LABORATORY MANUAL

MECHANICS OF SOLIDS LAB

II B.TECH - I Semester

AY-2017-2018

STUDENT MANUAL

DEPARTMENT OF MECHANICAL ENGINEERING

CMR ENGINEERING COLEGE
(Approved by AICTE, New Delhi & Affiliated JNTU, Hyderabad)
Kandlakoya (V), Medchal Road, RR.Dist – 501401

VISION OF THE INSTITUTE

- To be recognized as a premier institution in offering value based and futuristic quality technical education to meet the technological needs of the society

MISSION OF THE INSTITUTE

1. To impart value based quality technical education through innovative teaching and learning methods
2. To continuously produce employable technical graduates with advanced technical skills to meet the current and future technological needs of the society
3. To prepare the graduates for higher learning with emphasis on academic and industrial research.

VISION OF THE DEPARTMENT

To be a center of excellence in offering value based and futuristic quality technical education in the field of mechanical engineering.

MISSION OF THE DEPARTMENT

M1. To impart quality technical education imbibed with values by providing state of the art laboratories and effective teaching and learning process.

M2. To produce industry ready mechanical engineering graduates with advanced technical and lifelong learning skills.

M3. To prepare graduates for higher learning and research in mechanical engineering and its allied areas.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS):

PEO 1: The Graduates will exhibit strong knowledge in mathematics, sciences and engineering for successful employment or higher education in mechanical engineering.

PEO 2: The Graduates will design and implement complex modeling systems, conduct research and work with multi disciplinary teams.

PEO 3: The Graduates will be capable of communicating effectively with lifelong learning attitude and function as responsible members of global society.

PROGRAM OUTCOMES (POS):

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12...Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

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PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO.1 Design a Thermal system for efficiency improvement as per industrial needs.

PSO.2 Design and manufacture mechanical components using advanced manufacturing technology as per the industrial needs.

Course Name: Metallurgy & Mechanics of Solids Lab	
CO1	Examine the micro structure of pure metal and alloys by preparing using microscope.
CO2	Determine the hardenability of steel by jominy end quench test.
CO3	Determine the mechanical strength properties in tension, compression and shear using UTM.
CO4	Estimate the hardness number for metals and alloys using Brinells hardness test and Rockwell hardness test.
CO5	Estimate the impact strength of metal using izod and charpy test.
CO6	Calculate Torsional strength of a specimen using Torsion testing machine and strength in a helical spring.

Course Outcomes	Relationship of Course Outcomes (CO) to Program Outcomes (PO)											
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	-	-	-	-	-	-	-	-
CO2	3	2	3	3	-	-	-	-	-	-	-	-
CO3	3	2	3	3	-	-	-	-	-	-	-	-
CO4	3	2	3	3	-	-	-	-	-	-	-	-
CO5	3	2	3	3	-	-	-	-	-	-	-	-
CO6	3	2	3	3	-	-	-	-	-	-	-	-

CO	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2
CO6	-	2

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GENERAL INSTRUCTIONS FOR LABORATORY CLASSES

1. All the students must follow the prescribed dress code (apron, formals, shoes) wear their ID cards

2. All the students should sign in login register.

3. All students must carry their observation books and records without fail.

4. Students must take the permission of the laboratory staff before handling the machines in order to avoid any injury.

5. The students must have basic understanding about the theory and procedure of the experiment to be conducted.

6. Power supply to the test table/test rig should be given in the presence of only through the lab technician.

7. Do not LEAN on and do not come CLOSE to the equipment.

8. Instruments like TOOLS, APPARATUS and GUAGE sets should be returned before leaving the lab.

9. Every student is required to handle the equipment with care and follow proper precautions

10. Students should ensure that their work areas are clean.

11. At the end of each experiment, the student must take initials from the staff on the data / observations taken after completing the necessary calculations.

12. The record should be properly written with following section in each experiment:
    a) Aim of the experiment
    b) Apparatus / Tools / Instruments required
    c) Procedure / Theory
    d) Model Calculations
    e) Schematic Diagram
    f) Specifications / Designs Details
    g) Tabulations.
    h) Graph
    i) Result and discussions.

13. Students should attend regularly to all lab classes.

14. Day- to- day evaluation of student performance is carried out and recorded for finalizing internal marks.

SCHEME OF EVALUATION FOR EXTERNAL LABS

Correctness of Write up and Precautions	Conduct Experiment & observations	Model Calculations	Results and Graphs	Viva
Marks: 10	**Marks: 25**	**Marks: 15**	**Marks: 15**	**Marks: 10**
Total Marks: 75 Marks				

SCHEME OF EVALUATION FOR INTERNAL LABS

Day to Day Evaluation ------15 Marks					**Internal Exam------10 Marks**				
Uniform	Observation &Record	Performance of experiment	Results	Viva Voce	Correctness of Write up and Precautions	Conduct Experiment & observations	Model Calculations	Results and Graphs	Viva Voce
Marks:2	**Marks:3**	**Marks:3**	**Marks:4**	**Marks:3**	**Marks:2**	**Marks:2**	**Marks:2**	**Marks:2**	**Marks:2**
Total Marks: 15+10=25 Marks									

CONTENTS

1A).BRINELL HARDNESS TEST

AIM:

To find the Brinell hardness number of the material of the specimen.

APPARATUS:

Brinell hardness testing machine, Optical microscope, Indenters.

THEORY:

'Hardness' is the property of the material by virtue of which it offers resistance to indentation (i.e., penetration), scratching or to wear. Various techniques have been developed to measure the hardness of materials using different indenter geometries and materials. Because resistance to indentation depends on the shape of the indenter and the load applied, hardness is not a fundamental property. The most common standardized hardness tests are Brinell, Rockwell, Vickers, knoop and Scleroscope tests.

Brinelling is a term used to describe permanent indentations on a surface between contacting bodies. In this Brinell hardness test, a steel or tungsten carbide ball of specified diameter is pressed against a surface with a reasonable load. The Brinell hardness number (HB) is defined as the ratio of the load P, to the curved area of indentation^

i.e,

•$HB = P/[\Pi D/2\ [(D-\sqrt{(D^2-d^2)})]]$

Where P = Load in kg

D = Diameter of the ball (i.e., indenter) in mm

d = Diameter of the impression in mm

Because the impressions made by the same indenter at different loads are not geometrically similar, the Brinell hardness number depends on the load used, consequently the load employed should also be cited with the test results. The Brinell test is generally suitable for materials of low to medium hardness.

The commonly used indenters with corresponding loads for typical materials is given below.

