

**SRINIVASAN ENGINEERING COLLEGE**

**PERAMBALUR-621212**

**STRENGTH OF MATERIALS**

**Laboratory Manual**

**DEPARTMENT  
OF  
AERONAUTICAL ENGINEERING**

# **STRENGTH OF MATERIALS**

## **List of Practical**

<b>1)</b>	<b>To Study The Universal Testing Machine (U.T.M.)</b>
<b>2)</b>	<b>To determine Tensile test on a metal.</b>
<b>3)</b>	<b>To determine Hardness of Mild Steel.</b>
<b>4)</b>	<b>Torsion test on mild steel rod.</b>
<b>5)</b>	<b>To determine Impact strength of steel. (By Izod test )</b>
<b>6)</b>	<b>To determine Impact strength of steel.( By Charpy test)</b>
<b>7)</b>	<b>To determined Young's Modulus of Elasticity of different materials of beam simply supported at ends.</b>
<b>8)</b>	<b>To determined Shear Test on Metals.</b>
<b>9)</b>	<b>To determine the Stiffness of the Spring and Modulus of Rigidity of the Spring wire</b>
<b>10)</b>	<b>To Study various types of Strain Gauges.</b>
<b>11)</b>	<b>To determine Compressive Strength Of Brick.</b>

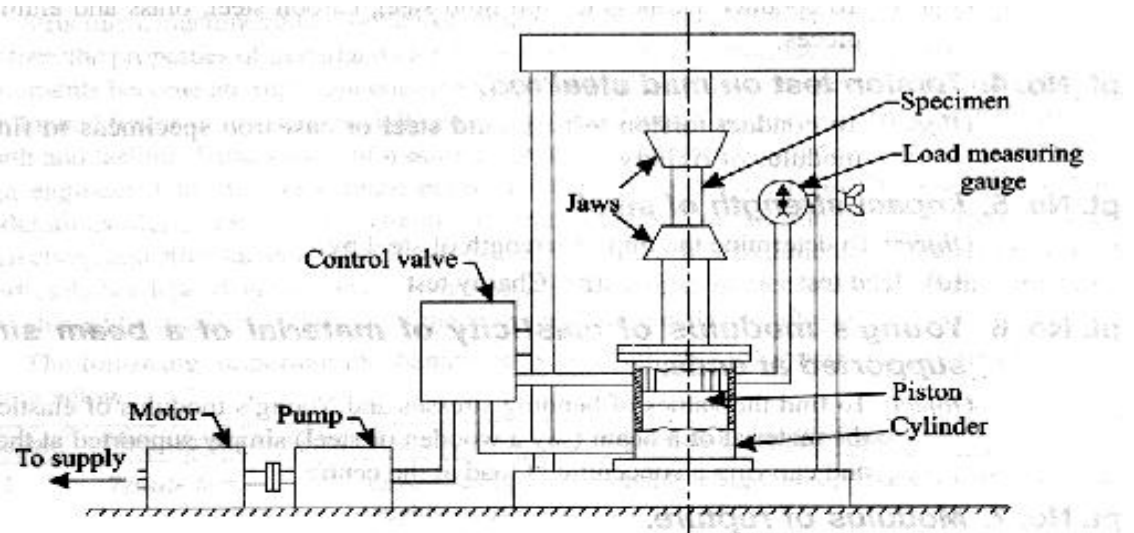
## EXPERIMENT NO. – 01

**AIM:** - Study of Universal Testing Machine (U.T.M.)

**OBJECT:** - To Study the various component parts of the Universal Testing Machine (U.T.M.) & test procedures of various practical's to be performed.

**APPARATUS:** - Universal Testing Machine with all attachment i.e. shears test attachment, bending attachment, tension grips, compression test attachment etc.

**DIAGRAM:-**



• Fig. 1. Tensile testing machine.

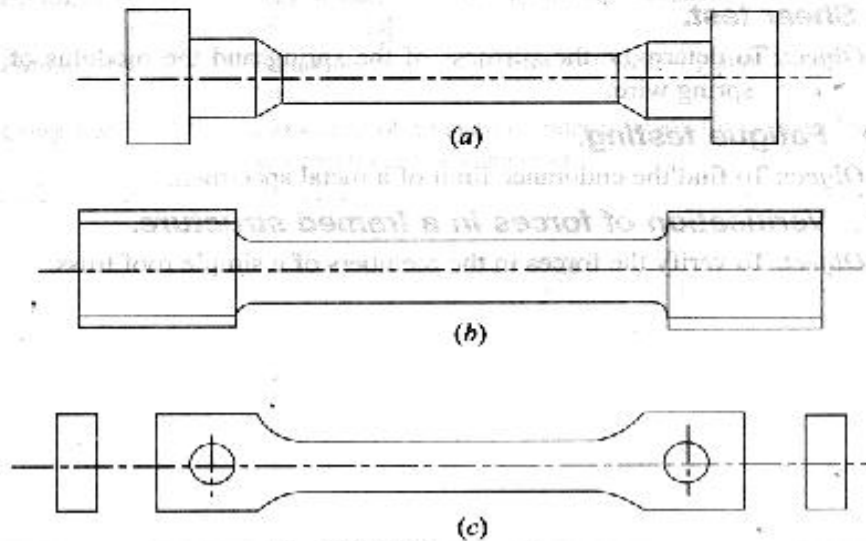


Fig. 2. Mild steel specimens.

**THEORY** : - The Universal Testing Machine consists of two units.

- 1) Loading unit,
- 2) Control panel.

### **LOADING UNIT:-**

It consists of main hydraulic cylinder with robust base inside. The piston which moves up and down. The chain driven by electric motor which is fitted on left hand side. The screw column maintained in the base can be rotated using above arrangement of chain. Each column passes through the main nut which is fitted in the lower cross head.

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 measurement of this assembly is carried out by number of bearings which slides over the columns.

The test specimen each fixed in the job is known as 'Jack Job'. To fix up the specimen tightly, the movement of jack job is achieved helically by handle.

### **CONTROL PANEL:-**

It consists of oil tank having a hydraulic oil level sight glass for checking the oil level. The pump is displacement type piston pump having free plungers those ensure for continuation of high pressure. The pump is fixed to the tank from bottom. The suction & delivery valve are fitted to the pump near tank Electric motor driven the pump is mounted on four studs which is fitted on the right side of the tank. There is an arrangement for loosening or tightening of the valve. The four valves on control panel control the oil stroke in the hydraulic system. The loading system works as described below.

The return valve is close, oil delivered by the pump through the flow control valves to the cylinder & the piston goes up. Pressure starts developing & either the specimen breaks or the load having maximum value is controlled with the base dynameters consisting in a cylinder in which the piston reciprocates. The switches have upper and lower push at the control panel for the downward & upward movement of the movable head. The on & off switch provided on the control panel & the pilot lamp shows the transmission of main supply.

### **METHOD OF TESTING:-**

**Initial Adjustment:** - before testing adjust the pendulum with respect to capacity of the test i.e. 8 Tones; 10 Tones; 20 Tones; 40 Tones etc.

For ex: - A specimen of 6 tones capacity gives more accurate result of 10 Tones capacity range instead of 20 Tones capacity range. These ranges of capacity are adjusted on the dial with the help of range selector knob. The

Department of Civil Engineering control weights of the pendulum are adjusted correctly. The ink should be inserted in pen holder of recording paper around the drum & the testing process is started depending upon the types of test as mentioned below.

### **TENSION TEST:-**

Select the proper job and complete upper and lower check adjustment. Apply some Greece to the tapered surface of specimen or groove. Then operate the upper cross head grip operation handle & grip the upper end of test specimen fully in to the groove. Keep the lower left valve in fully close position. Open the right valve & close it after lower table is slightly lifted. Adjust the lower points to zero with the help of adjusting knob. This is necessary to remove the dead weight of the lower table. Then lock the jobs in this position by operating job working handle. Then open the left control valve. The printer on dial gauge at which the specimen breaks slightly return back & corresponding load is known as breaking load & maximum load is known as the ultimate load.

### **COMPRESSION TEST:-**

Fix upper and lower pressure plates to the upper stationary head & lower table respectively. Place the specimen on the lower plate in order to grip. Then adjust zero by lifting the lower table. Then perform the test in the same manner as described in tension test.

