A LIST OF BASIC SAFETY RULES

1. When you handle chemicals wear eye protection (chemical splash goggles or full face shield).
2. When you work with furnaces for heat treatment procedures or other thermally activated equipment you should use special gloves to protect your hands.
3. Students should wear durable clothing that covers the arms, legs, torso and feet. (Note: sandals, shorts, tank tops etc. have no place in the lab. Students inappropriately dressed for lab, at the instructors discretion, be denied access)
4. To protect clothing from chemical damage or other dirt, wear a lab apron or lab coat. Long hair should be tied back to keep it from coming into contact with lab chemicals or flames.
5. In case of injury (cut, burn, fire etc.) notify the instructor immediately.
6. In case of a fire or imminently dangerous situation, notify everyone who may be affected immediately; be sure the lab instructor is also notified.
7. If chemicals splash into someone's eyes act quickly and get them into the eye wash station, do not wait for the instructor.
8. In case of a serious cut, stop blood flow using direct pressure using a clean towel, notify the lab instructor immediately.
9. Eating, drinking and smoking are prohibited in the laboratory at all times.
10. Never work in the laboratory without proper supervision by an instructor.
11. Never carry out unauthorized experiments. Come to the laboratory prepared. If you are unsure about what to do, please ask the instructor.
12. Always remember that HOT metal or ceramic pieces look exactly the same as COLD pieces are careful what you touch.
13. Know the location and operation of :
    - Fire Alarm Boxes
    - Exit Doors
    - Telephones

LABARATORY CLASSES - INSTRUCTIONS TO STUDENTS

1. Students must attend the lab classes with ID cards and in the prescribed uniform.
2. Boys-shirts tucked in and wearing closed leather shoes. Girls' students with cut shoes, overcoat, and plait incite the coat. Girls' students should not wear loose garments.
3. Students must check if the components, instruments and machinery are in working condition before setting up the experiment.
4. Power supply to the experimental set up/ equipment/ machine must be switched on only after the faculty checks and gives approval for doing the experiment. Students must start to the experiment. Students must start doing the experiments only after getting permissions from the faculty.
5. Any damage to any of the equipment/instrument/machine caused due to carelessness, the cost will be fully recovered from the individual (or) group of students.
6. Students may contact the lab in charge immediately for any unexpected incidents and emergency.
7. The apparatus used for the experiments must be cleaned and returned to the technicians, safely without any damage.
8. Make sure, while leaving the lab after the stipulated time, that all the power connections are switched off.
9. **EVALUATIONS:**
    - All students should go through the lab manual for the experiment to be carried out for that day and come fully prepared to complete the experiment within the prescribed periods. Student should complete the lab record work within the prescribed periods.
    - Students must be fully aware of the core competencies to be gained by doing experiment/exercise/programs.
    - Students should complete the lab record work within the prescribed periods.
    - The following aspects will be assessed during every exercise, in every lab class and marks will be awarded accordingly:
    - **Preparedness, conducting experiment, observation, calculation, results, record presentation, basic understanding and answering for viva questions.**
    - In case of repetition/redo, 25% of marks to be reduced for the respective component.

NOTE 1

- **Preparation** means coming to the lab classes with neatly drawn circuit diagram /experimental setup /written programs /flowchart, tabular columns, formula, model graphs etc in the observation notebook and must know the step by step procedure to conduct the experiment.
- **Conducting experiment** means making connection, preparing the experimental setup without any mistakes at the time of reporting to the faculty.
- **Observation** means taking correct readings in the proper order and tabulating the readings in the tabular columns.
- **Calculation** means calculating the required parameters using the approximate formula and readings.
- **Result** means correct value of the required parameters and getting the correct shape of the characteristics at the time of reporting of the faculty.
- **Viva voice** means answering all the questions given in the manual pertaining to the experiments.
- **Full marks will be awarded if the students performs well in each case of the above component**

NOTE 2

- Incompletion or repeat of experiments means not getting the correct value of the required parameters and not getting the correct shape of the characteristics of the first attempt. In such cases, it will be marked as **"IC" in the red ink** in the status column of the mark allocation table given at the end of every experiment. The students are expected to repeat the incomplete the experiment before coming to the next lab. Otherwise the marks for IC component will be reduced to **zero.**

NOTE 3

- Absenteeism due to genuine reasons will be considered for doing the **missed experiments.**
- In case of power failure, extra classes will be arranged for doing those experiments only and assessment of all other components preparedness; viva voice etc. will be completed in the regular class itself.

