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TORSIONAL TESTING ON UTM

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Abstract - *Torsion testers or torque test machines measure the torsional strength, stiffness and stress strain properties of materials. Torsion testing machines are used to simulate real life service conditions and to check product quality for products such as drill tool bit tips and medical devices, screws and other fasteners, wire, and much more. Universal testing machine is a basic experimental equipment which can test many mechanical properties of materials such as its stress and strain it is named after the fact that it can perform many standard tensile, compression and bending tests on materials, components and structures. But the main disadvantage of universal testing machine is that the torsional strength of the material cannot be determined. In this paper, we have designed and manufactured an attachment for the universal testing machine which would enable us to determine the torsional strength and stiffness of materials.*

Key Words: **Torsion testers, Universal testing machine, Tensile, Compression, Bending etc.**

1. INTRODUCTION

Mechanical testing plays an important role in finding fundamental properties of engineering materials. These can be used in development of new materials. For a material to be used in engineering structure subjected to a load, it is important to know the strength and rigidity of the material to withstand the loads. As a result, numbers of experimental techniques have developed by engineers for mechanical testing of engineering materials. These materials may be subjected to tension, compression, bending or torsional loading.

Torsion testers or torque test machines measure the torsional strength, stiffness and stress-strain properties of various materials and specimen. Torsion refers to twisting a straight member under the action of turning moment or torque which tends to produce rotation about the longitudinal axis. A machine part is said to be under torsion when it is subjected to twisting couples or torques. Torsional testing machines are used to simulate real life service conditions and to check product quality for products such as drill tool bit tips and medical devices, screws and other fasteners, wire.

A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength, compressive strength and bending strength of materials. The UTM consists of three crossheads, the middle crosshead can be moved manually through the screw column whereas the lower and upper crossheads are connected to the hydraulic cylinder which applies the required load.

The universal testing machine has many advantages but the main disadvantage is it's incapability to perform torsion tests. In this paper, we have designed and manufactured an attachment for universal testing machine to determine the torsional strength and stiffness of materials and specimens. This attachment would enable torsion testing of various materials on UTM with just an additional extension. The attachment will be mounted on the middle head of the UTM which can be attached and detached easily.

1.1 OBJECTIVES:

Design and develop an attachment to perform torsional tests on UTM. To analyse the results obtained by comparing it with the standard results of torsion and check the feasibility of the attachment. Also increase the flexibility of UTM and eliminate the need of a separate torsion testing machine.

1.2 SCOPE:

This fixture would replace the torsion testing machine by a small portable attachment thereby reducing the laboratory setup/space of an industry or any institutes. This setup will receive great importance in research and development field as various tests can be performed on different materials on the same machine without the need of moving the specimen.

2. ACTUAL MODEL

Fig No. 1: Attachment

The attachment consists of a solid base plate on which the entire setup is mounted. The setup comprises of two chucks which holds the specimen, one chuck is fixed while the other is rotating. The high tension steel wire rope move around the pulleys and are attached to the upper head of the UTM which pulls the rope in upward direction, thus rotating the chuck and giving the actual twisting motion. This attachment is clamped on the UTM with the help of bolts.

2.1 CALCULATIONS

Design of the attachment consists of:

BASE PLATE THICKNESS

The thickness of the base plate is calculated by considering the forces acting on it and the reaction forces.

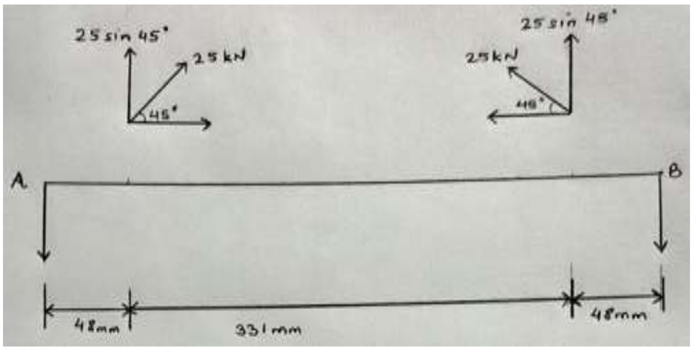

Fig No. 2: Forces acting on plate

Moment about point A.

