**MECHANICS OF MATERIALS LAB MANUAL**


***Department of Mechanical Engineering***

# VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

## MECHANICS OF MATERIALS LAB MANUAL

**Name:**______________________________________________

**H.T.No:**_____________________________________________

**Year/Semester:**______________________________________

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**(20A01305P) MECHANICS OF SOLIDS LABORATORY**

## List of Experiments

| | |
|---|---|
| 1 | Tension test |
| 2 | Compression test on Wood |
| 3 | Shear test on metals |
| 4 | Rockwell Hardness Test |
| 5 | Izod Impact test on metals |
| 6 | Charpy Impact test on metals |
| 7 | Bending test on Cantilever beam |
| 8 | Bending test on simply supported beam |
| 9 | Torsion test |
| 10 | Compression test on Open coiled springs |
| 11 | Tension test on Closely coiled springs |
| 12 | Use of electrical resistance strain gauges |

## COURSE OUTCOMES

### SUBJECT: Mechanics of Materials Laboratory

After completion of the course Students are able to:

| CO No. | STATEMENT |
|---|---|
| CO1 | Apply the concept of stress and strain in Mechanical components design |
| CO2 | Determine  the mechanical properties of materials by conducting destructive testings |
| CO3 | Apply the concepts of Compression, Tension and Deflection in design of structures |

# CONTENTS

## MECHANICS OF MATERIALS LAB

## SCHEME OF EVALUATION

| S.No. | Experiment | Date | Marks Awarded | | | | Total (30) |
|---|---|---|---|---|---|---|---|
| | | | Record (10) | Observation (10) | Viva Voce (5) | Attendance (5) | |
| 1 | Tension test | | | | | | |
| 2 | Compression test on Wood | | | | | | |
| 3 | Shear test on metals | | | | | | |
| 4 | Rockwell Hardness Test | | | | | | |
| 5 | Izod Impact test on metals | | | | | | |
| 6 | Charpy Impact test on metals | | | | | | |
| 7 | Bending test on (Steel/Wood) Cantilever beam | | | | | | |
| 8 | Bending test on simply supported beam | | | | | | |
| 9 | Torsion test | | | | | | |
| 10 | Compression test on Open coiled springs | | | | | | |
| 11 | Tension test on Closely coiled springs | | | | | | |
| 12 | Use of electrical resistance strain gauges | | | | | | |

**Signature of Lab In-charge**

# INSTRUCTIONS TO STUDENTS

## DO‘S

1. Learn objective & significance of the practical.
2. Keep silence in the lab.
3. Always perform the experiment carefully as directed by teacher
4. Don’t forget to bring calculator, graph sheet and other accessories when you come to lab.
5. Before performing practical’s read the instrument manual carefully.
6. Count all accessories before receiving equipments in lab.
7. Submit all the accessories to the Lab Technician after the completion of the experiment

## DONT‘S

1. Don’t use mobile phones during lab hours.
2. Don’t try to repair any faulty instrument.
3. Don’t run machine without permission.