### **FLEXURAL OR BENDING TEST:-**

Keep the bending table on the lower table in such a way that the central position of the bending table is fixed in the central location value of the lower table. The bending supports are adjusted to required distance. Stuffers at the back of the bending table at different positions. Then place the specimen on bending table & apply the load by bending attachment at the upper stationary head. Then perform the test in the same manner as described in tension test.

### **BRINELL HARDNESS TEST:-**

Place the specimen on the lower table & lift it up slightly. Adjust the zero fixed value at the bottom side of the lower cross head. Increase the load slowly ultimate load value is obtained. Then release the load slowly with left control valve. Get the impression of a suitable value of five to ten millimeter on the specimen & measure the diameter of the impression correctly by microscope & calculate Brinell hardness.

### **SHEAR TEST:-**

Place the shear test attachment on the lower table, this attachment consists of cutter. The specimen is inserted in roles of shear test attachment & lift the

lower table so that the zero is adjusted, then apply the load such that the specimen breaks in two or three pieces. If the specimen breaks in two pieces then it will be in angle shear, & if it breaks in three pieces then it will be in double shear.

### **STUDY OF EXTENSOMETER:-**

This instrument is an attachment to Universal / Tensile Testing Machines. This measures the elongation of a test piece on load for the set gauge length. The least count of measurement being 0.01 mm, and maximum elongation measurement up to 3 mm. This elongation measurement helps in finding out the proof stress at the required percentage elongation.

**WORKING OF THE INSTRUMENT:-**The required gauge length (between 30 to 120 ) is set by adjusting the upper knife edges ( 3 ) A scale ( 2 ) is provided for this purpose . Hold the specimen in the upper and lower jaws of Tensile / Universal Testing Machine. Position the extensometer on the specimen. Position upper clamp (4) To press upper knife edges on the specimen. The extensometer will be now fixed to the specimen by spring pressure. Set zero on both the dial gauges by zero adjust screws ( 7 ). Start loading the specimen and take the reading of load on the machine at required elongation or the elongation at required load. Force setter accuracies mean of both the dial gauge ( 8 ) readings should be taken as elongation. It is very important to note & follow the practice of removing the extensometer from the specimen before the specimen breaks otherwise the instrument will be totally damaged. As a safety, while testing the instrument may be kept hanging from a fixed support by a slightly loose thread.

### **TECHNICAL DATA:-**

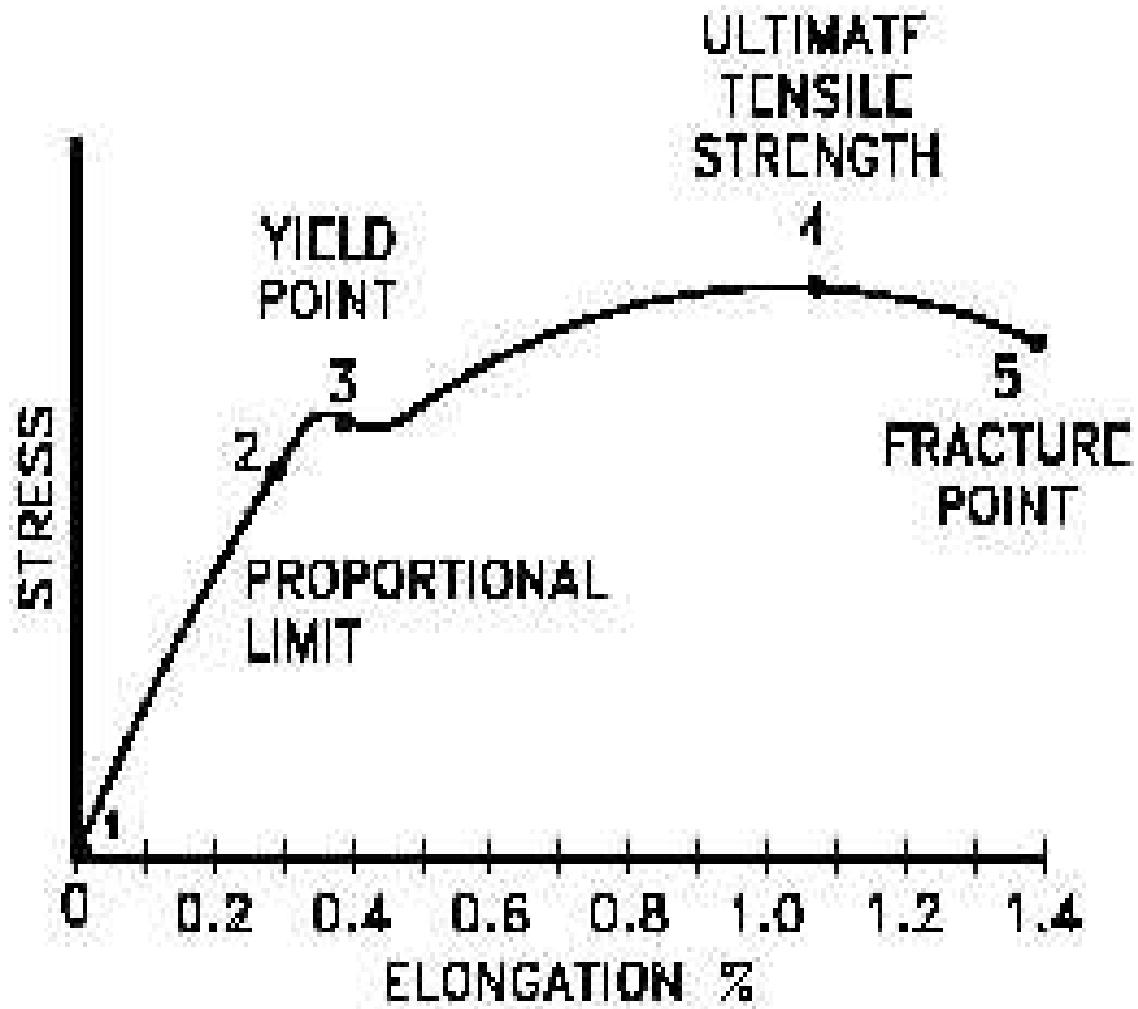
Measuring Range: 0 – 3 mm.

Least Count: 0. 01 mm.

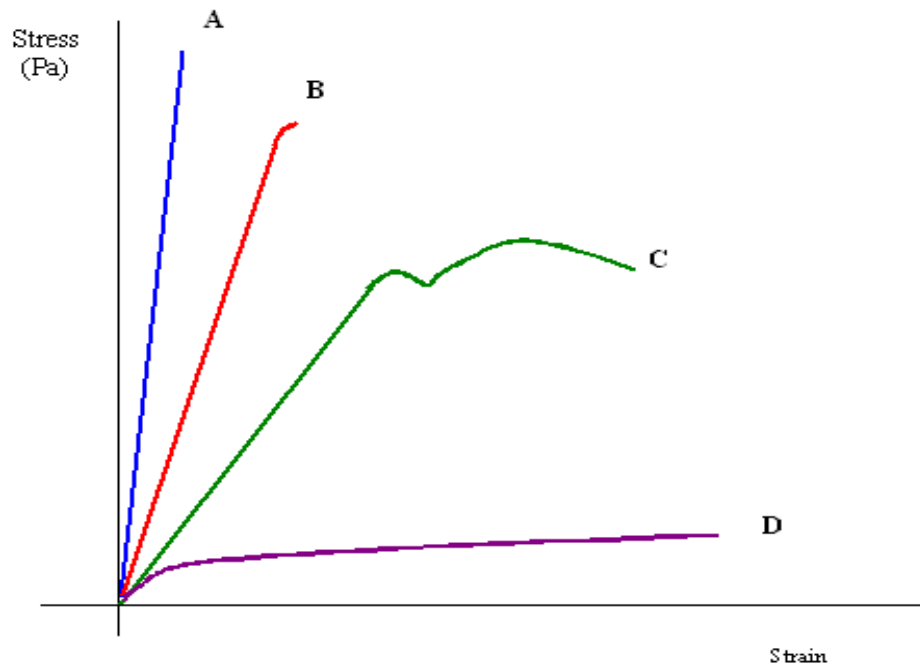
Gauge Length adjustable from: 30 – 120 mm

Specimen Size: 1 to 20mm Round or Flats up to 20 x 20 mm.

## A) Stress-strain graph of Mild Steel



## B) Stress-strain graphs of different materials.



- Curve **A** shows a **brittle** material. This material is also strong because there is little strain for a high stress. The fracture of a brittle material is sudden and catastrophic, with little or no plastic deformation. Brittle materials crack under tension and the stress increases around the cracks. Cracks propagate less under compression.
- Curve **B** is a **strong** material which is not ductile. Steel wires stretch very little, and break suddenly. There can be a lot of elastic strain energy in a steel wire under tension and it will “whiplash” if it breaks. The ends are razor sharp and such a failure is very dangerous indeed.
- Curve **C** is a **ductile** material
- Curve **D** is a **plastic** material. Notice a very large strain for a small stress. The material will not go back to its original length.

## EXPERIMENT NO. – 02

**AIM: -To determine tensile test on a metal.**

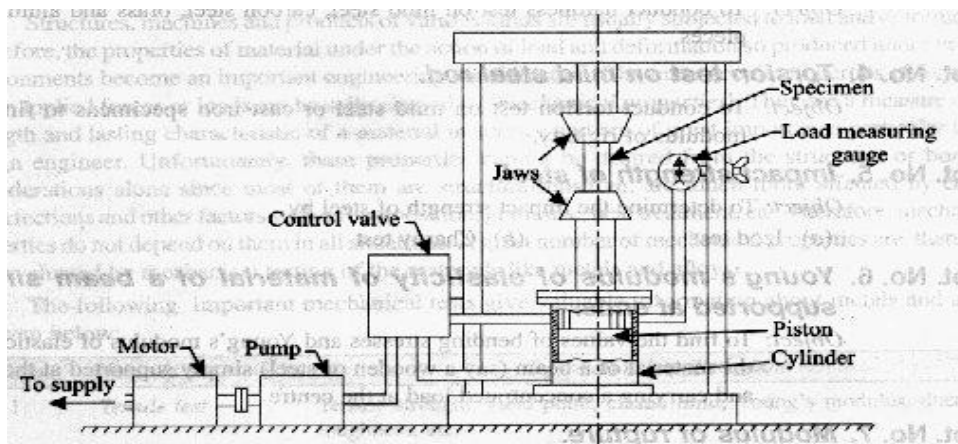
**OBJECT: -**To conduct a tensile test on a mild steel specimen and determine the following:

- |                                     |                            |
|-------------------------------------|----------------------------|
| (i) Limit of proportionality        | (ii) Elastic limit         |
| (iii) Yield strength                | (IV) Ultimate strength     |
| (v) Young's modulus of elasticity   | (VI) Percentage elongation |
| (vii) Percentage reduction in area. |                            |

**APPARATUS: -**

- (i) Universal Testing Machine (UTM)
- (ii) Mild steel specimens
- (iii) Graph paper
- (iv) Scale
- (v) Vernier Caliper

**DIAGRAM:-**



• Fig. 1. Tensile testing machine.

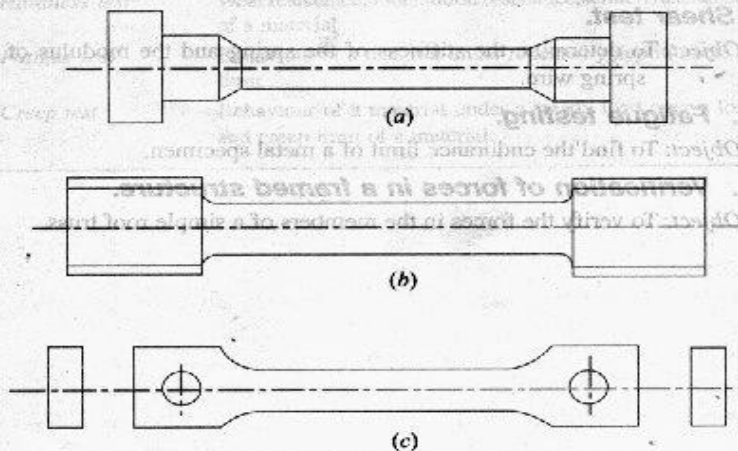


Fig. 2. Mild steel specimens.

**THEORY:-**The tensile test is most applied one, of all mechanical tests. In this test ends of test piece are fixed into grips connected to a straining device and to a load measuring device. If the applied load is small enough, the deformation of any solid body is entirely elastic. An elastically deformed solid will return to its original form as soon as load is removed. However, if the load is too large, the material can be deformed permanently. The initial part of the tension curve which is recoverable immediately after unloading is termed as elastic and the rest of the curve which represents the manner in which solid undergoes plastic deformation is termed plastic. The stress below which the deformations essentially entirely elastic is known as the yield strength of material. In some material the onset of plastic deformation is denoted by a sudden drop in load indicating both an upper and a lower yield point. However, some materials do not exhibit a sharp yield point. During plastic deformation, at larger extensions strain hardening cannot compensate for the decrease in section and thus the load passes through a maximum and then begins to decrease. This stage the “ultimate strength” which is defined as the ratio of the load on the specimen to original cross-sectional area, reaches a maximum value. Further loading will eventually cause ‘neck’ formation and rupture.

**PROCEDURE:-**

- 1) Measure the original length and diameter of the specimen. The length may either be length of gauge section which is marked on the specimen with a preset punch or the total length of the specimen.
2. Insert the specimen into grips of the test machine and attach strain-measuring device to it.
3. Begin the load application and record load versus elongation data.
4. Take readings more frequently as yield point is approached.
5. Measure elongation values with the help of dividers and a ruler.
6. Continue the test till Fracture occurs.
7. By joining the two broken halves of the specimen together, measure the final length and diameter of specimen.

**OBSERVATION:- A) Material:**

**A) Original dimensions**

Length = -----

Diameter = -----

Area = -----

**B) Final Dimensions:**

Length = -----

Diameter = .....

Area = .....

**OBSERVATION TABLE:-**

S.No	Load(N)	Original Gauge length	Extension (mm)	Stress = $\frac{\text{Load}}{\text{Area}}$ (N/mm <sup>2</sup> )	Increase in length Strain = $\frac{\text{Increase in length}}{\text{Original length}}$
1					
2					
3					
4					
5					

**To plot the stress strain curve and determine the following.**

**(i) Limit of proportionality**

$$= \frac{\text{Load at limit of proportionality}}{\text{Original area of cross-section}} = \dots \text{N/mm}^2$$

**(ii) Elastic limit =  $\frac{\text{load at elastic limit}}{\text{Original area of c/s}}$  N/mm<sup>2</sup>**

**(iii) Yield strength**

$$= \frac{\text{Yield load}}{\text{Original area of cross-section}} = \dots \text{N/mm}^2$$

**(iv) Ultimate strength**

$$= \frac{\text{Maximum tensile load}}{\text{Original area of cross-section}} = \dots \text{N/mm}^2$$

**(v) Young's modulus, E =  $\frac{\text{stress below proportionality limit}}{\text{Corresponding strain}}$  N/mm<sup>2</sup>**

**(vi) Percentage elongation**

$$= \frac{\text{Final length (at fracture)} - \text{original length}}{\text{Original length}} = \dots\%$$

**(vii) Percentage reduction in area**

$$= \frac{\text{Original area} - \text{area at fracture}}{\text{Original area}} = \dots\%$$

**RESULT:-** i) Average Breaking Stress =

ii) Ultimate Stress =

iii) Average % Elongation =

**PRECAUTION:-**

1. If the strain measuring device is an extensometer it should be removed before necking begins.
2. Measure deflection on scale accurately & carefully

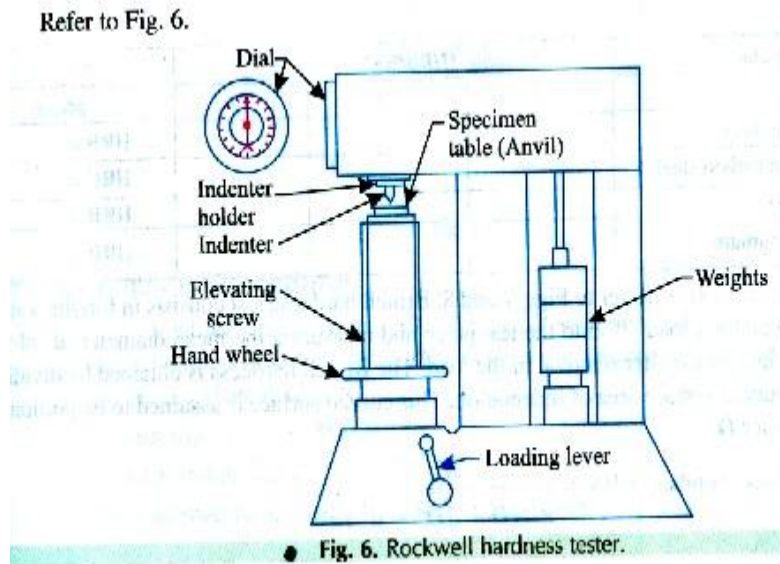
## EXPERIMENT NO-03

**AIM: -** Hardness Test of Mild Steel.

**OBJECT: -** To conduct hardness test on mild steel, carbon steel, brass and aluminum specimens.

**APPARATUS:-** Hardness tester, soft and hard mild steel specimens, brass, aluminum etc.

**DIAGRAM:-**



**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:

- Scratch hardness measurement,
- Rebound hardness measurement
- Indentation 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  $100 \pm 2N$  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:-**

S.NO	Specimens	Reading (HRC/)			Mean
		1	2	3	
1	Mild Steel				HRB =
2	High Carbon steel				HRC =
3	Brass				HRB =
4	Aluminum				HRB =

**RESULT:-** The hardness of the metal is found to be

- i) Hard steel =
- ii) Unhardened Steel =

**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.

## EXPERIMENT No :-04

**AIM:-** Torsion test on mild steel rod.

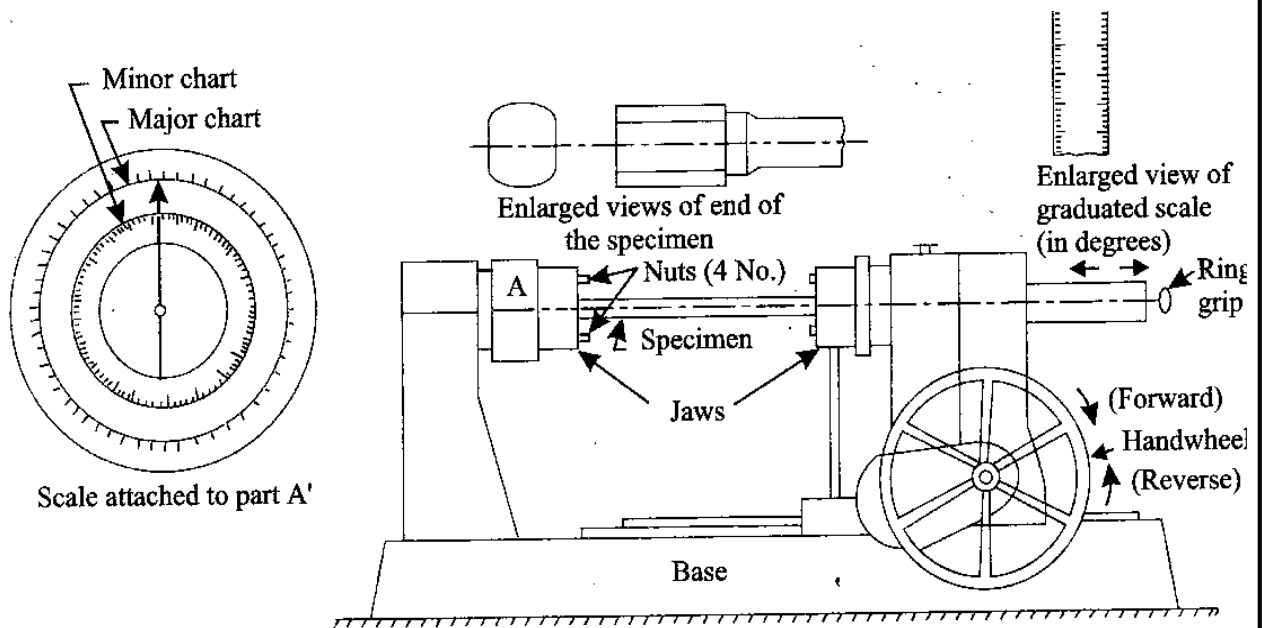
**OBJECT: -**To conduct torsion test on mild steel or cast iron specimens to find out modulus of rigidity

**APPARATUS: -**1. A torsion testing machine.

2. Twist meter for measuring angles of twist

3. A steel rule and Vernier Caliper or micrometer.

**DIAGRAM:-**



● Fig. 9. Torsion testing machine.

**THEORY: -**

A torsion test is quite instrumental in determining the value of modulus of rigidity of a metallic specimen. The value of modulus of rigidity can be found out through observations made during the experiment by using the torsion equation

$$\frac{T}{I_p} = \frac{C \theta}{l} = \frac{q}{r}$$

Where, T = Torque applied,

I<sub>p</sub> = Polar moment of inertia,

- C = Modulus of rigidity,
- $\theta$  = Angle of twist (radians), and
- l = Length of the shaft
- q = Shear stress
- r = Distance of element from center of shaft

**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 protector to zero for convenience and clamp it by means of knurled screw.
6. Carry out straining by rotating the handwheel 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 C by using relation

**OBSERVATION:-**

$$C = \frac{Tl}{\theta I_p}$$

Gauge length of the specimen, l = .....

Diameter of the specimen, d = .....

Polar moment of inertia,

$$I_p = \frac{\pi}{32} d^4 = \dots$$

**OBSERVATION TABLE:-**

Torque (T)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Angle of twist( $\theta$ )in 'radians'															
Modulus of rigidity (C) $N/mm^2$															

**RESULT :-** i) Modulus of rigidity of mild steel rod is -----  $N/mm^2$

ii) Modulus of rigidity of Aluminum rod is -----  $N/mm^2$

**PRECAUTION:-** 1) Measure the dimensions of the specimen carefully

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

## EXPERIMENT No :- 05

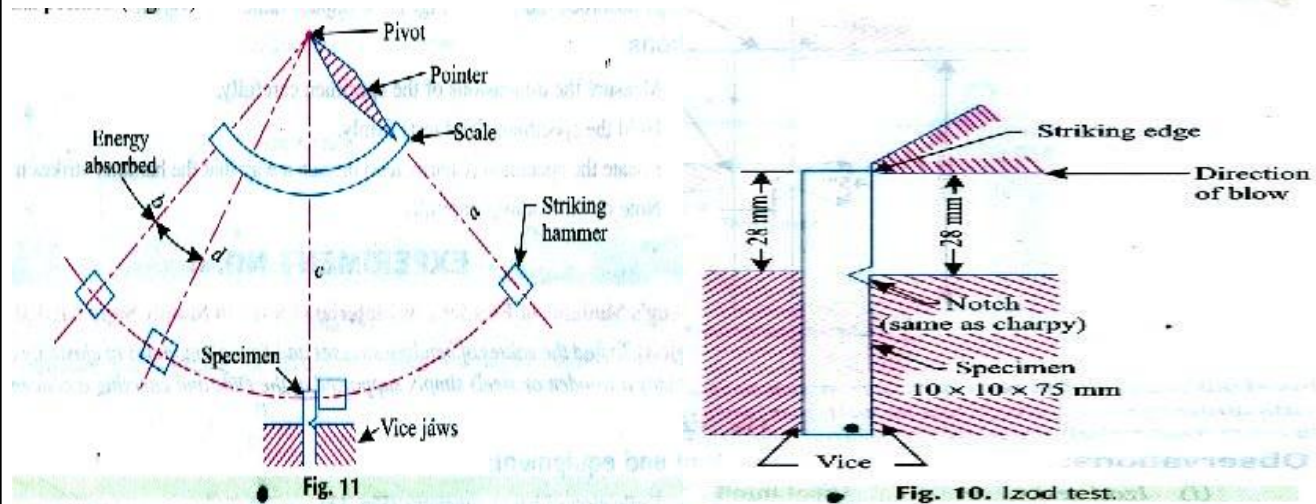
**AIM:** - To determine impact strength of steel.

**OBJECT:** - To determine the impact strength of steel by Izod impact test

**APPARATUS:** - 1. Impact testing machine

2. A steel specimen 75 mm X 10mm X 10mm

**DIAGRAM:-**



**THEORY:-**

An impact test signifies toughness of material that is ability of material to absorb energy during plastic deformation. Static tension tests of unnotched specimens do not always reveal the susceptibility of a metal to brittle fracture. This important factor is determined by impact test. Toughness takes into account both the strength and ductility of the material. Several engineering materials have to withstand impact or suddenly applied loads while in service. Impact strengths are generally lower as compared to strengths achieved under slowly applied loads. Of all types of impact tests, the notch bar tests are most extensively used. Therefore, the impact test measures the energy necessary to fracture a standard notch bar by applying an impulse load. The test measures the notch toughness of material under shock loading. Values obtained from these tests are not of much utility to design problems directly and are highly arbitrary. Still it is important to note that it provides a good way of comparing toughness of various materials or toughness of the same material under different condition. This test can also be used to assess the ductile brittle transition temperature of the material occurring due to lowering of temperature.

**PROCEDURE:-****(a) Izod test**

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machine's vice in such a way that the notch face the hammer and is half inside and half above the top surface of the vice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at that position.
3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with the machine.
4. Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost final position.
5. Again bring back the hammer to its idle position and back

**OBESERVATION:-****Izod Test.**

1. Impact value of - Mild Steel -----N-m
2. Impact value of - Brass -----N-m
3. Impact value of - Aluminum -----N-m

- RESULT:-**
- i. The energy absorbed for Mild Steel is found out to be                   Joules.
  - ii. The energy absorbed for Brass is found out to be                   Joules.
  - iii. The energy absorbed for Aluminum is found out to be                   Joules

**PRECAUTION:-**

1. Measure the dimensions of the specimen carefully.
2. Hold the specimen (Izod test) firmly.
3. Note down readings carefully.

## EXPERIMENT No :- 06

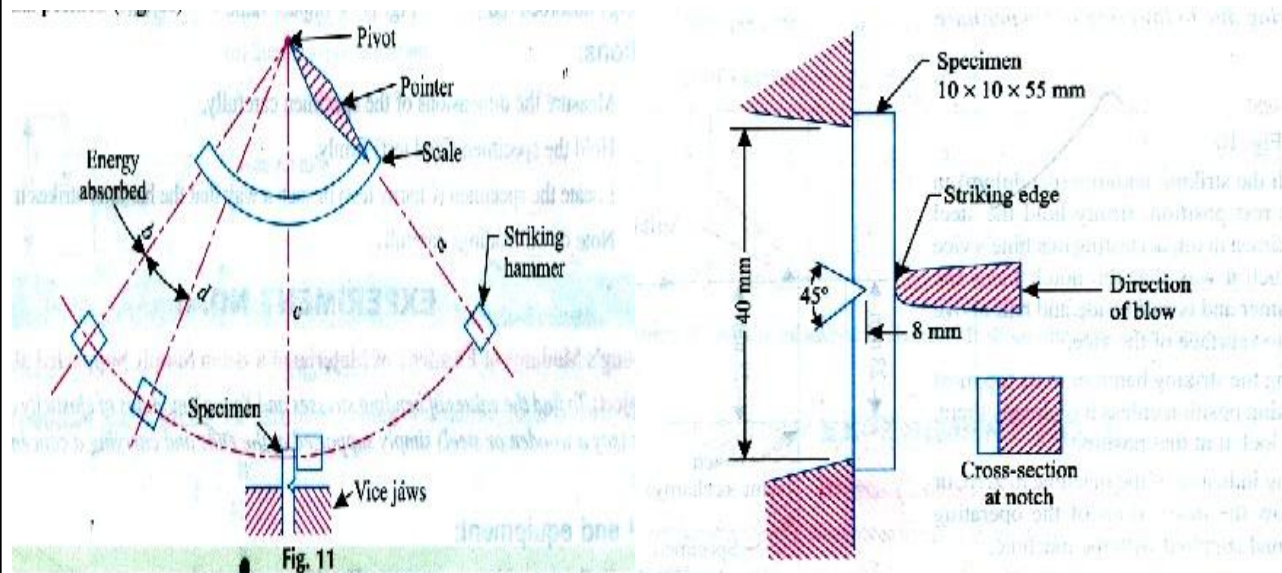
**AIM:** -To determined impact strength of steel.

**OBJECT:** -To Determine the impact strength of steel by (Charpy test)

**APPARATUS:** -1. Impact testing machine

2. A steel specimen 10 mm x 10 mm X 55mm

**DIAGRAM:-**



**THEORY:-** An impact test signifies toughness of material that is ability of material to absorb energy during plastic deformation. Static tension tests of unmatched specimens do not always reveal the susceptibility of a metal to brittle fracture. This important factor is determined by impact test. Toughness takes into account both the strength and ductility of the material. Several engineering materials have to withstand impact or suddenly applied loads while in service. Impact strengths are generally lower as compared to strengths achieved under slowly applied loads. Of all types of impact tests, the notch bar tests are most extensively used. Therefore, the impact test measures the energy necessary to fracture a standard notch bar by applying an impulse load. The test measures the notch toughness of material under shock loading. Values obtained from

these tests are not of much utility to design problems directly and are highly arbitrary. Still it is important to note that it provides a good way of comparing toughness of various materials or toughness of the same material under different condition. This test can also be used to assess the

ductile brittle transition temperature of the material occurring due to lowering of temperature.

**PROCEDURE :- ( a ) Charpy Test**

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machines vice in such a way that the notch faces the hammer and is half inside and half above the top surface of the vice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at that position.
3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with the machine.
4. Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost final position.
5. The specimen is placed on supports or anvil so that the blow of hammer is opposite to the notch.

**OBSERVATION:- Charpy test**

1. Impact value of - Mild Steel -----N-m
2. Impact value of - Brass -----N-m
3. Impact value of - Aluminum -----N-m

**RESULT:-**  
i. The energy absorbed for Mild Steel is found out to be                      Joules.  
ii. The energy absorbed for Brass is found out to be                      Joules.  
iii. . The energy absorbed for Aluminum is found out to be                      Joules

**PRECAUTION:-**

1. Measure the dimensions of the specimen carefully.
2. Locate the specimen (Charpy test) in such a way that the hammer, strikes it at the middle.
3. Note down readings carefully.

## EXPERIMENT NO :- 07

**AIM:** -To determined young's modulus of elasticity of material of beam simply supported at ends.

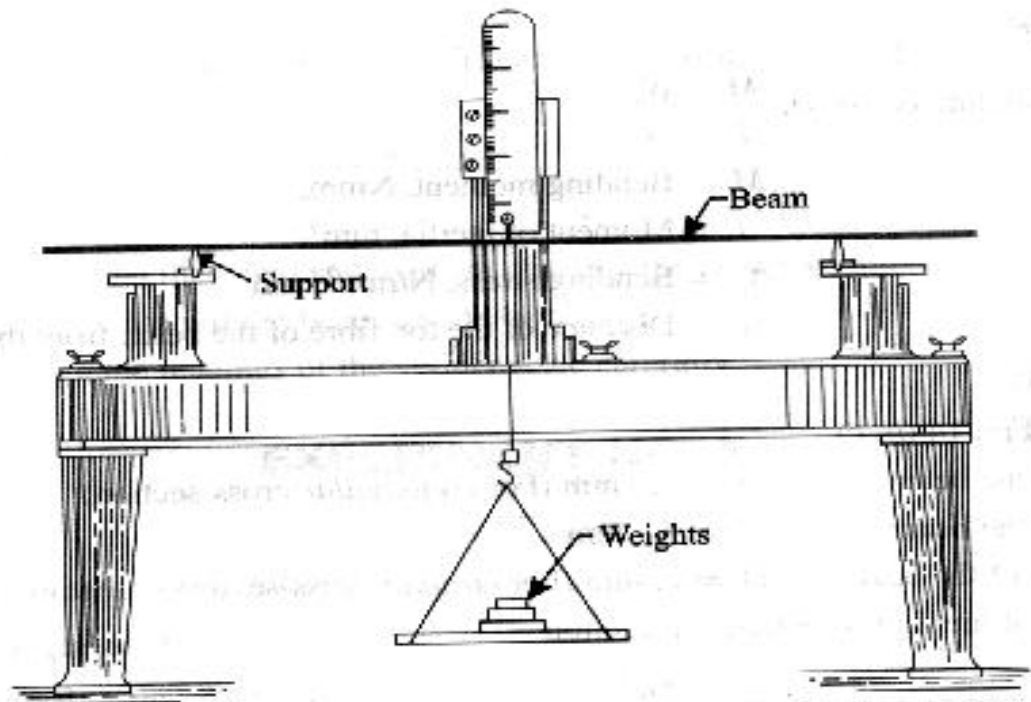
**OBJECT:-**To find the values of bending stresses and young's modulus of elasticity of the material of a beam simply supported at the ends and carrying a concentrated load at the centre.

**APPARATUS:** - 1.Deflection of beam apparatus

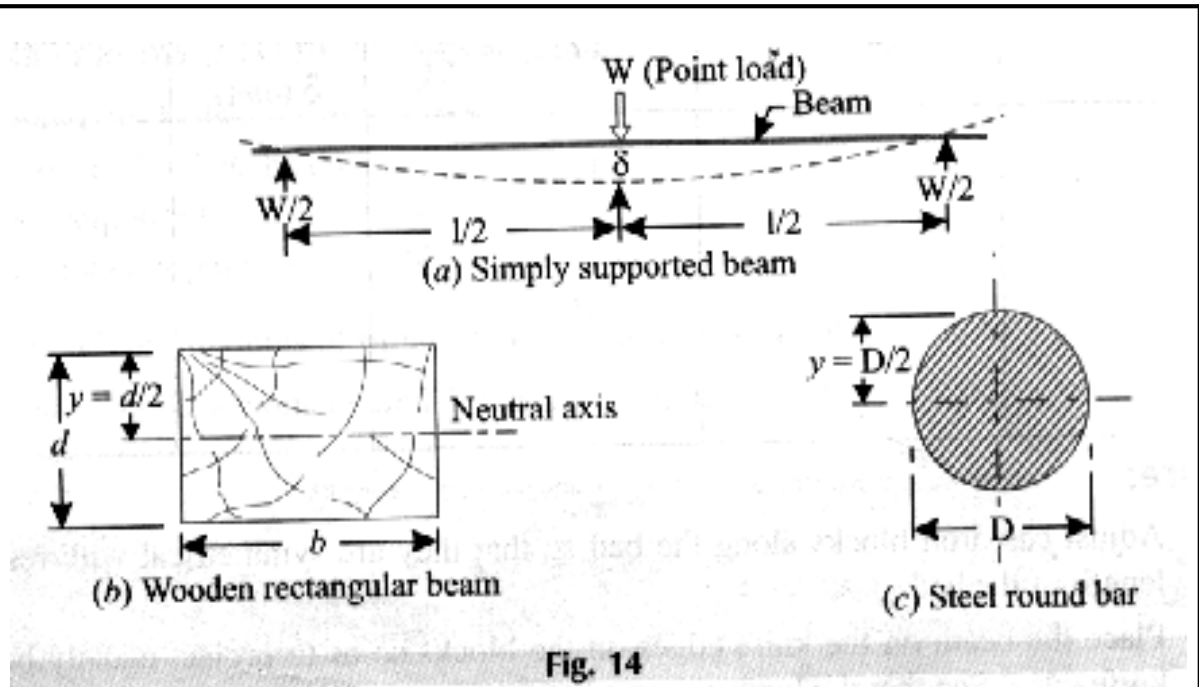
2. Pan 3. Weights

4. Beam of different cross-sections and material (say wooden and Steel beams)

**DIAGRAM:-**



● Fig. 13. Deflection of beam apparatus.



**THEORY:-**

If a beam is simply supported at the ends and carries a concentrated load at its centre, the beam bends concave upwards. The distance between the original position of the beams and its position after bending at different points along the length of the beam, being maximum at the centre in this case. This difference is known as ‘deflection’

In this particular type of loading the maximum amount of deflection ( $\delta$ ) is given by the relation,

$$\delta = \frac{W l^3}{48 EI} \quad \dots\dots\dots (i)$$

$$E = \frac{W l^3}{48 \delta I} \quad \text{-----} (ii)$$

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<sup>2</sup>

I =Second moment of area of the cross- section (e.i., moment of Inertia) of the beam, about the neutral axis, mm.<sup>4</sup>

## BENDING STRESS

As per bending equation,  $\frac{M}{I} = \frac{\sigma_b}{Y}$

Where,  $M$  = Bending moment, N-mm  
 $I$  = Moment of inertia, mm.<sup>4</sup>  
 $\sigma_b$  = Bending stress, N/mm<sup>2</sup>, and  
 $Y$  = Distance of the top fiber of the beam from the neutral axis

### PROCEDURE:

1. Adjust cast- iron block along the bed so that they are symmetrical with respect to the length of the bed.
2. Place the beam on the knife edges on the block so as to project equally beyond each knife edge. See that the load is applied at the centre of the beam
3. Note the initial reading of vernier scale.
4. Add a weight of 20N (say) and again note the reading of the vrenier scale.
5. Go on taking readings adding 20N (say)each time till you have minimum six readings.
6. Find the deflection ( $\delta$ ) in each case by subtracting the initial reading of vernier scale.
7. Draw a graph between load (W) and deflection ( $\delta$ ) . On the graph choose any two convenient points and between these points find the corresponding values of W and  $\delta$ . Putting these Values in the relation

$$\delta = \frac{WI^3}{48 \delta I} \quad \text{Calculate the value of E}$$

8. Calculate the bending stresses for different

loads using relation  $\left( \delta_b = \frac{My}{I} \right)$  As given in the observation table

### **OBSERVATION TABLE :-**

<b>S.No.</b>	<b>Load (N)</b>	<b>W</b>	<b>Bending moment</b> $M = \frac{WI}{4}$ (Nmm)	<b>Bending stress</b> $\sigma_b = \frac{M y}{I}$ N/mm <sup>2</sup>	<b>Deflection, <math>\delta</math> (mm)</b>	<b>Young's Modulus of elasticity, E = <math>\frac{WI^3}{48\delta I}</math></b>
1						
2						
3						
4						
5						

### **RESULT:**

1. The young's modulus for steel beam is found to be----- N/mm<sup>2</sup>.
2. The young's modulus for wooden beam is found to be----- N/mm<sup>2</sup>

### **PRECAUTION**

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

## **EXPERIMENT NO :- 08**

**AIM:** -To determined Shear Test of Steel.

**OBJECT:** - To conduct shear test on specimens under double shear:

**APPARATUS:** -

- i) Universal testing machine.
- ii) Shear test attachment.
- iii) Specimens.

### **DIAGRAM:-**

**THEORY:** -Place the shear test attachment on the lower table, this attachment consists of cutter. The specimen is inserted in shear test attachment & lift the lower table so that the zero is adjusted, then apply the load such that the specimen breaks in two or three pieces. If the specimen breaks in two pieces then it will be in single shear & if it breaks in three pieces then it will be in double shear.

### **PROCEDURE:**

1. Insert the specimen in position and grip one end of the attachment in the upper portion and one end in the lower portion.
2. Switch on the main switch of universal testing machine machine.
3. The drag indicator in contact with the main indicator.
4. Select the suitable range of loads and space the corresponding weight in the pendulum and balance it if necessary with the help of small balancing weights.
5. Operate (push) buttons for driving the motor to drive the pump.
6. Gradually move the head control level in left-hand direction till the specimen shears.
7. Down the load at which the specimen shears.
8. Stop the machine and remove the specimen

**Repeat the experiment with other specimens.**

### **OBESERVATION:-**

Diameter of the Rod,  $D = \dots$  mm

Cross-section area of the Rod (in double shear) =  $2 \times \pi/4 \times d^2 = \dots$  mm<sup>2</sup>

Load taken by the Specimen at the time of failure ,  $W =$  N

Strength of rod against Shearing =  $f \times 2 \times \pi/4 \times d^2$

$$f = W / 2 \times \pi/4 \times d^2 \text{ N/mm}^2$$

**RESULT:**

The Shear strength of mild steel specimen is found to be

$$= \dots\dots\dots \text{ N/mm}^2$$

**PRECAUTION :-**

- 1 The measuring range should not be changed at any stage during the test.
2. The inner diameter of the hole in the shear stress attachment should be slightly greater than that of the specimen.
3. Measure the diameter of the specimen accurately.

## EXPERIMENT NO :- 09

**AIM:** - Spring Testing

**OBJECT:** - To determine the stiffness of the spring and modulus of rigidity of the spring wire

**APPARATUS:** - i) Spring testing machine.

ii) A spring

iii) Vernier caliper, Scale.

iv) Micrometer.

**DIAGRAM:-**

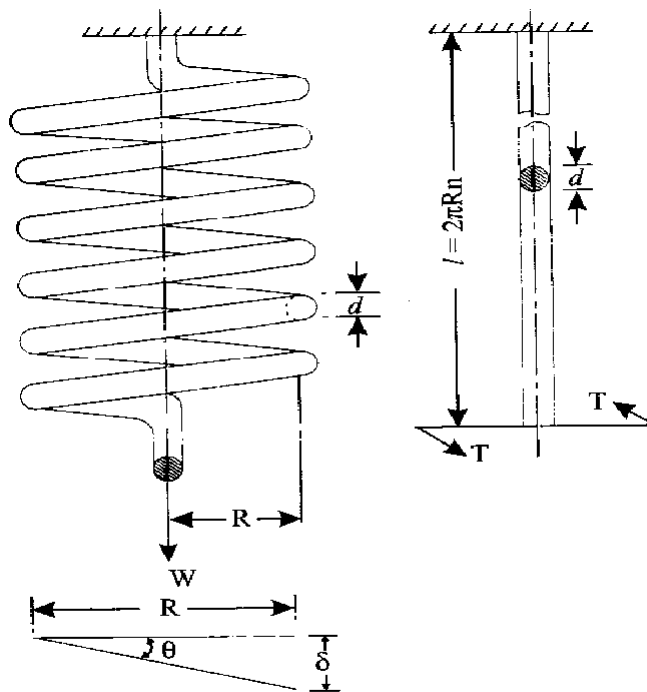


Fig. 14.1. Close-coiled helical spring.

**THEORY:** - Springs are elastic member which distort under load and regain their original shape when load is removed. They are used in railway carriages, motor cars, scooters, motorcycles, rickshaws, governors etc. According to their uses the springs perform the following Functions:

- 1) To absorb shock or impact loading as in carriage springs.
- 2) To store energy as in clock springs.

- 3) To apply forces to and to control motions as in brakes and clutches.
- 4) To measure forces as in spring balances.
- 5) To change the variations characteristic of a member as in flexible mounting of motors.

The spring is usually made of either high carbon steel (0.7 to 1.0%) or medium carbon alloy steels. Phosphor bronze, brass, 18/8 stainless steel and Monel and other metal alloys are used for corrosion resistance spring.

Several types of spring are available for different application. Springs may classified as helical springs, leaf springs and flat spring depending upon their shape. They are fabricated of high shear strength materials such as high carbon alloy steels spring form elements of not only mechanical system but also structural system. In several cases it is essential to idealise complex structural systems by suitable spring.

### **PROCEDURE:**

- 1) Measure the diameter of the wire of the spring by using the micrometer.
- 2) Measure the diameter of spring coils by using the vernier caliper
- 3) Count the number of turns.
- 4) Insert the spring in the spring testing machine and load the spring by a suitable weight and note the corresponding axial deflection in tension or 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.

### **OBSERVATION**

Least count of micrometer = .....mm

Diameter of the spring wire,  $d = \dots\dots\dots$ mm

(Mean of three readings)

Least count of vernier caliper = .....mm

Diameter of the spring coil,  $D = \dots\dots\dots$ mm

(Mean of three readings)

Mean coil diameter,  $D_m = D - d \dots\dots\dots$ mm

Number of turns,  $n =$

**OBSERVATION TABLE:**

S.NO	Load,W (N)	Deflection,( $\delta$ ) (mm)	Stiffness K = W / $\delta$ N / mm
1			
2			
3			
4			
5			

Mean k = .....

$$\text{Modulus of rigidity } C = \frac{8W D^3_m n}{\delta d^4}$$

$$\text{Spring Index} = \frac{Dm}{D}$$

**RESULT:** The **value** of spring constant k of closely coiled helical spring is found to be----- **N / mm**

- PRECAUTION:-**
- 1)The dimension of spring was measured accurately.
  - 2) Deflection obtained in spring was measured accurately

## **EXPERIMENT NO: - 10**

**OBJECT: -** To Study various types of strain Gauges.

**THEORY :-** A strain Gauge may be defined as any instrument or device that is employed to measure the linear deformation over a given gauge length, occurring in the material of a structure during the loading of structures. This definition is quite broad. In fact it covers the range of instruments included between the linear scale & the precise optical & electrical gauges now available. The many types of strain gauges available are quite varied both in applications & in the principle involved in their magnification, systems. Depending upon the magnification system the strain gauges may be classified as follows:

### **1) Mechanical**

1. Wedge & screw
2. Lever – simple & compound
3. Rack & pinion
4. Combination of lever & rack & pinion
5. Dial indicators

### **2) Electrical**

1. Inductance
2. Capacitance
3. Piezoelectric & piezoresistive

**Accuracy & repeatability :-** Sensitive does not ensure accuracy. Usually the very sensitive instruments are quite prone to error unless they are employed with utmost care. Before selecting a particular type of gauge following factors must also be carefully evaluated.

- 1) Readability

- 2) Ease of mounting
- 3) Required operator skill
- 4) weight
- 5) frequency response
- 6) cost.

### 1) Mechanical Strain Gauges:-

#### a) Wedge & screw origination:-

The wedge gauge is simply a triangular plate with its longer sides related at 1:10 slope when inserted between two shoulders dipped to the test specimen, extension could be detected nearest 0.05 mm .A single screw extensometer which is one of the pioneer instruments used for measurement of strain. The magnification in this instrument is accomplished solely by a screw micrometer a measures the relative motion of two coaxial tubes

1. Magnetic
2. Acoustical
3. Pneumatic
4. Scratch type
5. Photo stress gauge

#### Characteristic of a strain gauge:-

A strain gauge has the following four basic characteristics

- 1) Gauge length: - The gauge size for a mechanical strain gauge is characterized by the distance between two knife edges in contact with the specimen & by width of a movable knife edges non linear strum which should be as small as possible in that case.

2) Sensitivity :- It is the smallest value of strain which can be read on the scale associated with strain gauge .Sensitivity can be defined in two way :-

$$\text{i) Deformation sensitivity} = \frac{\text{Smallest reading of scale}}{\text{Multiplication factor}}$$

$$\text{ii) Strain sensitivity} = \frac{\text{Deformation sensitivity}}{\text{Base length}}$$

3) Range: - This represents the maximum strain which can be recorded with out resetting or replacing the strain gauge. The range & sensitivity are

1) Simple Mechanical lever magnification:-

The simple lever strain gauge gains its magnification factors by a suitable positioning of fulcrum cap's multiplying divider is an important extensiometer of this category. The magnification of this type of gauge is unlimited. The gauge length of cap's divider is 5cm & strain is magnified 10: 1 on graduated scale.

2) Compound Magnification System:-

Two commercially available gauges which utilize the compound magnification are illustrated by Barry gauge & tinusis oisen strain gauge.

The Barry strain gauge consists of frame a with two conically painted contact points. One point b is rigidly fixed to frame while other c is provided from a frame & is internal with a lever armed which alone magnifies the strain about 5.5. A screw micrometer or dial indicator is used to measure the motion of arm, thus permitting measurements of strain to nearest 0.005 m with a 0.025mm micrometer.

### 3) Compound lever Magnification:-

Two gauges of this category are Huggenberger strain gauge & parter lipp strain gauge. In these instruments the magnification system is composed of two or more simple levers in series. They have relatively small size & high magnification factor.

### 4) Mechanical by rack & pinion:-

The rack & pinion principle alone with various types of gear train is employed in gauge in which the magnification system is incorporated in an indicating dial. In general a dial indicator consists of an encased gear train actuated by a rack cut in spindle which follows the motion to be measured. A spring imposes sufficient spindle force to maintain a reasonably uniform & positive contact with the moving part. The gear train terminates with a light weight pointer which indicates spindle travel on a graduated dial. Lost motion in gear train is minimized by +ve force of a small coil spring the dial gauge extensometer is the most popular gauge of this type used in a material testing laboratory. Dial gauge indicators are frequently attached permanently to a structure to indicate the deflection or deflection on deformation obtained under working condition.

### 3) **Acoustical strain gauge:-**

The vibrating wire or acoustical gauge consists essentially of a steel wire tensioned between two supports a predetermined distance apart. Vibration of the distance alters the natural frequency of vibration of the wire & thus change in frequency may be correlated with the change in strain causing An electro – magnet adjacent to the wire may be used to set the wire in vibration & this wire movement will then generate an oscillating electrical signal . The signal may be compared with the pitch adjustable standard wire , the degree of adjustment necessary to match of two signal frequencies being provided by a tensioning screw on the slanted wave calibration of this screw allows direct

determination of change of length of a measuring gauge to be made once the standard gauge has been tuned to match the frequency of measuring wire.

The visual display produced is a cko renders adjustment easier. Tuning is now more usually accomplished by feeding the two signal in to two pours of plates of an oscillogram & making use of the luscious figure formation to balance the frequencies. Matching of tones is simplified & made more accurate by tuning out the beats with results when the vibration frequencies of two were are nearly the lame.

The fundamental frequency of stretch wire

$$f = \frac{1}{2L} \sqrt{\frac{p}{m}}$$

A = Cross sectional area

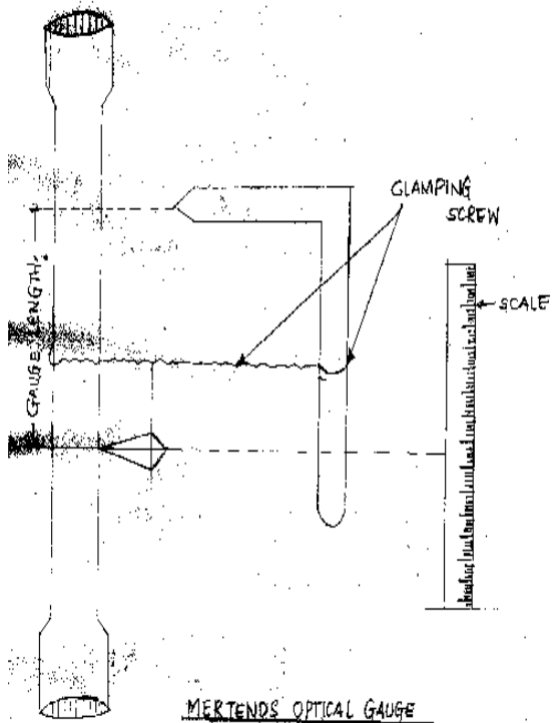
E = Young's modulus of were

h = length of vibrating were

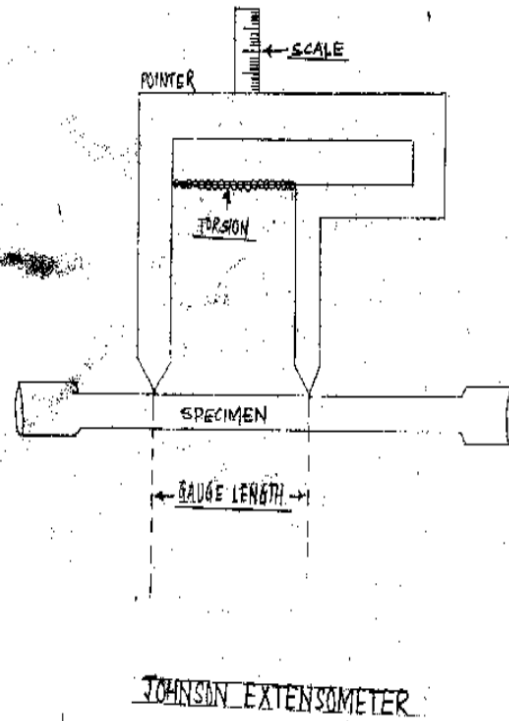
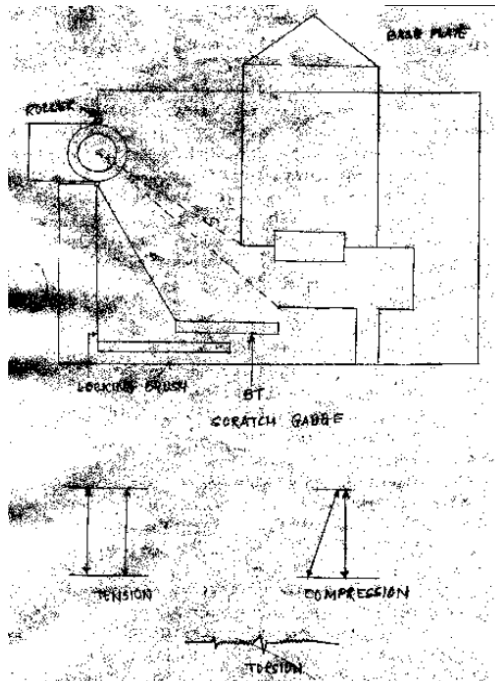
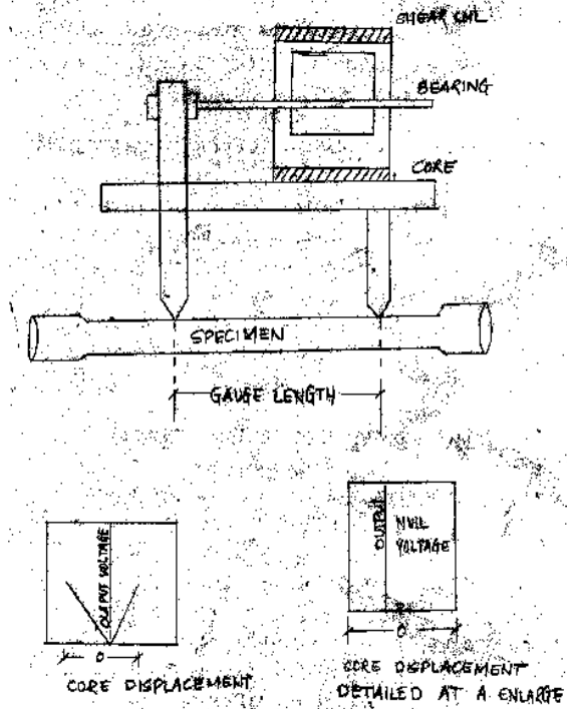
m = mass per unit length of were

p = tensioning force is were

w = increment in length of vibrating were



MERTENS OPTICAL GAUGE



JOHNSON EXTENSOMETER

## **EXPERIMENT NO: - 11**

**AIM: - COMPRESSIVE STRENGTH OF BRICK:-**

**OBJECT: -** The specimen brick is immersed in water for 24 hours. The frog of the Compressive Strength

**APPARATUS:** Bricks, Oven Venire Caliper, Scale,Etc.

**FORMULA: -**

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

**DIAGRAM:-**

**THEORY : -** Bricks are used in construction of either load bearing walls or in portion walls incase of frame structure. In bad bearing walls total weight from slab and upper floor comes directly through brick and then it is transversed to the foundation. In case the bricks are loaded with compressive nature of force on other hand in case of frame structure bricks are used only for construction of portion walls, layers comes directly on the lower layers or wall. In this case bricks are loaded with compressive nature of force. Hence for safely measures before using the bricks in actual practice they have to be tested in laboratory for their compressive strength.

**PROCEDURE: -**

1. Select some brick with uniform shape and size.
2. Measure its all dimensions. (LXBXH)
3. Now fill the frog of the brick with fine sand. And
4. Place the brick on the lower platform of compression testing machine and lower the spindle till the upper motion of ramis offered by a specimen the oil pressure start incrising the pointer

start returning to zero leaving the drug pointer that is maximum reading which can be noted down.

**OBSERVATION TABLE:-**

S.No	L X B XH Cm <sup>3</sup>	Area L X B Cm <sup>2</sup>	Load (N) (P)	Compressive Strength P/A(N/mm <sup>2</sup> )	Average Compressive Strength
01					
02					
03					
04					
05					

**CALCULATION:-**

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

**RESULT :-** The average compressive strength of new brick sample is found to be ..... Kg/sq.cm.

- PRECAUTION:-**
- 1) Measure the dimensions of Brick accurately.
  - 2) Specimen should be placed as far as possible in the center of 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.