Ball diameter (D)	Load (P) 'kgf	Typical application
2.5 mm	$30D^2$ =187.5	Steels and cast irons
5 mm	$10D^2$ = 250	Copper and aluminum alloys

PROCEDURE:

1. Select the proper diameter of indenter and load for the material of the given specimen.
2. Place the specimen securely on the testing table.
3. Turn the hand wheel in clockwise direction so that the testing table moves up and the indenter will push into the specimen.

4. Continue the movement of hand wheel until the small pointer comes to red dot.
5. Now, turn the 'load lever' in clockwise direction slowly, so that the total load is brought into action.
6. When the long pointer of dial gauge reaches a steady position, the loads may be released by moving back the load lever in anti clockwise direction.
7. Turn back the hand wheel and remove the specimen.
8. Measure the diameter of the impression by optical microscope.
9. Calculate the BHN by using formula.
10. Repeat the same procedure for other material of specimen.

S.No	Material	Load(P) (kgf)	Diameter of indenter(D) 'mm'	Diameter of indentation (d) 'mm'			Hardness number BHN in 'kg/mm^2'
				d_1	d_2	Average d = $(d_1 + d_2)/2$	

PRECAUTIONS:

1. Before measurement, operate the load lever several times to rise and lower the weights in order to eliminate air from the hydraulic system. *I*-.

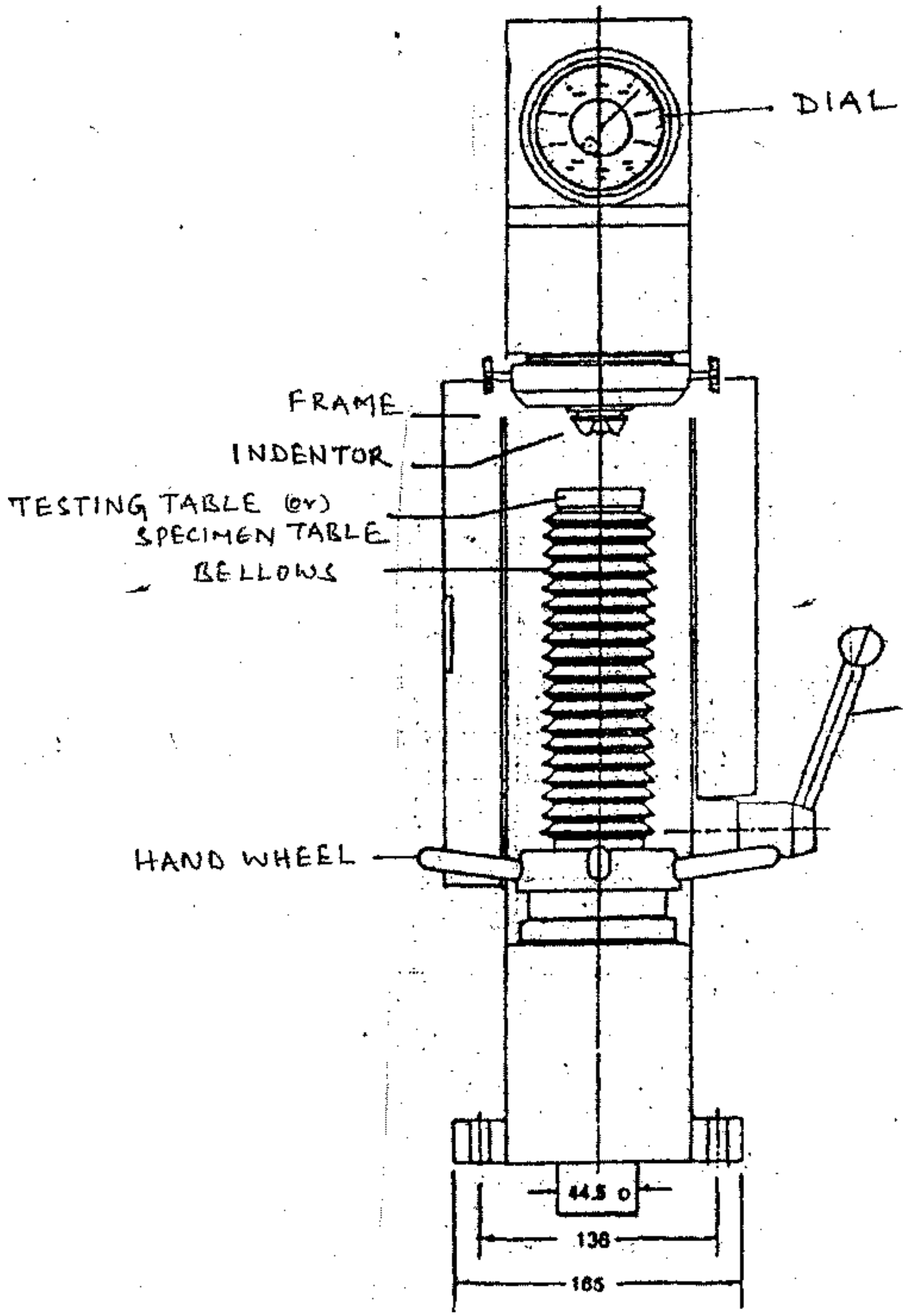
Operate the load lever slowly for accurate results. '

3. See that the surface of specimen is horizontal and is normal to axis of indenter.
4. Don't apply the minor load beyond red dot.

RESULT:

The Brinell Hardness Number for various materials is determined as follows.

Material	BHN	Load (kgf)



HARDNESS TESTING MACHINE

1B). ROCKWELL HARDNESS TEST

AIM: "'<

To find the Rockwell hardness number of the material of the specimen.

APPARATUS:

Rockwell hardness testing machine, Test specimens, Indenters.

THEORY:

'Hardness' is the property of the material by virtue of which it offers resistance to indentation (i.e, penetration), scratching or to wear. Various techniques have been developed to measure the hardness of materials using different indenter geometries and materials. Because resistance to indentation depends on the shape of the indenter and the load applied, hardness is not a fundamental property. The most common standardized hardness tests are Brinell, Rockwell, Vickers, knoop and Scleroscope tests.

The Rockwell Hardness Number, which is read directly from a dial on the testing machine, is expressed as fallows: If the Hardness number is '55' using the 'C' scale, then it is written as '55HRC'

There are several Rockwell test scales that use different loads, indenter materials and indenter geometries. Some of the most common hardness scales and the indenters with loads are listed below.