## TENSION TEST

**Exp. No: 1** **Date:**

**AIM:** To study the stress strain relations by conducting tension test using UTM on Mild Steel

**APPARATUS:** Universal testing machine, test specimen, Vernier caliper, Steel rule, extensometer

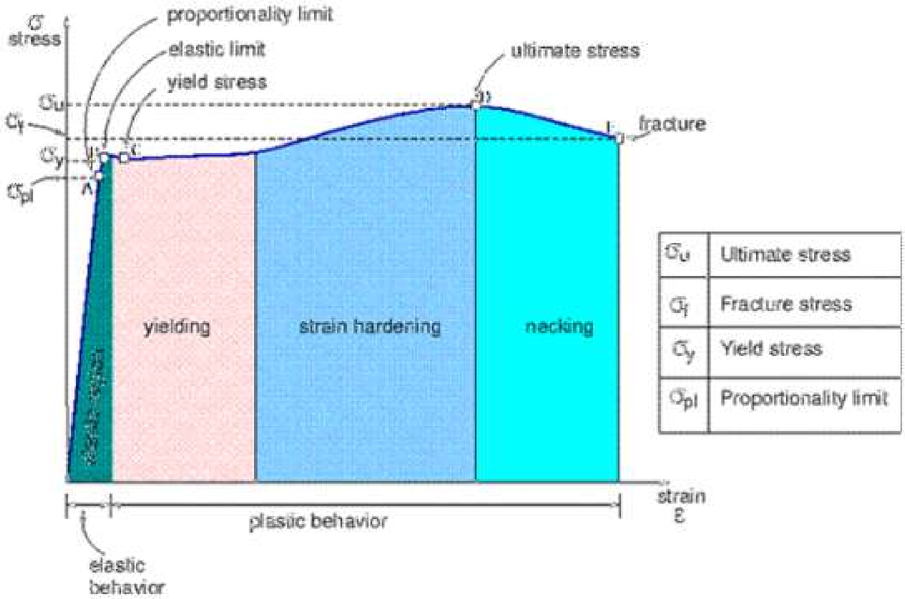
**Theory:**

In tension test ends of a test piece are fixed into grips connected to a straining device and to a load measuring device. The test involves straining a test piece by tensile force generally to fracture for the purpose of determining one or more of the mechanical properties.

The straining unit of universal testing machine consists of main hydraulic cylinder with robust base inside and piston which moves up and down. The lower table connected to main piston through a ball & the ball seat is joined to ensure axial loading. There is a connection between lower table and upper head assembly that moves up and down with main piston. The control panel consists of a power pack complete with drive motor and an oil tank, control valves and an autographic recorder. Load Indicator system consists of a large dial and a pointer. A dummy pointer is provided to record the maximum load reached during the test.

Load is applied by a hydrostatically lubricated ram. Main cylinder pressure is transmitted to the cylinder of the pendulum dynamometer system housed in the control panel. The cylinder of the dynamometer is also of self-lubricating design. The load transmitted to the cylinder of the dynamometer is transferred through a lever system to a pendulum. Displacement of the pendulum actuates the rack and pinion mechanism which operates the load indicator pointer and the autographic recorder. The deflection of the pendulum represents the absolute load applied on the test specimen. Return movement of the pendulum is effectively damped to absorb energy in the event of sudden breakage of a specimen.

STRESS STRAIN GRAPH OF MILD STEEL:




**Procedure:**

1. Take the specified specimen and measure the gauge length and diameter with the help of Vernier caliper by marking the indication with chalk piece.
2. After marking indications on the specimen for gauge length and for extensometer, fix the specimen in the UTM
3. Fix the extensometer along with the specimen with the help of clamp
4. Now the load is applied, that can be seen in dial indicator when we apply the load gradually
5. Load is applied gradually until the specimen breaks
6. Record the value of the ultimate load where at which the needle movement in the dial gauge shows in backward direction at some point
7. And measure the final diameter and final length of the specimen

**Observations:**

| **Test specimen Material** | **Mild Steel** | **Cast Iron** |
|---|---|---|
| Initial length of the specimen in mm | | |
| Final length of the specimen in mm | | |
| Initial diameter of the specimen in mm | | |
| Final diameter of the specimen in mm | | |
| Initial Area of the specimen in $mm^2$ | | |
| Final Area of the specimen in $mm^2$ | | |

**Calculations:**

| S.No. | Material | Load applied | | Extensometer reading | Stress | Strain | Young's Modulus (from Curve) |
|---|---|---|---|---|---|---|---|
| | | Kgf | N | mm | $N/mm^2$ | | $N/mm^2$ |
| 1 | Mild Steel | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 1 | Cast Iron | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |

**Precautions:**

1. Measurements should be taken carefully
2. Apply the load gradually without giving sudden load
3. Observe the readings without an error

**Result:**

## COMPRESSION TEST

**Exp. No: 2** **Date:**

**AIM: -** To determine the Compressive strength of a wood specimen.

**APPARATUS:** Wood, Venire Caliper, Scale, Etc.

$$\text{Compressive Strength} = \frac{\text{Max. Load at failure}}{\text{Loaded Area of wood}}$$

**PROCEDURE:**

1. Select some wood with uniform shape and size.
2. Measure its all dimensions. (LXBXH)
3. Place the wood on the lower platform of compression testing machine and lower the spindle till the upper motion of ram is offered by a specimen the oil pressure start increasing the pointer engineering start returning to zero leaving the drug pointer that is maximum reading which can be noted down.

**OBSERVATION TABLE:-**

| S.No. | LxBxH $mm^3$ | Area L x B $mm^2$ | Lo ad N | Compressive Strength P/A($N/mm^2$) | Average Compressive Strength |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**CALCULATION:**

$$\text{Compressive Strength} = \frac{\text{Max. Load at failure}}{\text{Loaded Area of brick}}$$

**PRECAUTION: -**

1) Measure the dimensions of wood accurately.
2) Specimen should be placed as for as possible in the lower plate.
3) The range of the gauge fitted on the machine should not be more than double the breaking load of specimen for reliable results.

