DEPARTMENT OF CIVIL ENGINEERING

LAB MANUAL

STRENGTH OF MATERIALS

NATIONAL INSTITUTE OF TECHNOLOGY | SRINAGAR J&K

Vision of the Institute

To establish a unique identity of a pioneer technical Institute by developing a high-quality technical manpower and technological resources that aim at economic and social development of the nation as a whole and the region in particular keeping in view the global challenges.

1. Mission of the Institute

M1. To create a strong and transformative technical educational environment in which fresh ideas, moral principles, research and excellence nurture with international standards.

M2. To prepare technically educated and broadly talented engineers, future innovators and entrepreneurs, graduates with understanding of the needs and problems of the industry, the society, the state and the nation.

M3. To inculcate the highest degree of confidence, professionalism, academic excellence and engineering ethics in budding engineers.

2. VISION OF THE DEPARTMENT

To nurture Civil engineers with passion for professional excellence, ready to take global challenges and to serve the society with high human values.

3. MISSION STATEMENT OF THE DEPARTMENT

(1) To provide facilities and infrastructure for academic excellence in the field of Civil engineering.

(2) To inculcate in the student the passion for understanding professionalism, ethics, safety, sustainability and then actively contribute in the society.

(3) To nurture creativity and encourage innovative solutions to real life challenging problems in Civil engineering students.

(4) To prepare student for lifelong learning in global perspective.

4. PROGRAM EDUCATIONAL OBJECTIVES

PEO1: To prepare students to get employment, profession and/or to pursue post-graduation and research in Civil engineering discipline in particular and allied engineering fields in general.

PEO2: To prepare students to identify and analyse Civil engineering problems in an iterative approach that involves defining, quantifying, testing and review of the identified problem.

PEO3: To prepare students to plan, organize, schedule, execute and communicate effectively as an individual, a team member or a leader in multidisciplinary environment.

PEO4: To provide the students, an academic environment that makes them aware of excellence in field of Civil Engineering and enables them to understand significance of lifelong learning in global perspective.

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TO DETERMINE IMPACT STRENGTH OF STEEL BY IZOD TEST

AIM: To determined impact strength of steel.

OBJECT: To determine the impact strength of steel by Izod impact test

APPARATUS:

1. Impact testing machine
2. A steel specimen 75 mm X 10mm X 10mm
3. Vernier calipers

THEORY:

In manufacturing locomotive wheels, coins, connecting rods etc. the components are subjected to impact (shock) loads. These loads applied suddenly. The stresses induced in the components are many times more than the stress produced by gradual loading. There fore, impact tests are performed to asses shock absorbing capacity of materials subjected to suddenly applied loads. These capabilities are expressed as (i) rupture energy (ii) modulus of rupture and (iii) notch impact strength.

Two types of notch impact tests are commonly

1. Charpy test
2. Izod test

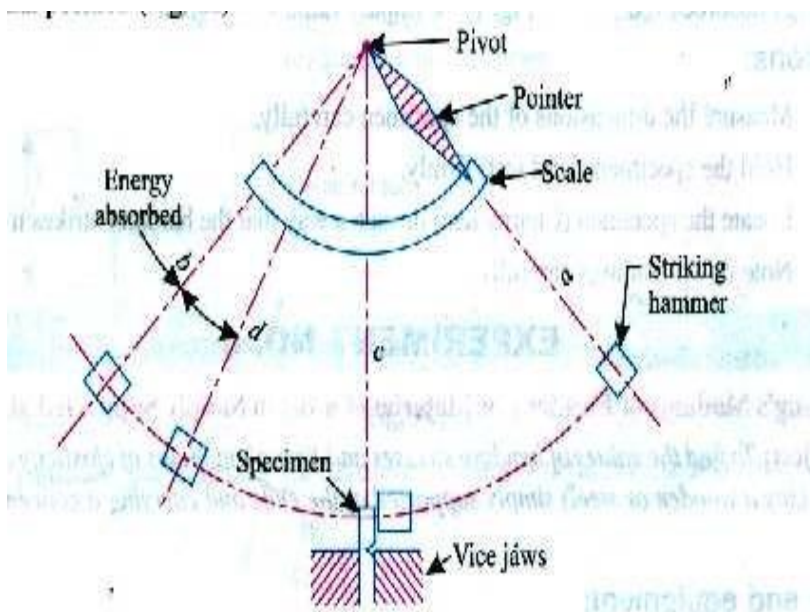
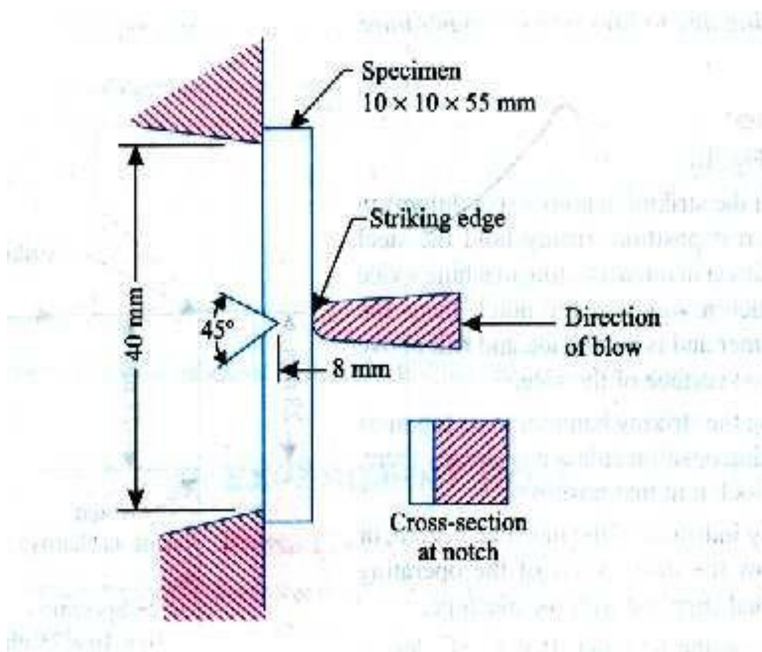

Pivot
Pointer
Scale
Energy absorbed
Striking hammer
Specimen
Vice jaws
b
d
c
e

Fig. 11


Specimen
10 × 10 × 55 mm
Striking edge
Direction of blow
40 mm
45°
8 mm
Cross-section at notch

In Izod test, the specimen is placed as cantilever beam. The specimens have V-shaped notch of 45^o. U-shaped notch is also common. The notch is located on tension side of Specimen during impact loading. Depth of notch is generally taken as - to - where t is thickness of the specimen.

SPECIFICATIONS OF M/C AND SPE CIMENT DETAILS:

Impact capacity=164 joules

Least count of capacity (dial) scale =2 joules

Weight of striking hammer =18.7kg

Swing diameter of striking hammer =1600mm

Angle of hammer before striking=90^0

Distance between supports=40mm

Striking velocity of hammer=5.6m/sec

Specimen size=75 mm X 10mm X 10mm

Type of notch = V- notch

Angle of notch =45^0

Depth of notch=2mm

PROCEDURE:

With the striking hammer (pendulum) in safe test position, firmly

Hold the steel specimen in impact testing machine’s vice in such away that the notch face the hammer and is half inside and half above the top surface of the vice.

EVALUATION OF TEST:

The notch impact strength ‘I’ is calculated according to the following relation I =

Where,

I = impact strength N-m or J

K = impact energy absorbed on repute N-m or J

A = area of cross section of specimen below the notch before test m^2

Area at V- notch, A=B X D …… m^2

Breadth at V – notch =B …… m

Depth at V-notch =D ……. m

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

Impact strength of the given specimen is ……………N-m

Bring the striking hammer to its top most striking position unless it is already there, and lock it at that position.

Bring indicator of the machine to zero, or follow the instructions ofthe operating manual supplied with the machine.

Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost final position.

Again bring back the hammer to its idle position and back.

PRECAUTIONS:

The specimen should be prepared in proper dimensions

Take reading more frequently

Make the loose pointer in contact with the fixed pointer after the pendulum

Do not stand infront of swimming hammer or releasing hammer

Place the specimen proper position

RESULT:

i. The energy absorbed for Mild Steel is found out to be-------Joules.

TO DETERMINE IMPACT STRENGTH OF STEELBY CHARPY TEST

AIM: To determined impact strength of steel**.**

OBJECT: To determine the impact strength of steel by Charpy test

APPARATUS:

1. Impact testing machine
2. A steel specimen 10 mm X 10mm X 55mm

THEORY:

An impact test signifies toughness of material that is ability of material to absorb energy during plastic deformation. Static tension tests of unmatched specimens do not always reveal the susceptibility of a metal to brittle fracture this important factor is determined by impact test. Toughness takes into account both the strength and ductility of the material. Several engineering materials have to withstand impact or suddenly applied 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 notch bar tests are most extensively used. Therefore, the impact test measures the energy necessary to fracture a standard notch bar by applying an impulse load. The test measures the notch toughness of material under shock 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

