Varuvan Vadivelan Institute of Technology

Dharmapuri – 636 703

LAB MANUAL

Regulation : 2013

Branch : *B.E.* - Mechanical Engineering

Year & Semester : II Year / IV Semester

CE6411- STRENGTH OF MATERIALS LABOROTARY

ANNA UNIVERSITY: CHENNAI

REGULATION - 2013

CE6315 - STRENGTH OF MATERIALS LABORATORY

OBJECTIVES:

To supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads. This would enable the student to have a clear understanding of the design for strength and stiffness

LIST OF EXPERIMENTS:

1. Tension test on mild steel rod
2. Double shear test on mild steel and aluminum rods
3. Torsion test on mild steel rod
4. Impact test on metal specimen (Izod and Charpy)
5. Hardness test on metals (Rockwell and Brinell Hardness number)
6. Deflection test on beams
7. Compression test on helical spring
8. Strain measurement using Rosette strain gauge
9. Effect of hardening – improvement in hardness and impact resistance of steels
10. Tempering – improvement mechanical properties comparison
    i. Unhardened specimen
    ii. Quenched specimen
    iii. Quenched and tempered specimen
11. Microscopic examination of
    i. Hardened samples
    ii. Hardened and tempered samples

GENERAL INSTRUCTION

- All the students are instructed to wear protective **uniform, shoes** &**identity card** before entering into the laboratory.
- Before starting the exercise, students should have a clear idea about the principal of that exercise
- All the students are advised to come with completed record and corrected observation book of previous experiment.
- Don't operate any instrument without getting concerned staff member's prior permission.
- The entire instrument is costly. Hence handle them carefully, to avoid fine for any breakage.
- Utmost care must be taken to avert any possible injury while on laboratory work. In case, anything occurs immediately report to the staff members.
- One student form each batch should put his/her signature during receiving the instrument in instrument issue register.

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4		Izod impact test		
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6		Brinell hardness test		
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INDRODUCTION OF STRENGTH OF MATERIALS

In materials science, the strength of a material is its ability to withstand an applied stress without failure. The applied stress may be tensile, compressive, or shear. It is a subject which deals with loads, elastic and forces acting on the material. For example, an external load applied to an elastic material or internal forces acting on the material. Deformation (e.g. bending) of the material is called strain, while the intensity of the internal resisting force is called stress.

The strength of any material relies on three different type of analytical method: strength, stiffness and stability, where strength means load carrying capacity, stiffness means deformation or elongation, and stability means ability to maintain its initial configuration. Yield strength refers to the point on the engineering stress-strain curve (as opposed to true stress-strain curve) beyond which the material begins deformation that cannot be reversed upon removal of the loading.

Ultimate strength refers to the point on the engineering stress-strain curve corresponding to the maximum stress.

A material's strength is dependent on its microstructure. The engineering processes to which a material is subjected can alter this microstructure. The variety of strengthening mechanisms that alter the strength of a material includes work hardening, solid solution strengthening, precipitation hardening and grain boundary strengthening and can be quantified and qualitatively explained.

However, strengthening mechanisms are accompanied by the caveat that some mechanical properties of the material may degenerate in an attempt to make the material stronger.

For example, in grain boundary strengthening, although yield strength is maximized with decreasing grain size, ultimately, very small grain sizes make the material brittle. In general, the yield strength of a material is an adequate indicator of the material's mechanical strength. Considered in tandem with the fact that the yield strength is the parameter that predicts plastic deformation in the material, one can make informed decisions on how to increase the strength of a material depend its micro structural properties and the desired end effect.

Strength is considered in terms of compressive strength, tensile strength, and shear strength, namely the limit states of compressive stress, tensile stress and shear stress, respectively.

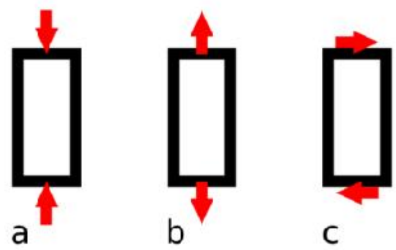
The effects of dynamic loading are probably the most important practical part of the strength of materials, especially the problem of fatigue. Repeated loading often initiates brittle cracks, which grow slowly until failure occurs.

However, the term strength of materials most often refers to various methods of calculating stresses in structural members, such as beams, columns and shafts. The methods that can be employed to predict the response of a structure under loading and its susceptibility to various failure modes may take into account various properties of the materials other than material (yield or ultimate) strength. For example failure in buckling is dependent on material stiffness (Young's Modulus).