**RESULT** **: -** The average compressive strength of wood is _______________

# SHEAR TEST

**Exp. No: 3** **Date:**

**AIM:** To determine the shear strength of the given specimen

**APPARATUS:** Universal testing machine, test specimen, Vernier caliper, Steel rule, Shear test set up

**THEORY:** In direct shear test, the shearing stress is considered as uniformly distributed over the entire cross section. The shear force is applied by a suitable test rig, two different cases of shearing may arise; i.e., single shear and double shear. In single shear shearing occurs across a single surface and in double shear shearing occurs across two surfaces. Knowledge of shear failure is important while designing any structures or machine components. Shear force causes the surface to go out of the alignment with each other and thus the material fails.

OBSERVATIONS:

Length of the specimen = _______________mm

Diameter of the specimen = _______________mm

| S.No. | Max. load at Failure (N) | Diameter of the Specimen (mm) | Cross sectional Area ($mm^2$) | Double shear Strength (P/2A) in $N/mm^2$ |
|---|---|---|---|---|
| | | | | |

**PROCEDURE:**

1. Measure the dimensions of the test specimen.
2. Insert the specimen in position and grip one of the ends of the attachment in the upper portion and the other end in the lower portion.
3. Switch on the main switch of universal testing machine.
4. Gradually move the head control level in left-hand direction till the specimen shears.

5. Stop the machine and remove the specimen.

**PRECAUTIONS:**

1) Measure the dimensions of wood accurately.
2) Specimen should be placed as for as possible in the lower plate.

**RESULT:**

# ROCKWELL HARDNESS TEST

**Exp. No: 4** **Date:**

**AIM: -** Determining the hardness of the given specimen

**APPARATUS:** - Hardness tester, Indenter, Specimen

**DIAGRAM:-**

Refer to Fig. 6.

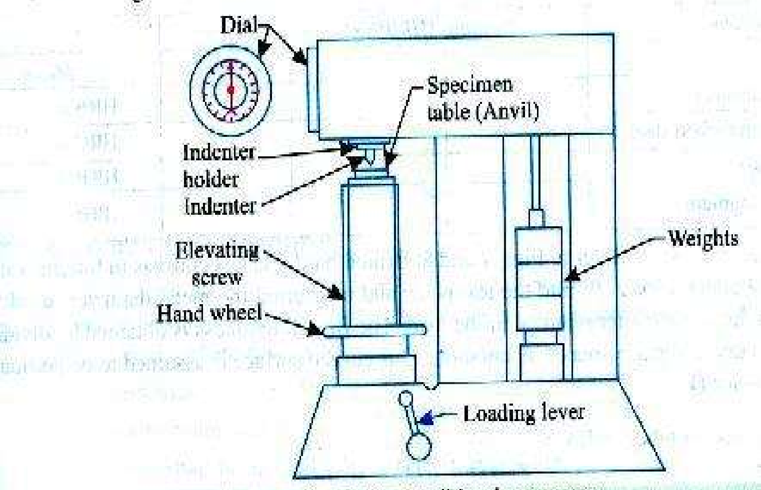



Fig. 6. Rockwell hardness tester.

**THEORY: -** The hardness of a material is resistance to penetration under a localized pressure or resistance to abrasion. Hardness tests provide an accurate, rapid and economical way of determining the resistance of materials to deformation. There are three general types of hardness measurements depending upon the manner in which the test is conducted:

a. Scratch hardness measurement,
b. Rebound hardness measurement
c. Indention hardness measurement.

In scratch hardness method the material are rated on their ability to scratch one another and it is usually used by mineralogists only. In rebound hardness measurement, a standard body is usually dropped on to the material surface and the hardness is measured in terms of the height of its rebound .The general means of judging the hardness is measuring the resistance of a material to indentation. The indenters usually a ball cone or pyramid of a material much harder than that being used. Hardened steel, sintered tungsten carbide or diamond indenters are generally used in indentation tests; a load is applied by pressing the indenter at right angles to the surface being tested. The hardness of the material depends on the resistance which it exerts during a small amount of yielding or plastic. The resistance depends on friction, elasticity, viscosity and the intensity and distribution of plastic strain produced by a given tool during indentation

**PROCEDURE:-**

1. Place the specimen securely upon the anvil.
2. Elevate the specimen so that it come into contact with the penetrate and put the specimen under a preliminary or minor load of 100±2N without shock
3. Apply the major load 900N by loading lever.
4. Watch the pointer until it comes to rest.
5. Remove the major load.
6. Read the Rockwell hardness number or hardness scale.

