MATERIAL TESTING LAB

LABORATORY MANUAL

Department of Mechanical Engineering

Government Polytechnic Tekari

The Government Polytechnic (GP) Tekari, Gaya, Bihar - 824235. It is a newly established state government institution under the Department of Science and Technology

Department of Mechanical Engineering

Vision

To be a center of excellence in Mechanical Engineering education and interdisciplinary research to confrontreal world societal problems with professional ethics.

Mission

1. To push the frontiers of pedagogy amongst the students and develop new paradigms in research.

2. To develop products, processes, and technologies for the benefit of society in collaboration withindustry and commerce.

3. To mould the young minds and build a comprehensive personality by nurturing strong professionalswith human ethics through interaction with faculty, alumni, and experts from academia/industry.

UNIVERSAL TESTING MACHINE

- A **universal testing machine** (**UTM**), also known as a **universal tester** is used to test the tensile strength and compressive strength of materials.
- An earlier name for a tensile testing machine is a **tensometer**.
- From the 1850's on, various devices for testing materials had been developed, but the goal of a truly universal testing machine proved elusive until 1880, when Philadelphia engineer Tinius Olsen, a Norwegian immigrant who had just lost his job, devised and patented what became known as the Little Giant. Here at last was a machine for tensile, transverse, and compression testing united in a single instrument.

TORSION TESTING SETUP

- The **Vickers hardness test** was developed in 1921 by Robert L. Smith and George E. Sandland at Vickers Ltd as an alternative to the Brinell method to measure the hardness of materials.
- The Vickers test is often easier to use than other hardness tests since the required calculations are independent of the size of the indenter, and the indenter can be used for all materials irrespective of hardness.
- The basic principle, as with all common measures of hardness, is to observe a material's ability to resist plastic deformation from a standard source.
- The Vickers test can be used for all metals and has one of the widest scales among hardness tests.
- The unit of hardness given by the test is known as the **Vickers Pyramid Number** (**HV**) or **Diamond Pyramid Hardness** (**DPH**).

MATERIAL TESTING LABORATORY (SYLLABUS)

III SEMESTER B. E (ME)

COURSE LEARNING OBJECTIVES

Students are expected to

1 To Determine the mechanical properties of different material specimen

2 To give the basic knowledge about the methods to enhance the properties of the materialfrom heat treatment process.

3 To gain the basic knowledge about wear characteristics of ferrous, nonferrous andcomposite materials.

4 To gain the practical knowledge about Non-destructive testing

PART – A

1. Preparation of specimen for Metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron,Brass, Bronze & composites.

2. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.

3. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.

4. Non-destructive test experiments like,

(a). Ultrasonic flaw detection

(b). Magnetic crack detection

(c). Dye penetration testing. To study the defects of Cast and Welded Specimens

PART – B

1. Tensile, shear and compression tests of metallic and non-metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test on metallic and non-metallic specimens.
4. Izod and Charpy Tests on M.S, C.I Specimen.
5. Brinell, Rockwell and Vickers's Hardness test.
6. Fatigue Test.

COURSE OUTCOME:

1 Demonstrate the knowledge and skills to conduct and analyzing the results w.r.t. Hardness testing, Tensile testing, Shear, Compression, Bending test, Fracture testing, Fatigue testing and Impact testing.

2 Acquire the basic knowledge about the methods to enhance the properties of the materialfrom heat treatment process.

3 Analyze the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.

4 Apply the knowledge of Non-destructive testing in industrial sectors

Atria Institute of Technology

(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi)

DEPARTMENT OF MECHANICAL ENGINEERING

MATERIAL TESTING LABORATORY

I - CYCLE

1. Izod Test
2. Brinell Hardness Test
3. Shear Test
4. Bending Test

II– CYCLE

5. Charpy Test
6. Rockwell Hardness Test
7. Torsion Test
8. Compression Test

III– CYCLE

9. Heat Treatment
10. Tensile Test

IV– CYCLE

11. Wear Test
12. Micro Structure

ATRIA INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING BENGALURU – 560078

DO's

1. Students must always wear uniform and shoes before entering the lab.
2. Proper code of conduct and ethics must be followed in the lab.
3. Windows and doors to be kept open for proper ventilation and air circulation.
4. Note down the specifications of the experimental setup before performingthe experiment.
5. Check for the electrical connections and inform if any discrepancy found tothe attention of lecturer/lab instructor.
6. Perform the experiment under the supervision/guidance of a lecturer/lab instructor only.
7. After the observations are noted down switch off the electrical connections.
8. In case of fire use fire extinguisher/throw the sand provided in the lab.
9. In case of any physical injuries or emergencies use first aid box provided.
10. Any unsafe conditions prevailing in the lab can be brought to the notice ofthe lab in charge

DONT's

1. Do not operate any experimental setup to its maximum value.
2. Do not touch/ handle the experimental setups/Test Rigs without their prior knowledge,
3. Never overcrowd the experimental setup/Test Rig, Leave sufficient space for the
4. Never rest your hands on the equipment or on the display board, because it fragile measurement devices like thermometers, manometers,

CONTENTS

Experiment No. 1

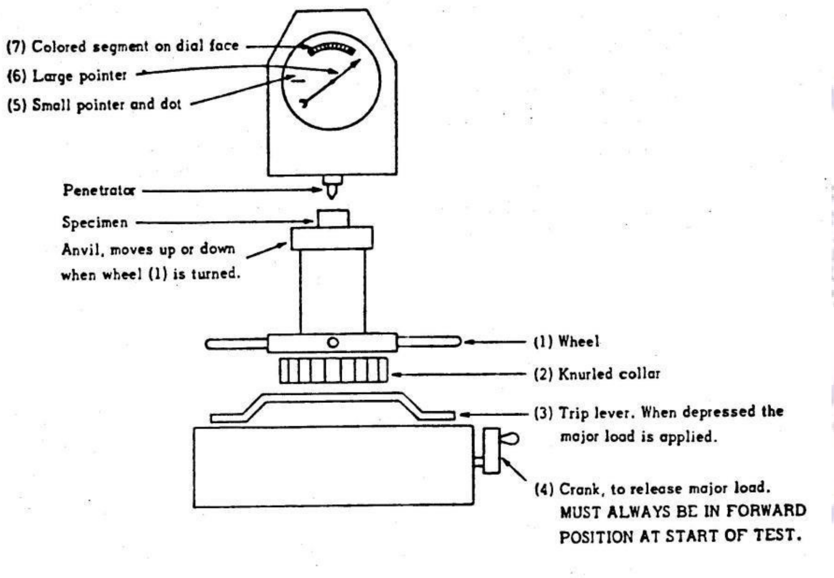
ROCKWELL HARDNESS TEST

Aim: To determine the Rockwell hardness for hard materials such as hardened steel & moderately hard materials such as brass.