TYPES OF LOADING:

- **Transverse loading** - Forces applied perpendicularly to the longitudinal axis of a member. Transverse loading causes the member to bend and deflect from its original position, with internal tensile and compressive strains accompanying change in curvature.
- **Axial loading** - The applied forces are collinear with the longitudinal axes of the members. The forces cause the member to either stretch or shorten.
- **Torsional loading** - Twisting action caused by a pair of externally applied equal and oppositely directed couples acting in a parallel planes or by a single external couple applied to a member that has one end fixed against rotation.

STRESSES:



A material being loaded in

a) Compression,

b) Tension,

c) Shear.

Uniaxial stress is expressed by

$$\sigma = \frac{F}{A},$$

Where ,F is the force [N] acting on an area A [m^2].The area can be the undeformed area or the deformed area, depending on whether engineering stress or true stress is used.

- ***Compressive stress*** (or compression) is the stress state caused by an applied load that acts to reduce the length of the material (compression member) in the axis of the applied load, in other words the stress state caused by squeezing the material. A simple case of compression is the uniaxial compression induced by the action of opposite, pushing forces. Compressive strength for materials is generally higher than that of tensile stress. However, structures loaded in compression are subject to additional failure modes dependent on geometry, such as Euler buckling.

- ***Tensile stress*** is the stress state caused by an applied load that tends to elongate the material in the axis of the applied load, in other words the stress caused by *pulling* the material. The strength of structures of equal cross sectional area loaded in tension is independent of cross section geometry. Materials loaded in tension are susceptible to stress concentrations such as material defects or abrupt changes in geometry. However, materials exhibiting ductile behavior (metals for example) can tolerate some defects while brittle materials (such as ceramics) can fail well below their ultimate stress.

- ***Shear stress*** is the stress state caused by a pair of opposing forces acting along parallel lines of action through the material, in other words the stress caused by *sliding* faces of the material relative to one another. An example is cutting paper with scissors.

Ex .No:1
Date :

TENSILE TEST ON STEEL BAR

AIM:

To conduct the tests on mild steel bar using UTM, determine the tensile strength .

APPARATUS REQUIRED:

- UTM
- Mild steel specimen,
- Vernier caliper/micrometer,
- Dial gauge.

UTM SPECIFICATION:

Model	: SE-UTM-400
Max capacity	: 40 **ton**
Minimum graduation	: 100 **kgf**
Dimensions L x W x H	: 2060 x 750 x 2180 **mm**
Pair of compression plate of diameter (for compression test)	: 120 **mm**
Ram stroke	: 200 **mm**
Piston speed at load	: 0-150 **mm / min**
Clamping jaw for round Specimen diameter (for tensile)	:10-25, 25-40 **mm**
Clamping jaw for flat specimens	: 0-15, 15-30, 65 **mm**

PROCEDURE:

1. The load pointer is set at zero by adjusting the initial setting knob.
2. The dial gauge is fixed and the specimen for measuring elongation of small amounts.
3. Measuring the diameter of the test piece by vernier caliper at least at three places and determine the mean value also mark the gauge length.
4. Now the specimen is gripped between upper and middle cross head jaws of the m/c.
5. Set the automatic graph recording system.
6. Start the m/c and take the reading.
7. The specimen is loaded gradually and the elongation is noted until the specimen breaks.

OBSERVATION:

1. Initial diameter of specimen d_1 = ________mm
2. Initial gauge length of specimen L_1 = ________mm
3. Initial cross-section area of specimen A_1 = ________mm^2
4. Load of yield point F_t = ________N
5. Ultimate load after specimen breaking **F** = ________ N
6. Final length after specimen breaking L_2 = ________mm
7. Dia. Of specimen at breaking place d_2 = ________mm
8. Cross section area at breaking place A_2 = ________mm^2
9. Bearing load point P_b =________N

FORMULA USED:

Area of the rod, $\mathbf{A} = \frac{\pi}{4} d^2$ **mm²**

Ultimate tensile strength $= \frac{Ultimate\ load}{cross\ sectional\ area\ of\ the\ bar}$ **N/mm²**

Percentage of elongation $= \frac{(Initial\ Length - Final\ Length)}{Initial\ Length}$ x 100 %

Modulus of elasticity, $\mathbf{E} = \frac{(P \times L)}{(A \times \delta L)}$ **N/ mm²**