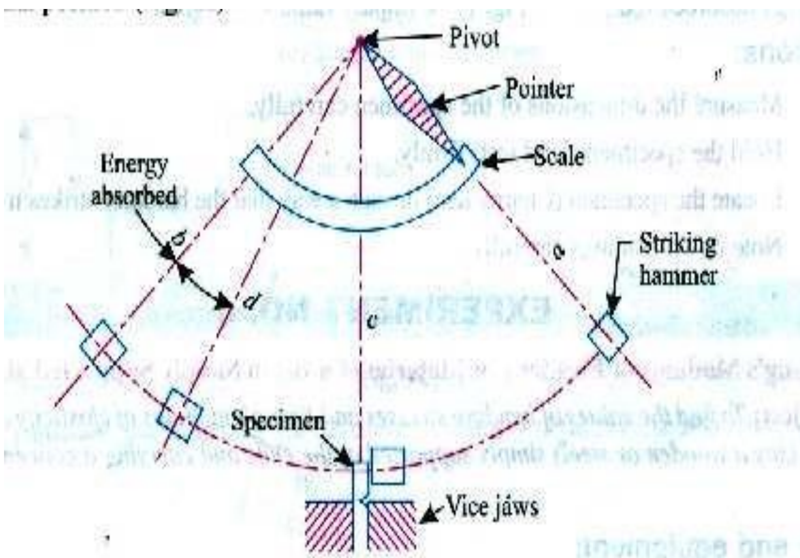
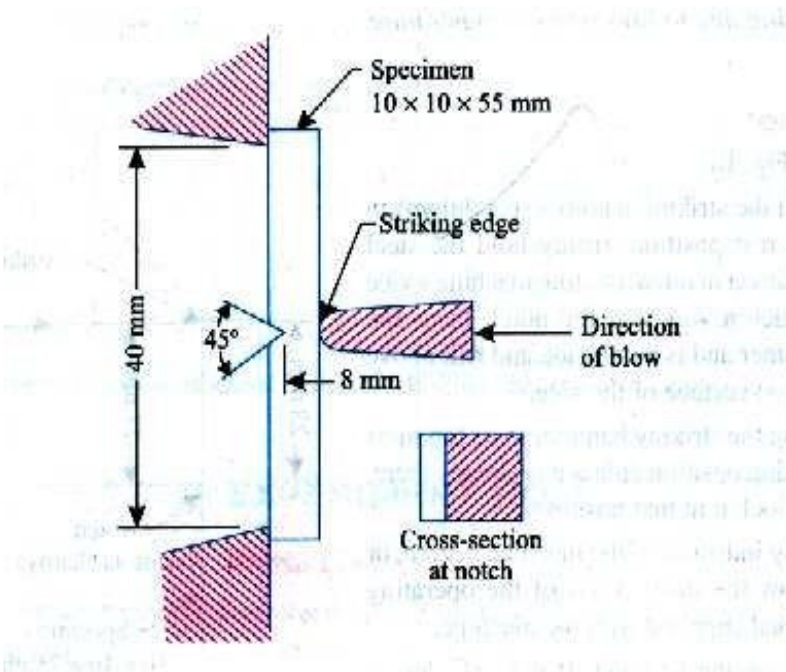


Fig. 11



of various materials or toughness of the same material under different condition. This test can also be used to assess the ductile brittle transition temperature of the material occurring due to lowering of temperature.

SPECIFICATIONS OF M/C AND SPE CIMENT DETAILS:

Impact capacity=300joules

Least count of capacity (dial) scale =2 joules

Weight of striking hammer =18.7kg

Swing diameter of striking hammer =1600mm

Angle of hammer before striking=160^0

Distance between supports=40mm

Striking velocity of hammer=5.6m/sec

Specimen size=55 mm X 10mm X 10mm

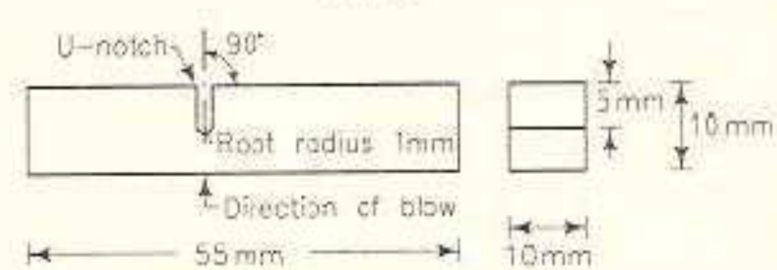
Type of notch = V- notch

Angle of notch $=45^0$

Depth of notch=2mm

DESCRIPTION OF MACHINE:

The pendulum impact testing machine consists of the robust frame, the pendulum, the specimen support and the measuring dial. The pendulum shaft is attend in anti friction bearings. The pendulum is clamped to pendulum shaft. The pendulum consists of the pendulum pipe and the pendulum hammer of U-shaped design. Into this, the striker is mounted for conducting Charpy impact



Specimen charpy impact test

FIG. 7-4

test. The range, within which the pendulum is swinging, is partially protected by the guard. A latch is provided which keeps the pendulum is elevated position.

A lever is provided for operating the latch and releasing the pendulum. There is a dial attached concentrically with the pendulum shaft. The scale is designed such that the impact energy absorbed in breaking the specimen can be read directly in joules.

PROCEDURE:

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machines vice in such a way that the notch faces s the hammer and is half inside and half above the top surface of the vice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at that position.

3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with the machine.

EVALUTION OF TEST:

The notch impact strength ‘I’ is calculated according to the following relation

I =

Where,

I= impact strength N-m or J

K = Impact energy absorbed on repute N-m or J

A = area of cross section of specimen below the notch before test m^2

Area at V- notch, A=B X D m^2

Breadth at V- notch = B m

Depth at V- notch =D m

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

4. Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost final position.
5. The specimen is placed on supports or anvil so that the blow of hammer is opposite to the notch.

PRECAUTIONS:

The specimen should be prepared in proper dimensions

Take reading more frequently

Make the loose pointer in contact with the fixed pointer after the pendulum

Do not stand infront of swimming hammer or releasing hammer

Place the specimen proper position

RESULT:

i. The energy absorbed for Mild Steel is found out to be-------Joules.

ROCKWELL HARDNESS TEST

AIM: Hardness Test of Mild Steel**.**

OBJECT: To determine the hardness of the given specimen using Rockwell hardness test.

APPARATUS: 1. Rockwell hardness testing machine

2 . Specimen of hard steel

THEORY:

Rockwell test is developed by the Wilson instrument co U.S.A in 1920.

This test is an indentation test used for smaller specimens and harder materials. The test is subject of IS: 1586.In this test indenter is forced into the surface of a test piece in two operations, measuring the permanent increase in depth of an indentation from the depth increased from the depth reached under a datum load due to an additional load.

Measurement of indentation is made after removing the additional load.

Indenter used is the cone having an angle of 120 degrees made of black diamond.

SPECIFICATION OF HARDNESS TESTING M/C AND INDENTORS:

A hardness test can be conducted on Brinell testing m/c, Rockwell hardness m/c or vicker testing m/c. the specimen may be a cylinder, cube, thick or thin metallic sheet. A Brinell cum- Rockwell hardness testing m/c along with the specimen is shown in figure.

Refer to Fig. 6.

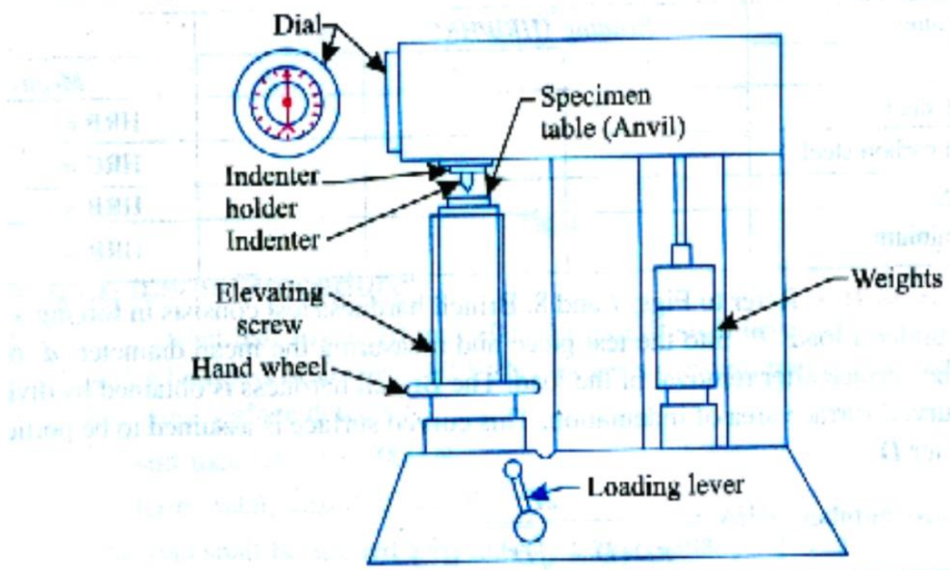


Fig. 6. Rockwell hardness tester.

TECHNICAL DATA:

Maximum test height:	295mm.
Depth of throat:	150mm.
Maximum depth of screw below base:	280mm.
Dimensions of machine:	210 X 470mm.
Height:	850mm.
Net weight:	125 kg

PROCEDURE:

For carrying out tests, the following procedure should be adopted very carefully; any negligence may lead damage to the indenter.

1. Adjust the weight on plunger of dash-post according to the Rockwell scale required as shown on chart.
2. Keep the lever at position A.

3. Place specimen securely on testing table. Turn the hand wheel clockwise, so that specimen will push the indenter and show a reading on dial gauge as small pointer at ‘3’ (red spot) and long pointer close to ‘0’ of outer scale.
4. Turn the lever from position A to B slowly so that, the total load is brought into action without any jerks.
5. The long pointer dial gauge reaches a steady position when indentation is complete. Then take back the lever to ‘A’ position slowly (Sudden return to lever from B to A my show erratic reading). The weights are thereby lifted off, only the initial load remaining active.
6. Read the figure against the long pointer that is the direct reading of the Rockwell hardness of specimen. Use Block or Red scale as per selection of Rock well scale.
7. Turn back the hand wheel and remove the specimen piece. Carry on the same procedure for further tests.

8. The first hardness valve so obtained may not be correct. All standards recommended neglecting first two reading to ensure that specimen, the indenter and the anvil are seating correctly. Further will be correct.

PRECAUTIONS:

1. Thickness of the specimen should not be less than 8 times the depth of indentation to avoid the deformation to be extended to the opposite surface of a specimen.