NOTE 4

- The end semester practical internal assessment marks will be based on the average of all the experiments.

INDEX

S.No	Date	Name of the Experiment	Mark	Staff Signature
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				

Completed date:

Average Mark: **Staff - in - charge**

TENSION TEST ON MILD STEEL

AIM:

To conduct tension test on the given mild steel rod for determining the yield stress, ultimate stress, breaking stress, percentage of reduction in area, percentage of elongation over a gauge length and young's modulus.

APPARATUS REQUIRED:

1. Vernier caliper.
2. Scale.

THEORY:

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

Usually a tension testis conducted at room temperature and the tensile load is applied slowly. During this test either round of flat specimens may be used. The round specimens may have smooth, shouldered or threaded ends. The load on the specimen is applied mechanically or hydraulically depending on the type of testing machine.

FORMULA USED:

1. Original area of the rod (A_o) = (3.14/4) X $(d_o)^2$ mm^2
2. Neck area of the rod (A_N) = (3.14/4) X $(d_N)^2$ mm^2

   Where,

   d_o =original area of cross section in 'mm'

   d_N =diameter of the rod at the neck in 'mm'
3. Percentage reduction in area =

   Where,

   A_o=original cross sectional area of the rod in 'mm'

   A_N=Neck area of the rod in 'mm'
4. Percentage of Elongation =

   Where,

   L_o=Final gauge length of the rod in 'mm'

   L_o=Original gauge length of the rod in 'mm'
5. Yield stress = N/mm^2
6. Ultimate stress = N/mm^2
7. Breaking stress = N/mm^2
8. Young's modulus = N/mm^2

Where,

P=Load in 'N'

L_o=Original length in 'mm'

A_o=Original cross sectional area of the rod in 'mm'

 =Extension of the rod in 'mm'

PROCEDURE:

1. Measure the diameter of the rod using Vernier caliper.
2. Measure the original length of the rod.
3. Select the proper jaw inserts and complete the upper and lower chuck assemblies.
4. Apply some graphite grease to the tapered surface of the grip surface for the smooth motion.
5. Operate the upper cross head grip operation handle and grip fully the upper end of the test piece.
6. The left valve in UTM is kept in fully closed position and the right valve in normal open position.
7. Open the right valve and close it after the lower table is slightly lifted.

8. Adjust the load to zero by using large push button (This is necessary to remove the dead weight of the lower table, upper cross head and other connecting parts of the load).
9. Operate the lower grip operation handle and lift the lower cross head up and grip fully the lower part of the specimen. Then lock the jaws in this position by operating the jaw locking handle.
10. Turn the right control valve slowly to open position (anticlockwise) until we get a desired loadings rate.
11. After that we will find that the specimen is under load and then unclamp the locking handle.
12. Now the jaws will not slide down due to their own weight. Then go on increasing the load.
13. At a particular stage there will be a pause in the increase of load. The load at this point is noted as yield point load.
14. Apply the load continuously, when the load reaches the maximum value. This is noted as ultimate load.
15. Note down the load when the test piece breaks, the load is said to be a breaking load.
16. When the test piece is broken close the right control valve, take out the broken pieces of the test piece. Then taper the left control valve to take the piston down.

GRAPH

Draw a graph between Elongations (X-axis) and load (Y-axis).

OBSERVATIONS

1. Original gauge length of the rod (L_o) = mm.
2. Original diameter of the rod (d_o) = mm.
3. Final length of the rod = mm.
4. Load at yield point = kN.
5. Ultimate load = kN.
6. Breaking load = kN.
7. Diameter at the neck (D_N) = mm.
8. Gauge in length = mm.

TABULATION:

S.NO	Load (KN)	Extensometer reading (mm)			Stress (N/mm^2)	Strain (No Unit)	Young's modulus X 10^5 (N/mm^2)
		Left	Right	Mean			

RESULT:

1. Final length of the rod = _______ mm.
2. Diameter at the neck (D_N) = _______ mm.
3. Percentage reduction in area =_______ %
4. Percentage of Elongation =_______ %
5. Yield stress = _______ N/mm^2
6. Ultimate stress = _______ N/mm^2
7. Breaking stress = _______ N/mm^2
8. Young's modulus = _______ X 10^5 N/mm^2

IMPACT TEST - CHARPY

AIM:

To determine the impact strength of the given material using Charpy impact test.