Theory:

Hardness is a material characteristic which can be defined as resistance to deformation (penetration, wear, compression etc.)

In Rockwell hardness test, a standard load (based on type of material) is applied through a standard indentor (cone or ball) for a specified duration, on the material & depth of impression / indentation is directly measured and read as hardness number on a dial gauge.



Rockwell Hardness Tester.

Equipments:

1. Rockwell hardness tester.
2. Cone diamond indentor (120^0 included angle) 'C' scale.
3. Ball indentor (1/16" dia. Hardened steel ball) for 'B' scale.
4. Hardness testing specimen.
5. Standard hardness test block. (for B& C scales).

Procedure:

1. Place the semi polished specimen on the platform.
2. Insert the diamond cone indentor for C scales and 1/16” steel ball for B scale inside the sleeve and tighten the screw. Check that there is no movement of indentor.
3. Set the required load (150Kg for C scale and 100Kg for B scale) by turning the knob provided by the side of the machine.
4. Bring the specimen into contact with the indentor by rotating the elevating screw by rotating the star handle. By further elevating the specimen, the minor load of 10Kg is applied such that pointer indicates ‘x’ on the smaller graduated arc scale and the longer pointer indicates on the outer C scale and 30 on the inner B scale.
5. Now turn the lever away from the observer slowly. The longer pointer moves away and when it comes to rest, wait 8 to 10 sec for the entire application of major load.
6. Now turn the lever slowly to the observer i.e. to the original position. Now the entire load is being lifted off from the specimen.
7. Now the longer pointer moves back and when it comes to a rest position, note the reading on the outer black dial(C scale) and on the inner red dial(B scale)
8. The reading on the dial indicates directly hardness number (RHN) which is dimensionless.
9. A minimum of 3 trial readings are taken at separate location on the surface of the specimen. The average value of these 3 readings gives the true Rockwell hardenings number which is reported as HRC and HRB for Rockwell in C scale and Rockwell in B scale respectively
10. The results are tabulated as follows

Table of Results:

Sl. No.	Material	Type of Indentor	Std. Load in Kg		Hardness HRC / HRB			Average
			Major	Minor	T1	T2	T3	
1								
2								
3								

Precautions:

1. The condition of the test surface, because of very small impression normally produced, must necessarily be smoother & free from surface imperfections such as scale, rust etc., It should be preferably polished with emery cloth before placing on the machine.
2. Since the penetration of indentor is a very small (< 0.05 mm) the thickness of specimen should be at least 10 X thickness of penetration.
3. Standardization of Rockwell machines is secured by use of standard test blocks. Test blocks calibrated initially are frequently used to check any deviation from normal readings.

Practical importance:

Because of its simplicity, accuracy & extremes versatility, the Rockwell hardness test is more widely used than any other hardness test. It permits measurement of wide range of hardness (soft, medium & hard).

Standards:

1. Rockwell hardness test (scales A, B & C) methods : IS:1586-1988

Viva Questions:

1. What is Hardness?
2. What is the significance of minor load in Rockwell method of hardness testing
3. What are the advantages and limitations of Rockwell method of hardness testing
4. Where are Rockwell hardness test and Brinell hard test employed
5. Which method hardness is employed to check hardness of thin strips

Experiment No. 02

BRINELL HARDNESS TEST

Aim: To study the Brinell hardness tester and determine the hardness number of the given specimen

Theory:

consists of measuring the resistance to plastic deformation of layers of metal near the surface of the specimen. In the process of hardness determination when the metal is indented by a special tip(steel ball), the tip first overcomes the resistance of the metal to elastic deformation and then a small amount of plastic deformation. Upon deeper indentation of the tip, it overcomes large plastic deformation. This fact enables relation to be established between the hardness and ultimate tensile strength of ductile metals.

Brinell hardness is one of the oldest and most used type. Brinell tests are static indentation test using relatively large indenters. The principle feature of a typical hydraulic operated Brinell testing machine are shown in the figure.

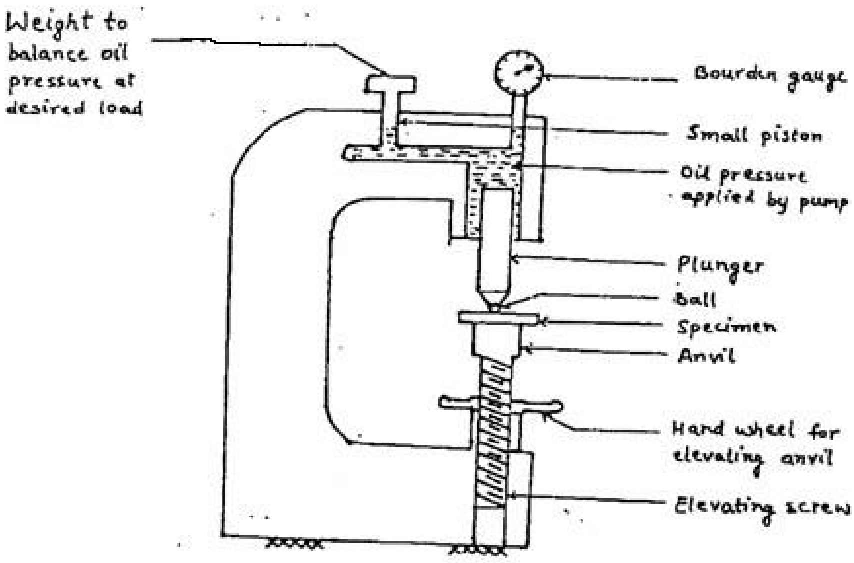
Equipment:

1. Brinell hardness tester
2. Micrometer
3. Microscope

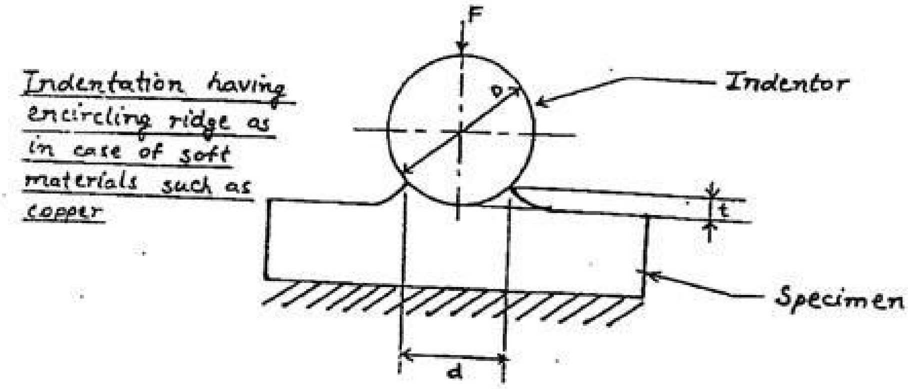
Procedure:

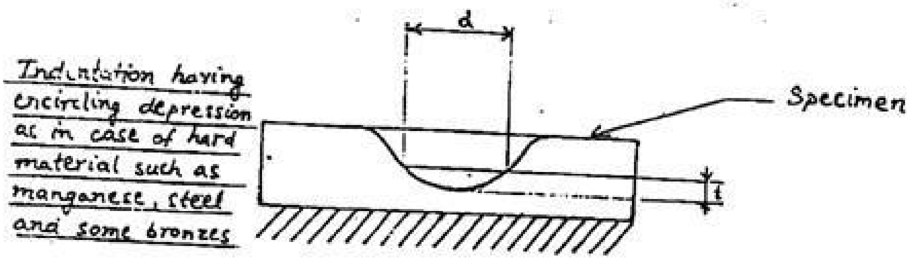
1. Place the specimen to be tested on the anvil
2. Raise the anvil by steel screw operated by the large hand wheel
3. Make the contact between the specimen and the ball indentor by turning the hand wheel
4. Apply the load by pumping the oil into the main cylinder which forces the main piston downwards and presses the ball into the specimen.

5. When the desired load is applied, the balance weight on the top of the machine is lifted by action of small piston, to avoid overload to the ball.
6. After applying the load on the ball for particular time(30sec), remove the load and measure the diameter of the indentation using a micrometer, microscope.



Brinell Hardness Tester





The hardness number is defined as the ratio of load in kg to the surface area of the indentation in mm^2

∴ Brinell hardness

$$= \frac{2F}{\pi D\left(D-\sqrt{D^2-d^2}\right)} = \frac{F}{\pi d t}$$

Where, F= load in kgf, D is the diameter of the ball in mm, d is the diameter of the impression in mm and t is the depth of indentation in mm.

Tabulation:

Sl. No.	Material	Load F kgf	Time of application of load sec	Diameter of indentation mm	HB = $\frac{2F}{\pi D\left(D-\sqrt{D^2-d^2}\right)}$ kgf /mm^2

Experiment No. 03

TORSION TEST

Aim: To determine the behavior of Mild steel when subjected to Torsion & obtain the following torsional properties: (1) Modulus of rigidity (2) Elastic shear strength

Theory:

A method of finding the shear properties of a material is by the use of torsion test. Torsional shear stress on circular cross section varies from zero at the axis of twist to a maximum at the extreme fibres. Within elastic range, the general equation is

$$\frac{T}{J} = \frac{G\theta}{l} = \frac{\tau}{r}$$

Where, T is the torsional moment in N-mm

J_p is the polar moment of inertia in mm^4 $\left(= \frac{\pi d^4}{32}\right)$

G is the modulus of rigidity in N/mm^2

θ is the angular distortion in radians

l is the gauge length in mm

τ is the shear stress in N/mm^2

From the above equation, for the solid rod,

Torque $T = \tau \pi d^3/16$

Equipment:

i) Torsion testing machine

ii) Micrometer

iii) Scale

Specimens: Torsion testing specimen is generally circular in cross-section, either solid or hollow. For solid rod, the length of the specimen is recommended to be 10 times the diameter. The ends are such that they can be securely gripped without developing stresses, sufficiently localized to cause failure in the grips. In order to obtain an approximately uniform stress and strain distribution along the cross-section, this test is usually performed on a thin tubular specimen.

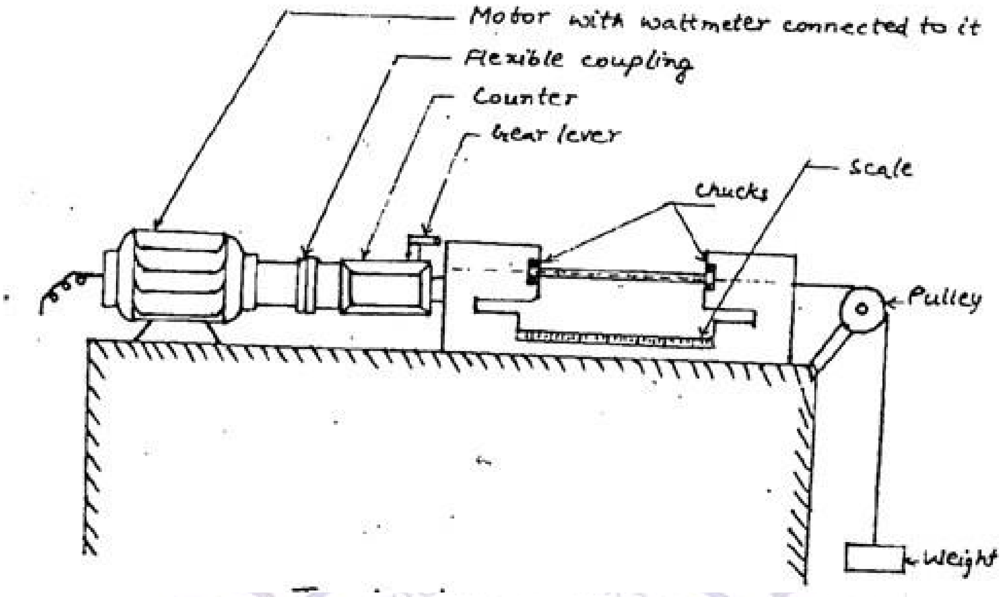
Torsion fracture is the shear fracture and is quite distinct from tension or compression fracture, there is no localized reduction of area or elongation. When a ductile material is subjected to a twisting moment, the fracture is plane and perpendicular to the axis. One end of the specimen usually makes several complete revolutions relative to the other before fracture takes place.

Procedure:

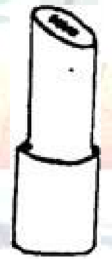
1. Measure the diameter d of the specimen at several sections micrometer to get mean value.
2. Measure the gauge length 1.
3. Adjust the torsion machine to read zero and then insert the specimen into two chucks.
4. Apply the load at load at slow speed(15rpm).
5. Note down the reading of wattmeter and simultaneously calculate torque T and angle of twist θ until failure occurs.

Tabulations:

Sl. No.	Length of Specimen 1mm	Diameter of Specimen d/mm	Wattmeter Reading PW	Torque $T = \frac{60p}{2\pi N}$	No. of revolutions on counter n	No. of divisions on circular scale (CSD)	$\theta = \{n + (\frac{csd}{100})\}2\pi$



Torsion Testing Macine.



Broken Piece.

Experiment No.4

TENSILE TEST

Aim: To conduct tensile test in ductile material and to determine the following;

i) Ultimate tensile stress (UTS)

ii) Yield stress (YS)

iii) Breaking stress

iv) % Elongation

v) Youngs modulus (E)

vi) % Reduction in area.