Yield stress $= \frac{Yield\ load}{cross\ sectional\ area}$ **N/ mm²**

% reduction in area $= \frac{(Initial\ area - Final\ area)}{Final\ area}$ x 100

% Bearing stress $= \frac{Breaking\ \ load}{Cross\ sectional\ area}$ **N/ mm²**

TABULATION:(TENSILE TEST ON STEEL BAR)

S. No	Descriptions	Values	Unit
1	Modulus of elasticity E		N/ mm^2
2	Yield stress		N/ mm^2
3	Ultimate tensile strength		N/ mm^2
4	Normal bearing stress		N/ mm^2
5	Actual bearing stress		N/ mm^2
6	% of reduction in area		%
7	Percentage of elongation		%

CALCULATION:

RESULT:

Thus the tensile test on mild steel bar was conducted and the following parameters are calculated.

a) Ultimate tensile strength =__________**N/ mm^2**

b) Percentage of elongation =__________**%**

c) Modulus of elasticity **E** =__________**N/ mm^2**

d) Yield stress =__________**N/ mm^2**

e) % reduction in area =__________**%**

f) Normal bearing stress =__________**N/ mm^2**

g) Actual bearing stress =__________**N/ mm^2**

Ex. No: 2

Date :

DOUBLE SHEAR TEST ON BAR

AIM:

To determine the maximum shear strength of the given bar by conducting double shear test.

APPARATUS REQUIRED:

1. Universal Testing machine (UTM)
2. Mild steel or Aluminum specimen
3. Device for double shear test
4. Vernier caliper

PROCEDURE:

1. Measure the diameter (d) of the given specimen.
2. Fit the specimen in the double shear device and place whole assembly in the UTM.
3. Apply the load till the specimen fails by double – shear.
4. Note down the load at which the specimen fails (P).
5. Calculate the maximum shear strength of the given specimen by using the following formula.

FORMULA USED:

$$\text{Maximum shear strength} = \frac{load\ at\ failure\ \ p}{2\ X\ cross\ sectional\ area\ of\ the\ bar}\ \text{N}/mm^2$$

OBSERVATION:

1. Material of the specimen = ________
2. Diameter of the specimen, **d** = ________ **mm**
3. Load at failure, **P** = ________ **KN**

CALCULATION:

RESULT:

Thus the shear strength of the given bar was conducted.

The maximum shear strength of the given specimen is __________ **N/mm^2**

Ex. No : 3

Date :

TORSION TEST ON MILD STEEL ROD

AIM:

To conduct the torsion test on given mild steel specimen and determine

1. Shear stress under a twist of one degree
2. Modulus of rigidity of given material
3. Strain energy under a twist of one degree
4. Ultimate tensional stress

APPARATUS REQUIRED:

1. Torsional testing machine
2. Vernier caliper

SPECIFICATION:

Clamping jaw for square specimen	: 40mm
Power supply	: 400/440 volts, 3phase, AC supply

OBSERVATION:

1. Diameter of the specimen **D** = _________ **mm**
2. Length of the specimen **L** = _________ **mm**

FORMULA USED:

$$\frac{\overline{T}}{J} = \frac{\overline{Fs}}{R} \quad \text{(Strength equation)}$$

$$\frac{T}{J} = \frac{C\theta}{L} \quad \text{(Stiffness equation)}$$

Where,

T= torque applied in N-mm ($T*10^4$)

J= Polar moment of inertia = $\frac{\pi}{32}D^4$ **mm^4**

F_S= Shear stress induced in **N/mm^2**

R= Radius of the specimen = D/2 in **mm**

C= shear modulus or modulus of rigidity in **N/mm^2**

θ= Angle of twist in radian

L= length of the specimen in **mm**

1. **F_S** = TR/J **N/mm^2**
2. **C** = TL/J. **N/mm^2**
3. **S.E** = $\frac{Fs^2}{40} x \frac{\pi}{4} D^2 L$ **N-mm**
4. **Fs_{max}** = T_{max}.RJ **N/mm^2**

Where **T_{max}**= Torque of failure **N-mm**

TABULATION: TORSION TEST ON MILD STEEL ROD

S. No	Angle of Twist (θ) degree	Angle of twist θ radian = $\theta \times \frac{\pi}{180}$	Torque Kg-m

PROCEDURE:

S. No	Radius of the specimen (R) mm	Torque applied (T) N-mm	Angle of twist (θ) radian	Shear stress N/mm^2 'Fs'	Modulus of rigidity of the material N/mm^2 'c'	Strain energy N-mm 'S.E'	Ultimate shear stress N/mm^2 Fs max

1. Measure the dimensions of the specimen using vernier caliper.
2. Introduce the specimen between the chucks and grip the specimen tightly.
3. Apply torque gradually by rotating the wheel.
4. Note down the torque in the digital indicator for every five degrees till the specimen broken.
5. Note down the maximum torque in the specimen.