Scale	Indenter	Load in kgf	Dial	Application
A	Diamond	60	Black	Carbides, Thin steel, Case hardened steel
B	1/1 6'' Ball	100	Red	Aluminium alloys, Copper alloys,Unhardened steels etc,
C	Diamond	150	Black	Hard cast irons, Pearlitic malleable iron, Deep case hardened steel, Titanium etc,

PROCEDURE:

1. Select the proper diameter of indenter and load, for the material of the given specimen.
2. Place the specimen securely on the testing table.
3. Turn the hand wheel in clockwise direction so that the testing table moves up and the indenter will push into the specimen.
4. Continue the movement of hand wheel until the small pointer comes to red dot.
5. Set the long pointer at 'SET POINT' by rotating outer ring of dial gauge.
6. Now, turn the 'load lever' in clockwise direction slowly, so that the total load is brought into action.
7. When the long pointer of dial gauge reaches a steady position, the loads may be released by moving back the load lever in anti clockwise direction.
8. Read the figure against the long pointer. That is the direct reading of the hardness of the specimen.
9. Turn back the hand wheel and remove the specimen.
10. Repeat the same procedure for other material of the specimens.

OBSERVATIONS & TABULAR COLUMN:

S.No	Material	Rockwell scale of weights placed			Rockwell Hardness Number
		Indenter	Load	Scale	

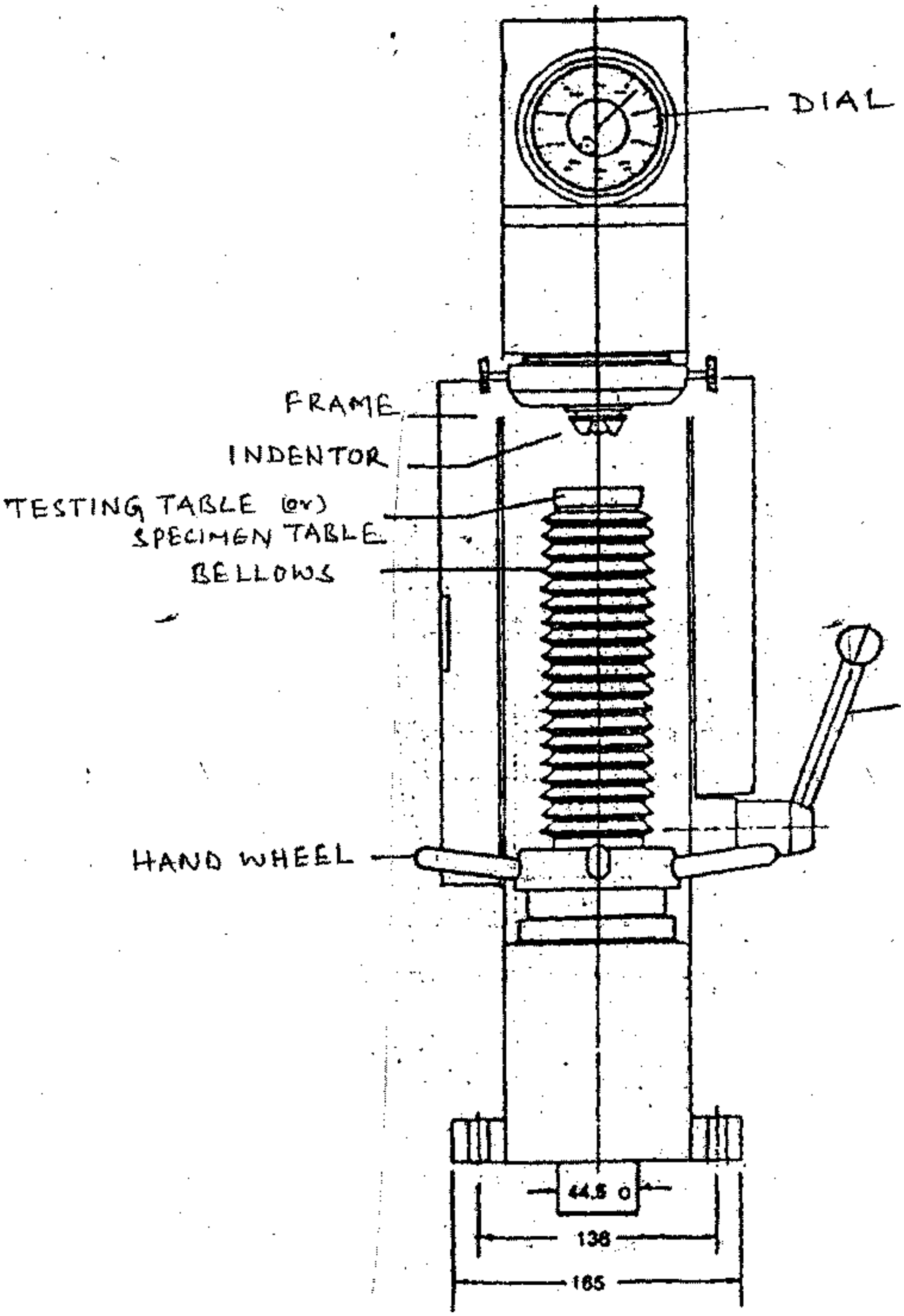
PRECAUTIONS:

1. Select the proper indenter and load to suit the material under the test.
2. Before measurement, operate the load lever several times to rise and lower the weights in order to eliminate air from the hydraulic system.
3. Operate the load lever slowly for accurate results.
4. See that the surface of the specimen is horizontal and is normal to the axis of the indenter.
5. Don't apply the minor load beyond the Red dot.

RESULT:

The Hardness Values of the given materials are determined as fallows.

Material Hardness Number



HARDNESS TESTING MACHINE

2.TORSION TEST ON SHAFT

AIM:
To find the rigidity modulus of the material of the given specimen

APPARATUS:
Torsion testing machine, square rod, vernier callipers, steel rule

THEORY:
If a square rod is subjected to axial twisting moment as shown in fig, the relation between Torque 'T ' and angle of twist '0' is given by

$T/J = G\theta/L$ Where T = Torque applied
J = Polar moment of inertia of the rod
G - rigidity modulus
θ = Angle of twist in radians
L = gauge length (i.e., Length of shaft over which the angle of twist is measured)

PROCEDURE:
1. Mark the gauge length on the rod.
2. Measure the sides of the rod at three sections with in.'the gauge length with the help of vernier calipers and take the average value for calculating the polar moment of inertia (J).
3. Fix the rod in the jaws of the machine, such that the distance between the faces of jaws is equal to gauge length.
4. Select the suitable scale on the dial depending on the weight on the pendulum.
5. Set the black pointer at zero by slowly rotating the rack which is extended left side of the panel.
6. Set the angle measuring disc at zero.
7. Apply the torque slowly by rotating the handle in the anti clock wise direction.
8. Note the torque from torque meter and the corresponding angle of twist from angle measuring disc.
9. Continue the application of the torque until permissible torque value is reached and tabulate the readings.

