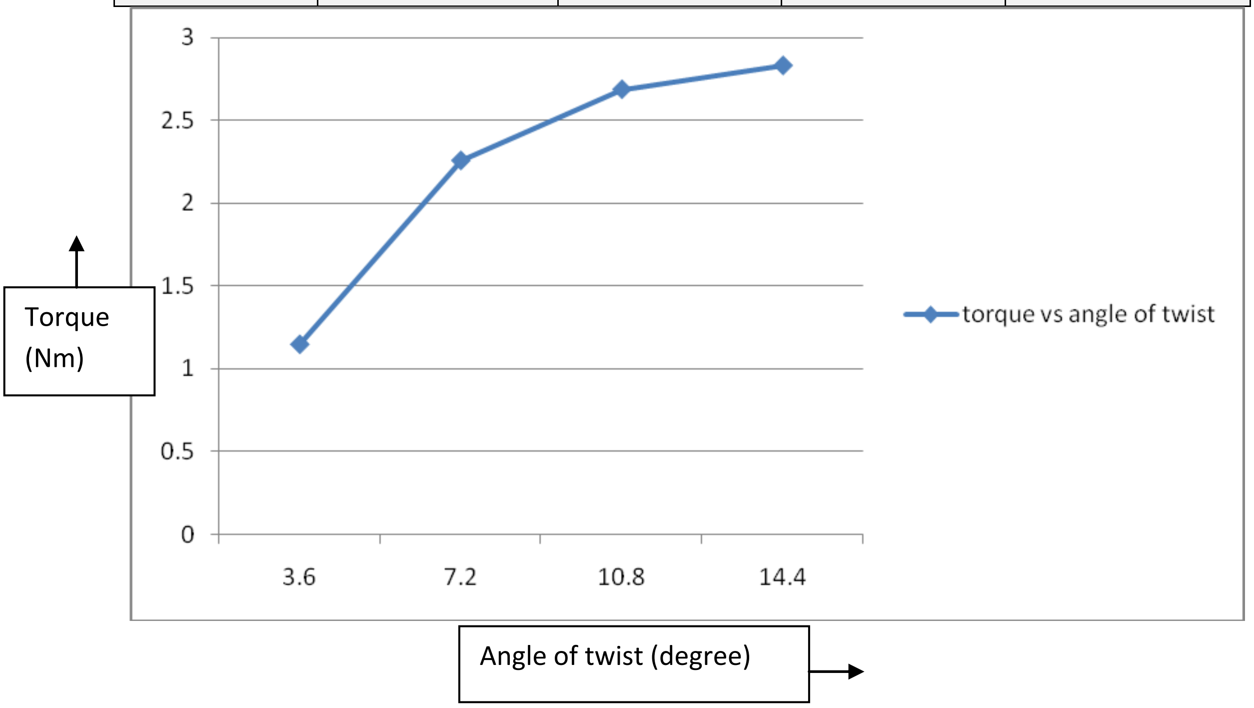
Diameter of specimen = 6 mm

Let, r1= radius of specimen= 3 mm

Table 6:Observation table for aluminum shaft

Sr. no.	Potentiometer reading [P]	Angle of twist (degrees) θ [36 ×P]	Strain gauge indicator reading (mV) [S]	Torque (Nm)
1	0	0	0	0
2	0.1	3.6	32	1.147
3	0.2	7.2	63	2.258
4	0.3	10.8	75	2.688

5	0.4	14.4	79	2.832



Graph 4: Torque v/s angle of twist for Aluminium

Second moment of area=J=$\pi d^4/32 = \pi \times 6^4/32 = 127.23\ mm^4$

Table 7:Result for Aluminium

SR. NO.	Torque	Angle of twist	Modulus of rigidity(GPa)	Mean modulus of rigidity	Shear stress(τ) (N/mm^2)	Shear strain(γ)
1	1.147	0.0628	28.71	24.28	27.04	0.000942
2	2.258	0.125	28.39		53.24	0.00187
3	2.688	0.1884	22.4		63.81	0.00282
4	2.832	0.2518	17.65		66.77	0.00377

IV CONCLUSION

1. The torsion phenomenon is observed physically.

2. The reading about torque and angle of twist is obtained and graph was also prepared which is proportional to shear stress Vs shear strain.

3. The value of modulus of rigidity is also found out for three materials.

4. This torsion testing machine is cost effective.

4. Material properties to be calculated such as shear stress, shear strain.

5. Shear stress versus strain graph is well understood.

6. The modulus of rigidity of three metals is different which shows corresponding strength of metals are different.

Acknowledement

I dedicate this paper to my beloved student friends Sanket Rayjadhav, Suraj Powar and Uday Pandare for their wholehearted efforts during experimentation work.

REFERENCE

[1]. Glenn E. Vallee ; "Design and Development of an Economical Torsion Testing Machine"; ASEE New England Section 2006 Annual Conference; 2006.
[2]. V. B. Bhandari; "Design of machine element"; McGraw-Hill; Third Edition.
[3].Student_strain_gauge_Manual-001.PDF.
[4]The paper of Hypertext publication about rosette strain gauge (strain-gauge-rosette-theory_ Davidson.PDF; 2010)
[5].Paper of time group TNS-DW series for Torsion Testing Specimen.