GRAPH:

Draw the graph between torque (y-axis) and angle of twist (x-axis) in degrees.

CALCULATION:

RESULT:

Thus the torsion test on given mild steel specimen was conducted and following parameters was obtained.

1. Shear stress under a twist of five degree (f_s) = ___________ **N/mm^2**
2. Modulus of rigidity of the given specimen(c) =___________ **N/mm^2**
3. Strain energy under a twist of five degree(S.E) =___________ **N-mm**
4. Ultimate shear stress =___________ **N/mm^2**

Ex. No : 4
Date :

IZOD IMPACT TEST

AIM:

To conduct the test to determine the impact strength of the given specimen by Izod impact test.

APPARATUS REQUIRED:

1. Impact testing machine with attachment for Izod test.
2. Given specimen
3. Vernier caliper
4. Scale.

SPECIFICATION:

Impact capacity	: 168 **J**
Least count of capacity scale	: 2 **J**
Weight of striking hammer	: 18.7 **kg**
Swing diameter of hammer	: 1600 **mm**
Angle of hammer before striking	: 90^o
Distance between supports	: 40 **mm**
Specimen size	: 10x10x75 **mm**
Type of notch	: V- notch
Angle of notch	: 45°
Depth of notch	: 2 **mm**

PROCEDURE:

1. Measure the length (l), breadth (b), & depth (d) of the given specimen.
2. Measure the position of notch (i.e. groove) from one end (l_g), depth of groove (d_g) and top width of the groove (w_g) in the given specimen.
3. Lift the pendulum and keep it in the position meant for Izod test.
4. Adjust the pointer to coincide with initial position (i.e. maximum value) in the izod scale.
5. Release the pendulum using the lever and note down the initial reading in the izod scale.
6. Repeat the step 3 and 4.
7. Place the specimen vertically upwards such that the shorter distance between one end of the specimen and groove will be protruding length and also the groove in the specimen should face the striking end of the hammer.
8. Release the pendulum again using the lever and note down the final reading in the izod scale.

FORMULA USED:

Impact strength = (Final izod scale reading – Initial izod scale reading) **J/mm^2**

OBSERVATION:

1. Material of the given specimen = __________
2. Type of notch (i.e. groove) = __________
3. Length of the specimen, **l** = __________ **mm**
4. Breadth of the specimen, **b** = __________ **mm**
5. Depth of the specimen, **d** = __________ **mm**
6. Position of groove from one end, **(l_g)** = __________ **mm**
7. Depth of groove **(d_g)** = __________ **mm**
8. Width of groove **(w_g)** = __________ **mm**
9. Initial izod scale reading = __________ **kg.m**
10. Final izod scale reading = __________ **kg.m**

TABULATION:

S. No	Energy observed By Specimen J	Effective cross sectional Area mm^2	Impact strength J/mm^2

CALCULATION:

RESULT:

Thus the impact strength of the given specimen was conducted using izod impact test. The impact strength of the given specimen is ____________**J/mm^2**.

Ex. No : 5

Date :

CHARPY IMPACT TEST

AIM:

To determine the impact strength of the given specimen by conducting charpy impact test.

APPARATUS REQUIRED:

1. Impact testing machine with attachment for charpy test.
2. Charpy specimen
3. Vernier caliper
4. Scale

SPECIFICATION:

Impact capacity	: 300 **J**
Least count of capacity scale	: 2 **J**
Weight of striking hammer	: 18.7 **kg**
Swing diameter of hammer	: 1600 **mm**
Angle of hammer before striking	: 160º
Distance between supports	: 40 **mm**
Specimen size	: 55 x 10 x 10 **mm**
Type of notch	: U- notch
Angle of notch	: 45°
Depth of notch	: 2 **mm**

PROCEDURE:

1. Measure the length (l), breadth (b), & depth (d) of the given specimen.

2. Measure the position of notch (i.e. groove) from one end (l_g), depth of groove (d_g) and top width of the groove (w_g) in the given specimen.
3. Lift the pendulum and keep it in the position meant for charpy test.
4. Adjust the pointer to coincide with initial position (i.e. maximum value) in charpy scale.
5. Release the pendulum using the lever and note down the initial reading in the charpy scale.
6. Repeat the step 3 and 4.
7. Place the specimen centrally over the supports such that the groove in opposite to the striking face.
8. Release the pendulum again using the lever and note down the final reading in the charpy scale.