OBSERVATIONS:
Material of the rod :
Shape of the rod :
Size of the rod, d = m.
Gauge length, 1 - m.

TABULAR COLUMN:

S.No	Torque *(T)*		Angle of twist (Θ)		Modulus of rigidity (G)	
	Kg-cm	N-m	Degrees	Radians	N/m^2	Gpa
-.					-.	

MODEL CALCULATIONS:
The polar moment of inertia, $J = d^4/ 6\ m^4$. Where d = Side of square rod in m.
Modulus of rigidity, $G = TL/J\ \Theta\ N/m^2$ Where

T = Torque in 'N-m'
L = Gauge length in 'm''
J = Polar moment of inertia in 'm^4
Θ = Angle of twist in 'radians'
G in G Pa = G in $N/m^2 \times 10^{-9}$.

GRAPH:
Draw the graph taking Angle of twist (Θ) on X - axis and Torque (T) on Y - axis and calculate the Modulus of rigidity (G) for a particular value of 'T / Θ'

PRECAUTIONS:

1. Fix the specimen in the grips securely.
2. Apply the torque uniformly and gradually.
3. Torque applied should be within permissible limits.'
4. Torque scale is to be selected correctly according to weight on pendulum dynamometer.

RESULT:
The Modulus of rigidity of the given material of the specimen is

3.TENSION TEST ON SPRING

AIM:
To find the rigidity modulus of the material of a given spring by conducting tension test under axial load.

APPARATUS:
Vernier calipers, loading frame with moving ring.

THEORY:
When an axial tensile load 'W is applied on spring, every section of the spring wire is subjected to a twisting moment' WR', where R is the mean radius of coil. For a closed coil helical spring,

$$8 = 64WR^3n/Gd^4.$$

Where, 8 = Deflection of spring
W = Load applied
R = Mean radius of the coil
G= Rigidity modulus
d = diameter of wire of the coil
n = Number of turns in the spring

From the above expression for a given spring, rigidity modulus (G) can be measuring deflection of spring (8) under a particular load (W).

PROCEDURE:
1. Fix the load discs to the pendulum according to the requirement.
2. Adjust to pointer to read zero under no load conditions.
3. Place the spring between the jaws and allow the jaws to close so that both the jaws should touch the spring.
4. Note the initial reading of the scale
5. Apply the load by pressing the by rotating hand wheel
6. Tabulate the scale readings for different loads during upscale i.e, during loading.
7. Tabulate the scale readings for corresponding loads in down scale i.e, during unloading.
8. Calculate the rigidity modulus by formula.

OBSERVATIONS:

Diameter of the spring wire,	d=	mm.
Mean radius of the coil,	R =	mm.
Number of effective turns of the spring,	n =	
Original length of the spring,	1=	mm.

TABULAR COLUMN:

S.No	Load in 'kg'	Load in'N'	Scale reading in 'cm'		Deflection (8)'cm'			in 'mm'S	Gin 'N/mm2'	Gin 'Gpa'
	-.		Loading	Un loading	L	UN	Avg	-.		

MODEL CALCULATIONS:

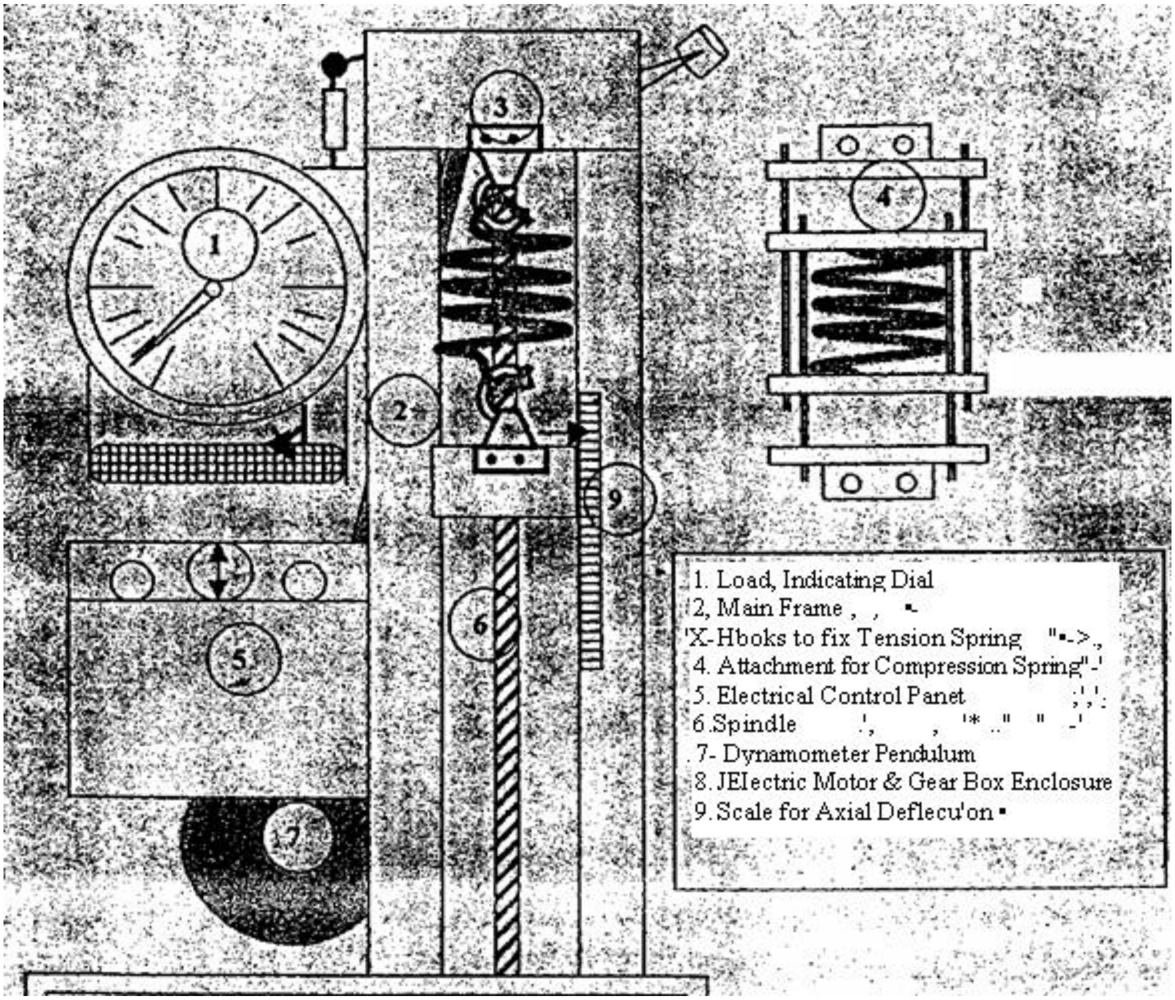
Modulus of rigidity, $G = 64\ WR^3n / \delta\ d^4$ (N/mm^2).
Where W =load in 'N'
R = Radius of coil in 'mm'
N = Number of turns in the spring
8 = deflection in 'mm'
d = diameter of wire of coil in 'mm' G
in Gpa = G in N/mm^2 10^{-3}.