Theory:

The tensile test is widely used to provide basic design information on the strength of materials and as acceptance test for specification of materials. In the tensile test, a tensile specimen as per agreed standard is subjected to continually increasing uni-axial tensile force while simultaneous observations are made of the constructed from the load, elongation measurement. The following parameters are found from stress-strain curves.

i) Elastic limit: The limiting load beyond which the material no longer behaves elastically (recovery of original dimensions when load is removed).

ii) Ultimate tensile stress: maximum load divided by the original cross sectional area of specimen.

iii) Yield stress: Stress required producing a small specified permanent deformation (0.2 % permanent strain).

iv) % Elongation: It is measured of ductility of material. It is obtained by measuring the difference in length before fracture & after fracture & dividing by the original length.

v) Modulus of elasticity: It is a measure of stiffness of material. The greater the modulus the smaller the elastic strain from the given application of stress. The slope of the initial position of stress-strain curve is the modulus of elasticity or youngs modulus.

Equipment required:

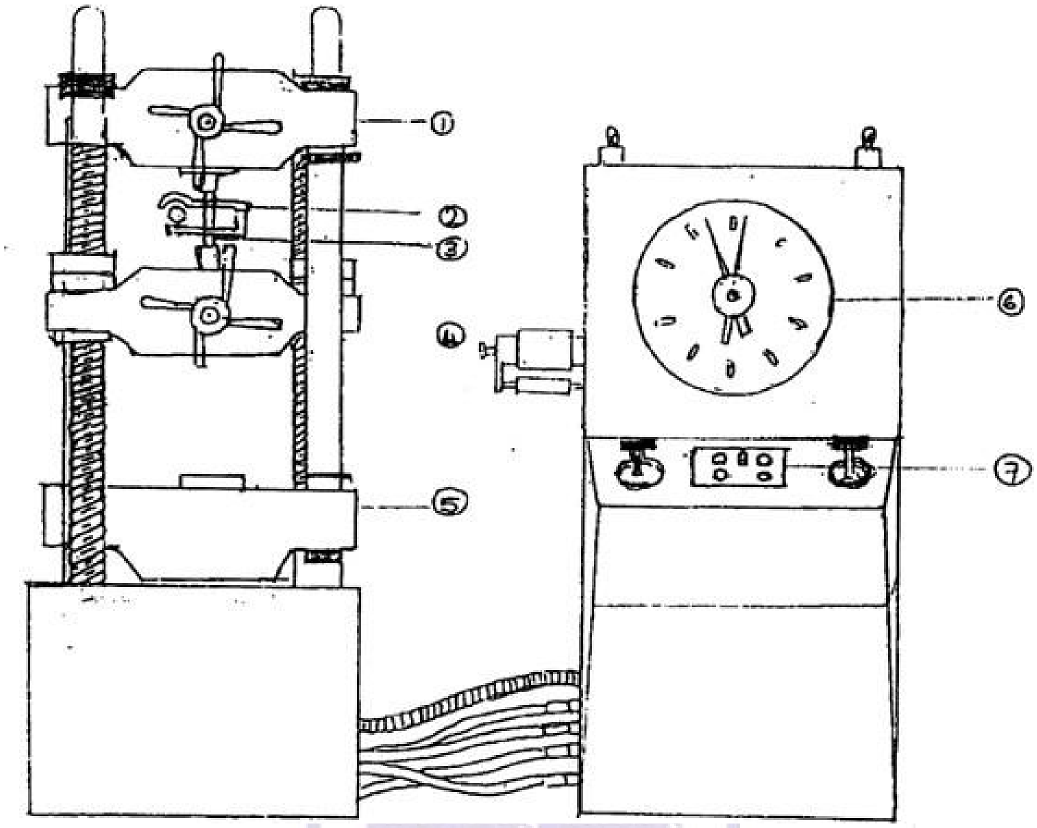
i) Universal testing machine.

ii) Tensile test specimens.

iii) Extensometer dial gauge.

iv) Steel scale, slide calipers & micrometer.

v) Support blocks.



Universal Testing Machine.

1. Upper cross head.
2. Extensometer with dial gauge.
3. Tensile specimen.
4. Inter mediate cross head.
5. Bottom cross head.
6. Load dial gauge.
7. Speed control valves.

Procedure:

1. Measure the initial diameter(d1)and mark the initial gauge length(I1)on the specimen.
2. Fix the upper end of the specimen inside the shackles of the upper cross head and bring the shackle of the intermediate cross head into contact with bottom of the specimen and the bottom end is fixed inside the shackle.
3. Mount the extensometer dial gauge (L.C=0.01mm) on the lower cross head bring the indicator of external dial gauge , elongation scale and load dial gauge to zero reading .
4. Start the machine and for every 400 kg increase, note the elongation (count the number of division on dial gauge X L.C).
5. When the load crosses the elastic point or yield point (this could be observed by the rapid movement of indicator of the extensometer dial gauge)note the reading on the elongation scale . Continue loading decreases the area of specimen and fails at particular load . Note the breaking load and elongation .
6. Remove the fractured specimen and measure the final gauge lengths(I2)and final diameter(d2)and observe the fracture.
7. Plot a graph of load V/s elongation . The results are tabulated as given below.

Table of tensile test result:

Table 1

Sl. No.	Material	Initial gauge length (11)mm	Initial Dia (d1)mm	Final Gauge length (l2)mm	Final dia (d2)mm	Original Cross section area mm^2	Final area mm^2

Table 2

Sl. No.	Load in N	Elongation No. of divisions'n' of dial gauge	Actual reading n* l.c mm(σl)	Stress = Load / Original area of cross section N/mm^2	Strain σl / l1 (t)	Youngs modulus E=Stress / Strain N/MM^2

Precautions:

1. The rate of loading should be uniform to get correct valve of various parameters.
2. The machine (UTM)Should be calibrated if deviations are found out.

Calculation:

Initial diameter of specimen = d1 mm

Final diameter of specimen = d2 mm

Initial gauge length = L1 mm

Final gauge length = L2 mm

Initial area of specimen(A1) = $\Pi d_1^2 /4$ mm^2

Final area of specimen (A2) = $\Pi d_2^2/4$ mm^2

%Elongation = $\frac{(L_2-L_1)}{L_1}$ 100

%Reduction in area = $\frac{A1-A2}{A1}$ 100

Yield stress = Yield load /original area of cross section, N/mm^2

Ultimate tensile stress = maximum load /original area of cross section (UTS) N/mm^2

Breaking stress or failure stress = Breaking load /Original area of cross section, N/mm^2

Practical Importance:

The basic data on mechanical properties of a ductile metal are from a tension test, in which a suitably designed specimen is subjected to increasing axial load until it fractures. The general behavior of materials under load can be classified as ductile or brittle depending on whether or not the material exhibits the ability to undergo plastic deformation. Yielding occurs when elastic limit has been exceeded and produces permanent change of shape which may prevent the part for functioning properly and longer. In ductile metal under static loading condition, yielding rarely results in fracture because the metal strain hardens as it deforms.