APPARATUS REQUIRED:

1. Vernier caliper
2. Scale

THEORY:

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

FORMULA USED:

$$\text{Impact strength} = \frac{\text{energy absorbed}}{\text{Cross sectional area}} \quad \text{J/mm}^2$$

PROCEDURE:

1. Raise the swinging pendulum weight and lock it.
2. Release the trigger and allow the pendulum to swing.
3. This actuates the pointer to move in the dial.
4. Note down the frictional energy absorbed by the bearings.
5. Raise the pendulum weight again and lock it in position.

6. Place the specimen in between the simple anvil support keeping the ”U” notch in the direction opposite to the striking edge of hammer arrangement.
7. Release the trigger and allow the pendulum to strike the specimen at its midpoint.
8. Note down the energy spent in breaking (or) bending the specimen.
9. Tabulate the observation.

OBSERVATION:

Area of cross section of the given material:

S.No	Material Used	Energy absorbed by force (A) J	Energy spent to break the specimen (B) J	Energy absorbed by the specimen (A-B) J	Impact Strength J/mm^2

Result:

The impact strength for the given material is __________ J/mm^2

ROCK WELL HARDNESS TEST

AIM:

To determine the Rockwell hardness number of the given specimen.

APPARATUS REQUIRED:

1. Emery paper
2. Penetrator

THOERY:

In Rock well hardness test consists in touching an indenter of standard cone or ball into the surface of a test piece in two operations and measuring the permanent increase of depth of indentation of this indenter under specified condition. From it Rockwell hardness is deduced. The ball (B) is used for soft materials (e.g. mild steel, cast iron, Aluminum, brass. Etc.) And the cone (C) for hard ones (High carbon steel. etc.)

HRB means Rockwell hardness measured on **B scale**

HRC means Rock well hardness measured on **C scale**

PROCEDURE:

1. Clean the surface of the specimen with an emery sheet.
2. Place the specimen on the testing platform.
3. Raise the platform until the longer needle comes to rest
4. Release the load.
5. Apply the load and maintain until the longer needle comes to rest
6. After releasing the load, note down the dial reading.
7. The dial reading gives the Rockwell hardness number of the specimen.
8. Repeat the same procedure three times with specimen.
9. Find the average. This gives the Rockwell hardness number of the given specimen.

TABULATION

S.No.	Material	Scale	Load (kgf)	Rockwell hardness Number			Rockwell hardness Number (Mean)
				1	2	3	

RESULT:

Rockwell hardness number of the given material is __________

PROCEDURE:

1. Specimen is placed on the anvil. The hand wheel is rotated so that the specimen along with the anvil moves up and contact with the ball.
2. The desired load is applied mechanically (by gear driven screw) and the ball presses into the specimen.
3. The diameter of the indentation made in the specimen by the pressed ball is measured by the use of a micrometer microscope, having transparent engraved scale in the field of view.
4. The indentation diameter is measured at two places at right angles to each other, and the average of two readings is taken.
5. The Brinell Hardness Number (BHN) which is the pressure per unit surface area of the indentation is noted down.

OBSERVATION:

S.No.	Material	Load in Kgf	Diameter Of the Indenter in mm	Diameter of the indentation in mm			Brinell Hardness Number(BHN)
				1	2	3	

RESULT:

Thus the Brinell hardness of the Given Specimen is

1. Mild Steel = ---------- BHN
2. EN 8 = ---------- BHN
3. EN 20 = ---------- BHN

COMPRESSIONTEST ON OPEN COIL HELICAL SPRING

AIM:

To determine the stiffness of spring, modulus of rigidity of the spring wire and maximum strain energy stored.