∑Ma = 0

(-25sin45*48) - (25sin45*379) + Rb (427) =0

848528.137 + 6699836.752 = Rb (427)

Rb = 17677.669 N

Forces in Y-direction

∑Fy = 0

-Ra -Rb+ 25sin45 + 25sin45= 0

Ra = 17677.669N

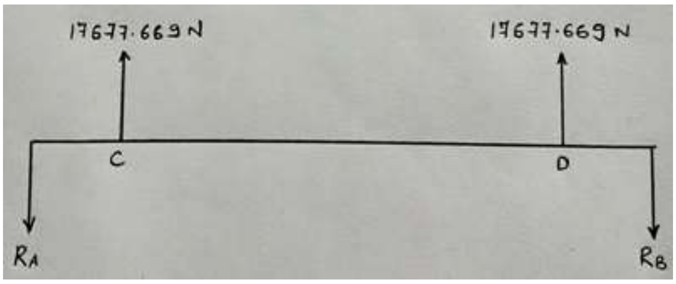

Fig No. 3: Reaction Forces

Shear Forces

SFA= -17677.669 N

SFC= 0

SFD= 17677.669 N

SFB= 0

Bending Moments

BMA= 0

BMC= (-17677.669)*48= -848528.136 Nmm

BMD= (-17677.669*379) + (17677.669*331) = -6699.583+5851.087

= 848528.136 Nmm

BMB= (-17677.669*427) + (17677.669*379) + (17677.669*48)

= 0

Base Plate Thickness (d):

$$\frac{M}{I} = \frac{F}{y}$$

$$\frac{848528.136}{427(d^3)/_{12}} = \frac{160}{d/_2}$$

$$\frac{848528.136}{35.583 * d^2} = 80$$

d= 17.26 mm

PULLEY SHAFT DIAMETER

$$\sigma = \frac{F}{A}$$

$$160 = \frac{25000}{\frac{\pi*(dp^2)}{4}}$$

dp ^2 = 199.044 mm

dp = 14.108 mm

BOLT DIAMETER

$$\sigma = \frac{F}{A}$$

$$160 = \frac{50000}{\frac{\pi*(db\,\hat{}\,2)}{4}}$$

db = 19.95 mm

db = 20 mm

FIXED SUPPORTS DIMENSIONS

$$\frac{M}{I} = \frac{F}{y}$$

$$\frac{3.25*(10^6)}{b(d\hat{}3)/_{12}} = \frac{160}{d/_2}$$

b= 12 mm

$$\frac{3.25*(10^6)}{320} = (df^2)$$

$$df^2 = 187500\,mm$$

df = 100 mm

Fig No. 2: Attachment Mounted On UTM

3. PARTS SPECIFICATION

Sr. No.	Parts	Material	Dimensions(mm)
1.	Base Plate	M.S	427x427
2.	Self-Centering Chuck	Cast Iron	Ø100
3.	Pulley	M.S	Ø75
4.	Steel Rope	Steel Wire	Ø10
5.	Pulley Pin	M.S	Ø15
6.	Bolts	M.S	Ø20

Table -1

4. RESULTS

Rod Diameter (d) =8mm

Length of Rod (L) =15mm

Radius (R) =62.5mm

Sr No.	Force (kN)	Torque (Nmm)	Angle of Twist (θ)
1	1.9	118750	18º
2	2	125000	20º
3	2.23	139375	40º
4	2.27	141875	60º
5	2.32	145000	80º

Table 2: Final Results

J= $\frac{\pi}{32} * d^4$

J= 401.92 mm^2

Torque T1= F1*R1

T1= 1.9*62.5*10^3

T1= 118750 Nmm

T2= F2*R2

T2= 2*62.5*10^3

T2 = 125000 Nmm

T3= F3*R3

T3= 2.23*62.5*10^3

T3= 139375 Nmm

T4= F4*R4

T4= 2.27*62.5*10^3

T4= 141875 Nmm

T5= F5*R5

T5= 2.32*62.5*10^3

T5= 145000 Nmm

Modulus of Rigidity

G1= $\frac{T1L}{J\theta}$

For Θ= 18º= 0.314 rad

G1= $\frac{118750*150}{401.92*0.314}$

G1= 141141.8 MPa= 141.141 GPa.

G2= $\frac{T2L}{J\theta}$

For Θ= 20º= 0.348 rad

G2= $\frac{125000*150}{401.92*0.348}$

G2= 134054.8 MPa= 134.05 GPa.

G3= $\frac{T3L}{J\theta}$

For Θ= 40º= 0.6977 rad

G3= $\frac{139375*150}{401.92*0.6977}$

G3= 74553.46 MPa= 74.55 GPa.

G4= $\frac{T4L}{J\theta}$

For Θ= 60º= 1.0466 rad

G4= $\frac{1418750*150}{401.92*1.0466}$

G4= 50591.41 MPa= 50.591 GPa.

G5= $\frac{T5L}{J\theta}$

For Θ= 80º= 1.395 rad

G5= $\frac{145000*150}{401.92*1.395}$

G5= 38792.29 MPa= 38.792 GPa.

Modulus of Rigidity G= $\frac{G1+G2+G3+G4+G5}{5}$

G= 87.826 GPa

5. FUTURE SCOPE

The Chuck can be replaced by another holding device which must be light in weight in order to reduce the weight of attachment. Also an alternative should be used in place of steel wire rope and ways to fix it to the attachment to increase the angle of twist which at present is limited to 110º (degrees).

6. CONCLUSION

In this project, we have presented the concept of a simple, efficient, low cost way of performing torsion tests on UTM. This sort of design will bring down the overall cost of machine.

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