Indian Standards:

1. Mechanical testing of metal-IS: 1608-1975 tensile testing

Viva Questions:

1. What is the significance of tensile testing?
2. Which property in a tension test is an indication of stiffness of material?
3. Define the term: Elastic limit, Yield point, Resistance and Toughness
4. What is breaking stress? How it is different from maximum stress
5. What is the difference between proportionality limit and elastic limit?
6. What is the correlation between tensile strength and hardness?
7. What factors should be considered in selecting gauge length

Experiment No. 05

IMPACT TEST

Aim: To determine the impact energy and specific impact factor for ductile materials such as mild steel by conducting (i) Charpy Impact test and(ii) Izod impact test.

Theory:

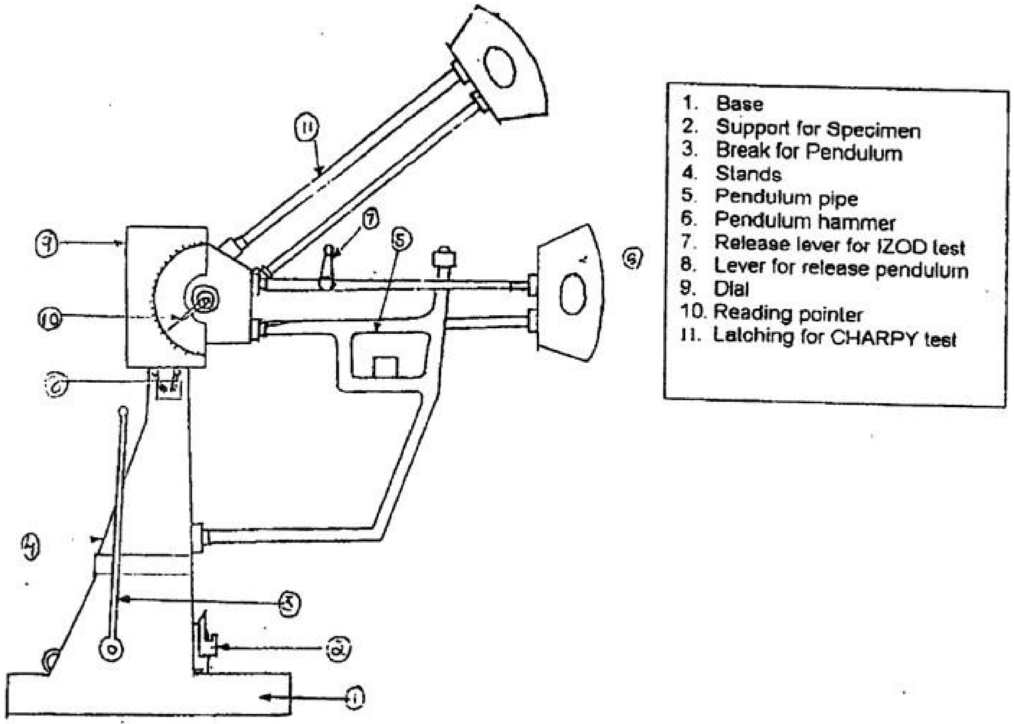
Impact test is done to determine the behavior of ductile material such as mild steel, aluminium, copper etc., when subjected to high rates of sudden loading, it measures the energy absorbed in breaking the specimen by a single blow or impact. Notched bar impact test uses a test specimen having a notch is supported as a beam and subjected to impact from a moving mass having sufficient kinetic energy to break the specimen. The energy absorbed by the specimen is measured by the loss in kinetic energy of moving mass.

Charpy Impact Test:

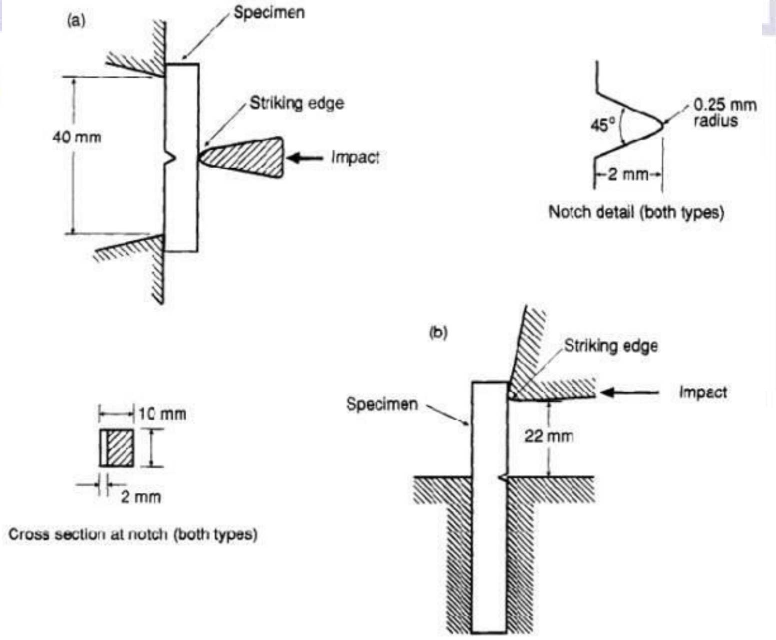
Specimen with U notch supported at both ends as a single beam is broken by a falling pendulum striking the face opposite to and immediately behind the notch. The energy absorbed by specimen is determined by subsequent rise of pendulum as a measure of impact strength or notch toughness and expressed as Joules J(N/mm^2).

Izod Impact Test:

Specimen with V notch is fixed at one end which acts like a cantilever and broken by a falling pendulum strikeing the face having the V notch . The energy absorbed is determined by the rise of pendulum as a measure of impact
strength and expressed as Joules.



Pendulum impact testing machine.



Specimens and Loading Configurations for

(a) Charpy V-Notch and (b) Izod Tests

Equipment:

1. Charpy /Izod impact testing machine.
2. Charpy impact testing specimen with U Groove.
3. Izod impact test specimen with V groove.
4. Vernier scale.