GRAPH

Plot a graph between W and δ and calculate 'G' for a particular value of W / δ.

RESULT:

Rigidity Modulus of spring is GPa.


1
2
3
4
5
6
7
9
1. Load, Indicating Dial
2, Main Frame
X-Hboks to fix Tension Spring
4. Attachment for Compression Spring
5. Electrical Control Panet
6.Spindle
7- Dynamometer Pendulum
8. JElectric Motor & Gear Box Enclosure
9. Scale for Axial Deflecu'on

4A) CHARPY IMPACT TEST

AIM: To find the Impact strength of the given material of the specimen.
APPARATUS:

1. Striker for charpy test.
2. Tools for making a notch.
3. Vernier calipers.
4. Allen keys for fixing specimen and striker to supports.

THEORY:

Impact strength is defined as 'the ability of the material to resist shock loads' i.e., the resistance of the material against shock loading or in other words 'It is the energy required to break the specimen under impact loads'. This test is essential for deciding the suitability of the material which is expected to resist repeated shocks.

The charpy impact test is a pendulum type single blow impact test in which notched specimen is supported at both ends as a simply supported beam as shown in figure and is broken by a falling pendulum. The energy absorbed as determined by the subsequent rise of pendulum is a measure of impact energy which when divided by cross-sectional area gives impact strength of the material.

The impac^strength depends largely on the shape and size of the jiptch of the specimen and therefore cannot be compared with each other.

PREPARATION OF SPECIMEN:

The notch on the 10 X 10 X 55 mm test specimen must be prepared according to the dimensions confirming to IS: 1499-1959 as shown in the figure. The plane of Symmetry of notch shall be perpendicular to the horizontal axis of the test piece.

PROCEDURE:

1. Prepare the specimen according to the given specified standards.
2. Fix the charpy striker firmly to the bottom of the hammer.
3. The latching tube for charpy test is to be firmly clamped to the bearing housing on the inclined face.
4. Now raise the hammer by hands and latch-in.
5. Release the hammer by operating the lever. The pointer will then indicate the initial energy in the pendulum.
6. Apply the brake and when the pendulum stops, raise it again by hands and latch-in.
7. Now place the prepared specimen on supports as a 'simply supported beam', with the notch behind the pendulum
8. Operate the lever so that the pendulum is released and specimen is hit. Now the pointer shown again the energy possessed by pendulum. The difference between initial and final readings gives the energy lost in breaking the specimen ink joules.
9. Bring the pendulum carefully to stand still position by applying the brake.
10. Remove the broken specimen and calculate the impact strength.

TABULAR COLUMN:

Material of specimen	Scale reading Before fracture (U1) Joules	Scale reading after fracture (U2) Joules	Energy absorbed by specimen K = (U_1 - U_2) Joules	Impact strength in J/ mm^2
	-.			

MODEL CALCULATIONS:

Impact strength of the specimen, I = K/A J/mm^2

Where ' -

K = Impact energy absorbed in Joules.

A - Area of cross-section of specimen below the notch before test in mm^2.

PRECAUTIONS:

1. Extreme care must be taken to see that correct striker and correct support/clamping are chosen for the test.
2. Operator should not stand in front of the pendulum as the broken piece may fly off or the swinging pendulum may cause injury.

RESULT: The impact strength of the material of the specimen J/mm^2

5. DIRECT TENSION TEST

AIM: To find the Modulus of elasticity of the given material of the specimen and also to Find:

1. Yield tress
2. Ultimate stress
3. Breaking stress
4. Percentage of elongation
5. Percentage reduction in cross-sectional area of the specimen

APPARATUS:

Universal testing machine, Vernier calipers, Gauge marker, Steel rule and Specimen.

THEORY:

In this test the ductile extension of the material are studied at different loads. The specimen (ductile material) is fixed in the grips of the machine and a gradually increasing pull is applied along its length. The loads are measured on the main dial of the machine and the extensions on the elongation scale. The stress-strain diagram is plotted to study the behavior of the material at different loads.

The stress-strain diagram for a mild steel specimen is shown in figure. The diagram begins with a straight line O to A, in which stress is directly proportional to strain. Point A marks the limit of proportionality beyond which the curve becomes slightly curved, until point B, the elastic limit of the material. If the load is increased further, yielding takes place; Point C is the point of sudden large extension, known as yield point. After the yield point stress is reached, the ductile extensions take place, the strains increasing at an accelerating rate as represented by C and D. The material becomes perfectly plastic in this region (C to D), which means that it can deform without an increase in the applied load. If the load is further increased, the steel begins to strain harden. During strain hardening, the material appears to regain some of its strength and offers more resistance, thus requiring increased tensile load for further deformation. The point E is the maximum load or ultimate load up to which the bar extends uniformly over it's parallel length, but if straining is continued, a local deformation (neck formation) starts at E and after considerable local extension, the specimen breaks at F called breaking stress.

PROCEDURE:

1. Measure the diameter of the given mild steel rod by vernier calipers.
2. Mark the gauge length on the rod with steel rule.
3. Fix the specimen securely in the jaws of the machine, i.e., between center and upper cross heads.
4. Switch ON the power knob and hydraulic button.
5. Keep the left control valve fully in closed position and now slightlv. open the right control valve and close it after the lower table is slightly lifted up i.e., when the pointer on the dial starts moving.
6. Adjust the load pointer to zero by rotating the rack which is extended in the lift side of the machine. This is necessary to remove the dead weight of the lower table; upper crbss head and other connecting parts, from the load.