FORMULA USED:

Impact strength = (Final charpy scale reading – Initial charpy scale reading) in **/mm^2**

OBSERVATION:

1. Material of the given specimen =__________
2. Type of notch (i.e. groove) = _________
3. Length of the specimen, **l** = __________ **mm**
4. Breadth of the specimen, **b** = _________ **mm**
5. Depth of the specimen, **d** =__________ **mm**
6. Position of groove from one end, **(l_g)** = __________ **mm**
7. Depth of groove **(d_g)** = __________ **mm**
8. Width of groove **(w_g)** = __________ **mm**
9. Initial charpy scale reading = __________ **kg.m**
10. Final charpy scale reading = ___________ **kg.m**

TABULATION: CHARPY IMPACT TEST

S. No	Energy observed By Specimen J	Effective cross sectional area mm^2	Impact strength J/mm^2

RESULT:

Thus the impact strength of the given specimen was conducted using charpy impact test. The impact strength of the given specimen is ___________**J/mm^2**

Ex. No : 6

Date :

BRINELL HARDNESS TEST

AIM:

To measure the hardness of the given specimen using Brinell hardness number

APPARATUS REQUIRED:

1. Brinell hardness set up
2. Ball indenter
3. Microscope

SPECIFICATION:

Load range	: 500 **kgf** to 3000 **kgf**
Maximum test height	: 254 **mm**
Depth of throat	: 150 **mm**
Gross weight	: 210 **kg** (approx)
Height	: 990 **mm**
Size of base	: 495 x 255 **mm**

PROCEDURE:

1. The surface of the specimen is cleaned and kept on the table of testing machine.
2. Press a steel ball on the surface of work piece given.
3. The load applied is allowed to continue for a period of 30 seconds.
4. The diameter of the resulting impression is measured with the help of calibrated microscope.
5. The measured diameter is converted into the equivalent Brinell hardness number by the formulae.

FORMULA USED:

Brinell hardness number (BHN) = Load on the Ball/area of indentation of steel ball

$$\text{BHN} = \frac{P}{\frac{\pi D}{2}\left(D - \sqrt{(D^2 - d^2)}\right)}$$

Where,

P- Load applied on the indenter in **Kg**

D- Diameter of steel ball indenter in **mm**

d- Diameter of ball impression in **mm**

TABULATION: BRINELL HARDNESS TEST

Specimen material	Diameter (Ø) of ball intender mm	Load P Kg	Diameter (Ø) of ball impression			Average $(d_1+d_2+d_3)/3$ mm	Brinell hardness number (no unit)
			d_1 mm	d_2 mm	d_3 mm		

CALCULATION:

RESULT:

Thus the hardness test of the given specimen was conducted and hardness number was obtained. The Brinell hardness number for given specimen is____________

Ex. No : 7
Date :

ROCKWELL HARDNESS TEST

AIM:

To conduct the test to measure the hardness of the different materials like hard steel, mild steel, aluminum, brass etc.

APPARATUS REQUIRED:

1. Rockwell hardness tester
2. Diamond cone intender
3. Specimen.

PROCEDURE:

1. Clean the test piece and place on the special anvil of machine.
2. Further turn the wheel (i.e. for 3 rotation) to force the test specimen against the intender.
3. Set the pointer on the appropriate position based on the scale used.
4. Push forward the lever and apply the major load.
5. As soon as the pointer in the dial comes to rest reverse the lever direction.
6. The Rockwell hardness is read on the appropriate scale dial directly.