Procedure :

1. Raise the pendulum and fix it to the pendulum notch, place a thick wooden plank on the stand below the pendulum pipe.
2. Keep the reading pointer at 300j on the outer scale (max reading for charpy test) & 150j on the inner scale (max reading for izod test). Release the charpy /izod lever and allow the pendulum to swing freely. Arrest the movement of pendulum by applying the pendulum brake. See the indicator reading so that it will be zero. If not there will be zero error.
3. Now again raise the pendulum & fix it.
4. Now fix the specimen inside the clamping device as follows. Charpy- specimen should be kept as simply supported beam with the U notch being opposite to direction of pendulum movement. Izod-Hold the specimen vertically such that of V notch is just above the horizontal surface of clamping device and the notch is facing the pendulum. Fix the specimen firmly which should act as cantilever, by tightening clamping screws.
5. After ascertaining that there are no persons in the range of swinging pendulum, operate the charpy / izod lever. Now the pendulum will swing freely and the specimen will be smashed.
6. Stop the swinging pendulum by applying the pendulum break.
7. Note the reading on the dial corresponding to the pointer. The reading to be taken starting from zero reading. The value gives the impact energy directly in joules. Specific impact factor in calculated by dividing impact energy by cross section area below respective notches.
8. Tabulate results as follows:

Table: Measurement of impact energy & specific impact factor.

Charpy impact Test

Sl. No.	Material	Breadth (b)mm	Depth Below the notch (d)mm	Cross Section Area below the notch b*d mm^2 (A)	Impact Energy (I) Joules	Specific Impact Factor = I/A J/mm^2
1						
2						
3						

Izod Impact Test

Sl. No.	Material	Breadth (b)mm	Depth Below the notch (d)mm	Cross Section Area below the notch b*d mm^2	Impact Energy (I) Joules	Specific Impact Factor = I/A J/mm^2
1						
2						
3						

Precautions:

The notch shall be carefully prepared so that no grooves appear at the base of the notch.

Practical importance:

Notched bar impact tests are used to determine tendency of a material to behave in a brittle manner. The results obtained help in selecting materials which are resistant to brittle fracture by means of transition temperature curves (variation of impact strength v/s temperature).

Experiment No.06

COMPRESSION TEST

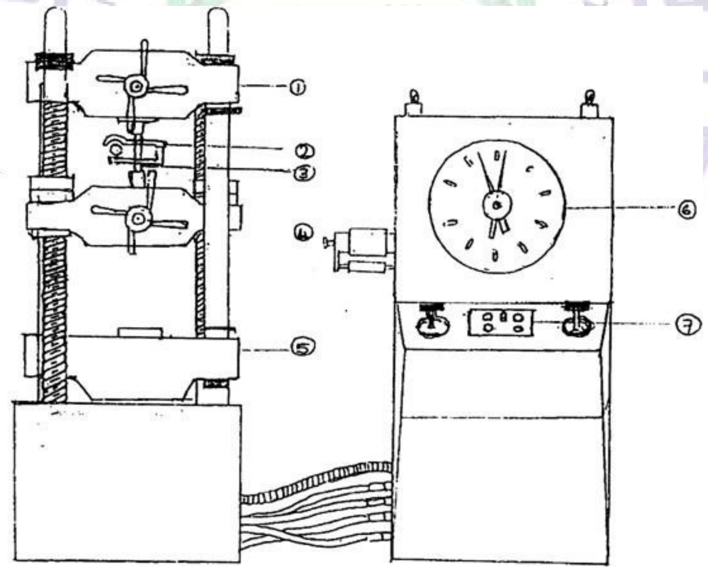
Aim: To conduct compression test on ductile and brittle materials**.**

Theory:

The compression of short cylindrical specimen between anvils of ductile metals results in barrel shape after reaching the maximum compression load . No fracture taken place for brittle materials there will be no change in cross section or height of specimen . On reaching the max compression load , the specimen suddenly fractures.

Equipment required:

1. Universal testing machine.
2. Cylindrical test specimen.
3. Dial gauge of L.C=0.01MM.
4. Vernier calipers.
5. Compression plates (Top & bottom)



Universal Testing Machine.

1. Upper cross head.
2. Extensometer with dial gauge.
3. Tensile specimen.
4. Inter mediate cross head.

5. Bottom cross head.
6. Load dial gauge.
7. Speed control valves.

Procedure:

1. Fix the lower and upper compression plate above the bottom cross head and below the intermediate cross head.
2. Measure the initial diameter (d1) and height of specimen (h1)
3. Place the compression specimen at the center of bottom plate and bring the top of specimen in contact with the top plate by moving the intermediate cross head downwards
4. Mount the compression dial gauge on the lower cross head bring the indicator to zero. Bring the indicator of load dial gauge also to zero
5. Load the specimen in intervals of 400 kg for MS and 200 kg for brittle material like cast iron and record the compression dial gauge reading(No. of division on dial gauge XLC).
6. The experiment is continued till the specimen attains a barrel shape on reaching max load for ductile metals or fracture for brittle materials. Measure the final Dia d2 and final height h2 for ductile metals. The readings are tabulated as follows.

Plot a graph of stress v/s strain. Calculate Young's Modulus in compression (for ductile materials and failure compressive stress for brittle materials).

Table: Result of compression test:

Load in		Compression in mm X 0.01MM Deflection	Compression Strain	Compression Stress	Modulus in compression = Compression Stress / Compression Strain N/mm^2
Kg	N				

Calculation:

Initial diameter of specimen = d1 mm

Final diameter of specimen = d2 mm

Initial height of specimen = h1 mm

Final height of specimen = h2 mm

Initial area of specimen (A1) = $\frac{\pi d_1^2}{4}$ mm^2

Final area of specimen (A2) = $\frac{\pi d_2^2}{4}$ mm^2

% increase in area = $\frac{A2 - A1}{A1}$ 100

% decrease in height = $\frac{h1 - h2}{h1}$

Compression stress = load up-to elastic point / A1

Compression strain = $\sigma h/h1$

$\sigma h = h1 - h2$

Young's modulus in compression = compressive stress / compressive strain

N/mm^2 (slope of load v/s compression graph).

Max compressive stress (for ductile materials) = Max compression load / Original area of cross section = N/mm^2

Max compressive stress at failure (for brittle material) = Failure load / A1=N/mm^2

Experiment No. 07

SHEAR STRENGTH TEST

Aim: To determine ultimate shear strength in single & double shear for ductile material.

Theory:

Shear stress is caused by a force which acts parallel to an area of cross section and tends to produce sliding of one portion part another portion. If the force in resisted by failure through a single area then the material is said to be in single shear. If two areas resists the fracture, then the material is said to be in double shear.