**OBESERVATION TABLE:-**

| Trial | Material | Total Load | Rockwell Hardness Number |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

**PRECAUTION:-**

1. Brielle test should be performed on smooth, flat specimens from which dirt and scale have been cleaned.
2. The test should not be made on specimens so thin that the impression shows through the metal, nor should impression be made too close to the edge of a specimen.

**RESULT: -**

## IZOD IMPACT TEST

**Exp. No: 5** **Date:**

**AIM** **:** To determine the impact strength of the given specimen by conducting Izod Impact test.

**APPARATUS** **:** Impact testing machine, specimen.

**THEORY:**

The loads that are suddenly applied on a structure with an impact are Known as shock or impact loads. The test consists of breaking a test piece, gripped vertically at the level of notch, by one below from a swinging hammer under prescribed conditions. The specimen should be struck by the hammer on the side of the notch (Notch on the tension side). The energy absorbed is noted, from which the impact strength is obtained.

**PROCEDURE:**

1. The Izod striker is firmly secured to the bottom of the hammer with the help of clamping piece.
2. The support for Izod test is to be fixed to the base with the help of Socket head screws.
3. The latching tube is to be firmly secured to the bracket fitted at the top of stands with the help of socket head screws.
4. Adjust the reading pointer to 164 J dial reading, when the pendulum is hanging free vertically.
5. Now raise the hammer by hands and latch in.
6. Release the hammer by operating the levers. The pointer will then indicate the energy loss due to friction which should be zero. Raise the hammer and lock it.
7. Place the specimen on the support as a cantilever. The specimen should be placed in such a way that the notch is on tension side, when the pendulum is released (Notch should face towards the hammer). For correct centering of the specimen, use the settingGuage.
8. Press down the lever with left hand. After ascertaining that no person is within the range of swinging pendulum, push down lever so that the pendulum is released and the specimen is broken.

9. Wait until the pendulum reverses its direction of motion and bring the pendulum carefully to stand still position by applying the pendulum brake.
10. Note down the reading on the scale indicated bythe pointer.

**OBSERVATIONS:**

Breadth, b=

Depth, d=

Energy absorbed without the specimen, $E_1$ =

Energy absorbed for breaking the specimen, $E_2$ =

**CALCULATIONS:**

$$\text{Impact strength} = \frac{E_2 - E_1}{a}$$

Where, a=c/s area of the specimen=

**RESULT:**

## CHARPY IMPACT TEST

**Exp. No: 6** **Date:**

**AIM** **:** To determine the impact strength of the given specimen by Conducting Charpy impact test.

**APPARATUS** **:** Impact testing machine, specimen.

**THEORY:**

The loads that are suddenly applied on a structure with an impact are known as shock or impact loads. The test consists of breaking a test piece; U-notched in the middle and supported at each end, by one blow from a swinging should be struck by the hammer on the side opposite to the notch (Notch on the tension side). The energy absorbed is noted, from which the impact strength is obtained.

**PROCEDURE:**

1. The Charpy striker is firmly secured to the bottom of the hammer with the help of clamping piece.
2. The support for charpy test is to be fixed to the base with the help of socket head screws.
3. The latching tube is to be firmly secured to the bracket fitted at the top of stands with the help of socket head screws.
4. Adjust the reading pointer to 300 J dial reading, when the pendulum is hanging free vertically.
5. Now raise the hammer by hands and latch in.
6. Release the hammer by operating the levers. The pointer will then indicate the energy loss due to friction.
7. Place the specimen on the support as a simply supported beam. The specimen should be placed in such a way that the notch is on tension side, when the pendulum is released (Notch should face opposite to the hammer). For correct centering of the specimen, use the setting gauge.
8. Press down the lever with left hand. After ascertaining that no Person is within the range of swinging pendulum, push down lever so that the pendulum is released and the specimen is broken.

9. Wait until the pendulum reverses its direction of motion and bring the pendulum carefully to stand still position by applying the Pendulum brake.
10. Note down the reading on the scale indicated by the pointer.

**OBSERVATIONS:**

Breadth, b =

Depth, d =

Energy absorbed without the specimen, $E_1$ =

Energy absorbed for breaking the specimen, $E_2$ =

**CALCULATIONS:**

Impact strength = $\frac{E_2 - E_1}{a}$

Where, a = c/s area of the specimen

**RESULT:**

# CANTILEVER BEAM

**Exp. No: 7** **Date:**

**AIM**: -To determined young's modulus and bending stress of material of cantilever beam

**APPARATUS**: 1. Deflection of beam apparatus 2. Pan 3. Weights 4. Beam

**THEORY**: The beam which has one end is fixed and another end is free is called cantilever beam. For the cantilever beam the bending moment is zero at free end and maximum at fixed end. When the cantilever beam is subjected to a load at free end the beam will bend in convexity downwards. The deflection at free end is maximum and at fixed end is zero.