TABULAR COLUMN:

S.No	Load 'P' (kN)	Elongation '8l '(mm)	Stress 'P - P/A_0 (N/mm^2)	Strain e $= 81/1_0$

MODEL CALCULATIONS

The original area of cross-section of the specimen, $A_0 = \pi d_o^2/4$ mm^2.
Stress, P = Load/ Area of cross-section = P/A_0 N/mm^2.
Strain, e = elongation /Original length =8 L/l_o.
Plot a graph taking stress on Y-axis and corresponding strain on X-axis.
Within the proportional limit (i.e, within straight line portion),
Young's modulus = Slope of the straight line portion
i.e., E = Stress/Strain
E = p/e N/mm^2.

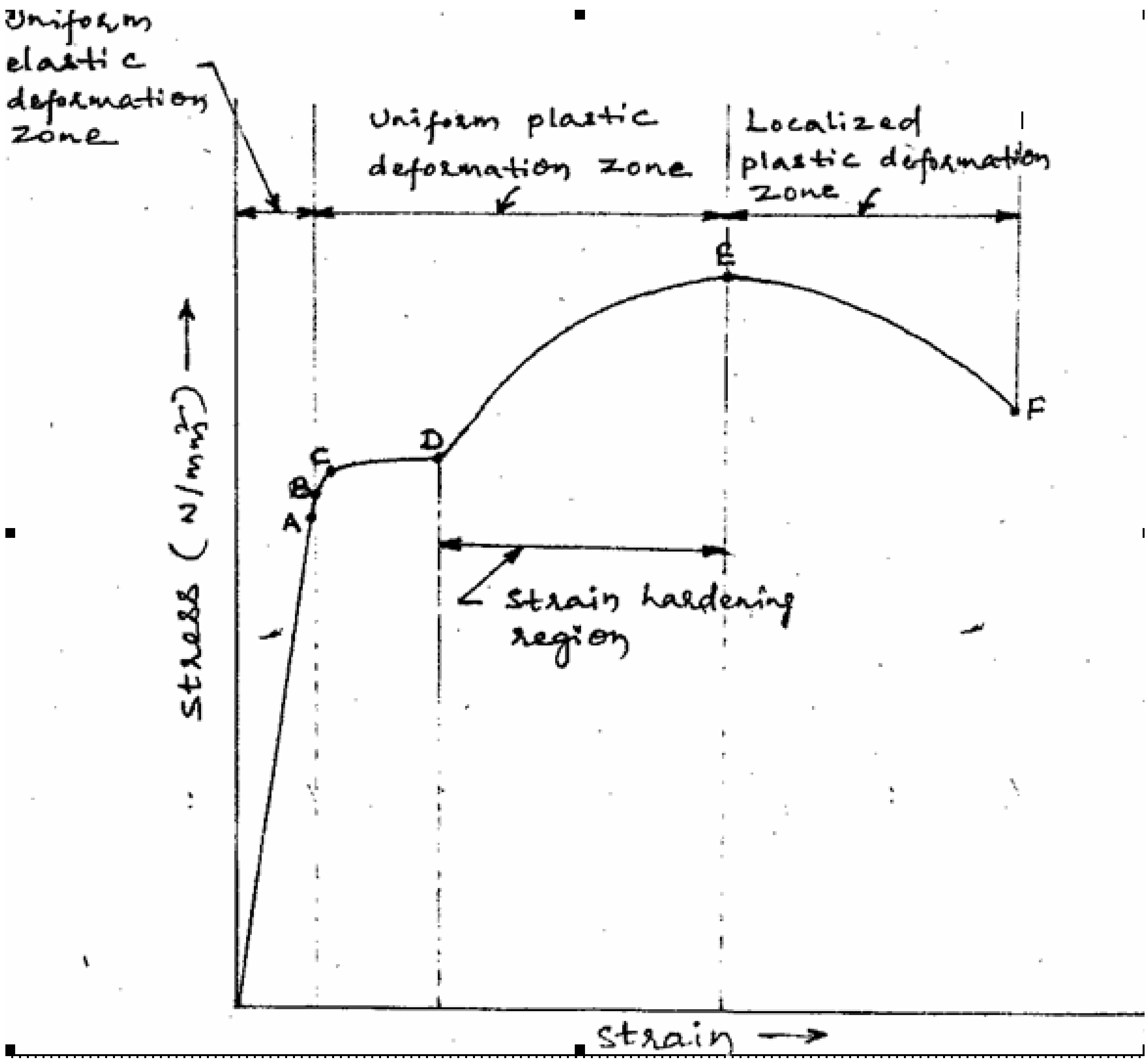
The Yield stress = Load at yield point/area of cross-section
i.e $p_y = P_v / A_0$ N/mm^2.
Ultimate stress = Ultimate load/Aria of cross-section ^
i.e $P_b = P_b/A_0$ N/mm^2.
Breaking stress = Braking load/Area of cross-section
i.e., $= Pb/A_0$ N/mm^2.
Percentage of of elongation -(If- 1_0)* lOO/lo.
Percentage reduction iii cross-sectional area = (AO- Af)* $100/A_0$. •'

PRECAUTIONS:

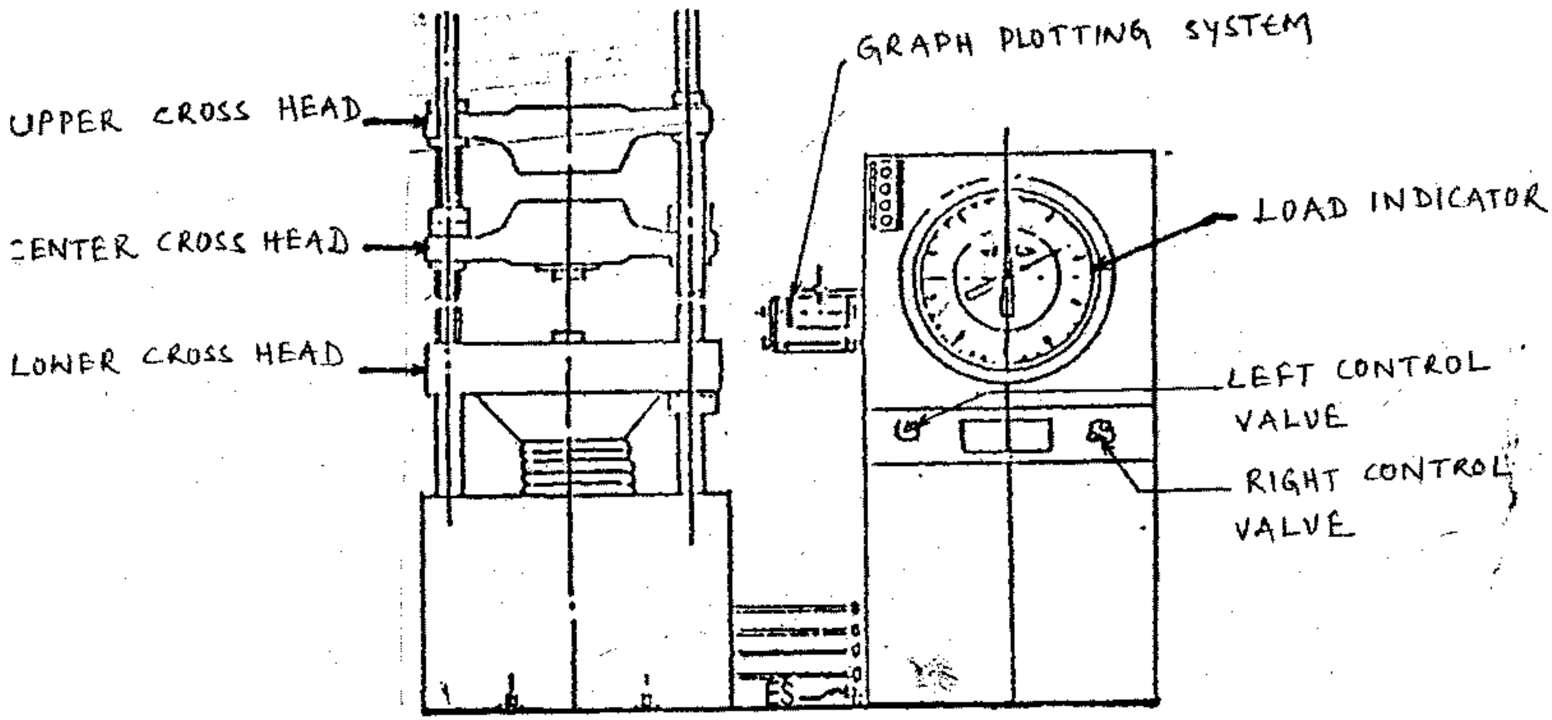
1. The loads due to weights (dead weights) of cross-heads must be removed.
2. The gripping of specimen in the jaws must be perfect.
3. Operate the control valves slowly.
4. After completion of the test release the hydraulic load by opening the left control valve.

RESULT:

1. The Young's modulus of the material, E
2. The Yield stress of the specimen, P_v
3. The Ultimate stress, P_u N/mm^2
4. The Breaking stress, P_b= N/mm^2
5. The percentage of elongation
6. The percentage reduction in cross-section



Uniform elastic deformation zone
Uniform plastic deformation zone
Localized plastic deformation zone
A
B
C
D
E
F
Strain hardening region
Stress (N/mm²) →
Strain →


UPPER CROSS HEAD
CENTER CROSS HEAD
LOWER CROSS HEAD
GRAPH PLOTTING SYSTEM
LOAD INDICATOR
LEFT CONTROL VALVE
RIGHT CONTROL VALVE

C Z: 73 u H O•x Z:

9. DEFLECTION TEST ON SIMPLY SUPPORTED BEAM

AIM: To determine the modulus of elasticity of the \material of the beam and • to demonstrate the effect of following on the deflection of the beam.

- Span of the beam
- Modulus of elasticity of the beam
- Cross section of the beam i.e., Moment of inertia of the beam

APPARATUS:

Supports, Beams of different materials, Dial gauge, Loading pan with loads, Vernier
Calipers, Steel rule.

THEORY:

Consider a beam supported at both ends by knife edges.

Let L = Length of the beam in 'mm '
I = Moment of inertia of the beam about neutral axis in 'mm^4'.
E = Young's modulus in'N/mm^2'.
W = Central load in'N'.

Then the central deflection in 'mm'
$\delta = WL^3 / 48 El$. . The deflection at 'L/4' from either end in 'mm' is given by,
$\delta = 11WL^3/768EI$ from the above formulae we can observe that

- Hollow section with same cross sectional area of a solid section will have more load carrying capacity and hence more stiffness, because I hoiiow> I solid.
- Beams are used with depth longer than width because of more moment of inertia
- for the same cross sectional area.
- Mild steel is stiffer than Aluminum because the Young's modulus of the former material is bigger.

If the deflection of. the material is high, its stiffness will be low, because stiffness of component in bending is defined as 'the ratio of load required per unit deflection in bending i.e, Bending stiffness, $K_b = W / \delta$

EXPERIMENTAL SET -UP:

The set- up contains the following

1. Two simple supports for holding the beam at both ends.
2. Loading arrangement with different weights.
3. Dial gauge with stand.
4. Measuring tape or steel rule.
5. Beams of different materials.

OBSERVATIONS:

Point of loading : Mid span

Point of deflection measurement

Least count of dial gauge : 0.01

Material of the beam Length of the beam, L Breadth of the beam, b Depth of the beam, d = mm

TABULAR COLUMN:

S.No	Load (kg)	Load (N)	Dial gauge readings (mm)			Modulus of elasticity, E (N/mm^2)	E value in 'Gpa'
			Loading	Unloading	Average (δ)		

MODEL CALCULATIONS:

The moment of inertia of the beam about neutral axis, $I = bd^3 /12$ mm ^{4}

If W = Central load in 'N'

δ = Deflection in 'mm' at the mid span,

Then, Modulus of elasticity, $E = WL^3/ 48 \delta I$ N/mm^2

$= [WL^3/48 \delta I]x10^{-3}$ Gpa

If W = Central load in 'N'

δ = Deflection in 'mm' at the distance of L/ 4 from either end,

Then, Modulus of elasticity, $E = 11 WL^3 /768 \delta I$ N/mm^2

$= [11 WL^3/768 \delta I]x10^{-3}$ Gpa

PRECAUTIONS:

1. Beam should be positioned horizontally.
2. Take care to see that the dial gauge spindle knob is touching the beam while taking the reading.
3. Loading should not be done beyond elastic limit.

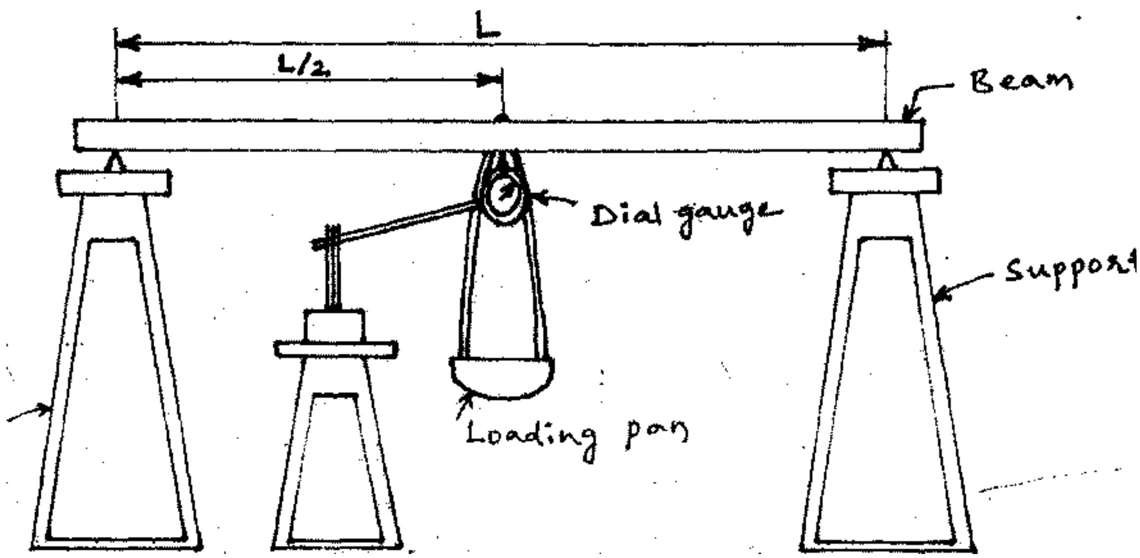
GRAPH:

Draw the graph taking load (W) on X-axis and deflection (δ) on Y - axis and calculate ' E 'value for a particular value of' W / δ .

RESULT:

The Modulus of elasticity, E of the given materials are calculated as

Mild steel = Gpa



DEFLECTION TEST ON SIMPLY SUPPORTED BEAM

4B).IZOD IMPACT TEST

AIM: To find the Impact strength of the given material of the specimen.

APPARATUS:

1. Striker for Izod test.
2. Tools for making a notch.
3. Vernier calipers.
4. Allen keys for fixing specimen and striker to supports.

THEORY:

Impact strength is defined as 'the ability of the material to resist shock loads' i.e., the resistance of the material against shock loading or in other words 'It is the energy required to break the specimen under impact loads'. This test is essential for deciding the suitability of the material which is expected to resist repeated shocks.

The izod impact test is a pendulum type single blow impact test in which notched specimen is supported at both ends as a simply supported beam as shown in figure and is broken by a falling pendulum. The energy absorbed as determined by the subsequent rise of pendulum is a measure of impact energy which when divided by cross-sectional area gives impact strength of the material.

The impact strength depends largely on the shape and size of the pitch of the specimen and therefore cannot be compared with each other.

PREPARATION OF SPECIMEN:

The notch on the 10 X 10 X 55mm test specimen must be prepared according to the dimensions confirming to IS: 1499-1959 as shown in the figure". The plane of Symmetry of notch shall be perpendicular to the horizontal axis of the test piece.

PROCEDURE:

1. Prepare the specimen according to the given specified standards.
2. * Fix the izod striker firmly to the bottom of the hammer.
3. The latching tube for izod test is to be firmly clamped to the bearing housing on the inclined face.
4. Now raise the hammer by hands and latch-in.
5. Release the hammer by operating the lever. The pointer will then indicate the initial energy in the pendulum.
6. Apply the brake and when the pendulum stops, raise it again by hands and latch-in.
7. Now place the prepared specimen on 'specimen support's a 'simply supported beam', the notch behind the pendulum as shown in figure.
8. Operate the liver so that the pendulum is released and specimen is hit. Now the pointer shown again the energy possessed by pendulum. The difference between initial and final readings gives the energy lost in breaking the specimen ink joules.
9. Bring the pendulum carefully to stand still position by applying the break.
10. Remove the broken specimen and calculate the impact strength.

TABULAR COLUMN:

Material of specimen	Scale reading Before fracture (U1) Joules	Scale reading after fracture (U2) Joules	Energy absorbed by specimen K = (U_1 - U_2) Joules	Impact strength in J/ mm^2
	-.			

MODEL CALCULATIONS:
Impact strength of the specimen, I = K/A J/mm^2
Where ' • -

K = Impact energy absorbed in Joules.

A - Area of cross-section of specimen below the notch before test in mm^2.

PRECAUTIONS:

1. Extreme care must be taken to see that correct striker and correct support/clamping are chosen for the test.
2. Operator should not stand in front of the pendulum as the broken piece may fly off or the swinging pendulum may cause injury.

RESULT: The impact strength of the material of the specimen J/mm^2

6. COMPRESSION TEST ON CUBE (WOOD or BRICK)

AIM: - To perform compression test on UTM.

APPARATUS:-

1. UTM,
2. Cube shaped specimen,
3. Steel rule

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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 transverse 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 ram is offered by a specimen the oil pressure start increasing the pointer start returning to zero leaving the drug pointer that is maximum reading which can be noted down.

CALCULATION:-

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

RESULT:- The average compressive strength of new brick sample is found to be **KPa**

PRECAUTIONS:-

1) Measure the dimensions of Brick accurately.

2) Specimen should be placed as for as possible in the 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.

7. PUNCH SHEAR TEST

AIM: -To find the shear strength of given specimen

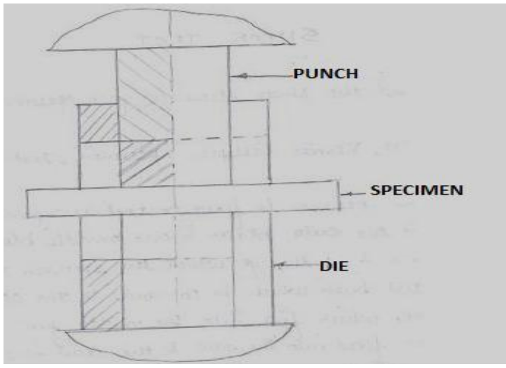
APPARATUS: -

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.
OBESERVATIONS:-

Diameter of the Rod, D = ….. mm

Cross-section area of the Rod (in double shear) = 2x π/4x d^2 =.. mm^2

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

Strength of rod against Shearing = $\boldsymbol{f}$x2x π/4x d^2

$\boldsymbol{f} = \mathbf{W / 2.\pi/4.d^2}$ N/mm^2

RESULT:

The Shear strength of mild steel specimen is found to be = ……………… N/mm^2

PRECAUTIONS:-

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.