B scale ball intender _______100 **kg**
C scale diamond intender _______150 **kg**

TABULATION:

S.NO	Specimen	Load in kg		intender	Dial readings			average
		Max Load*9.81 N	Min Load*9.81 N		R_1 mm	R_2 mm	R_3 mm	$(R_1+R_2+R_3)/3$

CALCULATION:

RESULT:

Thus the hardness test was conducted for the different materials like hard steel, mild steel, aluminum, brass etc. Rockwell hardness number for hard steel of

i) Load 100kg = ________
ii) Load 150kg = ________

Ex. No : 8
Date :

DEFLECTION TEST ON BEAMS

AIM:

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

APPARATUS REQIRED:

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

FORMULA USED:

Bending Stress,

$$\frac{M}{I} = \frac{\sigma b}{Y} \text{(As per bending equation)}$$

Where, **M** = bending moment, **N-mm**

I = moment of inertia, $\mathbf{mm^4}$

σ_b = Bending stress, $\mathbf{N/mm^2}$

Y = Distance of the tip fiber of the beam from the neutral axis, **mm**

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 and again note the reading of vernier 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 caliper.
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. Putting these values in the relation $E= \frac{Wl^3}{48\delta I}$
8. Calculate the bending stresses for different loads using relation ($\delta_b = \frac{My}{I}$) as given in the observation table.

TABULATION: DEFLECTION TEST ON BEAMS

S.NO	Load (W) N	Deflection (δ) mm	Bending stress $\sigma_b = \frac{My}{I}$ N/mm²	Bending moment $M = \frac{WI}{4}$ N-mm	Young's modulus of elasticity, $E = \frac{Wl^3}{48\delta I}$ N/mm²
1					
2					
3					
4					
5					

CALCULATION:

RESULT:

Thus the deflection test was conducted and young's modulus of elasticity of the material was obtained.

1. The young's modulus for steel beam is found to be ________ **N/mm^2**.
2. The young's modulus for wooden beam is found to be ________ **N/mm^2**.

Ex. No : 9
Date :

COMPRESSION TEST ON HELICAL SPRING

AIM:

To conduct the test to determine the modulus of rigidity and stiffness of the given spring specimen.

APPARATUS REQUIRED:

1. Spring test machine
2. Spring specimen
3. Vernier caliper

PROCEDURE:

1. Measure the outer diameter (D) and diameter of the spring coil (D) for the given spring.
2. Count the number of turns i.e. coils (n) in the given specimen.
3. Place the spring at the center of the bottom beam of the spring testing machine.
4. Raise the bottom beam by rotating right side wheel till the spring top touches the middle cross beam.
5. Note down the initial reading from the scale in the machine.
6. Apply a load of 25kg and note down the scale reading. Increase the load at the rate of 25kg up to a maximum of 100kg and note down the corresponding scale readings.
7. Find the actual deflection of the spring for each load by deducting the initial scale reading from the corresponding scale reading.
8. Calculate the modulus of rigidity for each load applied by using the following formula.
9. Determine the stiffness for each load applied by using the following formula.

FORMULAE USED:

Modulus of rigidity,

$$\mathbf{C} = \frac{64\,P\,R^3 n}{d^4 \delta} \ \mathbf{N/mm^2}$$

Stiffness, $\mathbf{K} = P/\delta$ **N/mm**

$\mathbf{R} = D - d/2$ **mm**

Where,

P = Load in **N**

R = Mean radius of the spring in **mm**

d = Diameter of the spring coil in mm

δ = Deflection of the spring in mm

D = Outer diameter of the spring in mm

OBSERVATION:

1. Material of the spring specimen =____________
2. Outer diameter of the spring. **D** =____________ **mm**
3. Diameter of the spring coil, **d** =____________ **mm**
4. Number of coils / turns, **n** =____________ **Nos**
5. Initial scale reading =____________ **mm**

TABULATION : COMPRESSION TEST ON HELICAL SPRING

S.No.	Applied Load in		Scale reading in		Actual deflection	Modulus of rigidity	Stiffness in
	kg	N	cm	Mm	mm	N/mm^2	N/mm
Average							

CALCULATION:

RESULT:

Thus the compression test on helical spring was conducted and following parameters was calculated.

The modulus of rigidity of the given spring = _____________ **N/mm^2.**

The stiffness of the given spring = _____________**N/mm**.

Ex. No : 10

Date :

STUDY OF MICROSCOPE

AIM:

To know about Microscopic examination of given hardened samples.

CONSTRUCTION OF THE MICROSCOPE:

In the construction of the microscope, the following basic features of design should be considered. The unit construction of the base and the arm, the coarse and the fine focusing movements, the rotating nose piece, the inclined monocular body, including the means of sub-stage focusing.

BASE:

The heavy base in microscope model has built in illuminator for artificial light. To make the base safe from electric shock, it is made covered from the bottom with the metallic sheet and fitted with four rubber legs to facilitate uneven surface. An ON/OFF switch is also provided in left hand side of the base for the quick control illuminator with adjustable halogen lamp. The variable transformer is designed for 220-230v mains supply. On the base, to the left is a variable potentiometer with which we can adjust the brightness of the halogen lamp.