When the cantilever beam is subjected to a load at free end then the maximum bending moment is given by

M= WL

Where W =Load acting on the beam

L= length of the beam

When the cantilever beam is subjected to a load at free end then the deflection is given by

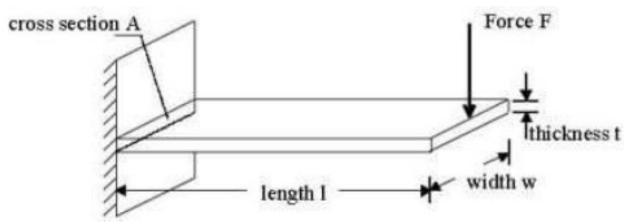
$$\delta = \frac{WL^3}{3EI}$$

Where W =Load acting at the free end , N

L =Length of the beam mm

E =Young's modulus of material of the beam, N/mm2

I =Second moment of area of the cross- section (i.e, moment of Inertia) of the beam, about the neutral axis, $mm^4$



$$I = \frac{bd^3}{12} \text{ for rectangular beam}$$

where

b= width of beam and d= depth of the beam

$$I = \frac{\pi d^4}{64} \text{ for cirucular section}$$

Where

d= diameter of the beam

**Bending Stress:**

When the stress produced to due to bending moment, the stress is known as bending stress. The bending stress can be obtained by bending equation

Where

**OBESERVATION TABLE :-**

| SI.NO | LOADS ON BEAM | δ1 | δ2 | δ | Young's modulus $E = \frac{WL^3}{3\delta I}$ | Bending moment M=WL | Bending stress $f = \frac{M}{I} y$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |

δ1= deflection in increasing order

δ2= deflection in decreasing order

E =Young's modulus of material of the beam, $N/mm^2$

R= radius of curvature

M=bending moment= WL Nmm

I =Second moment of area of the cross- section,$mm^4$

f= bending stress, $N/mm^2$

y=distance from N.A. ,mm

**Procedure:**

1. place the cantilever beam, Take dimension i.e., Length, Width, Thickness of the specimen
2. check the flatness of given beam with the help of dial gauge
3. Place the dial gauge under the beam where the deflection is to be measured.
4. place the hanger at the end point of the beam
5. now place the weights in span in increasing order at free end
6. calculate the deflections in dial gauge for different weights
7. repeat the experiment with various loads of the beams
8. calculate deflections in decreasing order also
9. using the equation calculate the bending stress

**Precautions:**

1. Make sure that beam and load are placed a proper position.
2. The cross- section of the beam should be large.
3. Note down the readings of the vernier scale carefully

**Result:**

The young's modulus for beam is ___________________$N/mm^2$.

The Bending stress for beam is______________________$N/mm^2$

## SIMPLY SUPPORTED BEAM

**Exp. No: 8** **Date:**

**Aim**: -To determine the modulus of elasticity of material of beam simply supported at ends.

**Apparatus**: 1. Deflection of beam apparatus 2. Pan 3. Weights 4. Beam

**Theory**:- If the beam is supports at the two ends, the beam is known simply supported beam. When a beam is subjected to load the beam goes under deformation. The difference between the elastic curve to original position of the beam is called deflection. When a simply supported beam subjected to point load at the midpoint, the beam bends concave upwards.

The deflection at mid point is given by

$$\delta = \frac{WL^3}{48EI}$$

From above equation

$$E = \frac{WL^3}{48\delta I}$$

Where

W =Load acting at the center, N

L =Length of the beam between the supports mm

E =Young's modulus of material of the beam, N/mm$^2$

I =Second moment of area of the cross- section (i.e, moment of Inertia) of the beam, about the neutral axis, mm$^4$