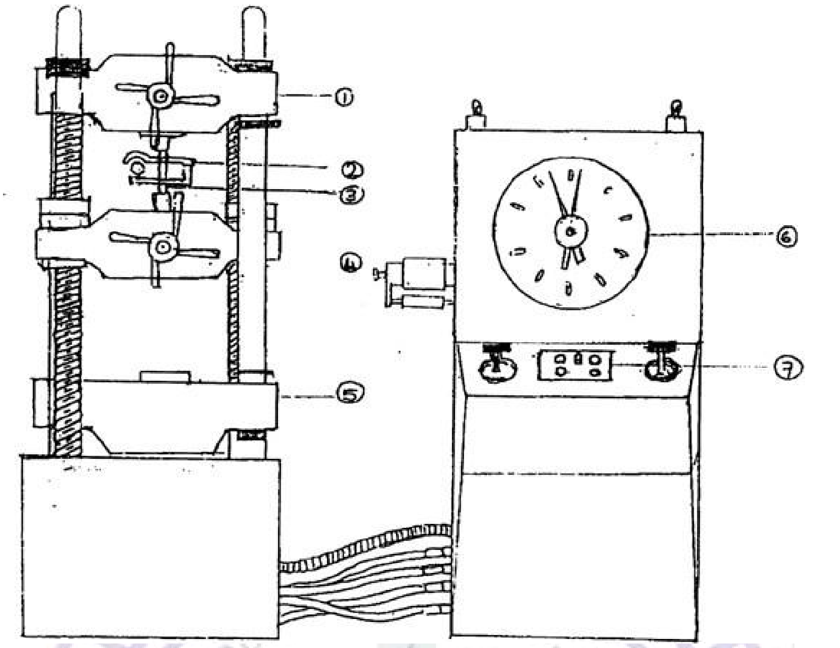
In single shear the shear strength = failure load / area of cross section of specimen

$$\text{In double shear, shear strength} = \frac{\text{failure load}}{2 \text{ X area of cross section}}$$

Where d= dia of specimen, P= failure load

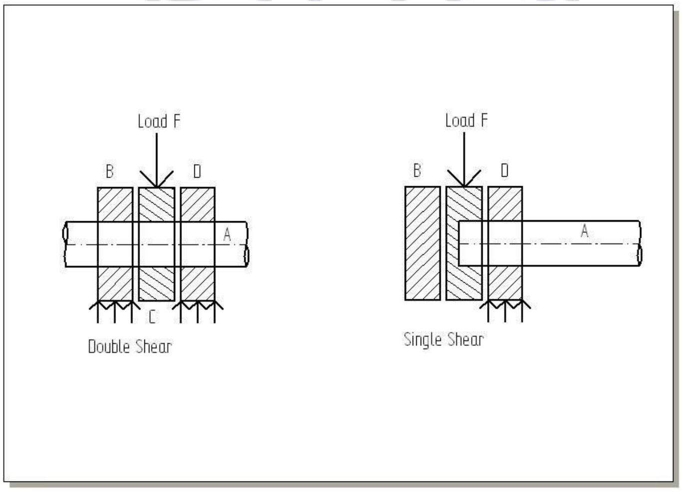
Equipment required:

1. UTM
2. Shear shackles for single and double shear
3. Vernier / Micrometer
4. Shear specimen of MS, Brass & Aluminium.



Universal Testing Machine.

1. Upper cross head.
2. Extensometer with dial gauge.
3. Tensile specimen.
4. Inter mediate cross head.
5. Bottom cross head.
6. Load dial gauge.
7. Speed control valves.



Procedure:

1. The diameter of specimen is measured using vernier / micrometer.
2. The specimen is then inserted inside appropriate shear shackles and the specimen with shackles is placed inside the shear center plate.
3. The entire assembly is placed on the lower cross head of UTM
4. The adjustable intermediate cross head is then moved down till it makes contact with the top of the center plate.
5. The machine is started and the load is applied gradually.
6. The load at which two specimen brakes in single shear / double shear is recorded from the load dial gauge.
7. The reading is tabulated as shown.

Calculation:

In single shear, shear strength = $4P/\pi d^2$

In double shear, shear strength = $2P/\pi d^2$

Where d = Dia of specimen in mm P= Failure load in N.

Table of results:

Sl. No	Material	Area of cross section in mm^2	Max. Shear Load N		Max Shear strength N/ mm^2	
			Single	Double	Single	Double

Experiment No.08

BENDING TEST

AIM: To conduct the bending test on mild steel and thereby to obtain:

i) Modulus of elasticity

ii) Maximum bending stress

APPARATUS: Scale, UTM, dial gauge and specimen.

THEORY:

If forces act on a piece of material in such a way that they tend to induce compressive stresses over one part of a cross section of the piece and tensile stresses over the remaining part, the piece is said to be in bending. The common illustration of bending action is a beam acted on by a transverse loads; bending can also be caused by moments or couples such as from eccentric loads parallel to longitudinal axis of a piece.

In structures and machine, bending my be accompanied by direct stress, transverse shear or torsional shear. For convenience, however, bending stresses may be considered separately and in tests to determine the behavior of materials in bending, attention is usually confined to beams.

The bending stress equation is $$\frac{M}{I} = \frac{fb}{y} = \frac{E}{R}$$

Where M = Max, bending moment; for point load M $= \frac{WL}{4}$

I = Moment of inertia $= \frac{bd^3}{12}$

F_b = bending stress $= \frac{3WL}{2bd^2}$

for square section, $F_b = \frac{3WL}{2d^3}$

Y = D/2 = distance from neutral axis

E = modulus of elasticity

R = radius of curvature

The modulus of elasticity is calculated as follows:

The maximum deflection for a point load acting at the center of the beam is given by

$$\delta = \frac{WL^3}{48EI} \text{ or } E = \frac{WL^3}{48\,\delta I}$$ (w/ δ is obtained from graph of load Vs deflection)

Procedure:

1. The length, breadth and depth of the specimen were measured.
2. The specimen was placed on the UTM platform n simply supported position
3. The top platform of UTM was brought down such that the load was applied at the centre of the specimen.
4. Before the application of the load the dial gauge was fixed to measure the deflection.
5. The load was applied in increment of 200Kg and the deflection in the dial gauge was noted until the specimen fails.
6. The graph of load Vs deflection is plotted, and w/ δ was obtained from the initial linear portion of the curve

Observaiton & Tabulation

Breadth of specimen, b =.............................. mm

depth of specimen, d =.............................. mm

Length of specimen, L =.............................. mm

Calculations:

Maximum bending stress, $f_b = \frac{3W_{max}L}{2bd^2}$ N/mm^2

Moment of Inertia, $I = \frac{bd^3}{12}$ mm^4

Modulus of elasticity $E = \frac{WL^3}{48\delta f}$

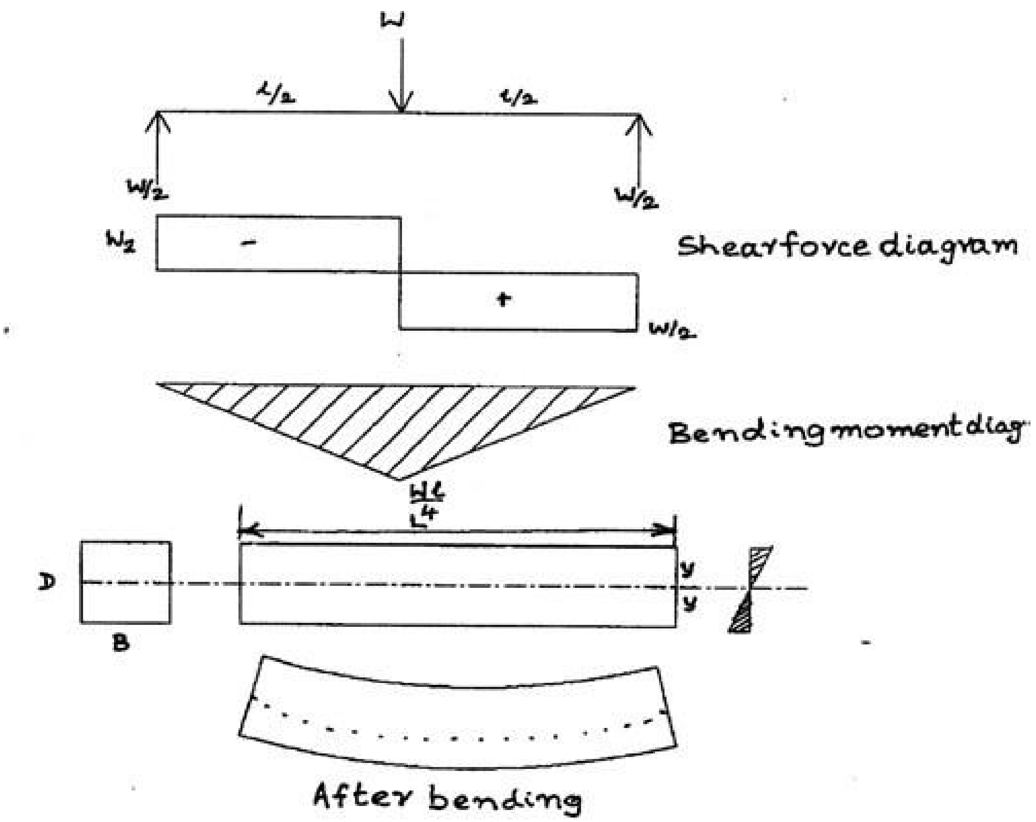
From graph of load Vs deflection, W/δ is found out.

Table of load Vs deflection.

Load in		Deflection in dial indicator	Deformation in mm x least count
Kg	N		

INFERENCE: The maximum bending stress for the given specimen =………………

The modulus of elasticity of the wood material =……………….



EXPERIMENT – 09

TEST ON SPRINGS

OBJECTIVE

To determine the Shear Modulus (or) Modulus of Rigidity of the given spring material.

APPARATUS

Spring Testing Machine 2000 kgf

PROCEDURE:

1) Note the particulars of the spring such as mean diameter of the spring, mean diameter of the spring wire, number of turns.
2) Place the spring below the platon in such a way that the axis of the spring is truly vertical and exactly below the centre of the loading frame. Rotate the handle of the loading frame and bring down the proving ring to touch the spring and rest over it without applying any load. Any further rotation of the hand wheel causes application of load on to the spring.
3) Fix the deflection measuring dial gauge below the bottom plate of the proving ring. Pull down the needle of the dial gauge and leave it and ensure that all times the deflection gauge shows the same reading.
4) Note the initial reading of the deflection gauge and the calibrated value of the proving ring (i.e., 1 div = _____ kg).
5) Apply the required amount of load by rotating the hand wheel and bringing the proving ring dial needle to the calibrated reading. Note the deflection gauge reading.
6) Repeat step (5) by increasing the load on the spring. Take at least 15 sets of readings.

PRECAUTIONS:

1. Load should be applied on the spring without any eccentricity.
2. Deflection gauge needle should touch the bottom plate of the providing ring and should be vertical.
3. Gently apply the load by rotating the hand wheel, without any vibrations either in the spring or in the loading frame.

OBSERVATIONS:

Mean radius of the spring, R = cm

Number of turns in the spring, n =

Mean diameter of the spring wire, d = cm

Modulus of rigidity of the given spring, $C = \frac{64\ W\ R^3\ n}{d^4}$,

where, W – Load applied on the spring (kg)

- Deflection of the spring (cm)

Initial deflection gauge reading = mm

S.No.	Applied load (kg)	Deflection Gauge reading (mm)	Net deflection (cm)	Shear Modulus, C ($\times 10^5 kg/cm^2$)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				

Average C = $\times 10^5$ kg/cm^2

RESULTS:

Average Shear Modulus of the given spring, C = $\times 10^5$ kg/cm^2

Experiment. 10

DEFLECTION TEST ON BEAM

AIM:

To determine the Young's modulus of the given specimen by conducting bending test.

APPARATUS AND SPECIMEN REQUIRED:

1. Bending Test Attachment
2. Specimen for bending test
3. Dial gauge
4. Scale
5. Pencil / Chalk

PROCEDURE:

1. Measure the length (L) of the given specimen.
2. Mark the centre of the specimen using pencil / chalk
3. Mark two points A & B at a distance of 350mm on either side of the centre mark. The distance between A & B is known as span of the specimen (l)
4. Fix the attachment for the bending test in the machine properly.
5. Place the specimen over the two supports of the bending table attachment such that the points A &B coincide with centre of the supports. While placing, ensure that the tangential surface nearer to heart will be the top surface and receives the load.
6. Measure the breadth (b) and depth (d) of the specimen using scale.
7. Place the dial gauge under this specimen at the centre and adjust the dial gauge reading to zero position.
8. Place the load cell at top of the specimen at the centre and adjust the load indicator in the digital box to zero position.
9. Select a strain rate of 2.5mm / minute using the gear box in the machine.
10. Apply the load continuously at a constant rate of 2.5mm/minute and note down the deflection for every increase of 0.25 tonne load up to a maximum of 6 sets of readings.
11. Calculate the Young's modulus of the given specimen for each load using the following formula:

$$\text{Young's modulus, } E = \frac{Pl^3}{48I\delta}$$

Where,

P = Load in N

L = Span of the specimen in mm

40

I = Moment of Inertia in mm^4 ($bd^3/12$)

b = Breadth of the beam in mm.

d = Depth of the beam in mm

δ = Actual deflection in mm.

12. Find the average value of young's modulus that will be the Young's modulus of the given specimen.

OBSERVATION:

1. Material of the specimen = ...
2. Length of the specimen, L = ... mm
3. Breadth of the specimen, b = ... mm
4. Depth of the specimen, d = ... mm
5. Span of the specimen, l = ... mm
6. Least count of the dial gauge, LC = ... mm

TABULATION:

S.No	Load in		Deflection in mm			Young's Modulus in (N/mm^2)
	kg	N	Loading	Unloading	Mean	
					Average	

Result:

The young's modulus of the given specimen = --------------------N/mm^2