TABULAR COLUMN: (ROCKWELL TEST):

Sl.No	Specimen Material	Type of indenter	Diameter of indenter (mm)	Load applied (kg)	Rock well reading HRA/HRB/HRC

2. Indentation should not be made nearer to the edge of a specimen to avoid unnecessary concentration of stresses. In such case distance from the edge to the center of indentation should be greater than 2.5 times diameter of indentation.
3. Rapid rate of applying load should be avoided. Load applied on the ball may rise a little because of its sudden action. Also rapidly applied load will restrict plastic flow of a material, which produces effect on size of indentation.

CHART: Chart for most commonly used for Rockwell hardness test.

Total test force preliminary test force (10kgf)	60kgf	100kgf	150kgf
Indicator	Diamond Cone 120^o	Ball 1/16 Diameter	Diamond Cone 120^o
Scale	A	B	C
Pointer position on dial at	Set	Set	Set
Dial to be read	Black	Red	Black

Typical application	Thin steel and shallow case hardened steel	Soft steel, malleable, copper and aluminum alloys	Steel, hard cast steel, deep case hardened steel, others metals

OBSERVATION:

1. Take average of five values of indentation of each specimen. Obtain the hardness number from the dial of a machine.
2. Compare Brinell and Rockwell hardness tests obtained.

RESULT:

Rockwell Hardens Number of the given specimen, HRA/HRB/HRC =------------------------

BRINELL HARDNESS TEST

AIM:

To find hardness of the given specimen by Rockwell & Brinell testing Machine

APPARATUS:

1. Brinell Hardness testing machine
2. specimen of mild steel / cast iron/ non ferrous metals and
3. Brinell microscope.

PRINCIPLE BRINELL TESTING:

Brinell hardness test is an indentation hardness test using a calibrated machine to force a hard steel ball indenter under specified conditions of load and name, into the surface of the material under test and to measure the diameter of the resulting impression after release of the load.

SPECIFICATION OF HARDNESS TESTING M/C AND INDENTORS

A hardness test can be conducted on Brinell testing m/c, Rockwell hardness m/c or vicker testing m/c. the specimen may be a cylinder, cube, think or thin metallic sheet. A Brinellcum- Rockwell hardness testing m/c along with the specimen is shown in figure. Its

SPECIFICATION ARE AS FOLLOWS:

1. Ability to determine hardness upto 500BHN.
2. Diameter of ball (as indentor) used D = 2.5mm, 5mm, 10mm.
3. Maximum application load = 3000kgf.

4. Method of load application = Lever type
5. Capability of testing the lower hardness range = 1 BHN on application of 0.5D2 load.

TESTING METHOD: This test consists of indenting the surface of the metal by a hardened steel all of specified diameter 'D' mm under a given load 'F' N and measuring the average diameter 'd' mm of the impression by a Brinell microscope. The Brinell hardness HB is defined as the quotient of the applied force 'F' divided by the spherical area of the impression.

Brinell hardness, HB =) (

Where,

F= Load…….N

D= Diameter of the indenter ……… mm

d= Diameter of the impression……… mm

DESCRIPTION:

The hardness test is of cast iron body. The enclosed design protects the internal operating parts from determined dust and extraneous elements. The main screw is also protected by a rubber below. The basic system is of weights and levers. The weights under hydraulic dash – pot time control are applied on free end of lever, which transmits the pressure. On plunger and there by on the work –piece for determination of hardness value. A clamping device enable the tight clamping of work – piece during the test which at times can not be checked under normal conditions.

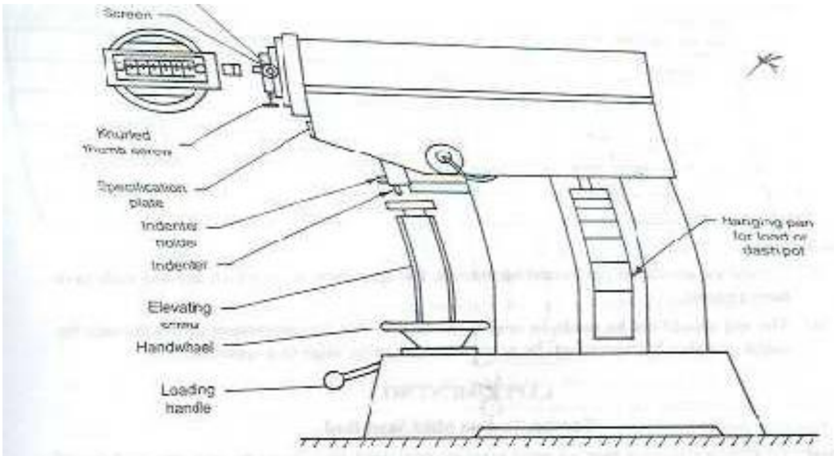


Fig. 7. Brinell hardness tester.

Brinell hardness number, $BHN = \frac{2P}{\pi D\,(D - \sqrt{D^2 - d^2})}$

Test Requirements/Procedure:

TECHNICAL DATA:

Maximum test height: 295mm.

Depth of throat: 150

Maximum depth of screw below base: 280 mm.

Dimension of machine: 210 X 470 mm.

Height:	850 mm.
Net weight:	125 kg.

PROCEDURE:

For carrying out tests, the following procedure should be adopted very carefully; any negligence may lead damage to the indenter.

1. Adjust the weights on plunger of dash – pot according to the Rockwell scale required as shown on chart.
2. Keep the leaver at position A.
3. Place specimen securely on testing table. Tern the hand wheel clockwise, so that specimen will push the indenter of diameter 'D' and show a reading on dial gauge as small point at '3'(Red spot) and long pointer close to '0' of outer scale.
4. Turn the lever from position A to B slowly so that, the total load is brought into action with out any jerks.

TABULAR COLUMN: (BRINELL TEST)

Sl.No	Specimen Material	Type of indenter	Diameter of indenter (mm)	Load applied (Kg)	Brinell hardness

Take,

If diameter of ball indenter ‘D’ is 2.5 mm, then $F/D^2 = 30$

If diameter of ball indenter ‘D’ is 5 mm, then $F/D^2 = 10$

5. The long pointer dial gauge reaches a steady position when indentation is complete. Then take back the lever to ‘A’ position slowly. (Sudden return to lever from B to A may show erratic reading. The weights are hereby lifted off, only the initial load remaining active

6. Replace the specimen from the testing table to the surface plate. Then measure the impression diameter of ‘d’ by using Brinell microscope.

7. Carry on the same procedure for further tests.

CHART: Chart for most commonly used for Brinell hardness tests.

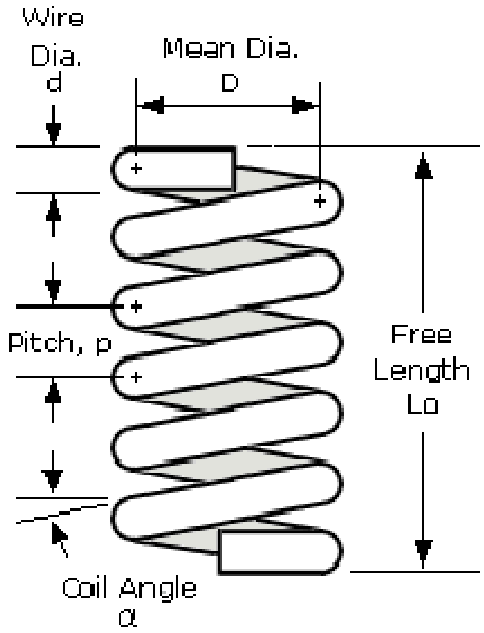
1st force preliminary test force (10Kgf)	187.5Kgf	250 Kgf
	Ball – 2.5 mm diameter	Ball – 5mm diameter
Application	Steel and cast iron	Copper and aluminum alloys

PRECAUTIONS:-

1. The specimen should be clean properly.
2. Take reading more carefully and correct.
3. Place the specimen properly.
4. Jack adjusting wheel move slowly
5. After applying load remove the load.

RESULT:

Brinnel Hardness Number of the given specimen, HB =



SPRING TEST

AIM:

To determine the stiffness and rigidity modulus of the given spring by conducting impression test.

APPARATUS:

1. Closely coiled helical spring
2. Spring testing machine.
3. vernier caliper.
4. Micrometer

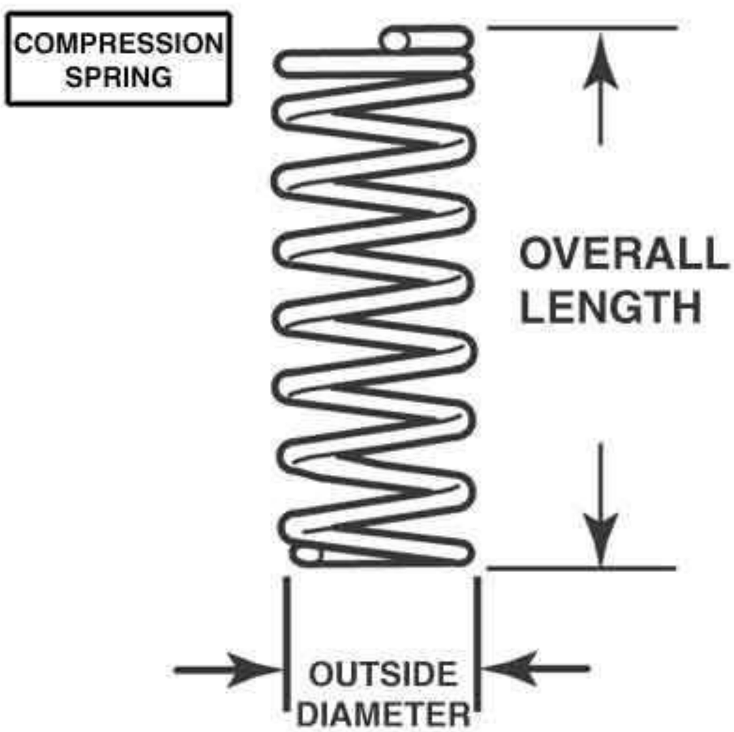
THEORY:

Springs are elastic member which distort under load and regain their original shape when load is removed. They are used in railway carriages, motor cars, scooters, motorcycles, rickshaws, governors etc. According to their uses the springs perform the following Functions:

1. To absorb shock or impact loading as in carriage springs
2. To store energy as in clock springs.
3. To apply forces to and to control motions as in brakes and clutches.
4. To measure forces as in spring balances.
5. To change the variations characteristic of a member as in flexible mounting of motors.