$I = \frac{bd^3}{12}$ for rectangular beam

where

b= width of beam and d= depth of the beam

$I = \frac{\pi d^4}{64}$ for cirucular section

Where

d= diameter of the beam

**Bending Stress**: When the stress produced to due to bending moment, the stress is known as bending stress. The bending stress can be obtained by bending equation

$$\frac{E}{R} = \frac{M}{I} = \frac{f}{y}$$

Where E =Young's modulus of material of the beam, $N/mm^2$

R= radius of curvature

M=bending moment=$\frac{WL}{4}$,Nmm

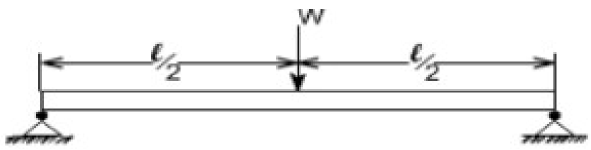
I =Second moment of area of the cross- section,$mm^4$

**OBESERVATION TABLE :-**

| SI.NO | LOADS ON BEAM | δ1 | δ2 | Δ | Young's modulus $E = \frac{WL^3}{48\delta I}$ | Bending moment M=$\frac{WL}{4}$ | Bending stress $f = \frac{M}{I}y$ |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |

δ1= deflection in increasing order

δ2= deflection in decreasing order



f= bending stress, $N/mm^2$

y=distance from N.A. ,mm

For simply supported beam bending moment is zero at supports and maximum at mid point when the load is symmetrical

**Procedure:**

1. place the simply supported beam, Take dimension i.e., Length, Width, Thickness of the specimen
2. check the flatness of given beam with the help of dial gauge
3. Place the dial gauge under the beam where the deflection is to be measured.
4. place the hanger at the midpoints of the beam
5. now place the weights in span in increasing order at mid point
6. calculate the deflections in dial gauge for different weights
7. repeat the experiment with various loads of the beams
8. calculate deflections in decreasing order also
9. using the equation calculate the bending stress

**Precautions:**

1. Make sure that beam and load are placed a proper position.
2. The cross- section of the beam should be large. 3. Note down the readings of the vernier scale carefully

**Result:**

The young's modulus for beam is ____________________ $N/mm^2$

The Bending stress for beam is ______________________$N/mm^2$

## TORSION

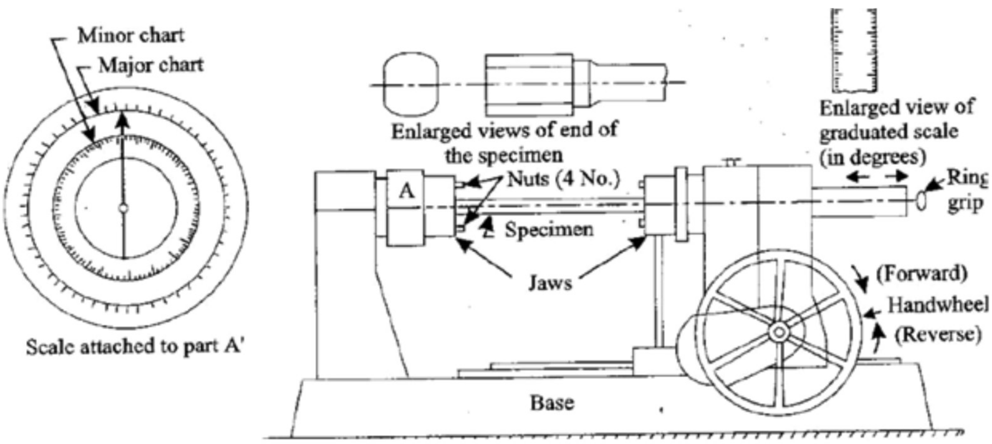
**Exp. No: 9** **Dates:**

**AIM: -** To determine modulus of rigidity of a given Mild Steel rod specimen.

**APPARATUS: -**

1. A torsion test machine along with angle of twist measuring attachment.
2. Standard specimen of mild steel or cast iron.
3. Steel rule.
4. Vernier caliper or a micrometer.

**DIAGRAM:-**




**THEORY:-**

For transmitting power through a rotating shaft it is necessary to apply a turning force. The force is applied tangentially and in the plane of transverse cross section. The torque or twisting moment may be calculated by multiplying two opposite turning moments. It is said to be in pure torsion and it will exhibit the tendency of shearing off at every cross section which is perpendicular to the longitudinal axis.

Torsion equation is given by below

$$T/J = \tau/R = G\theta/L$$

$$G = T\,L/J\,\theta \text{ N/mm}^2$$

T= maximum twisting torque (N mm)

J = polar moment of inertia (mm4) = $\pi d^4/32$

$\tau$ = shear stress (N/mm$^2$) G = modulus of rigidity (N/mm$^2$)

$\theta$ = angle of twist in radians

L= length of shaft under torsion (mm)

**PROCEDURE:-**

1. Select the driving dogs to suit the size of the specimen and clamp it in the machine by adjusting the length of the specimen by means of a sliding spindle.
2. Measure the diameter at about three places and take the average value.
3. Choose the appropriate range by capacity change lever
4. Set the maximum load pointer to zero.
5. Set the protractor to zero for convenience and clamp it by means of knurled screw.
6. Carry out straining by rotating the hand wheel in either direction.
7. Load the machine in suitable increments.
8. Then load out to failure as to cause equal increments of strain reading.
9. Plot a torque- twist (T- $\theta$) graph.
10. Read off co-ordinates of a convenient point from the straight line portion of the torque twist (T-$\theta$) graph and calculate the value of G by using relation.

**OBESERVATIONS:-** Gauge length of the specimen,

L = ……… Diameter of the specimen,

d = ……… Polar moment of inertia,

J = ($\pi$/32) $d^4$ =........

| S.No. | Torque, Kg-cm | Torque N-mm | Angle of twist | | Modulus of Rigidity(G) $N/mm^2$ | Average (G) $N/mm^2$ |
|---|---|---|---|---|---|---|
| | | | Degrees | Radians | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**PRECAUTIONS:-**

1) Measure the dimensions of the specimen carefully

2) Measure the Angle of twist accurately for the corresponding value of Torque.

3) The specimen should be properly to get between the jaws.

4) After breaking specimen stop to m/c.

**RESULT: -** Thus the torsion test on given mild steel specimen is done and the modulus of rigidity is ___________________$N/mm^2$.

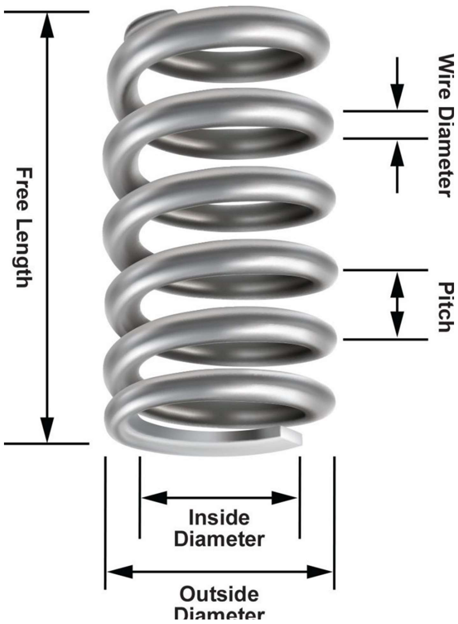
## OPEN COILED SPRING

**Exp. No: 10** **Date:**

**AIM: T**o determine stiffness and Modulus of rigidity of a open coiled spring

**APPARATUS:** Spring testing machine, Spring Specimen, Micrometer, Vernier Caliper

**Theory :**




**Procedure :**

1. By using the micrometre measure the diameter of the wire of the spring
2. By using the vernier calliper measure the diameter of the spring coils
3. Count the number of turns
4. Insert the spring in the spring testing machine and load the spring by using suitable weight and note the corresponding axial deflection in compression
5. Increase the load and take the corresponding axial deflection readings
6. Plot a curve between load and deflection. The shape of the curve gives the stiffness of the spring

**Observations :**

Spécifications of a spring to be measured initially,

Least count of micrometer=____________mm

Diameter of spring wire, d=___________mm

Least count of Vernier Caliper=__________mm

Diameter of the spring coil, D=_________mm

Mean coil Diameter, Dm=__________mm

Number of turns, n=______

**Calculations :**

| S.No. | Load ( N) | Deflection (mm) | Stiffness = Load/Deflection (N/mm) | Modulus of Rigidity |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

**Modulus of Rigidity, $C= [8W(D_m)^3 n]/\delta(d)^4$**

**Mean Stiffness =**

**Modulus of Rigidity, C = N/$mm^2$**

**Result:**

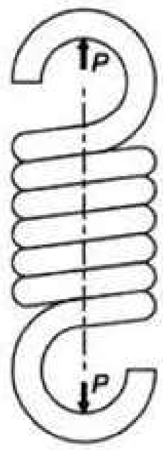
## CLOSED COILED SPRING

**Exp. No: 11** **Date:**

**AIM: T**o determine stiffness and Modulus of rigidity of a closed coiled spring

**APPARATUS:** Spring testing machine, Spring Specimen, Micrometer, Vernier Caliper

**Theory :**




**Procedure :**

1. By using the micrometre measure the diameter of the wire of the spring
2. By using the vernier calliper measure the diameter of the spring coils
3. Count the number of turns
4. Insert the spring in the spring testing machine and load the spring by using suitable weight and note the corresponding axial deflection in tension
5. Increase the load and take the corresponding axial deflection readings
6. Plot a curve between load and deflection. The shape of the curve gives the stiffness of the spring

**Observations :**

Spécifications of a spring to be measured initially, Least count of micrometer=____________mm

Diameter of spring wire, d=___________mm

Least count of Vernier Caliper=__________mm

Diameter of the spring coil, D=_________mm

Mean coil Diameter, Dm=__________mm

Number of turns, n=______

**Calculations :**

| **S.No.** | **Load ( N)** | **Deflection (mm)** | **Stiffness = Load/Deflection (N/mm)** | **Modulus of Rigidity** |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

**Modulus of Rigidity, C= $[8W(D_m)^3n]/\delta(d)^4$**

**Mean Stiffness =**

**Modulus of Rigidity, C = N/$mm^2$**

**Result:**

## ELECTRICAL RESISTANCE STRAIN GAUGES

**Exp. No: 12** **Date:**

**AIM:** To study the use of electrical resistance strain gauges

**INTRODUCTION:**

Experimental stress analysis is an important tool in the design and testing of many products. Several practical techniques are available including photo elastic, coatings and models, brittle coatings, and electrical resistance strain gauges. In this experiment, the electrical resistance strain gauge will be utilized.

There are three steps in obtaining experimental strain measurements by using a strain gauge:

1. Selecting a strain gauge

2. Mounting the gauge on the test structure

3. Measuring strains corresponding to specific loads.

The operation and selection criteria for strain gauges will be discussed. In this experiment, you will mount a strain gauge on a beam and test its accuracy. Measurements will be made with a strain gauge rosette in this experiment to obtain the principal stresses and strains on a cantilevered beam

**What's a Strain Gauge Used For?**

The Birdman Contest is an annual event held on Lake Biwa near Kyoto, Japan. In this contest cleverly designed human-powered airplanes and gliders fly several hundred meters across the lake. Aside from the great spectacle of this event, it is a wonderful view of engineering experimentation and competition. Despite the careful designs and well-balanced airframes occasionally the wings of these vehicles fail and crash into the lake. There have been some spectacular crashes but few, if any, injuries to the contestants. Increasingly, each time a new airplane, automobile, or other vehicle is introduced, the structure of such vehicles is designed to be lighter to attain faster running speeds and less fuel consumption. It is possible to design a lighter and more efficient product by selecting light-weight materials. However, as with all technology, there are plusses and minuses to be balanced. If a structural material is made lighter or thinner the safety of the vehicle is compromised unless the required strength is maintained. By the same token, if only the strength is taken into consideration, the vehicle's weight will increase and its economic feasibility is compromised. In engineering design the balance between safety and economics is one variable in the equation of creating a successful product. While attempting to design a component or vehicle that provides the appropriate strength it is important to understand the stress borne by the various parts under different conditions. However, there is no technology or test tool that allows direct measurement of stress. Thus, strain on the surface is frequently measured in order to determine internal stress. Strain gauges are the most common instrument to measure surface strain.

**STRAIN GAUGE:**

There are many types of strain gauges. The fundamental structure of a strain gauge consists of a grid-shaped sensing element of thin metallic resistive foil (3 to 6 microns thick) that is sandwiched between a base of thin plastic film (12-16 micron thick) and a covering or lamination of thin film.

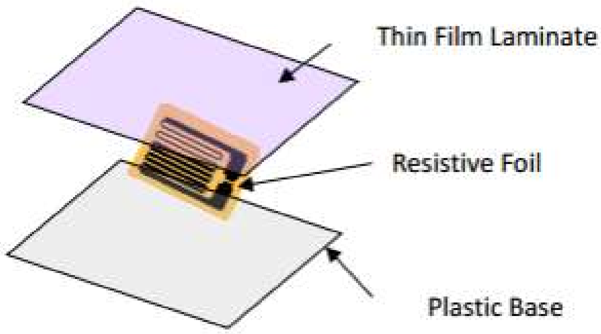



**Figure 1.** Strain gauge construction

Strain gauge is tightly bonded to the specimen. Therefore, depending that unit deformation on the specimen, the sensing element may elongate or contract. During elongation or contraction, electrical resistance of the metal wire changes. The strain gauge measure the strain on the specimen by means of the principle resistance changes. Generally, sensing element are made of copper-nickel alloy in strain gauge.

**RESULT:**