ARM:

The basic function of arm is to provide a unit on which each individual sub-assembly is conveniently mounted and in strict alignment with another. The arm is a rigid design with a deep curve providing a convenient grip when the instrument is moved. It is so designed that any head may be rotated around 360° in any desired position. The lower side of the arm carries focusing mechanism and upper carries nose-piece.

REVOLVING NOSE PIECE:

The dust proof quadruple nose-piece is a precise unit, providing a rapid and reliable change of objective. Each objective when rotated into position is located precisely on the optical axis of the microscope, its correct position being determined by a click stop. The position is so designed that it will maintain its accurate alignment during many years of use a perceptible audio click will be both felt and heard when the objective has been correctly rotated into position.

FOCUSING MECHANISM:

The coarse and the fine focusing movements are provided in the bottom position of the arm separately. The shape, size and grip of movement heads on either side of the arm are designed to give smooth control of movements. For final sharpness of the image, it is advisable to adjust the fine focusing mechanism to its central position.

The total range of vertical movement for the fine adjustment is 2mm. the movement is characterized by exceptionally smooth and accurate precision.

PROCEDURE TO USE THE MICROSCOPE:

1. Place all the objectives in the optical axis and the eye piece e.g5X in the monocular tube.
2. Rotate the optical axis and set the microscope and set the microscope for magnification of 20X, i.e. the eye piece being 5X and the objective being 4X
3. Place the metallurgical specimen on the stage in such a way that the polished side faces the objective, now switch on the microscope.
4. Viewing through the monocular head, move the stage up and down with the help of the coarse movement until a structure appears.
5. Now focus the microscope to full sharpness of the metallurgical structure by means of the fine focusing.

RESULT:

Thus the metallurgical structure of the specimen is studied by using the microscope.

Ex. No : 11

Date :

HEAT TREATMENT PROCESS

AIM:

To examine the metallurgical structure of the specimen after the heat treatment.

TEMPERING PROCESS:

Tempering is a process of heat treating, which is used to increase the toughness of iron-based alloys. It is also a technique used to increase the toughness of glass. For metals, tempering is usually performed after hardening, to reduce some of the excess hardness, and is done by heating the metal to a much lower temperature than was used for hardening. The exact temperature determines the amount of hardness removed, and depends on both the specific composition of the alloy and on the desired properties in the finished product. For instance, very hard tools are often tempered at low temperatures, while springs are tempered to much higher temperatures. In glass, tempering is performed by heating the glass and then quickly cooling the surface, increasing the toughness.

QUENCHING PROCESS:

Tempering is most often performed on steel that has been heated above its upper critical (A_3) temperature and then quickly cooled, in a process called quenching, using methods such as immersing the red-hot steel in water, oil, or forced-air.

The quenched-steel, being placed in, or very near, its hardest possible state, is then tempered to incrementally decrease the hardness to a point more suitable for the desired application.

DESCRIPTION:

The body o the furnace is made up of thick gauge MS sheets and supported with angles and flats.

SPECIFICATION

Heating element	: Silica carbide rods
Insulation	: Ceramic wool
Chamber	: Alumina contain illuminate slab/brick fired up to 1600°c
Thermocouple	: pt-pt-rh (13%)
Internal chamber size	: 6” x 6”x12”
Power supply	: 415v, 32amps

PROCEDURE:

1. Collect the materials in basin of the furnace.
2. Close the lid
3. Set the operating recrystallization temperature by using temperature controller
4. Controller will automatically cut off the power supply after setting temperature attain.
5. Collect the red hot metal from the basin.
6. Quench the hot material to get hardened
7. Place the metal on the v block to take the indentations in any hardness tester like Brinell or Rockwell hardness tester,
8. Observe the readings for various temperatures.

TABULATION: HEAT TREATMENT PROCESS

S.NO	Temperature (in degree)	BHN number	BHN number (After hardening)

RESULT:

Thus the study of the hardness of the material is completed after quenching.

Ex. No : 12

Date :

IMPROVEMENT OF MECHANICAL PROPERTIES

COMPARISIONS OF ROCKWELL HARDNESS TEST

AIM:

To check the hardness of the unhardened specimen, Quenched specimen, Quenched and tampered specimen.