For spring wire diameter (d) :

S.NO	**M.S.R.**	**V.C.R.**	**M.S.R+(V.C.R.X L.C.)**
			Average=



Several types of spring are available for different application. Springs may classified as helical springs, leaf springs and flat spring depending upon their shape. They are fabricated of high shear strength materials such as high carbon alloy steels spring form elements of not only mechanical system but also structural system. In several cases it is essential to idealise complex structural systems by suitable spring.

PROCEDURE:

1) Measure the diameter of the wire of the spring by using the micrometer.

2) Measure the diameter of spring coils by using the vernier caliper

3) Count the number of turns.

4) Insert the spring in the spring testing machine and load the spring by a suitable weight and note the corresponding axial deflection in tension or compression.

5) Increase the load and take the corresponding axial deflection readings.

6) Plot a curve between load and deflection. The shape of the curve gives the stiffness of the spring.

OBSERVATIONS:

Least count of micrometer = ……mm

Diameter of the spring wire, d =………mm

(Mean of three readings)

Least count of vernier caliper = ……mm

Diameter of the spring coil, D = ……mm

(Mean of three readings)

Mean coil diameter, Dm = D - d……mm

Number of turns, n =

Mean radius of the spring = ——…….m

TABULAR COLUMN:

S.NO	LOAD	DEFLECTION	K=W/	MODULUS OF RIGIDITY

DESCRIPTION:

The compression test is similar to the tensile test and all the mechanical properties determined in the tensile test can be determined. When an axial compressive load 'W' is applied on a spring, every section of spring wire is subjected to a twisting moment W X R, Where 'R' is the mean radius of the coil. If' ' is the deflection of spring due to compressive load then, the stiffness of the spring,

K = w/

For a closely coiled helical spring.

$$\delta =$$

where,

δ = Deflection of the spring

W= Load applied

R = Mean radius of the coil

G = modulus of Rigidity

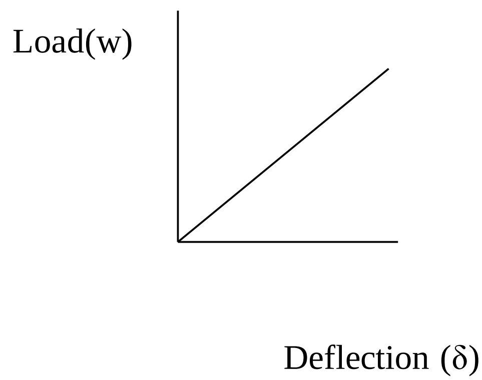
D= Diameter of the wire of the coil

N= No. of terns of the spring.

From the above expression for a given spring, 'G' can be determined by measuring under a particular load 'W

GRAPH:

A graph between Load Vs deflection is drawn. From the graph at a particular value of W the corresponding value of (δ)is noted. By using this values of **G** is calculated.



RESULT:

Stiffness of the spring K = ……………N/mm

Modulus of rigidity, G = ………………N/mm^2

COMPRESSIVE STRENGTH OF BRICK

AIM:

To determine the compressive strength of brick

OBJECT: - The specimen brick is immersed in water for 24 hours. The frog of

The Compressive Strength

APPARATUS:

Bricks, Oven Venire Caliper, Scale.

FORMULA: -

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

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 transversed 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: -

OBSERVATION TABLE:

S.NO	LXBXH cm^3	Area LXB Cm^2	Load (p)	Compressive strength(P/A)

Average Compressive strength=……….

CALCULATION:- -

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

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

PRECAUTION: -

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.

RESULT: -

The average compressive strength of new brick sample is found to be ………. Kg/sq.cm.

FOR DIAMETER (d):

S.NO	**M.S.R.**	**V.C.R.**	**M.S.R+(V.C.R.X L.C.)**
			Average=

TORSION TEST ON MILD STEEL

AIM:- Torsion test on mild steel rod

OBJECTIVE:

To conduct torsion test on mild steel or cast iron specimens to find out modulus of rigidity

APPARATUS:-

1. A torsion testing machine
2. Vernier Caliper
3. mild steel specimen

THEORY:- when two equal opposite torques applied on a shaft, the shaft is said to be in pure torsion. When the shaft is subjected to torsion, shear stresses and shear strains are produced in the material. A torsion test is quite instrumental in determining the value of modulus of rigidity of a metallic specimen. The value of modulus of rigidity can be found out by using torsion equation

$$ — = \frac{!}{"} = \frac{\#}{\$} $$

Where,

T= Torque applied

J = Polar moment of inertia

G = Modulus of rigidity

θ = Angle of twist (radians)

L = Length of rod

OBESERVATION

a. Gauge length of the specimen, l = ………
b. Diameter of the specimen, d = ………

c. Polar moment of inertia,

$$\% = \frac{\&^{\cdot\,(}}{)*}$$

SI.NO	1	2	3	4	5	6	7	8	9	10
Torque(T)										
Angle of twist (θ) in degrees										
Modulus of rigidity (G) N/mm^2										

q = shear stress

R = radius of rod

PROCEDURE:-

1. Select the driving dogs to suit the size of the specimen and clamp it in the Machine by adjusting the length of the specimen by means of a sliding spindle
2. Measure the diameter at about three places and take the average value
3. Choose the appropriate range by capacity change lever
4. Set the maximum load pointer to zero
5. Set the protector to zero for convenience and clamp it by means of knurled Screw
6. Carry out straining by rotating the hand wheel in either direction
7. Load the machine in suitable increments
8. Then load out to failure as to cause equal increments of strain reading
9. Plot a torque- twist (T- θ) graph
10. Read off co-ordinates of a convenient point from the straight line portion

Straight line portion of the torque twist (T- θ) graph and calculate the value of ‘G’ by using relation

$$+ = \frac{!}{"}$$

PRECAUTIONS:-

1) Measure the dimensions of the specimen carefully

2) Measure the Angle of twist accurately for the corresponding value of Torque

3) Maintain the distance from torsion machine when it is working

4) The cross section and the along the shaft is same

RESULT:-

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

SIMPLY SUPPORTED BEAM

AIM: -To determined young's modulus of elasticity of material of beam simply supported at ends.

OBJECT:-To find the values of bending stresses and young's modulus of elasticity of the material of a beam simply supported at the ends and carrying a concentrated load at the centre.

APPARATERS:

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

THEORY:-

If the beam is supports at the two ends, the beam is known simply supported beam. When a beam is subjected to load the beam goes under deformation. The difference between the elastic curve to original position of the beam is called deflection. When a simply supported beam subjected to point load at the midpoint, the beam bends concave upwards.

The deflection at mid point is given by

$$= \frac{\quad}{4801}$$

From above equation

$$0 = \frac{}{48 \quad 1}$$

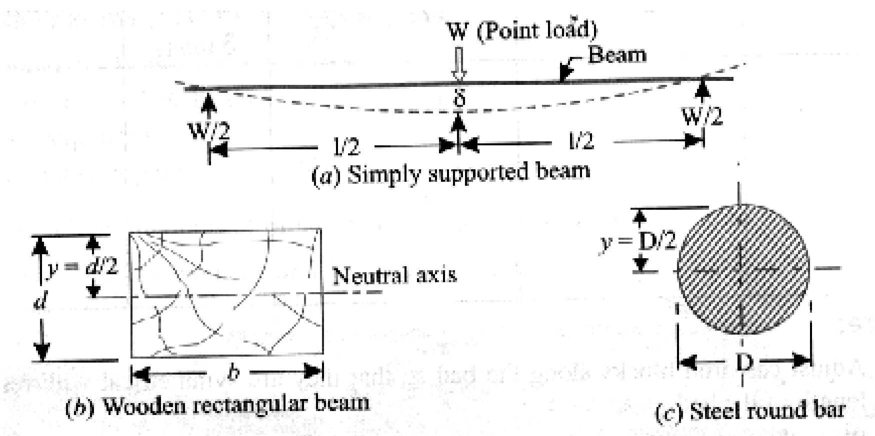


Fig. 14

<u>for diameter or depth of beam (d)</u>

S.NO	M.S.R.	V.C.R.	M.S.R+(V.C.R.X L.C.)
			Average=

Where

W =Load acting at the center, N

L =Length of the beam between the supports mm

E =Young’s modulus of material of the beam, N/mm^2

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

$$1 = \frac{2}{3} \quad \text{for rectangular beam}$$

where

b= width of beam and d= depth of the beam

$1 =$ for cirucular section

Where

d= diameter of the beam

<u>BENDING STRESS</u>:

When the stress produced to due to bending moment, the stress is known as bending stress. The bending stress can be obtained by bending equation

$$\frac{0}{4} = \frac{5}{1} = \frac{6}{7}$$

Where E =Young’s modulus of material of the beam, N/mm^2

R= radius of curvature

M=bending moment= 8 ,Nmm

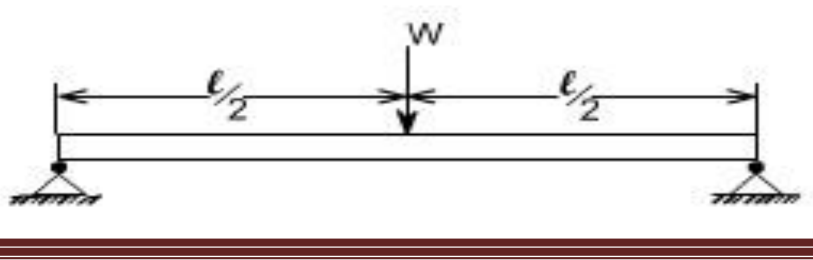
I =Second moment of area of the cross- section,mm^4

OBESERVATION TABLE :-

SI.NO	LOADS ON BEAM	δ1	δ2	Δ	Young's modulus $0 = \frac{-}{48\ 1}$	Bending moment M= 8	Bending stress $6 = \frac{5}{1} 7$
1							
2							
3							
4							
5							
6							

δ1= deflection in increasing order

δ2= deflection in decreasing order



f= bending stress, N/mm^2

y=distance from N.A. ,mm

For simply supported beam bending moment is zero at supports and maximum at mid point when the load is symmetrical

PROCEDURE:

1. place the simply supported beam, Take dimension i.e., Length, Width, Thickness of the specimen
2. check the flatness of given beam with the help of dial gauge
3. Place the dial gauge under the beam where the deflection is to be measured.
4. place the hanger at the midpoints of the beam
5. now place the weights in span in increasing order at mid point
6. calculate the deflections in dial gauge for different weights
7. repeat the experiment with various loads of the beams
8. calculate deflections in decreasing order also
9. using the equation calculate the bending stress

PRECAUTIONS:

1. Make sure that beam and load are placed a proper position.
2. The cross- section of the beam should be large.
3. Note down the readings of the vernier scale carefully

RESULT:

1. The young's modulus for steel beam is found to be----- N/mm$^{2.}$

(OR)

2. The young's modulus for wooden beam is found to be----- N/mm^2

CANTILEVER BEAM

AIM: -To determined young's modulus of elasticity of material of cantilever beam

OBJECT:-To find the values of bending stresses and young's modulus of elasticity of the material of a cantilever beam and carrying a concentrated load at the end.

APPARATERS:

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

THEORY:

The beam which has one end is fixed and another end is free is called cantilever beam. For the cantilever beam the bending moment is zero at free end and maximum at fixed end. When the cantilever beam is subjected to a load at free end the beam will bend in convexity downwards. The deflection at free end is maximum and at fixed end is zero.

When the cantilever beam is subjected to a load at free end then the maximum bending moment is given by

`M= WL

Where W =Load acting on the beam

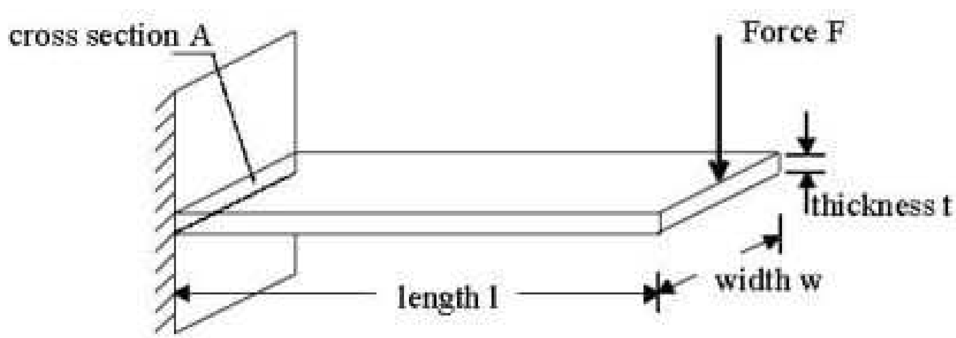
L= length of the beam

When the cantilever beam is subjected to a load at free end then the deflection is given by

$$= \frac{\text{[illegible]}}{301}$$

<u>for diameter or depth of beam (d)</u>

S.NO	**M.S.R.**	**V.C.R.**	**M.S.R+(V.C.R.X L.C.)**
			Average=



From above equation

$$0 = \frac{\quad}{3 \quad 1}$$

Where

W =Load acting at the free end , N

L =Length of the beam mm

E =Young's modulus of material of the beam, N/mm^2

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

$1 = \frac{2}{3}$ for rectangular beam

where

b= width of beam and d= depth of the beam

$1 =$ for cirucular section

Where

d= diameter of the beam

BENDING STRESS:

When the stress produced to due to bending moment, the stress is known as bending stress. The bending stress can be obtained by bending equation

$$\frac{0}{4} = \frac{5}{1} = \frac{6}{7}$$

Where

OBESERVATION TABLE :-

SI.NO	LOADS ON BEAM	δ1	δ2	δ	Young's modulus $0 = \frac{,-}{3\ 1}$	Bending moment M=WL	Bending stress $6 = \frac{5}{1}7$
1							
2							
3							
4							
5							
6							

δ1= deflection in increasing order

δ2= deflection in decreasing order

E =Young's modulus of material of the beam, N/mm^2

R= radius of curvature

M=bending moment= WL Nmm

I =Second moment of area of the cross- section,mm^4

f= bending stress, N/mm^2

y=distance from N.A. ,mm

PROCEDURE:

1. place the cantilever beam, Take dimension i.e., Length, Width, Thickness of the specimen
2. check the flatness of given beam with the help of dial gauge
3. Place the dial gauge under the beam where the deflection is to be measured.
4. place the hanger at the end point of the beam
5. now place the weights in span in increasing order at free end
6. calculate the deflections in dial gauge for different weights
7. repeat the experiment with various loads of the beams
8. calculate deflections in decreasing order also
9. using the equation calculate the bending stress

PRECAUTIONS:

1. Make sure that beam and load are placed a proper position.
2. The cross- section of the beam should be large.
3. Note down the readings of the vernier scale carefully

RESULT:

1. The young's modulus for steel beam is found to be----- N/mm^{2}.

STUDY OF UNIVERSAL TESTING MACHINE

AIM: -

Study of Universal Testing Machine (U.T.M.)

OBJECT: -

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

APPARATUS:

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

THEORY : - The Universal Testing Machine consists of two units.

1) Loading unit,
2) Control panel.

LOADING UNIT:-

It consists of main hydraulic cylinder with robust base inside. The piston which moves up and down. The chain driven by electric motor which is fitted on left hand side. The screw column maintained in the base can be rotated using above arrangement of chain. Each column passes through the main nut which is fitted in the lower cross head.

The lower table connected to main piston through a ball & the ball seat is joined to ensure axial loading. There is a connection between lower table and upper head assembly that moves up and down with main piston. The measurement of this assembly is carried out by number of bearings which slides over the columns.

The test specimen each fixed in the job is known as 'Jack Job'. To fix up the specimen tightly, the movement of jack job is achieved helically by handle.

CONTROL PANEL:-

It consists of oil tank having a hydraulic oil level sight glass for checking the oil level. The pump is displacement type piston pump having free plungers those ensure for continuation of high pressure. The pump is fixed to the tank from bottom. The suction & delivery valve are fitted to the pump near tank Electric motor driven the pump is mounted on four studs which is fitted on the right side of the tank. There is an arrangement for loosing or tightening of the valve. The four valves on control panel control the oil stroke in the hydraulic system. The loading system works as described below.

The return valve is close, oil delivered by the pump through the flow control valves to the cylinder & the piston goes up. Pressure starts developing & either the specimen breaks or the load having maximum value is controlled with the base dynameters consisting in a cylinder in which the piston reciprocates. The switches have upper and lower push at the control panel for the downward & upward movement of the movable head. The on & off switch provided on the control panel & the pilot lamp shows the transmission of main supply.

METHOD OF TESTING:-

Initial Adjustment:

before testing adjust the pendulum with respect to capacity of the test i.e. 8 Tones; 10 Tones; 20 Tones; 40 Tones etc.

For ex: **-** A specimen of 6 tones capacity gives more accurate result of 10 Tones capacity range instead of 20 Tones capacity range. These ranges of capacity are adjusted on the dial with the help of range selector knob. The control weights of the pendulum are adjusted correctly. The ink should be inserted in pen holder of recording paper around the drum & the testing process is started depending upon the types of test as mentioned below.

TENSION TEST:-

Select the proper job and complete upper and lower check adjustment. Apply some Greece to the tapered surface of specimen or groove. Then operate the upper cross head grip operation handle & grip the upper end of test specimen fully in to the groove. Keep the lower left valve in fully close position. Open the right valve & close it after lower table is slightly lifted. Adjust the lower points to zero with the help of adjusting knob. This is necessary to remove the dead weight of the lower table. Then lock the jobs in this position by operating job working handle. Then open the left control valve. The printer on dial gauge at which the specimen breaks slightly return back & corresponding load is known as breaking load & maximum load is known as the ultimate load.

COMPRESSION TEST:-

Fix upper and lower pressure plates to the upper stationary head & lower table respectively. Place the specimen on the lower plate in order to grip. Then adjust zero by lifting the lower table. Then perform the test in the same manner as described in tensio

FLEXURAL OR BENDING TEST:-

Keep the bending table on the lower table in such a way that the central position of the bending table is fixed in the central location value of the lower table. The bending supports are adjusted to required distance.

Stuffers at the back of the bending table at different positions. Then place the specimen on bending table & apply the load by bending attachment at the upper stationary head. Then perform the test in the same manner as described in tension test.

BRINELL HARDNESS TEST:-

Place the specimen on the lower table & lift it up slightly. Adjust the zero fixed value at the bottom side of the lower cross head. Increase the load slowly ultimate load value is obtained. Then release the load slowly with left control valve. Get the impression of a suitable value of five to ten millimeter on the specimen & measure the diameter of the impression correctly by microscope & calculate Brinell hardness.

SHEAR TEST:-

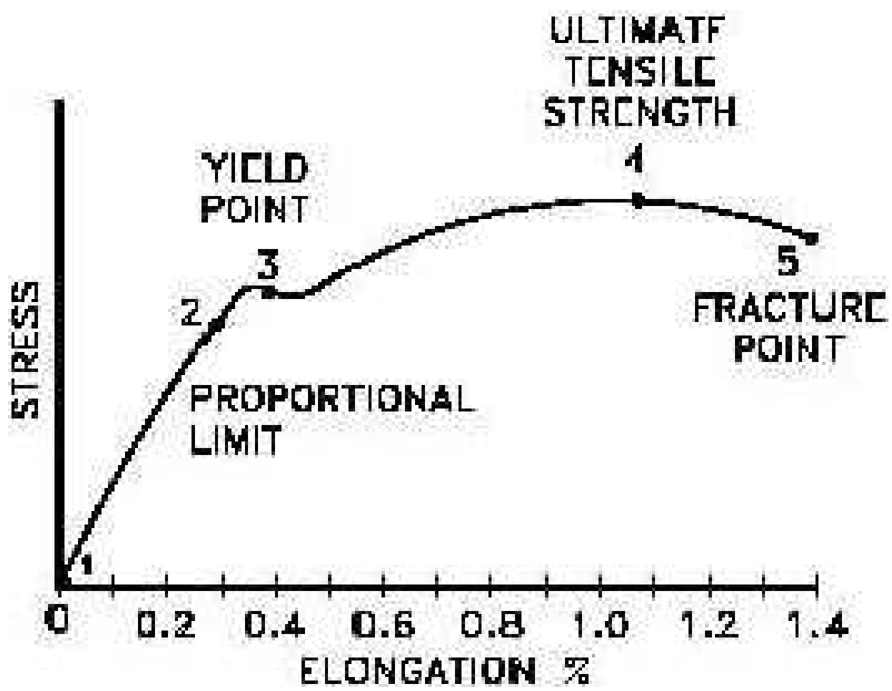
Place the shear test attachment on the lower table, this attachment consists of cutter. The specimen is inserted in roles of shear test attachment & lift the lower table so that the zero is adjusted, then apply the load such that the specimen breaks in two or three pieces. If the specimen breaks in two pieces then it will be in angle shear, & if it breaks in three pieces then it will be in double shear.

STUDY OF EXTENSOMETER:-

This instrument is an attachment to Universal / Tensile Testing Machines. This measures the elongation of a test place on load for the set gauge length. The least count of

Measurement being 0.01 mm and maximum elongation measurement up to 3 mm. This elongation measurement helps in finding out the proof stress at the required percentage elongation.

A) STRESS-STRAIN GRAPH OF MILD STEEL



WORKING OF THE INSTRUMENT:

The required gauge length(between 30to 120) is set by adjusting the upper knife edges (3) A scale (2) is provided for this purpose . Hold the specimen in the upper and lower jaws of Tensile / Universal Testing Machine. Position the extensometer on the specimen. Position upper clamp (4) To press upper knife edges on the specimen. The extensometer will be now fixed to the specimen by spring pressure. Set zero on both the dial gauges by zero adjust screws (7). Start loading the specimen and take the reading of load on the machine at required elongation or the elongation at required load. Force setter accuracies mean of both the dial gauge (8) readings should be taken as elongation. It is very important to note & follow the practice of removing the extensometer from the specimen before the specimen breaks otherwise the instrument will be totally damaged. As a safety, while testing the instrument may be kept hanging from a fixed support by a slightly loose thread.

TECHNICAL DATA:-

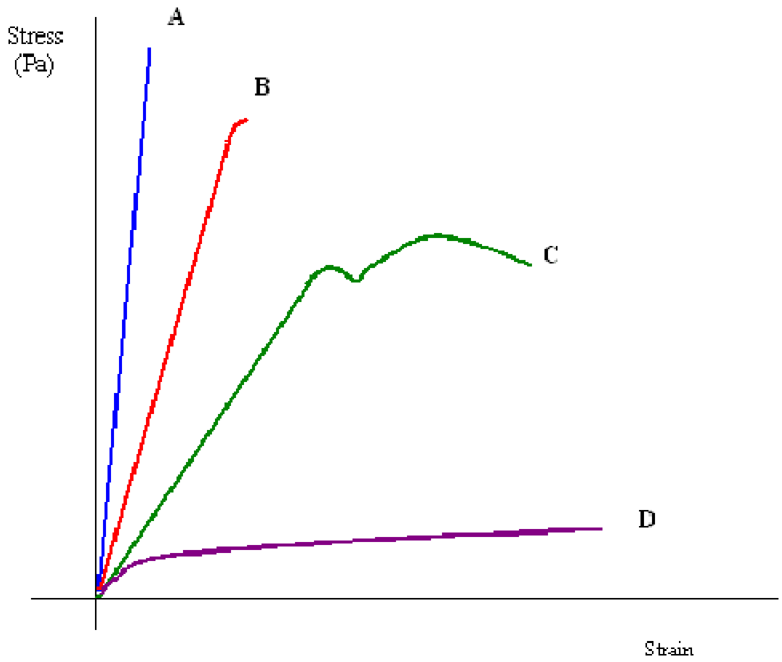
Measuring Range: 0 – 3 mm.

Least Count: 0. 01 mm.

Gauge Length adjustable from: 30 – 120 mm

Specimen Size: 1 to 20mm Round or Flats up to 20 x 20 mm

B) Stress-strain graphs of different materials.



Curve **A** shows a **brittle** material. This material is also strong because there is little strain for a high stress. The fracture of a brittle material is sudden and catastrophic, with little or no plastic deformation. Brittle materials crack under tension and the stress increases around the cracks. Cracks propagate less under compression.

Curve **B** is a **strong** material which is not ductile. Steel wires stretch very little, and break suddenly. There can be a lot of elastic strain energy in a steel wire under tension and it will “whiplash” if it breaks. The ends are razor sharp and such a failure is very dangerous indeed.

Curve **C** is a **ductile** material

Curve **D** is a **plastic** material. Notice a very large strain for a small stress. The material will not go back to its original length.

TENSILE TEST ON UTM

AIM: - To determine tensile test on a metal

OBJECT: -

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

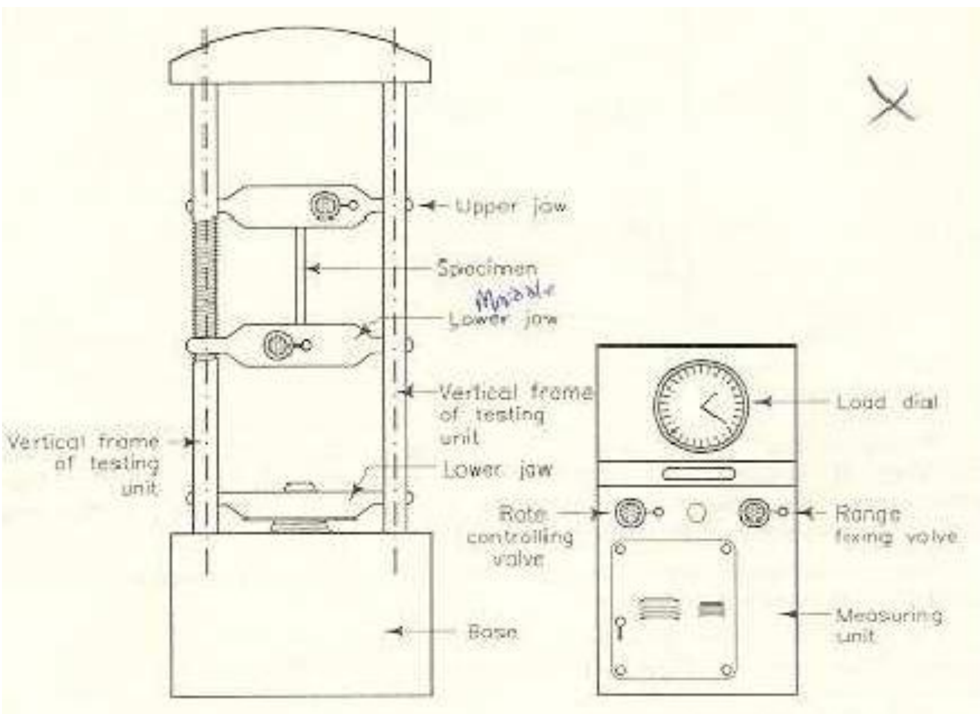
(i) Limit of proportionality
(ii) Elastic limit
(iii) Yield strength
(iv) Ultimate strength
(v) Young's modulus of elasticity
(vi) Percentage elongation
(vii) Percentage reduction in area.

APPARATUS:

1. UTM
2. Mild steel specimens
3. Graph paper
4. Scale
5. Vernier Caliper

THEORY:-

The tensile test is most applied one, of all mechanical tests. In this test ends of test piece are fixed into grips connected to a straining device and to a load measuring device. If the applied load is small enough, the deformation of any solid body is entirely elastic. An elastically deformed solid will return to its original form as soon as load is removed. However, if the load is too large, the material can be deformed permanently. The initial part of the tension curve which is recoverable immediately after unloading is termed. As elastic and the rest of the curve which represents the manner in which solid undergoes plastic



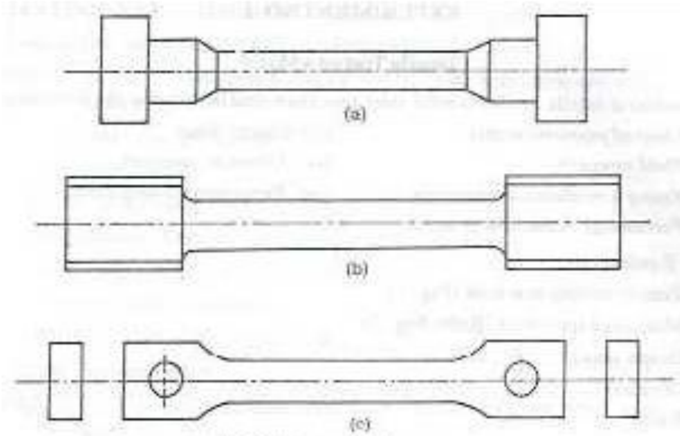


Fig. 2. Mild steel specimens.

deformation is termed plastic. The stress below which the deformations essentially entirely elastic is known as the yield strength of material. In some material the onset of plastic deformation is denoted by a sudden drop in load indicating both an upper and a lower yield point. However, some materials do not exhibit a sharp yield point. During plastic deformation, at larger extensions strain hardening cannot compensate for the decrease in section and thus the load passes through a maximum and then begins to decrease. This stage the "ultimate strength"' which is defined as the ratio of the load on the specimen to original cross-sectional area, reaches a maximum value. Further loading will eventually cause 'neck' formation and rupture.

SPECIFICATIONS

Tensile Clearance at fully descended working piston (mm) – 50 to 700

Jaws for round bar (mm) 10 to 25& 25 to 40

Jaws for sheets metals (mm)	0 to 15 and 15 to 30
Width (mm)	65

DESCRIPTION

Select the proper jaw inserts and complete the upper and lower chuck assemblies as described. Apply some graphite grease to the tapered surface of the grip for the smooth motion then operate the upper cross head grip operation handle and grip fully the upper and of the test piece. The left valve is kept in fully closed position

OBSERVATIONS

1. Initial diameter of specimen d1 = ------
2. Initial gauge length of specimen L1 = -----
3. Initial cross-section area of specimen A1 = ----
4. Load of yield point Ft. = -----
5. Ultimate load after specimen breaking F = -----
6. Final length after specimen breaking L2 = ------
7. Dia. Of specimen at breaking place d2 = -------
8. Cross section area at breaking place A2 = ---

DIAMETER OF SPECIMEN:(INTIAL DIA d1)

Sl.No	MSR	VC	Total reading	Average diameter
	m	m	m	m

NECK DIAMETER AFTER BREAKING (d2)

Sl.No	MSR	VC	Total reading	Average diameter
	m	m	m	m

and the right valve normal open position. Open the right valve and close at after the lower table is slightly lifted. Now adjust the load to zero to TARE push button (this is necessary to remove the head weight of the lower table, upper crossed and other connecting parts from the load.

Operate the lower grip operation handle left the lower head up and grip fully the lower part of the specimen. The the lock the jaws in this position by operating the jaw locking handle. Then turn the right control valve slowly to open the position, (anti clock wise) until you get a desired loading rate. After this you will find that the specimen is under load and looser unclamp the locking handle. Now the jaws will not slide down due to their own weight then go on increasing the load. When the test piece is broken, close the right control valve and take out the broken test pieces. Then open the test control valve to take the position down

A_1= Area of the specimen = = $\frac{3}{}$ ………………..mm^2

A_2 = Area of the Neck = ………………..mm^2

Original length between selecting points, l = … m

Length between points after elongation, l_o = …….. m

Percentage of elongation, $\frac{(:\ ;\ \ :)}{:}$ X 100 =

(i) Limit of proportion= $\dfrac{\text{Load at limit of proportionaliy}}{\text{Original area of cross-section}}$

(ii) $\text{Stress at elastic limit} = \dfrac{\text{load at elastic limit}}{\text{Original area of c/s}}$ N/mm^2

(iii) $\text{Yield strength} = \dfrac{\text{Yield load}}{\text{Original area of c/s}}$ N/mm^2

(iv) $\text{Ultimate strength} = \dfrac{\text{Maximum tensile load}}{\text{Original area of c/s}}$ N/mm^2

(v) $\text{Young's modulus} = \dfrac{\text{Stress at below proportionality}}{\text{Corresponding strain}}$ N/mm^2

PROCEDURE:-

1. Measure the original length and diameter of the specimen. The length may either be length of gauge section which is marked on the specimen with a preset punch or the total length of the specimen.
2. Insert the specimen into grips of the test machine and attach strain-measuring device to it.
3. Begin the load application and record load versus elongation data
4. Take readings more frequently as yield point is approached.
5. Measure elongation values with the help of dividers and a ruler.
6. Continue the test till Fracture occurs.

7. By joining the two broken halves of the specimen together, measure the final length and diameter of specimen.

PRECAUTIONS:-

1. Measure deflection on scale accurately & carefully
2. Maintain distance from while the experiment is processing
3. The specimen should be prepared in proper dimentions.
4. The specimen should be properly to get between the jaws.
5. Take reading carefully.
6. After breaking specimen stop to m/c.

(vi) Percentage elongation= $\dfrac{\text{Final length (at fracture) – original length}}{\text{Original length}}$ %

(vii) Percentage reduction in area = $\dfrac{\text{Original area-area at fracture}}{\text{Original area}}$ = %

RESULT;

1. Braking stress = $\leq$ …………. N/mm^2
2. Ultimate stress = $\geq$ ………………. N/mm^2
3. Average % Elongation =……………..%

COMPRESSION TEST ON UTM

AIM: - compressive test on a given specimen

OBJECT:

To conduct compressive test of given specimen to determine the compressive strength

APPARATUS:

1. Universal testing machine,
2. Compression pads,
3. Given specimen(clay brick)

THEORY:

Several m/c and structure components such as columns and struts are subjected to compressive load in applications. These components are made of high compressive strength materials. Not all the materials are strong in compression. Several materials, which are good in tension, are poor in compression. Contrary to this, many materials poor in tension but very strong in compression. Cast iron is one such example. That is why determine of ultimate compressive strength is essential before using a material. This strength is determined by conduct of a compression test.

Compression test is just opposite in nature to tensile test. Nature of deformation and fracture is quite different from that in tensile test. Compressive load tends to squeeze the specimen. Brittle materials are generally weak in tension but strong in compression. Hence this test is normally performed on cast iron, cement concrete etc. But ductile materials like aluminum and mild steel which are strong in tension, are also tested in compression.

COMPRESSION TEST ON BRICK

Breadth of the Brick, B = m

Length of the Brick, L = m

Formulae:

Compression stress = ≥=…………… N/mm^2

Where,

W = Maximum Load N

A = Area of the specimen = L×B mm^2

L = Length of the Brick m

B = Breadth of Brick m

Graph: Load Vs Elongation

DESCRIPTION:

Fix upper and lower pressure plates on the lower cross – head and lower table respectively. Place the specimen on lower compression plate. The specimen must be aligned exactly according to the marking on the compression plate order to give the complete cross-section the specimen a change to participate equally in the acceptance of load. Then adjusted to by lifting the lower table and perform the test in the same way as the tension test.

TEST SET-UP, SPECIFICATION OF M/C AND SPECIMEN DETAILS:

A compression test can be performed on UTM by keeping the test-piece on base block and moving down the central grip to apply load. It can also be performed on a compression testing machine. A compression testing machine shown in fig. it has two compression plates/heads. The upper head moveable while the lower head is stationary. One of the two heads is equipped with a hemispherical bearing to obtain.

Uniform distribution of load over the test-piece ends. A load gauge is fitted for recording the applied load.

SPECIMEN :-

In cylindrical specimen, it is essential to keep $h/d \leq 2$ to avoid lateral instability due to bucking action. Specimen size = $h \leq 2d$.

for clay brick the specimen size should be 190 X 90 X 90 mm

PROCEDURE

1. Place the specimen in position between the compression pads
2. Switch on the UTM

For compression test we can also:

Draw stress-strain (σ-ε) curve in compression,

Determine Young's modulus in compression,

Determine ultimate (max.) compressive strength, and

Determine percentage reduction in length (or height) to the specimen

3. Bring 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) the button for driving the motor to drive the pump.
6. Gradually move the head control ever in left hand direction till the specimen fails.
7. Note down the load at which the specimen shears
8. Stop the machine and remove the specimen.
9. Repeat the experiment with other specimens

PRECAUTIONS

1. Place the specimen at center of compression pads
2. The specimen should be prepared in proper dimensions
3. Stop the UTM as soon as the specimen fails
4. Cross sectional area of specimen for compression test should be kept large as compared to the specimen for tension test: to obtain the proper degree of stability.
5. Take reading carefully.

RESULT :-

The compressive strength of given specimen = -------N/mm^2

BENDING TEST ON UTM

AIM:

To perform the bending test on UTM

OBJECT:

To determine the values of bending stresses and young's modulus of the material of a beam (say a wooden or steel) simply supported at the ends and carrying a concentrated load at the center.

APPARATUS:

1. UTM or Beam apparatus
2. Bending fixture
3. vernier caliper
4. meter rod
5. test piece

THEORY:-

If the beam is supports at the two ends, the beam is known simply supported beam. When a beam is subjected to load the beam goes under deformation. The difference between the elastic curve to original position of the beam is called deflection. When a simply

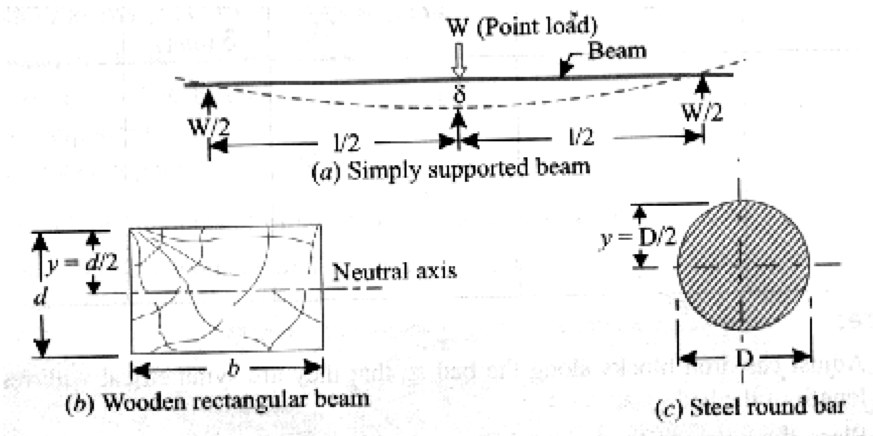


Fig. 14

for diameter or depth of beam (d)

S.NO	M.S.R.	V.C.R.	M.S.R+(V.C.R.X L.C.)
			Average=

supported beam subjected to point load at the midpoint, the beam bends concave upwards.

The deflection at mid point is given by

$$= \frac{}{4801}$$

From above equation

$$0 = \frac{}{48\ 1}$$

Where

W =Load acting at the center, N

L =Length of the beam between the supports mm

E =Young's modulus of material of the beam, N/mm^2

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

$1 = \frac{2}{3}$ for rectangular beam

where

b= width of beam and d= depth of the beam

OBESERVATION TABLE :-

SI.NO	LOADS ON BEAM	δ1	δ2	δ	Young's modulus $0 = \frac{-}{48\ 1}$	Bending moment M=8	Bending stress $6 = \frac{5}{1}7$
1							
2							
3							
4							
5							
6							

δ1= deflection in increasing order

δ2= deflection in decreasing order

1 = for cirucular section

Where

d= diameter of the beam

BENDING STRESS:

When the stress produced to due to bending moment, the stress is known as bending stress. The bending stress can be obtained by bending equation

$$\frac{0}{4} = \frac{5}{1} = \frac{6}{7}$$

Where E =Young's modulus of material of the beam, N/mm^2

R= radius of curvature

M=bending moment=$\frac{8}{\ }$,Nmm

I =Second moment of area of the cross- section,mm^4

f= bending stress, N/mm^2

y=distance from N.A. ,mm

For simply supported beam bending moment is zero at supports and maximum at mid point when the load is symmetrical

PROCEDURE:

1. Adjust the supports alone the UTM bed so that they are symmetrically with respect to the length of the bed
2. Place the beam on the knife-edges on the blocks so as to project equally beyond each knife-edge. See that the load is applied at the center of the beam.
3. Note the initial reading of vernier scale.
4. Apply a load and again note the reading of the vernier scale.
5. Go on taking reading applying load in steps each time till you have minimum 6 readings.
6. Find the deflection (d) in each time by subtracting the initial reading of vernier scale
7. Draw a graph between load (W) and deflection (δ). On the graph choose any two convenient points and between these points find the corresponding values of W and (δ).
8. Calculate youngs modulus and bending equaion using relation
9. Repeat the experiment for different beams.

PRECAUTIONS:

1. Test piece should be properly touch the fixture.
2. Test piece should be straight.
3. Take reading carefully.
4. Elastic limit of the beam should not be exceeded.

RESULT:

1. The young's modulus for steel beam/wooden beam is found to be----- $N/mm^{2.}$
2. The bending stress for steel beam/wooden beam is found to be----- N/mm^2

SHEAR TEST ON UTM

AIM: -

To determined Shear Test of Steel.

OBJECT: -

To conduct shear test on specimens under double shear:

APPARATUS: -

1. Universal testing machine.
2. Shear test attachment.
3. Specimens.

THEORY:

A type of force which causes or tends to cause two contiguous parts of the body to slide relative to each other in a direction parallel to their plane of contact is called the shear force. The stress required to produce fracture in the plane of cross-section, acted on by the shear force is called shear strength.

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.

OBESERVATION:-

Diameter of the Rod, d = ….. mm

Cross-section area of the Rod (in double shear) =2X— mm2

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

The shear strength shall be calculated from the following formulae :

$$\tau_s = \frac{@}{AB}$$

$$\tau_{s} = \frac{8}{}$$

where ‘d’ is the actual diameter of the specimen

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
9. Repeat the experiment with other specimens

PRECAUTIONS :-

1. **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.
4. The specimen should be all place equal dia.
5. After shearing specimen stop to m/c.

RESULT:

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

VERIFICATION OF MAXWELL'S RECIPROCAL THEOREM

AIM:

To verify Maxwell reciprocal theorem

APPARATUS:

Weights, hanger, dial gauge, scale and vernier calipers

THEORY:

Maxwell's theorem in its simplest form states the deflection of any point A of Any elastic structure due to load P at any point B is same as the deflection of the beam due to same load applied at A.

It is, therefore easily verified that the deflection curve for a point in a structure is same as the deflected curve of the structure when unit load is applied at point for which the influence curve was obtained.

PROCEDURE:

1. Apply the load either at centre of simply supported span or at the free end of the beam. The deflected form can be obtained
2. Measure the height of the beam at certain distance by means of dial gauge before and after loading and determine the deflection before and after at each point separately
3. Now move a load along the beam at certain distance and for each position of the load, the deflection of the point was noted where the load is applied in step1 this deflection should be measured at each such point before and after loading, separately

OBSERVATION TABLE:

Distance from the pinned end	Loaded central point by cantilever end		Deflection of various points mm (2-3)	Load moving along beam		Deflecttion of various point mm (5-6)
	Beam unloaded dial gauge reading(mm)2	Beam unloaded dial gauge reading(mm)3	Beam unloaded dial gauge reading(mm)5	Beam unloaded dial gauge reading(mm)5	Beam loaded dial gauge reading(mm)6	

4. Plot the graph between deflection as ordinate and position of point abssica the plot graph drawn in step 2 and step 3. These are the influence line ordinates for deflection of the beam

PRECAUTIONS:

1. Apply the load without any jerk
2. Perform the experiment at a location which away from any
3. Avoid external disturbance
4. Ensure that the supports or rigid

RESULT:

The Maxwell's reciprocal theorem is verified experimentally and analytically

USE OF ELECTRICAL RESISTANCE STAIN GAUGES

AIM:

To determine the Strain of the cantilever beam subjected to Point load at the free end and to plot the characteristic curves.

APPARATUS:

1. Cantilever Beam Strain gauge Trainer Kit
2. Weights and Millimeter

FORMULA USED:

Strain, $S = \frac{C}{DE!}$

Where,

P=Load applied in Kg.

L = Effective length of the beam in cm.

B = Width of the beam in cm.

T = thickness of the beam in cm.

E = young's modulus = $2x10^5 N/mm^{2.}$

S = Micro strain

THEORY:

When the material is subjected to any external load, there will be small change in the Mechanical properties like thickness of the material or change in the length

OBSERVATION:

Si.no	Weight (gms)	Actual readings (using formula) micro strains	Display readings		Error(%)
			While loading micro strains	While un loading micro strains	
1	100				
2	200				
3	300				
4	400				
5	500				
6	600				
7	700				
8	800				
9	900				
10	1000				

$$\% \text{ ERROR} = \frac{\text{Actual reading - display reading}}{\text{Maximum weight}} \times 100$$

Depending upon the nature of load applied to the material. The change in mechanical properties will remain till the load is released. The change in the property is called Strain (or) material gets strained.

Strain S = $\partial L/L$

Since the change in length is very small, it is difficult to measure ∂L, so the strain is measured in micro strain. Since it is difficult to measure the length, Resistance strain gauge are used to measure strain in the material directly. Strain gauges are bonded directly on the material using special adhesive s. As the material get strained due to load applied the resistance of the strain gauge changes proportional to the load applied. This change in resistance is used to convert mechanical property into electrical signal which can be easily measured and stored for analysis.

The change in the resistance of the strain gauge depends on the sensitivity of the strain gauge which is expressed in terms of a gauge factor, Sg

$$S_g = \frac{\Delta G}{G}$$

The output $\Delta R/R$ of a strain gauge is usually converted into voltage signal with a Wheatstone bridge. If a single gauge is used in one arm of Wheatstone bridge and equal but fixed resistors is used in the other arm, the output voltage is

$$E_O = \frac{\mathrm{HI}}{\frac{\Delta \mathbf{J} \mathrm{K}}{\mathbf{J} \mathrm{K}}} \qquad E_O = \frac{3}{\mathrm{HILM}\Delta}$$

The input voltage is controlled by the gauge size and the initial resistance of the gauge. As a result, the output voltage E_o usually ranges between 1 to 10 ΔV / micro units of strain.

PROCEDURE:

1. The instrument is switched on (i.e.,). The display glows to indicate the instrument is ON.
2. The Instrument is allowed to be in ON position for 10 minutes for initial worm-up.
3. From the selector switch, FULL or HALF bridge configuration is selected.

5. The potentiometer is adjusted for ZERO till the displays reads ' 000’
6. 1 Kg load is applied on the pan of the cantilever the CAL Potentiometer is adjusted till the display reads 377 micro strains. When the weights are removed the display should come to ZERO, in case of any variation, ZERO Potentiometer is adjusted again and the procedure is repeated again. Now the instrument is calibrated to read micro strains.
7. Then the loads are applied on the pan in steps of 100 gm up to 1kg. When the cantilever is strained, instrument displays exact micro strain.
8. The readings are noted down in the tabular column. Percentages error in readings, hysteresis and accuracy of the instrument can be calculated by comparing with the theoretical results.

RESULT:

Thus the strain of the cantilever beam subjected to free end loading, is obtained in micro strains and the characteristics curves – Load Vs Strain, Output Voltage Vs Strain and Actual Vs Display readings are plotted.