EQUIPMENTS REQUIRED:

1. Spring testing machine
2. A open coil spring
3. Vernier caliper

FORMULAE:

1. Deflection (δ) = $\frac{64\ WR^3 n \sec\alpha}{d^2}$ $[\cos^2\alpha / N + 2\sin^2\alpha / E]$ N/mm^2

   Where,

   W=Load applied in Newton

   R=Mean radius of spring coil = (D-d) / 2

   n= No of Coils

   α=Helix angle of spring

   N=Modulus of rigidity of spring Material

   E=Young's modulus of the spring material

2. Tan α = pitch / 2ΠR
3. Pitch = (L-d) / n

   Where,

   d=Dia of spring wire in mm

   L=Length of spring in mm

   N=no of turns in spring

4. Stiffness of spring (K)=w / δ

   Where,

   δ=Deflection of spring in mm

   W=Load applied in Newton

5. Maximum energy stores = 0.5 x W_{max} x δ_{max}

   Where,

   W_{max}=Maximum load applied

   δ_{Max}=Maximum deflection

PROCEDURE:

1. By using Vernier caliper measure the diameter of the wire of the spring and also the diameter of spring coil.
2. Count the number of turns.
3. Insert the spring in the spring testing machine and load the spring by a suitable weight and note the corresponding axial deflection in compression.
4. Increase the load and take the corresponding axial deflection readings.
5. Plot a curve between load and deflection. The shape of the curve gives the stiffness of the spring

OBSERVATION:

Diameter of spring coil (D) =

Diameter of spring wire (d) =

Number of turns in spring =

Tabulation: To determine the load versus deflection (min 12 readings)

S.No	Load in Kgf	Scale readings in mm		Deflection in mm	Rigidity modulus in N/mm^2	Stiffness in N/mm

OBSERVATION:

To determine the wire diameter, and coil diameter of spring (each 3 readings)

Least count of Vernier =

S.No	Main Scale Reading (MSR) in mm	Vernier scale reading (VSR)	VSR x LC in mm	Total reading = MSR=(VSRxLC) in mm

RESULT:

Under compression test on open coil helical spring

a. Rigidity Modulus (N) =
b. Stiffness of spring (K)=
c. Maximum energy stored =

DOUBLE SHEAR TEST ON GIVEN SPECIMEN

AIM:

To conduct shear test on given specimen under double shear.

EQUIPMENTS REQUIRED:

1. UTM with double shear chuck
2. Vernier Caliber
3. Test Specimen

DESCRIPTION:

In actual practice when a beam is loaded the shear force at a section always comes to play along with bending moment. It has been observed that the effect of shearing stress as compared to bending stress is quite negligible. But sometimes, the shearing stress at a section assumes much importance in design calculations.

Universal testing machine is used for performing shear, compression and tension. There are two types of UTM.

1. Screw type
2. Hydraulic type.

Hydraulic machines are easier to operate. They have a testing unit and control unit connected to each other with hydraulic pipes. It has a reservoir of oil, which is pumped into a cylinder, which has a piston. By this arrangement, the piston is made to move up. Same oil is taken in a tube to measure the pressure. This causes movement of the pointer, which gives reading for the load applied.

DETAILS OF UTM:

Capacity: 400 KN.

Range : 0 - 400 KN.

PRECAUTION:

The inner diameter of the hole in the shear stress attachment is slightly greater than that of the specimen.

PROCEDURE:

1. Measure the diameter of the hole accurately.
2. Insert the specimen in position and grip one end of the attachment in the upper portion and the other end in the lower portion.

3. Switch on the main switch on the universal testing machine.
4. Bring the drag indicator in contact with the main indicator.
5. Gradually move the head control lever in left hand direction till the specimen shears.
6. Note down the load at which specimen shears.
7. Stop the machine and remove the specimen.

OBSERVATION:

Diameter of the specimen (d) = ----- mm

Cross sectional area in double shear, (A) = $2 \times \pi d^2 / 4$ mm^2

Shear Load taken by specimen at the time of failure (P) = ------ KN.

$$\text{Shear strength} = \frac{\text{Maximum shear force}}{\text{Area of the specimen.}}$$

RESULT:

Shear strength of the given material = -------- N / mm^2

IMPACT TEST - IZOD

AIM:

To determine the impact strength of the given material using Izod impact test.

APPARATUS REQUIRED:

1. Vernier caliper
2. Scale

THEORY:

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

FORMULA USED:

$$\text{Impact strength} = \frac{\text{energy absorbed}}{\text{Cross sectional area}} \ \text{J/mm}^2$$

PROCEDURE:

1. Raise the swinging pendulum weight and lock it.
2. Release the trigger and allow the pendulum to swing.
3. This actuates the pointer to move in the dial.
4. Note down the frictional energy absorbed by the bearings.

5. Raise the pendulum weight again and lock it in position.
6. Place the specimen in between the simple anvil support keeping the ”U” notch in the direction opposite to the striking edge of hammer arrangement.
7. Release the trigger and allow the pendulum to strike the specimen at its midpoint.
8. Note down the energy spent in breaking (or) bending the specimen.
9. Tabulate the observation.

OBSERVATION:

Area of cross section of the given material:

S.No	Material Used	Energy absorbed by force (A) J	Energy spent to break the specimen (B) J	Energy absorbed by the specimen (A-B) J	Impact Strength J/mm^2

RESULT:

The impact strength for the given material is __________ J/mm^2

TORSION TEST ON MILD STEEL SPECIMEN

AIM:

To conduct the torsion test on the given specimen for the following

1. Modulus of rigidity
2. Shear stress

APPARATUS REQUIRED:

1. Vernier caliper
2. Scale

FORMULA USED:

1. Modulus of rigidity, C = $\frac{TL}{J\alpha}$ N/mm^2

   Where,

   α =angle of degree

2. Shear stress (t) =TR/L N/mm^2

PROCEDURE:

1. Measure the diameter and length of the given rod.
2. The rod is fixing in to the grip of machine.
3. Set the pointer on the torque measuring scale.
4. The handle of machine is rotate in one direction.
5. The torque and angle of test are noted for five degree.
6. Now the handle is rotated in reverse direction and rod is taken out

THEORY:

A torsion test is quite intruded in determining the values of modulus of rigidity of metallic specimen the values of modulus of rigidity can be found out through observation made during experiment by using torsion equation

$$T/G = C\alpha/L$$

OBSERVATION:

Diameter of the Specimen = mm

Gauge length of the Specimen = mm

TABULATION:

S.NO	ANGLE OF TWIST	Twist in Rod	Torque		Modulus of Rigidity (N/mm^2)	Shear Stress (N/mm^2)
			N-M	N-MM		

RESULT:

Thus the torsion test on given mild steel specimen is done and the values of modulus of rigidity and shear stress are calculated

COMPRESSION TEST ON CONCRETE CUBE

AIM:

To determine the ultimate stress to which the specimen c concrete cube withstand.

APPARATUS REQUIRED:

1. Scale

FORMULA USED:

$$\text{Ultimate stress} = \frac{\text{Ultimate load}}{\text{Area of the specimen}} \quad (\text{N/mm}^2)$$

PROCEDURE:

1. Fix upper and lower pressure plate on the lower cross head and lower table respectively.
2. Place the specimen on the lower compression plate .the specimen should aligned exactly. According to the marking on the compression plate in order to give the complete cross section of the specimen a chance to participate equally in the acceptance load.
3. Then adjust the zero by lifting the lower table.
4. Operate the upper cross head to grip the upper end of the test piece.
5. The left valve in the UTM is kept in fully closed position and the right valve in the normal open position.
6. Open the right valve and close it after lower table is slightly lifted.
7. Adjust the load to zero by using the push button.
8. Operate the lower grip operation handle lift the lower cross head up and grip fully the lower part of the specimen then lock the specimen in this position by operation jaw locking handle.
9. Turn the right control valve slowly to open the position until (anticlockwise) we get a assumed loading mass.
10. After that we will find that the specimen is under load and the under the locking handle.

OBSERVATION:

Size of the Cube (a) = mm

Area of the Cube (A) = mm^2

TABULATION:

S.No	SPECIMEN	Cross section Area (mm)	Ultimate Load		Ultimate Stress (N/mm^2)
			KN	N	

RESULT:

Thus the ultimate stress that the concrete cube can withstand = ________N/mm^2.

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

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

TENSION TEST ON CLOSED COIL HELICAL SPRING

AIM:

To determine the modulus of rigidity and stiffness of the given tension spring specimen.

APPARATUS AND SPECIMEN REQUIRED:

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

PROCEDURE:

1. Measure the outer diameter (D) and diameter of the spring coil (D) for the given tension spring.
2. Count the number of turns i.e. coils (n) of the given specimen.
3. Fit the specimen in the top of the hook of the spring testing machine.
4. Adjust the wheel at the top of the machine so that the other end of the specimen can be fitted to the bottom hook in the machine.
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:

   Modulus of rigidity, $N = \frac{64PR^3n}{d^4\delta}$

   Where,

   P = Load in N

   R = Mean radius of the spring in mm (D –d /2)

   d = Diameter of the spring coil in mm

   δ = Deflection of the spring in mm

   D = Outer diameter of the spring in mm.
9. Determine the stiffness for each load applied by using the following formula:

   Stiffness, K = P/δ
10. Find the values of modulus of rigidity and spring constant of the given spring by taking average values.

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 = cm = mm

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

Result:

The modulus of rigidity of the given spring = -------------------N/mm^2

The stiffness of the given spring = -------------------N/mm^2

TEMPERING- IMPROVEMENT MECHANICAL PROPERTIES COMPARISON

AIM:

To perform the heat treatment tempering on the given material C-40 steel.

APPARATUS REQUIRED:

1. Muffle furnace: tongs
2. Given material: C-40 steel
3. Quenching medium: water

PROCEDURE:

- **Quenching:**
  - It is an operation of rapid cooling by immersing a hot piece into a quenching bath.
- **Tempering:**
  - It is defined as the process of reheating the hardened specimen to some temperature before the critical range followed by any rate of cooling such a reheating permit the trapped temperature to transform and relieve the internal stresses.

1. The given specimen is subjected to Rockwell hardness test and Rockwell hardness number is measured before hardening that the specimen is subjected to rough grinding.
2. The specimen is placed inside the combustion chamber of muffle furnace and is noted up to 830˚ C.
3. Then the specimen is soaked for 10 minutes at the same temperature 830˚C.
4. After soaking it is taken out from the furnace and it is quenched in the water.
5. The specimen is cooled, now the tempering is completed.
6. Again the specimen is subjected to Rockwell hardness test and Rockwell hardness number is measured.

TABULATION:

S.NO	SPECIMEN MATERIAL	LOAD (kgf)	PENETRATOR	SCALE	RHN

RESULT:

The heat treatment tempering on the given material C-40 steel and its Rockwell hardness number is measured

1. Rockwell hardness number before tempering =
2. Rockwell hardness number after tempering =

MECHANICAL PROPERTIES FOR UNHARDENED OR HARDENED SPECIMEN

AIM

To find hardness number and impact strength for unhardened, hardened specimen or Quenched and tempered specimen and compare mechanical properties.

MATERIAL AND EQUIPMENT

Unhardened specimen, Hardened or Quenched and tempered specimen, muffle furnace, Rockwell testing machine, impact testing machine.

PROCEDURE

- **HARDENING:**
  - It is defined as a heat treatment process in which the steel is heated to a temperature within or above its critical range, and held at this temperature for a considerable time to ensure thorough penetration of the temperature inside the component and allowed to cool by quenching in water, oil or brine solution.

Case (I) - Unhardened specimen

1. Choose the indenter and load for given material.
2. Hold the indenter in indenter holder rigidly
3. Place the specimen on the anvil and raise the elevating screw by rotating the hand wheel up to the initial load.
4. Apply the major load gradually by pushing the lever and then release it as before.
5. Note down the readings in the dial for corresponding scale.
6. Take min 5 readings for each material.

Case (II) - For Hardened specimen

1. Keep the specimen in muffle furnace at temperature of 700˚ to 850˚ for 2 hours
2. The specimen is taken from muffle furnace and quenched in water or oil.
3. Then above procedure is followed to test hardness

Case (III) - For Tempered specimen

1. Keep the specimen in muffle furnace at temperature of 650˚ for 2 hours
2. Allow the specimen for air cooling after taking from muffle furnace
3. Then same procedure is followed foe the specimen

OBSERVATION:

ROCKWEL HARDNESS TEST:

- **Cases for hardness =**
- **Cross sectional area =**

S.No	Material	Temperature (˚C)	Load (kgf)	Indenter detail	Scale	RHN			
						Trial 1	Trail 2	Trail 3	Mean
1	Deep case Hardened steel								
2.	Deep case Hardened steel								
3.	Mild steel								
4.	Mild steel								

CHARPY TEST:

S.No	Material and Condition	Energy absorbed (Joules)	Cross-sectional area below the notch (mm^2)	Impact strength (J/ mm^2)
1.	Mild steel-unhardened			
2.	Quenched			

RESULT:

1. **Hardness in**
   (i) Deep case hardened steel
      (a) Unhardened =
      (b) Quenched =
   (ii) Mild steel
      (a) Unhardened =
      (b) Quenched =
2. **Impact strength in**
   (i) Deep case hardened steel
      (a) Unhardened =
      (b) Quenched =

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