# School of Mechanical Engineering (SMEC)

# STRENGTH OF MATERIALS LAB

**Reg. No. :--------------------------------**

**Name :--------------------------------**

**Branch :--------------------------------**

**Year :--------------------------------**

VIT UNIVERSITY

(Estd. u/s 3 of UGC Act 1956)

## School of Mechanical & Building Sciences

**Branch:------------------------------**

# SRENGTH OF MATERIALS LAB

**Reg. No.-----------------------**

Certified that this is a bonafide record of work done by

Mr./Mrs.-----------------------------------------of -------------------------------------

Class during the year --------------------at VIT University, Vellore -632 014.

This record is submitted for the Practical Examination on:----------------

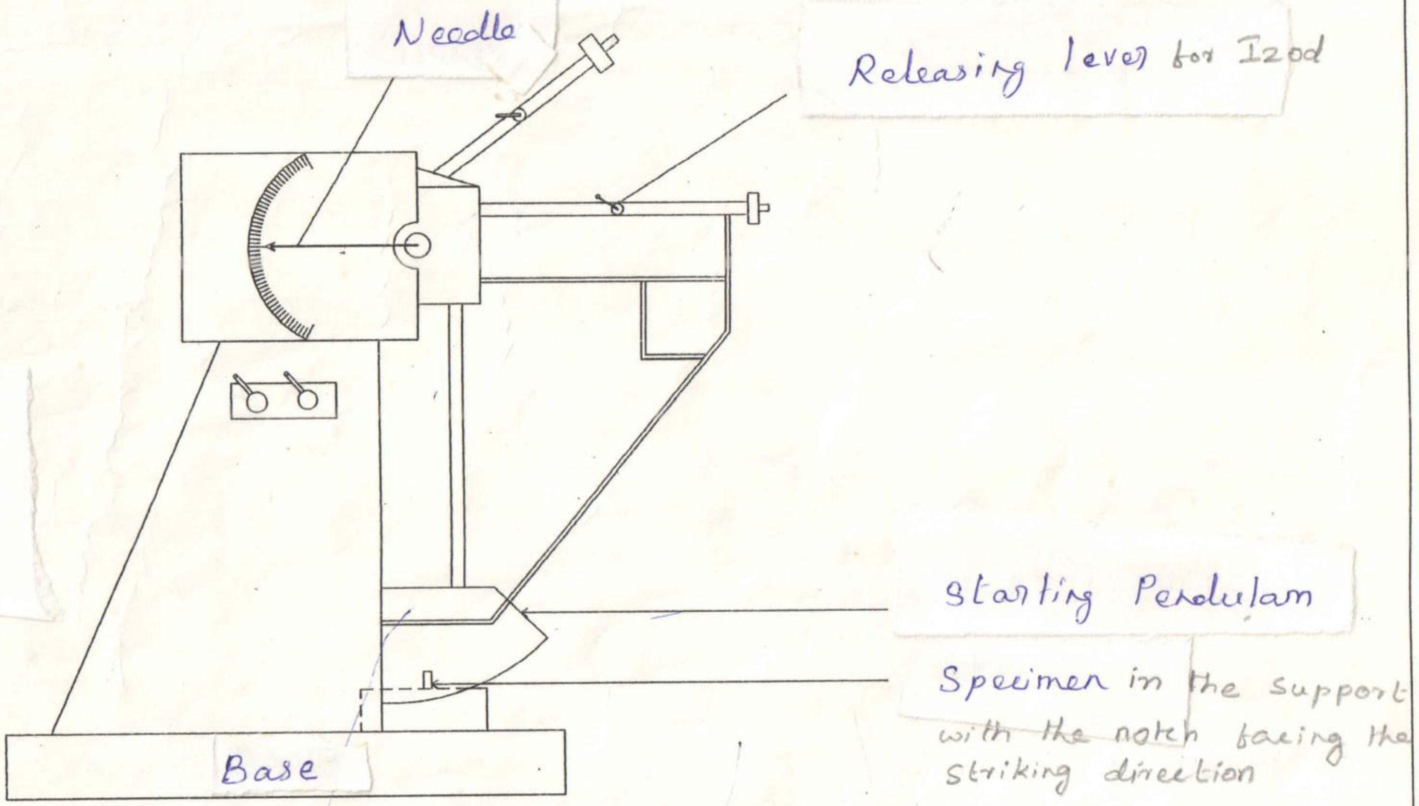
Date:

Faculty In-charge

Signature
Internal Examiner

Signature
External Examiner

# INDEX




IMPACT TESTING MACHINE

# 1. IMPACT STRENGTH OF THE MATERIAL (IZOD TEST)

**Ex. No.:** **Date:**

**AIM**

To determine the impact strength of the specimen material using Izod's Groove

**BASIC CONCEPT**

For a gradually applied load, the stress developed in the body is equal to the load per unit area. In field, selection of suitable material for some jobs will depend on the material's capability to take up repeated momentary maximum stress due to impact or shock loads. The impact strength of the material is the measure of the energy required to break a specimen of unit area.

**APPARATUS**

1. Impact Testing Machine
2. Vernier Caliper

**FORMULAE**

Impact strength = $\frac{\text{Actual energy}}{\text{Cross-sectional area}}$ (N-m/mm$^2$)

**PROCEDURE**

1. Secure the striker fully to the center of percussion of the hammer with screws.
2. Swing the hammer freely to note down the energy loss due to friction.
3. Fix the test specimen in the support with the notch facing the striking direction and tighten the clamp screws.
4. Read the pointer scale.
5. Release the striker by operating a lever and break the sample.
6. Bring the pendulum to rest by applying brakes.
7. Read the pointer and scale value. This is the energy required to break the specimen.
8. The results are tabulated.

**OBSERVATION**

**Table 1: To measure breadth and depth of the test specimen**

Least count of the vernier caliper = 0.02 mm

| S.No. | Description | M.S.R (mm) | V.S.R | | T.R = M.S.R + V.S.R (mm) |
|---|---|---|---|---|---|
| | | | (Divisions) | (mm) | |
| 1.<br>2.<br>3. | **Breadth, B** | | | | **Mean:** |
| 1.<br>2.<br>3. | **Depth, D at groove** | | | | **Mean:** |

Cross-sectional area at groove = B × D = ________________ = ________________ $mm^2$

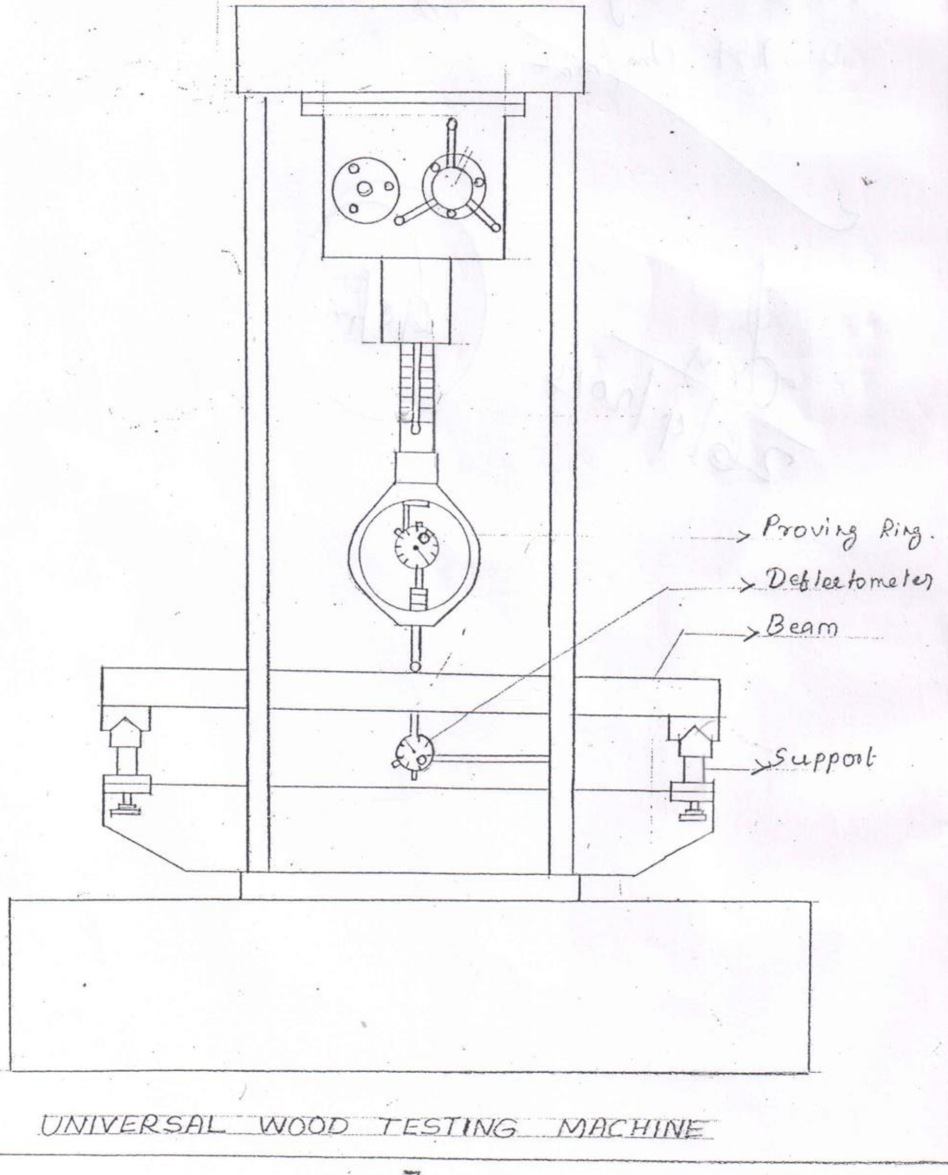
**Table 2: To determine the impact strength of the test specimen**

| S.No. | Loss of energy due to friction | | Energy required to break the specimen (N-m) | Actual energy required (N-m) | Impact strength ($N\text{-}m/mm^2$) |
|---|---|---|---|---|---|
| | Joule | N-m | | | |
| | | | | | |

## RESULT

The impact strength of the material was found to be = ________________ N-m/$mm^2$

## INFERENCE




UNIVERSAL WOOD TESTING MACHINE

## 2. DEFLECTION TEST ON WOODEN BEAM

**Ex. No.:** **Date:**

**AIM**

To conduct deflection test on the given wooden beam for determining the Young's modulus of the beam material

**BASIC CONCEPT**

The amount of deflection at any point of a simply supported beam subjected to concentrated load within the span depends on the Young's modulus of the beam material, the span, width and depth of the beam, the distance at which the deflection is measured and position of load.

**APPARATUS**

1. Wood Testing Machine
2. Deflectometer
3. Proving ring
4. Vernier caliper
5. Scale

**FORMULAE**

From the central point loading and deflection, we get

Young's modulus, $E = \frac{WL^3}{48\delta I}$ ($N/mm^2$)

Where,

W = load applied in N

L = span of beam in mm

$\delta$ = deflection in mm

I = Moment of Inertia = $\frac{BD^3}{12}$ ($mm^4$)

B = Breadth of beam in mm

D = Depth of beam in mm

**OBSERVATION**

Length of the beam = ---------------------- mm

**Table 1: To measure breadth and depth of the beam**

| S.No. | Description | M.S.R (mm) | V.S.R (Div) | V.S.R × L.C (mm) | T.R = M.S.R + (V.S.R × L.C) (mm) |
|---|---|---|---|---|---|
| 1.<br>2.<br>3. | Breadth, B | | | | Mean: |
| 1.<br>2.<br>3. | Depth, D | | | | Mean: |

Moment of inertia, $I = \frac{BD^3}{12}$ ($mm^4$)

**Table 2: To determine Young's modulus of the material**

Least count of the proving ring (Load measuring device) = 81 N

Least count of the deflectometer = 0.01 mm

| Sl.No. | Proving Ring Reading | | Deflectmeter Reading | | Young's Modulus, $E = \frac{WL^3}{48\delta I}$ ($N/mm^2$) |
|---|---|---|---|---|---|
| | Load (Divisions) | Load (N) | Deflection (Divisions) | Deflection (mm) | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Mean:**

**PROCEDURE**

1. The wood testing machine is adjusted as required and proving ring is fixed.
2. The cross-sectional dimensions of the given beam specimen are measured with the help of vernier caliper.
3. The length of the beam is measured.
4. The beam is placed centrally on the supports.
5. The deflect meter is placed at the centre of its span
6. The beam is gradually loaded and deflection is noted for every 112 N and up to a load of 1008 N.
7. The results are tabulated.

**GRAPH**

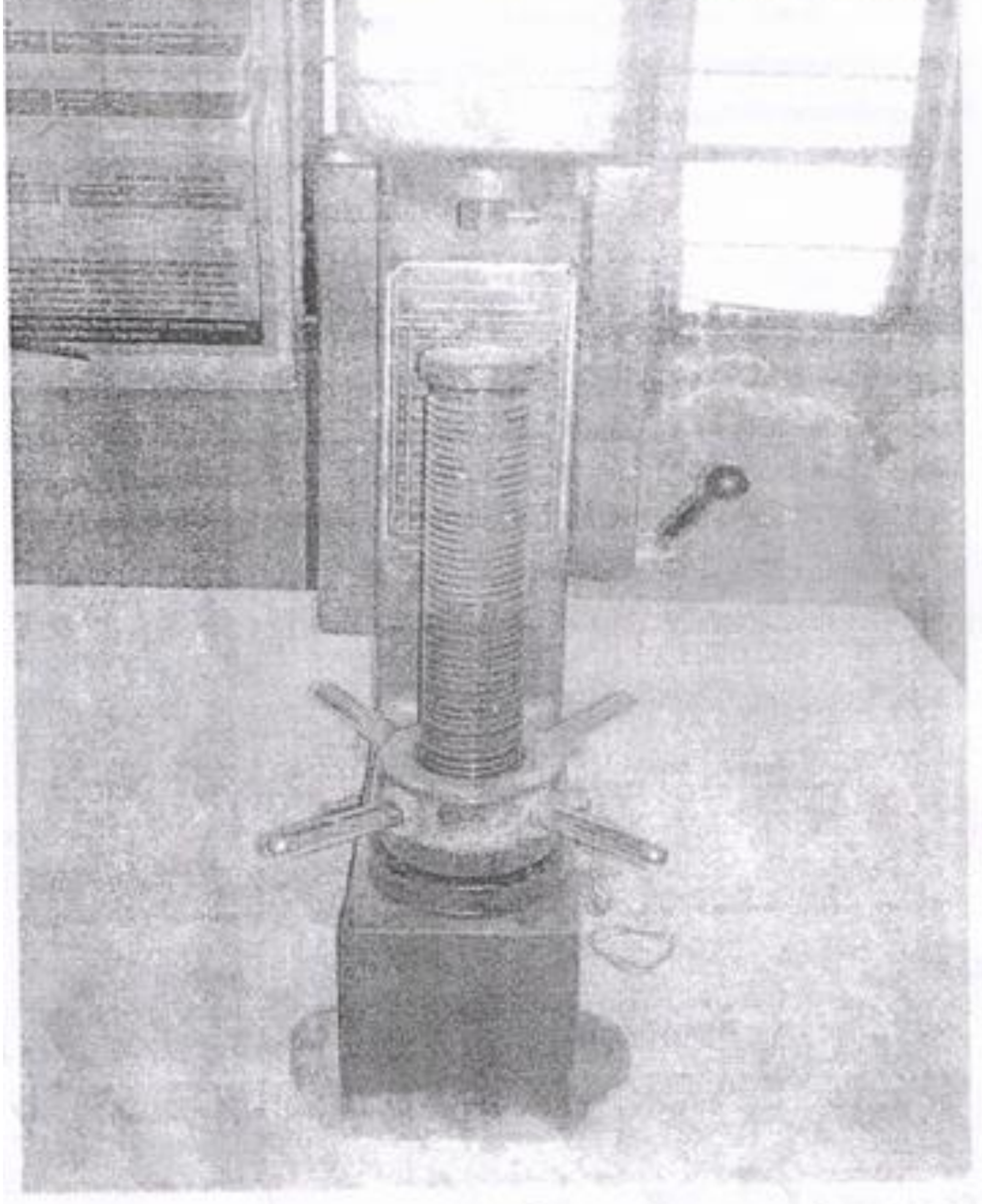
The graph is drawn for load W versus deflection δ, taking deflection δ in X-axis and load W in Y-axis. If the graph is not passing through the origin, a line is drawn parallel to the previous line passing through the origin. The slope of this line is substited in the formulae to find the Young's modulus of the material.

**RESULT**

The Young's modulus of the given wooden beam, E = -----------------------------N/mm$^2$ (from calculation)

= ------------------------------N/mm$^2$ (from graph)

**INFERENCE**



Rockwell Hardness Testing Machine

# 3. ROCKWELL HARDNESS TEST

**Ex. No.:** **Date:**

**AIM**

To measure the hardness of different materials like mild steel, brass, copper and aluminium

**BASIC CONCEPT**

The hardness number is read directly from an indicator on the machine having two scales B & C. The term hardness of a material may be defined as the resistance to deformation due to indentation, abrasion, scratching & machining.

**APPARATUS**

1. Rockwell hardness tester
2. Diamond cone penetrator
3. 1.58 mm diameter steel ball point penetrator

**PROCEDURE**

1. Clean the test piece and place on the special anvil (work table) of the machine. Turn the capston wheel to elevate the test specimen to contact the indentor point.
2. Further turn the wheel (3 rotations) to force the test specimen against the indentor. This will ensure that the minor load of 10 kg has been applied on specimen.
3. Push forward the lever and apply the major load.
4. As soon as the pointer in the dial comes to rest-reverse the lever direction which will release the major load. The pointer will rotate in the reverse direction.
5. The rockwell hardness is read on the appropriate scale dial directly.

**TABULATION**

**Table 1: To determine the rockwell hardness number for different materials**

| Sl.No. | Material | Scale | Dial | Indentor | Total load (kg) | Minor load (kg) | Major load (kg) | Rockwell hardness number | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Trial | Mean |
| 1 | Mild steel | C | Black | Diamond cone | 150 | 10 | 140 | | |
| 2 | Brass | B | Red | 1.58 mm dia steel ball | 100 | 10 | 90 | | |
| 3 | Copper | B | Red | 1.58 mm dia steel ball | 100 | 10 | 90 | | |
| 4 | Aluminium | B | Red | 1.58 mm dia steel ball | 100 | 10 | 90 | | |

**RESULT**

The Rockwell hardness number for:

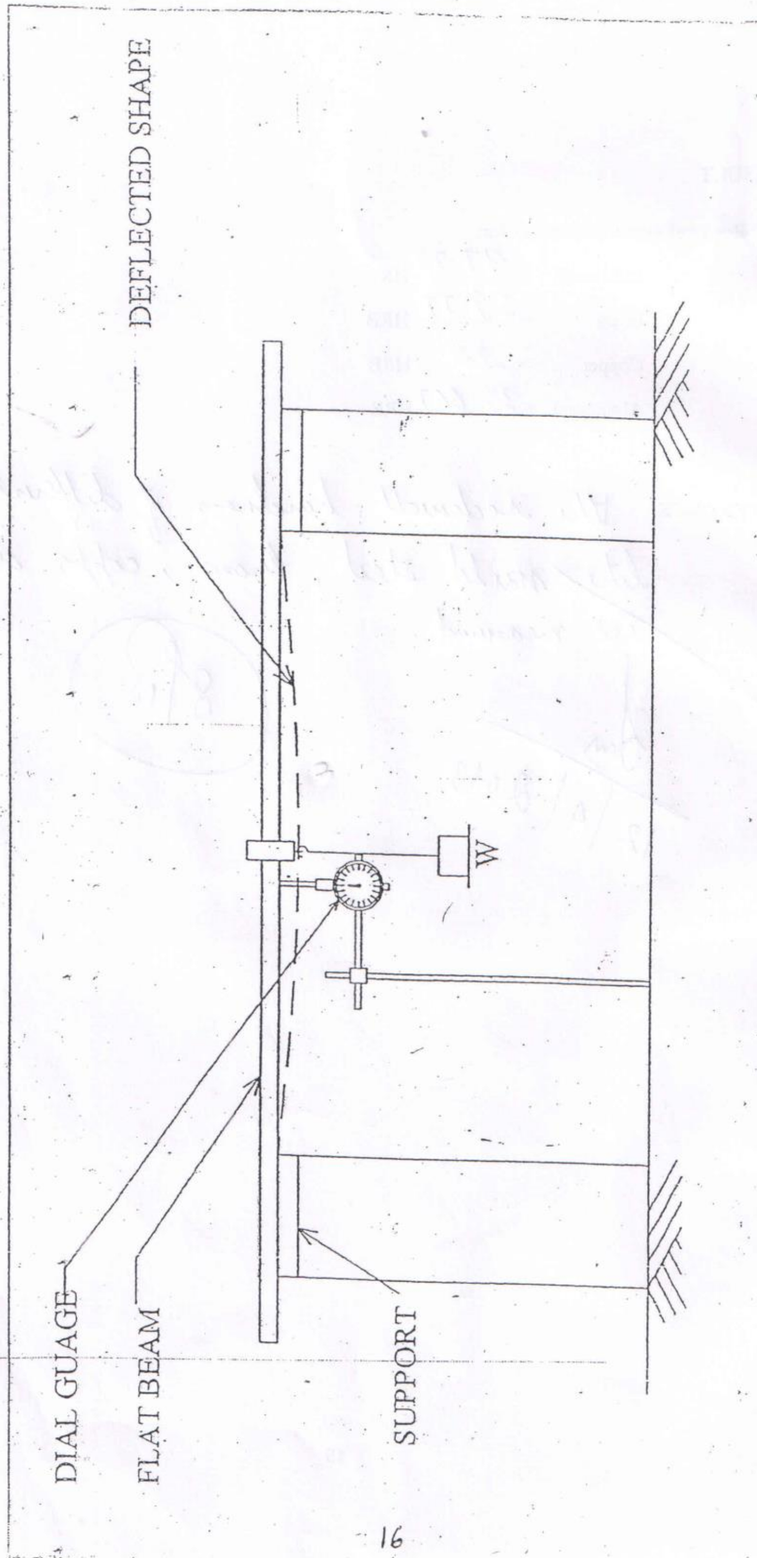
Mild steel = -------------- HRC

Brass = -------------- HRB

Copper = -------------- HRB

Aluminum = -------------- HRB

**INFERENCE**




ELASTIC BEAM SIMPLY SUPPORTED

## 4. ELASTIC BEAM – SIMPLY SUPPORTED

**Ex. No.:** **Date:**

**AIM**

To conduct deflection test on the given mild steel beam for determining the Young's modulus of the beam material.

**BASIC CONCEPT**

The amount of deflection at any point of a simply supported beam subjected to a concentrated load within the span depends on the Young's modulus of the beam material, the span of the beam, width and depth of the beam, the distance at which the deflection is measured and position of load.

**APPARATUS**

1. Deflection bench arrangement
2. Deflectometer
3. Vernier caliper
4. Scale

**FORMULAE**

From the central point loading and deflection, we get

Young's modulus, $E = \frac{WL^3}{48\delta I}$ ($N/mm^2$)

I = Moment of Inertia = $\frac{BD^3}{12}$ ($mm^4$)

Where,

W = Load applied in N

L = Span of beam in mm

δ = Deflection in mm

B = Breadth of beam in mm

D = Depth of beam in mm

**OBSERVATION**

Length of the beam = ---------------------- mm

**Table 1: To measure breadth and depth of the beam.**

Least count of the vernier caliper = 0.02 mm

<table>
<tr><th rowspan="2">S.No.</th><th rowspan="2">Description</th><th rowspan="2">M.S.R (mm)</th><th colspan="2">V.S.R</th><th rowspan="2">T.R = M.S.R + V.S.R (mm)</th></tr>
<tr><th>(Divisions)</th><th>(mm)</th></tr>
<tr><td>1.<br>2.<br>3.</td><td>Breadth, B</td><td></td><td></td><td></td><td>Mean:</td></tr>
<tr><td>1.<br>2.<br>3.</td><td>Depth, D</td><td></td><td></td><td></td><td>Mean:</td></tr>
</table>

$$I = \frac{BD^3}{12} \; (mm^4)$$

**Table 2: To determine the Young's modulus of the material**

Least count of the deflectmeter = 0.01 mm

| S.No. | Load in | | Deflectmeter reading (Deflection, δ) | | | | Young's modulus, $E = \frac{WL^3}{48\delta I}$ ($N/mm^2$) |
|---|---|---|---|---|---|---|---|
| | kg | N | Loading (Divisions) | Unloading (Divisions) | Mean (Divisions) | Deflection (mm) | |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |

**Mean:**

**PROCEDURE**

1. The length of the given beam specimen is measured.
2. The cross sectional dimensions of the given specimen are measured with the help of vernier caliper.
3. Mark the mid-span of the beam and place the deflectometer at the centre of the beam.
4. Load the beam at an uniform rate at the mid-span from 9.81 N to 39.24 N (1 kg to 4 kg) and note down the corresponding deflection.
5. Remove load at the same uniform rate and note down the corresponding deflectometer readings.
6. The results are tabulated.

**GRAPH**

The graph is drawn for load W versus deflection δ, taking deflection δ in X-axis and load W in Y-axis. If the graph is not passing through the origin, a line is drawn parallel to the previous line passing through the origin. The slope of this line is substituted in the formulae to find the Young's modulus of the material.

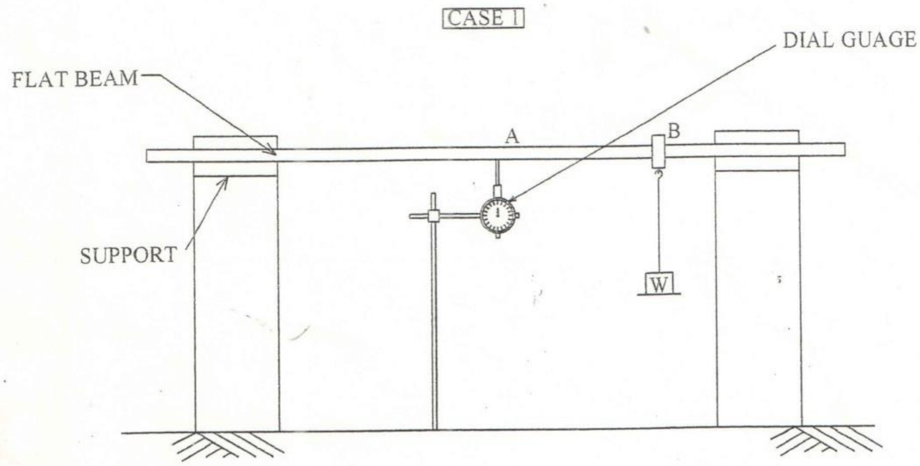
**RESULT**

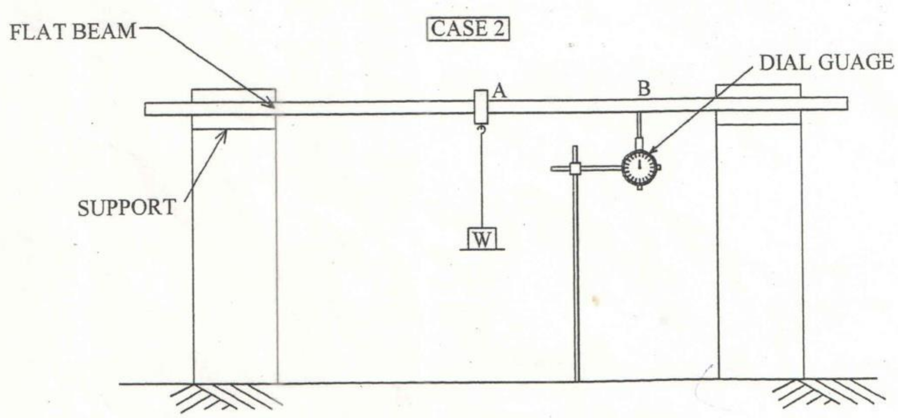
Young's modulus, E = ------------------------------ $N/mm^2$ (from calculation)

= ------------------------------ $N/mm^2$ (from graph)

**INFERENCE**

5




MAXWELL RECIPROCAL THEROM

# 5. VERIFICATION OF MAXWELL'S RECIPROCAL THEOREM

**Ex. No.:** **Date:**

**AIM**

To verify Maxwell's Reciprocal Theorem

**BASIC CONCEPT**

Maxwell's Reciprocal Theorem is as follows:

The deflection at A due to unit force at B is equal to deflection at B due to unit force at A.

Thus $\delta_{AB} = \delta_{BA}$

**APPARATUS**

1. Deflection bench arrangement

2. Deflectometer

4.Scale

**PROCEDURE**

1. Place the given beam over the supports and measure the span of the beam.
2. Place the load at $^1/_4{}^{th}$ of span (point A) from left hand side and place the deflection at mid span of the beam (point B).
3. Load the beam at an uniform rate at point A from 1 kg to 4 kg and note down the corresponding deflectometer readings at point B.
4. Remove load at point A at the same uniform rate and note down the corresponding deflectometer readings at point B.
5. Place load at point B and deflectometer at point A.
6. Load the beam at an uniform rate at point B from 1 kg to 4 kg and note down the corresponding deflectometer readings at point A.

**TABULATION**

**Table 1: Load at A and deflection at B**

Least count of the deflectmeter = 0.01 mm

| S.No. | Load in | | Deflectmeter reading at B (Deflection, δ) | | | |
|---|---|---|---|---|---|---|
| | kg | N | Loading (Divisions) | Unloading (Divisions) | Mean (Divisions) | Deflection (mm) |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |

**Mean:**

**Table 2: Load at B and deflection at A**

Least count of the deflectmeter = 0.01 mm

| S.No. | Load in | | Deflectmeter reading at A (Deflection, δ) | | | |
|---|---|---|---|---|---|---|
| | kg | N | Loading (Divisions) | Unloading (Divisions) | Mean (Divisions) | Deflection (mm) |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |

**Mean:**

7. Remove load at point B at the same uniform rate and note down the corresponding deflectometer readings at point A.
8. The results are tabulated.

**RESULT**

**INFERENCE**

Universal Spring Testing Machine

## 6. TEST ON CLOSE – COILED HELICAL SPRING

**Ex. No.:** **Date:**

**AIM**

To conduct tension test on the given close-coiled helical spring and to determine the following:

1. Stiffness of the material
2. Rigidity modulus of the material

**BASIC CONCEPT**

Springs are invariably used to absorb energy and to release it as and when required. The energy stored due to applied load is directly proportional to its deflection.

**APPARATUS**

1. Spring testing machine
2. Vernier caliper

**FORMULAE**

Modulus of rigidity, $G = \frac{64WR^3n}{\delta d^4}$ (N/mm$^2$)

Where,

n = No of coils in the spring

W = load applied (N)

R = mean radius of the coil (mm)

$\delta$ = deflection of the spring (mm)

d = diameter of the spring wire (mm) and

Stiffness of the spring, $S = \frac{W}{\delta}$ (N/mm)

**OBSERVATION**

No. of coils, n = -------------

**Table 1: To measure external diameter of coil and thickness of spring wire**

Least count of the vernier caliper = 0.02 mm

| S.No. | Description | M.S.R (mm) | V.S.R | | T.R = M.S.R + V.S.R (mm) |
|---|---|---|---|---|---|
| | | | (Divisions) | (mm) | |
| 1.<br>2.<br>3. | External diameter of the coil | | | | Mean: |
| 1.<br>2.<br>3. | Diameter of the spring wire | | | | Mean: |

**Table 2: To determine the modulus of rigidity of the material**

| Sl.No. | Load in | | Deflection (mm) | Modulus of rigidity, $G = \frac{64WR^3n}{\delta d^4}$ ($N/mm^2$) | Stiffness, $S = \frac{W}{\delta}$ (N/mm) |
|---|---|---|---|---|---|
| | Kg | N | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Mean:**

Where,

W = load (N)

$\delta$ = deflection (mm)

**PROCEDURE**

1. For the given spring, the number of coils is noted
2. Using vernier caliper, the external diameter and the thickness of the spring wire is measured.
3. The machine is switched ‘on’ and the spring is loaded. The deflections are noted at every 10 kg interval.
4. The deflection is taken till the load reaches 60 kg.
5. By applying the formulae, the modulus of rigidity and stiffness of the spring are calculated.

**GRAPH**

Load versus deflection graph is drawn by taking deflection in X-axis and load in Y-axis. The slope of this line is substited in the formulae to find the Rigidity modulus of the material.

**RESULT**

Rigidity modulus, G = ------------------------------ $N/mm^2$ (from calculation)

= ------------------------------ $N/mm^2$ (from graph)

Stiffness of the spring, S = ------------------------------ N/mm

**INFERENCE**

**Brinell Hardness Testing Machine**

## 7. BRINELL HARDNESS TEST

**Ex. No.:** **Date:**

**AIM**

To measure the brinell hardness number for the given specimen.

**BASIC CONCEPT**

Brinell tests are static indentation tests using relatively large indentors. For a number of engineering materials which are subjected to friction such as steel, cast iron etc., it is necessary to find out their resistance to wear and tear (hardness). The brinell hardness test is carried out by forcing a hardened steel ball of diameter 'D' under a load of 'P' into a test specimen and measuring the mean diameter 'd' of the indentation left on the surface after the removal of load. Normally for hard materials a ball of 10 mm diameter shall be used. For soft materials 5 mm, 2.5 mm, 2 mm, and 1 mm are to be used depending upon the softness of the surface.

**APPARATUS**

1. Optical Brinell hardness testing machine
2. Ball indentors
3. Emery paper

**FORMULAE**

Brinell hardness number = Load/Indenting area

$$\frac{\mathbf{2P}}{\pi D\,(D - \sqrt{D^2 - d^2})}$$

Where

P = the major load chosen (kg)

D = diameter of the indentor (mm)

d = diameter of the impression (mm)

**TABULATION**

**Table 1: To determine the brinell hardness number for different materials**

| Sl.No. | Material | Diameter of the indentor 'D' (mm) | Diameter of impression 'd' (mm) | | Load 'P' (kg) | Brinell Hardness Number |
|---|---|---|---|---|---|---|
| | | | Trial | Mean | | |
| 1 | Mild steel | 5 | | | 750 | |
| 2 | Aluminium | 5 | | | 500 | |

**PROCEDURE**

1. The surface of the specimen is cleaned with emery paper.
2. Based on the type of materials, the major load and the indentor are selected from the following table.

| **Material** | **Dia. Of the ball indentor (mm)** | **Load (kg)** |
|---|---|---|
| Mild steel | 10 | 3000 |
| Mild steel | 5 | 750 |
| Aluminum | 5 | 500 |

   One loading pan and eleven loose weights each equivalent to 250 kgf. Thus the total weight is 3000 kgf for maximum load for 10 mm indentor only
3. The required weight and indentor is chosen.
4. The indentor is inserted and fastened with the screw.
5. Switch on the machine and keep the hand lever at read position. Place the specimen securely on testing position.
6. Turn the hand wheel in clock wise direction, so that specimen will get clamped against clamping cone with slight pressure (Too much clamping force is not necessary).
7. Turn the hand lever from unload position, so that the total load is brought in to action.
8. When the dial gauge pointer reaches a steady position the load may be maintained for up to 6 seconds for accurate work. For releasing the load, take back the lever to unload position. the weights are lifted off and indicator will come to rest (original position).
9. After positioning lever to 'Read' position indentor will get swiveled and diameter of indentation will be projected on screen. Measure the diameter of indentation and calculate the Brinell hardness number.

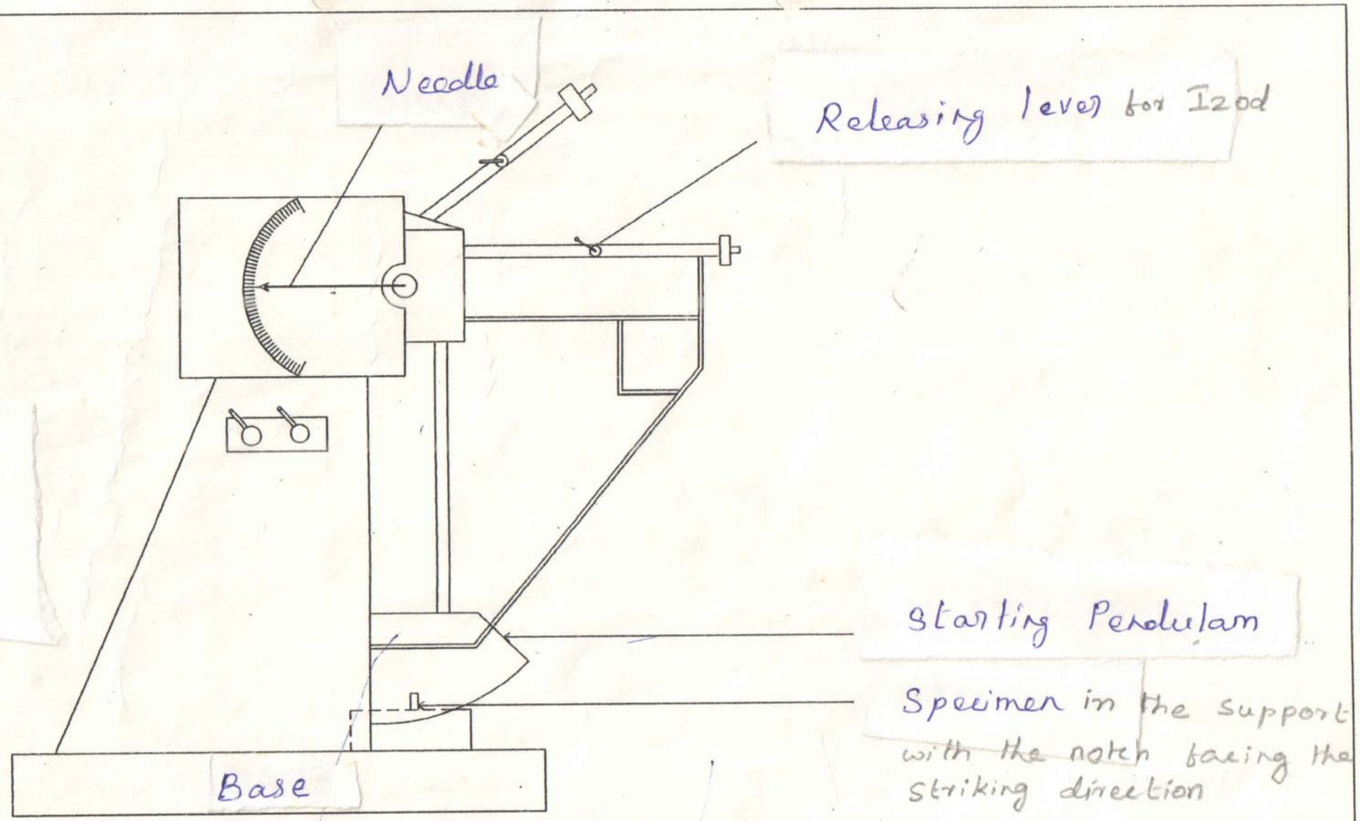
**RESULT**

Brinell hardness number for:

Mild steel = --------------

Aluminium = --------------

**INFERENCE**




IMPACT TESTING MACHINE

8.

## 8. IMPACT STRENGTH OF THE MATERIAL (CHARPY TEST)

**Ex. No.:** **Date:**

**AIM**

To determine the impact strength of the specimen material using Charpy Groove

**BASIC CONCEPT**

For a gradually applied load, the stress developed in the body is equal to the load per unit area. In field, selection of suitable material for some jobs will depend on the material's capability to take up repeated momentary maximum stress due to impact or shock loads. The impact strength of the material is the measure of the energy required to break a specimen of unit area.

**APPARATUS**

1. Impact Testing Machine
2. Vernier Caliper

**FORMULAE**

Impact strength = $\frac{\text{Actual energy}}{\text{Cross-sectional area}}$ ($N\text{-}m/mm^2$)

**PROCEDURE**

1. Secure the striker fully to the center of percussion of the hammer with screws.
2. Swing the hammer freely to note down the energy loss due to friction.
3. Place the test specimen in the support with the notch facing opposite to the striking direction.
4. Read the pointer scale.
5. Release the striker by operating a lever and break the sample.
6. Bring the pendulum to rest by applying brakes.
7. Read the pointer and scale value. This is the energy required to break the specimen.
8. The results are tabulated.

**OBSERVATION**

**Table 1: To measure breadth and depth of the test specimen**

Least count of the vernier caliper = 0.02 mm

| S.No. | Description | M.S.R (mm) | V.S.R | | T.R = M.S.R + V.S.R (mm) |
|---|---|---|---|---|---|
| | | | (Divisions) | (mm) | |
| 1.<br>2.<br>3. | Breadth, B | | | | Mean: |
| 1.<br>2.<br>3. | Depth, D<br>At groove | | | | Mean: |

Cross-sectional area at groove = B × D = ---------------------------- = $mm^2$

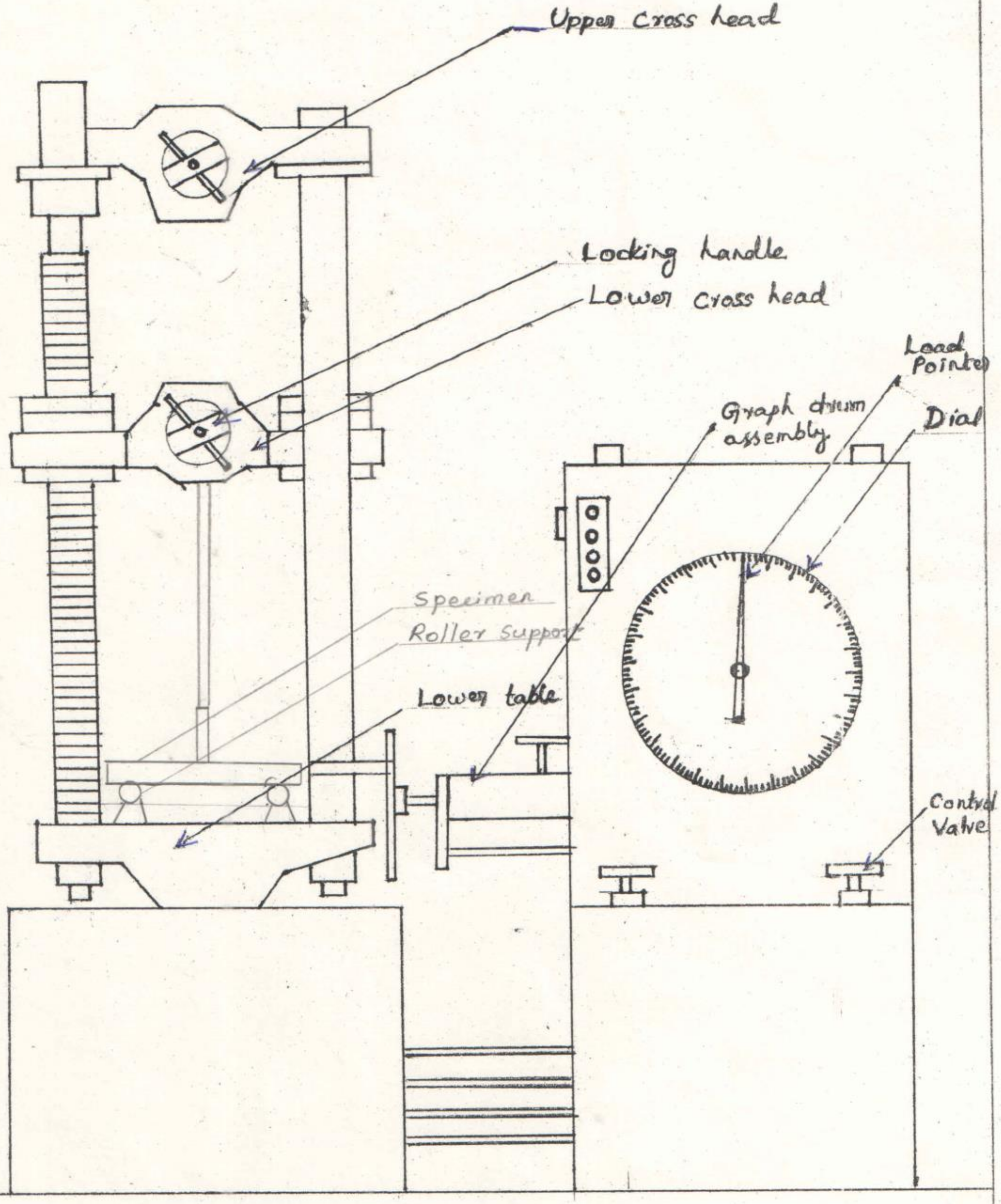
**Table 2: To determine the impact strength of the test specimen**

| S.No. | Loss of energy due to friction | | Energy required to break the specimen (N-m) | Actual energy required (N-m) | Impact strength ($N\text{-}m/mm^2$) |
|---|---|---|---|---|---|
| | Kg-m | N-m | | | |
| | | | | | |

**RESULT**

The impact strength of the material was found to be = -------------------------- N-m/$mm^2$

**INFERENCE**




UNIVERSAL TESTING MACHINE

## 9. DEFLECTION TEST ON RECTANGULAR BEAM

**Ex. No.:** **Date:**

**AIM**

To conduct deflection test on the given mild steel beam for determining the Young's modulus and Maximum bending stress.

**BASIC CONCEPT**

The amount of deflection at any point of a simply supported beam subjected to a concentrated load within the span depends on the Young's modulus of the beam material, the span of the beam, width and depth of the beam, the distance at which the deflection is measured and position of load.

**APPARATUS**

1. Universal Testing Machine
2. Deflectometer
3. Vernier caliper
4. