



GOVT CO-ED POLYTECHNIC

BYRON BAZAR RAIPUR(C.G.)

LAB MANUAL

Branch: Mechanical Engineering

Year & Semester: 2nd Year/ 4th Semester

STRENGTH OF MATERIAL LAB (2037362(037))
(Lab)

CONTENTS

S. No.	Title of Experiment
1.	Study Of Universal Testing Machine
2.	Determine Tensile test on metal
3.	Pressure measurement using bourdon tube
4.	Pressure gauge calibration using dead weight tester.
5.	Flow measurement using rotameter
6.	Measurement of temperature using RTD
7.	Measurement of temperature using thermocouple

EXPERIMENT NO-01

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

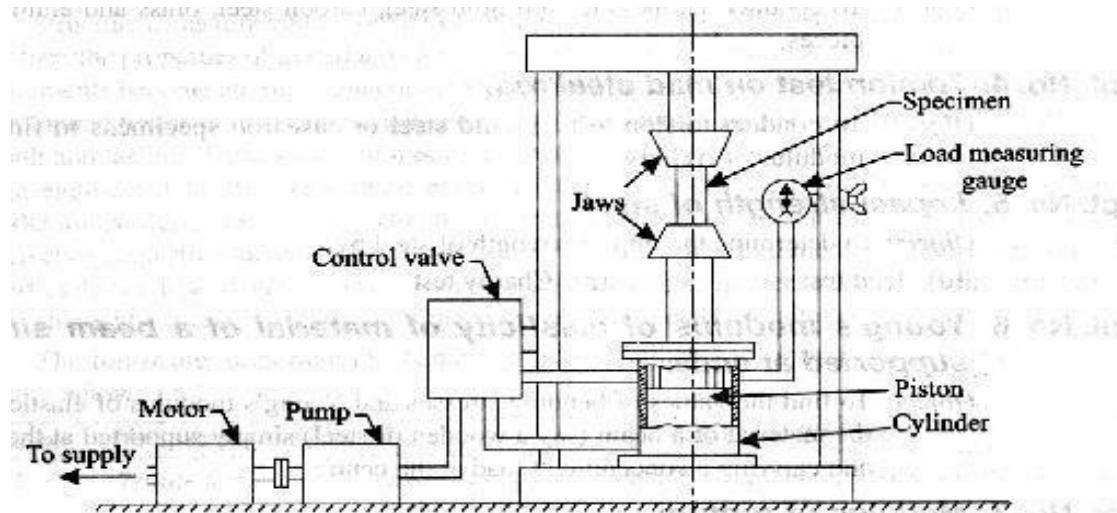
OBJECT: -

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

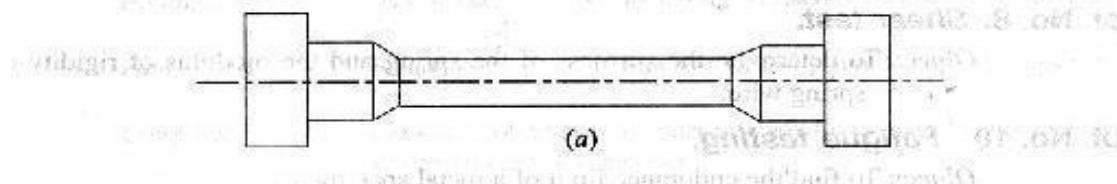
APPARATUS: -

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

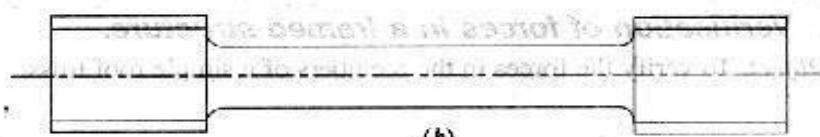
DIAGRAM:-



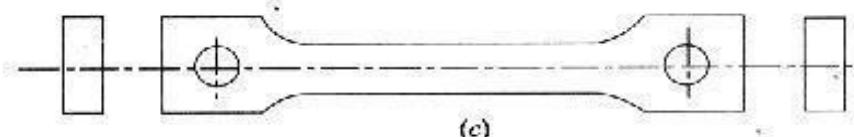
• Fig. 1. Tensile testing machine.



(a)



(b)



(c)

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 loosing 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 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.

Strength Of Materials

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 place 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 30to 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:-

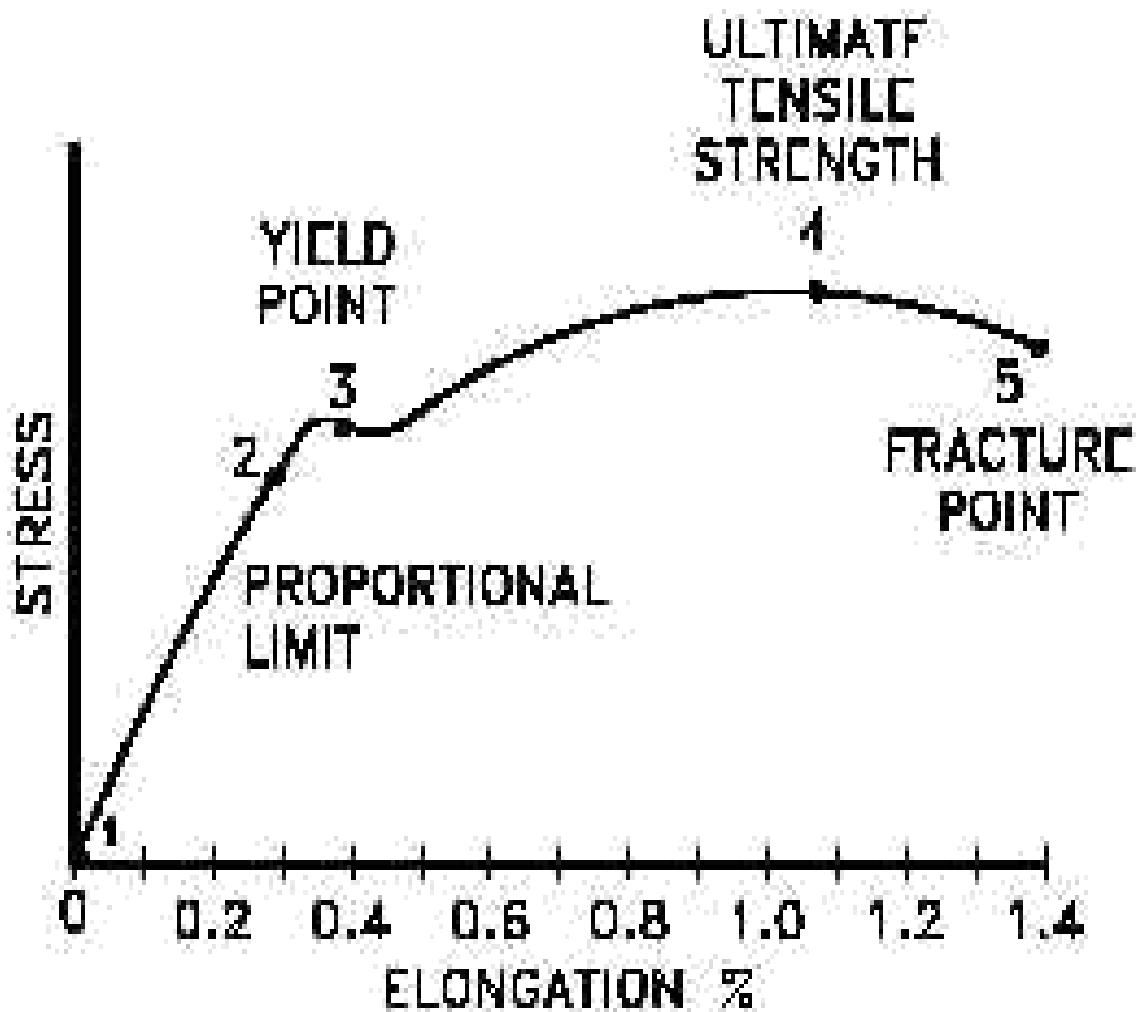
Measuring Range: 0 – 3 mm.

Least Count: 0. 01 mm.

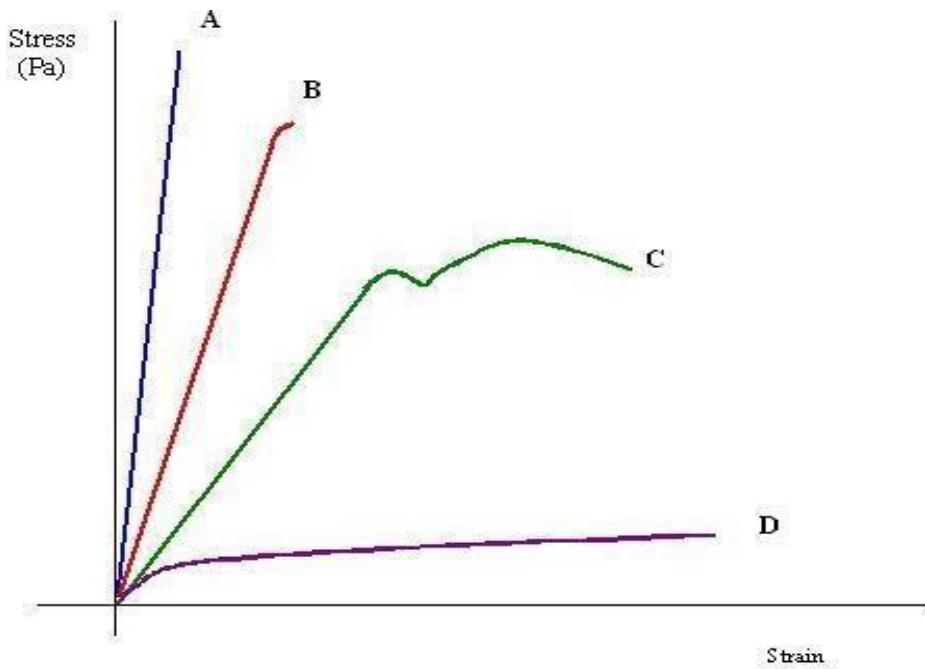
Gauge Length adjustable from: 30 – 120 mm

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: -

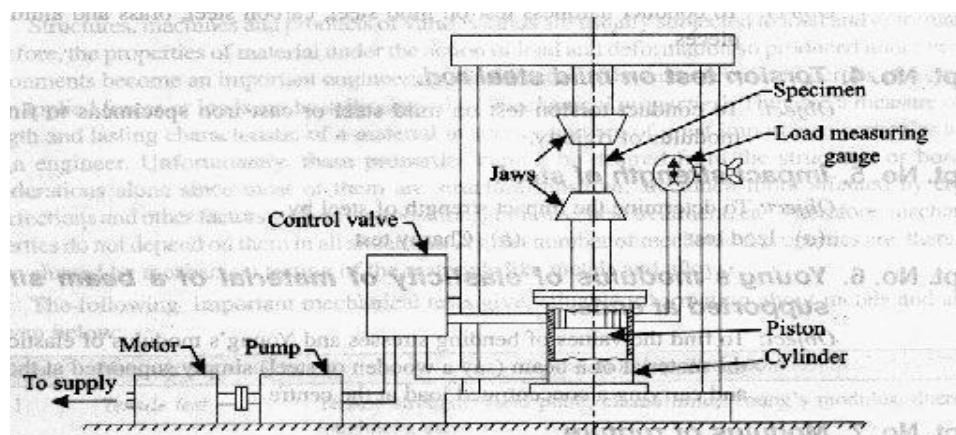
To conduct a tensile test on a mild steel specimen and determine the following:

(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.

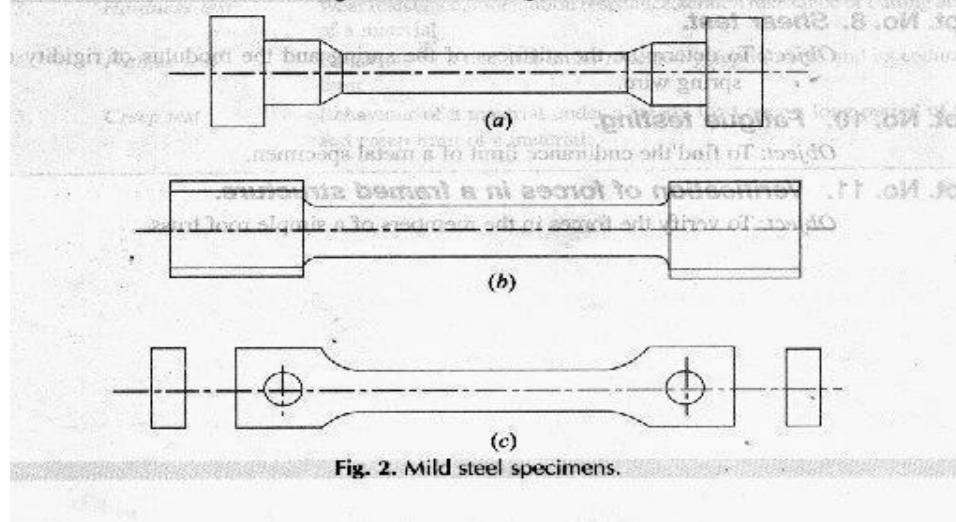


Fig. 2. Mild steel specimens.

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:-

Material:

A) Original dimensions

Length = -----

Diameter = -----

Area = -----

B) Final Dimensions:

Length = -----

Diameter = -----

Area = -----

OBSERVATION TABLE:-

S. No.	Load (N)	Gauge length (mm)	Extension	Stress = Load / Area (N/mm ²)	Strain = Increase
					in length / Original length
1					
2					
3					
4					
5					

To plot the stress strain curve and determine the following.

1. Limit of proportion

Load at limit of proportionality / original area of cross-section..... N/m

2. Elastic limit

Load at elastic limit / original area of c/s..... N/mm²

3. Yield strength

Yield load / original area of cross-section..... N/mm²

4. Ultimate strength

Maximum tensile load / original area of cross-section N/mm²

5. Young's modulus, E

Stress below proportionality limit / corresponding strain N/mm²

6. Percentage elongation

{Final length (at fracture) – original length} / original length %

7. Percentage reduction in area

(Original area - area at fracture) / original area %

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:-

Torsion test on mild steel rod.

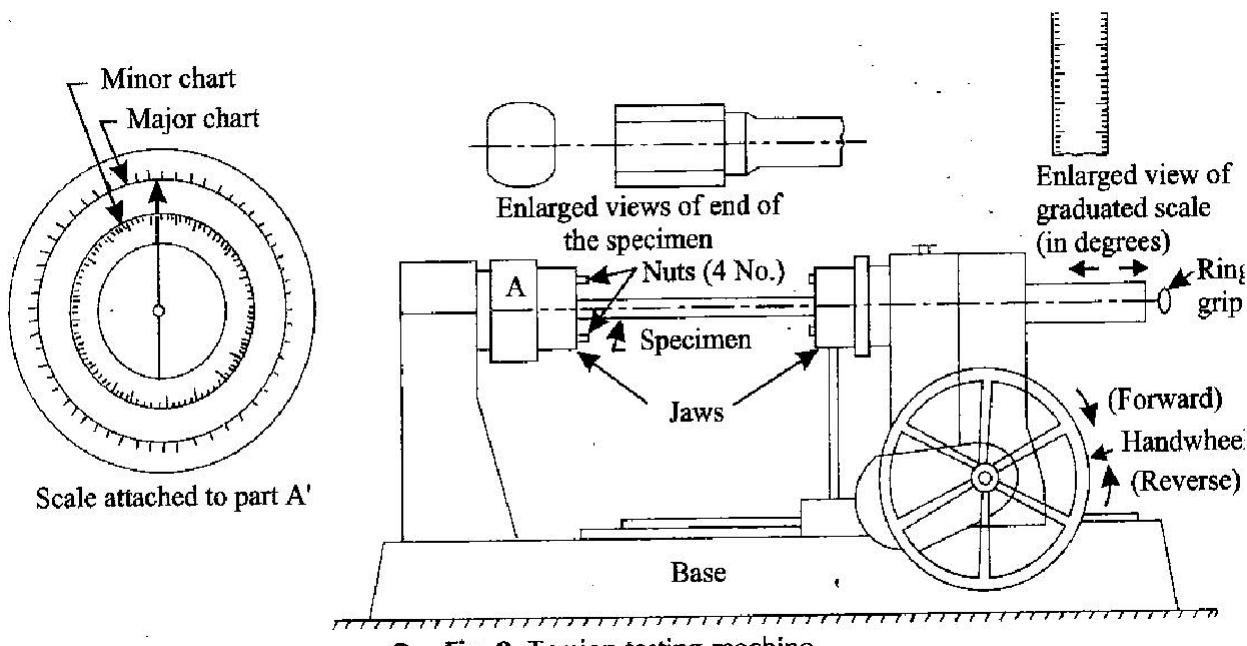
OBJECT: -

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 thought observations made during the experiment by using the

torsion equation

$$T/I_p = C \theta/l = q/r$$

Where,

T = Torque applied,
 I_p = Polar moment of inertia, C = Modulus of rigidity,
 θ = 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:-

$$C = Tl / \theta I_p$$

Gauge length of the specimen $l = \dots$ Diameter of

the specimen $d = \dots$

Polar moment of inertia $I_p = \pi d^4 / 32 = \dots$

OBSERVATION TABLE:-

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

RESULT:-

Modulus of rigidity of mild steel rod is ----- N/mm^2 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 :- 04

AIM: -

To determine young's modulus of elasticity of material of beam simply supported at ends.

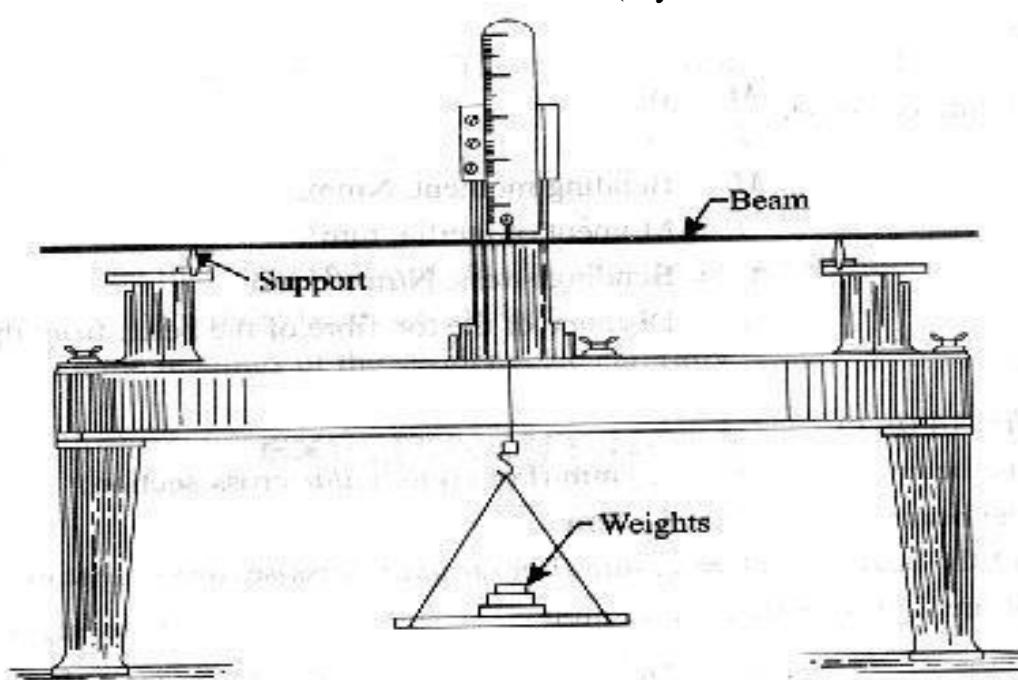
OBJECT:-

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.

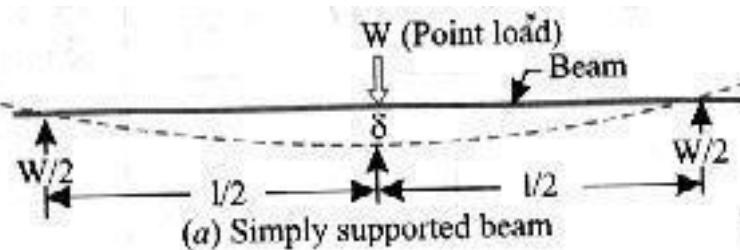
APPARATUS: -

1. Deflection of beam apparatus
2. 2. Pan
3. 3. Weights
4. Beam of different cross-sections and material (say wooden and Steel beams)

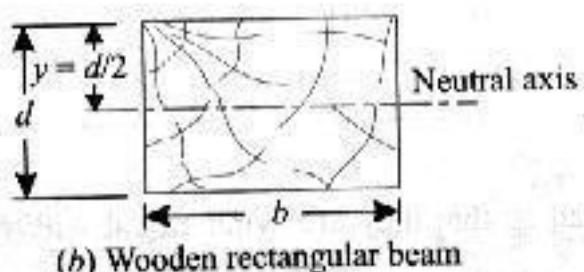
DIAGRAM:-



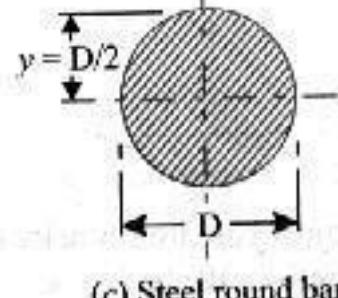
● Fig. 13. Deflection of beam apparatus.



(a) Simply supported beam



(b) Wooden rectangular beam



(c) Steel round bar

Fig. 14

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 (δ) is given by the relation,

$$\delta = WL^3/48EI \dots\dots\dots (i)$$

$$E = WL^3/48\delta I \dots\dots\dots (ii)$$

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/mm²

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

BENDING STRESS

As per bending equation, $M/I = \sigma_b / Y$

Where, M = Bending moment, N-mm

I = Moment of inertia, mm.⁴

σ_b = Bending stress, N/mm², and beam

Y = Distance of the top fiber of the 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 (δ) in each case by subtracting the initial reading of vernier scale.
7. Draw a graph between load (W) and deflection (δ) . On the graph choose any two convenient points and between these points find the corresponding values of W and δ .
8. Calculate the bending stresses for different loads using relation $\delta_b = My/I$ As given in the observation table.

OBSERVATION TABLE :-

S.No.	Load W (N)	Bending moment $M =$	Bending stress (Nmm)	Deflection δ (mm)	Young's Modulus of elasticity, $E =$
1					
2					
3					
4					
5					

RESULT:

1. The young's modulus for steel beam is found to be ----- N/mm².
2. The young's modulus for wooden beam is found to be ----- N/mm²

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 :- 05

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.

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, $D = \dots \text{mm}$

Cross-section area of the Rod (in double shear) = $2\pi/4d^2 = \dots \text{mm}^2$

Load taken by the Specimen at the time of failure , $W = \dots \text{N}$

Strength of rod against

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

RESULT:

The Shear strength of mild steel specimen is found to be..... 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 :- 06

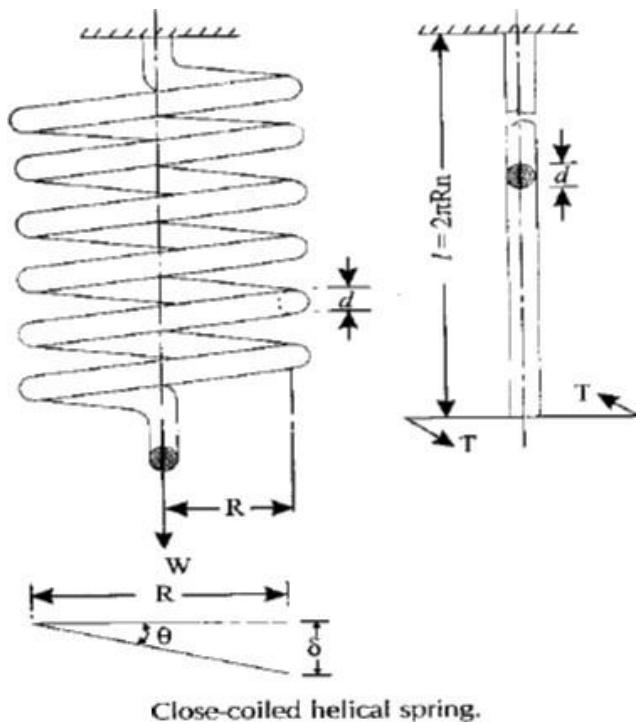
AIM: Determine the stiffness of the spring and modulus of rigidity of the spring wire

OBJECT: To determine the stiffness of the spring and modulus of rigidity of the spring

APPARATUS:

- i) Spring testing machine.
- ii) A spring iii) Vernier caliper,
- iii) Scale.
- iv) Micrometer.

DIAGRAM:



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 classify 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 idealize 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 = mm (Mean of three readings) Least count of vernier caliper =mm

Diameter of the spring coil, D =mm (Mean of three readings) Mean coil diameter, $D_m = D - d =$ mm

Number of turns, $n =$

TABLE:

S.No	Load W (in N)	Deflection (mm)	Stiffness $K = \frac{W}{x}$	Modulus of Rigidity(C) $\frac{Wx^3}{4D^4}$

Mean k =

$$\text{Modulus of rigidity C} = \frac{8D^3x}{4D^4} = \frac{2x}{D}$$

=

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

PRECAUTIONS:

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

ADVANTAGES:

1. To apply forces and to control motions as in brakes and clutches.
2. To store energy as in clock springs.
3. This test is conducted to find the material properties of the spring like modulus of rigidity. This can be obtained by observing the values of deflections of the spring with the application of different amounts of the load applied along the axis of the spring. The observed values of deflections are compared with the theoretical value for the deflection of the spring under the load and shear modulus is to be obtained.
4. To reduce the effect of shock or impact loading as in carriage springs

RESULT:

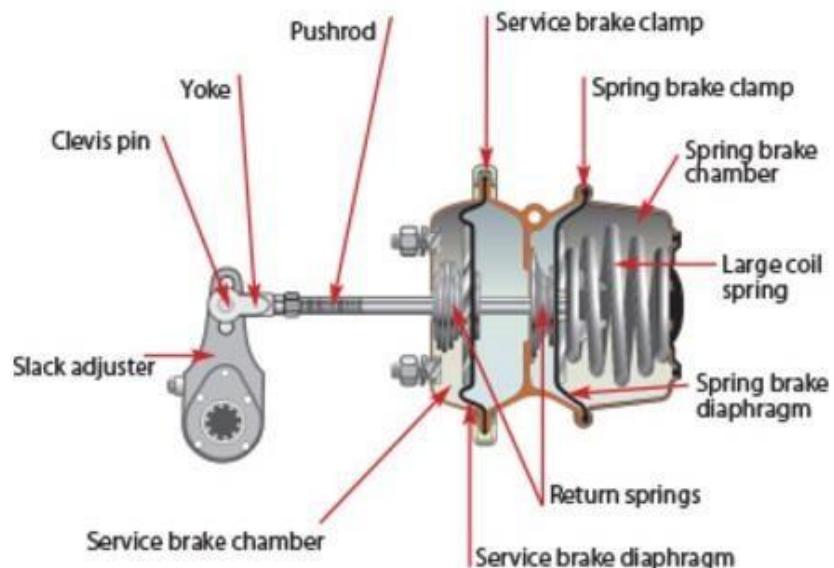
The value of spring constant k of closely coiled helical spring is found to be_
_____ N/mm

VIVA QUESTIONS:

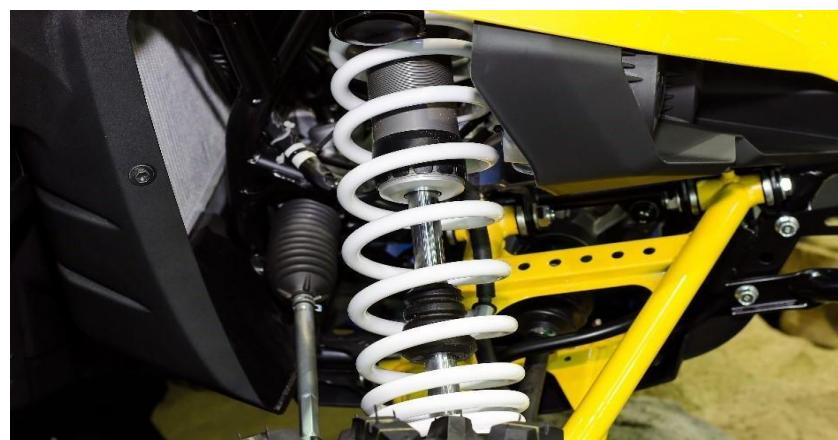
1. What is meant by stiffness
2. Define deflection
3. What are different types of springs
4. Define helical spring
5. What is the strain energy stored in the springs

APPLICATIONS:

1. To apply forces and controlling motion, as in brakes and clutches.



2. Used in suspension system

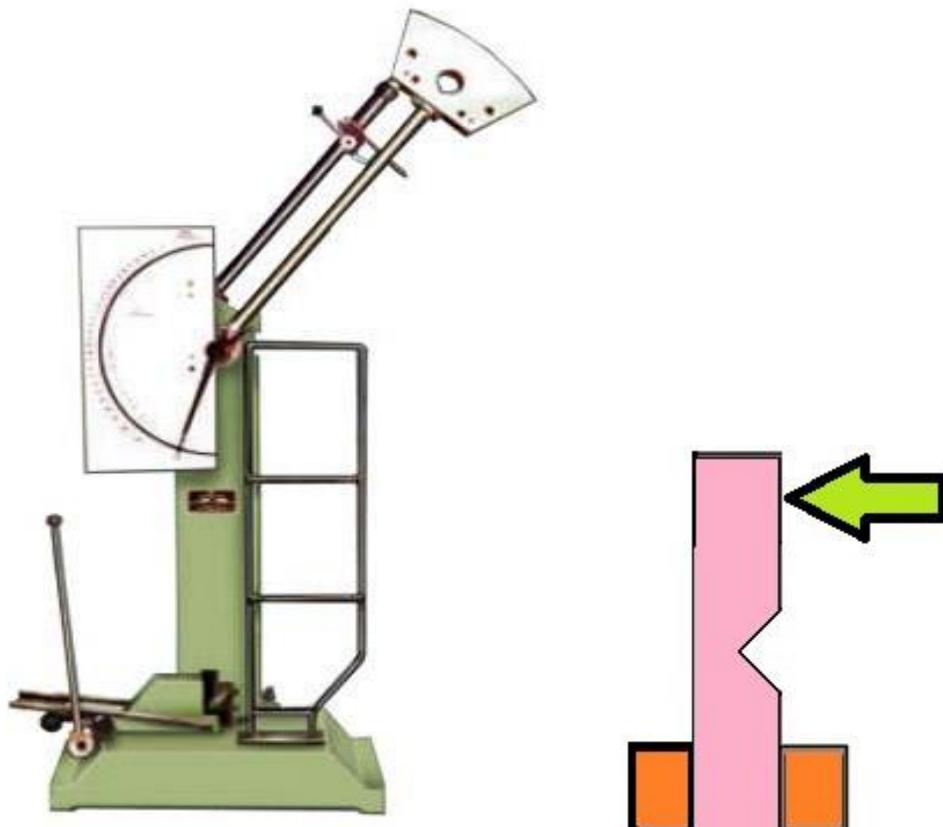


EXPERIMENT No. 7

AIM: To determine the Impact strength (Specific impact factor) through Izod test.

APPARATUS: Impact testing machine, MS Specimen

DIAGRAM:



PROCEDURE:

1. For conducting charpy test, a proper striker is to be fitted firmly to the bottom of the hammer with the help of the clamping piece.
2. The latching take for charpy test is to be firmly fitted to the bearing housing at the side of the columns.
3. The frictional loss of the machine can be determined by free fall test, raise the hammer by hands and latch in release the hammer by operating lever the pointer will then indicate the energy loss due to friction. From this reading confirm that the friction loss not exceeding 0.5% of the initial potential energy. Otherwise frictional loss has to be added to the final reading.

4. The specimen for izod test is firmly fitted in the specimen support with the help of clamping screw and élan key. Care should be taken that the notch on the specimen should face to pendulum striker.
5. After ascertaining that there is no person in the range of swinging pendulum, release them pendulum to smash the specimen.
6. Carefully operate the pendulum brake when returning after one swing to stop the oscillations.
7. Read-off position of reading pointer on dial and note indicated value.
8. Remove the broken specimen by loosening the clamping screw.

The notch impact strength depends largely on the shape of the specimen and the notch. the values determined with other specimens therefore may not be compared with each other.

TABLE:

S.NO	Area of cross section specimen (A)	Impact Energy (K)	I (Impact strength)

	Charpy Impact Testing	Izod Impact Testing
Materials Tested	Metals	Plastics & Metals
Types of Notches	U-notch and V-notch	V-notch only
Position of the Specimen	Horizontally, notch facing away from the pendulum	Vertically, notch facing toward the pendulum
Striking Point	Middle of the sample	Upper Tip of the sample
Common Specimen Dimensions	55 x 10 x 10 mm	64 x 12.7 x 3.2 mm (plastic) or 127 x 11.43 mm round bar (metal)
Common Specifications	ASTM E23, ISO 148, or EN 10045-1	ASTM D256, ASTM E23, and ISO 180

PRECAUTIONS:

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

RESULT:

The Impact strength of the given specimen is ----- $\frac{\text{J}}{\text{mm}^2}$

VIVA QUESTIONS:

1. In what way the values of impact energy will be influenced if the impact tests are conducted on two specimens, one having smooth surface and the other having scratches on the surface
2. What is the effect of temp? On the values of rupture energy and notch impact strength?
3. What is resilience? How is it different from proof resilience and toughness?
4. What is the necessity of making a notch in impact test specimen?
5. If the sharpness of V-notch is more in one specimen than the other, what will be its effect on the test result ?

APPLICATIONS:

1. in forging industry.



2. in the rubber industry.