APPARATUS REQUIRED:

1. Rockwell hardness tester
2. Diamond cone intender
3. Specimen.
4. Furnace

PROCEDURE:

Unhardened specimen:

1. Clean the test piece and place on the special anvil of machine.
2. Further turn the wheel (i.e. for 3 rotation) to force the test specimen against the intender.
3. Set the pointer on the appropriate position based on the scale used.
4. Push forward the lever and apply the major load.
5. As soon as the pointer in the dial comes to rest reverse the lever direction.
6. The Rockwell hardness is read on the appropriate scale dial directly.

B scale ball intender ________100 **kg**
C scale diamond intender ________150 **kg**

Quenched specimen, Quenched and tempered specimen.

- Collect the material in basin of the furnace.
- Close the lid.
- Set operating recrystallisation temperature by using temperature controller.
- Controller will automatically cut off the power supply after setting temperature attain.
- Collect the red hot metal from the basin.
- Quenched the hot material to get hardened.
- Place the metal on V block to black to take indentation in any hardness tester like Rockwell hardness tester.
- Observe the reading for various temperatures.

RESULT:

Thus the hardness test of given specimen was conducted and obtained The hardness number of the given specimen

Rockwell hardness number for Unhardened specimen steel of Load 100kg = _____

Rockwell hardness number for Quenched specimen steel of Load 100kg = _____

Rockwell hardness number for Quenched and Tempered specimen steel of Load 100kg = _____

Ex. No : 13

Date :

IMPROVEMENT OF MECHANICAL PROPERTIES COMPARISIONS OF CHARPY IMPACT TEST

AIM:

To check the impact strength for unhardened specimen, Quenched specimen, Quenched and tampered specimen by conducting charpy impact test.

APPARATUS REQUIRED:

1.Impact testing machine with attachment for charpy test.

2.Charpy specimen

3.Vernier caliper

4.Scale

SPECIFICATION:

Impact capacity	: 300 **joules**
Least count of capacity scale	: 2 **joule**
Weight of striking hammer	: 18.7 **kg**
Swing diameter of hammer	: 1600 **mm**
Angle of hammer before striking	: 160º
Distance between supports	: 40 **mm**
Specimen size	: 55x10x10 **mm**
Type of notch	: U- notch
Angle of notch	: 45°
Depth of notch	: 2 **mm**

PROCEDURE:

1. Measure the length (l), breadth (b), & depth (d) of the given specimen.
2. Measure the position of notch (i.e. groove) from one end (l_g), depth of groove (d_g) and top width of the groove (w_g) in the given specimen.
3. Lift the pendulum and keep it in the position meant for charpy test.
4. Adjust the pointer to coincide with initial position (i.e. maximum value) in charpy scale.
5. Release the pendulum using the lever and note down the initial reading in the charpy scale and Repeat the step 3 and 4.
6. Place the specimen centrally over the supports such that the groove in opposite to the striking face.
7. Release the pendulum again using the lever and note down the final reading in the charpy scale.

FORMULA USED:

a) Impact strength = $\frac{Energy\ Observed\ specimen}{Cross\ sectional\ area}$ **J/mm^2**

Energy observed specimen = Final scale reading – Initial scale reading

Effective cross sectional area = (Breadth x Thickness) **mm^2**

OBSERVATION:

1. Material of the given specimen =____________
2. Type of notch (i.e. groove) = ____________
3. Length of the specimen, **l** = _____________ **mm**
4. Breadth of the specimen, **b** = _____________ **mm**
5. Depth of the specimen, **d** = ____________ **mm**
6. Position of groove from one end, **(l_g)** = _____________ **mm**
7. Depth of groove **(d_g)** =____________ **mm**
8. Width of groove (**w_g**) = _____________ **mm**
9. Initial charpy scale reading =______________ **kg-m**
10. Final charpy scale reading =______________ **kg-m**

<u>TABULATION: IMPROVEMENT OF MECHANICAL PROPERTIES COMPARISIONS OF CHARPY IMPACT TEST</u>

S. No	Improvement mechanical properties comparison	Energy observed Specimen J		Effective cross sectional area mm^2	Impact strength J/mm^2
		Initial	Final		
1	Unhardened specimen				
2	Quenched specimen				
3	Quenched and tempered specimen				

CALCULATION:

RESULT:

Thus the impact test of given specimen was conducted and obtained. The impact strength of given specimen

Unhardened specimen = _____________ **J/mm^2**

Quenched specimen = _____________ **J/mm^2**

Quenched and Tempered specimen = _____________ **J/mm^2**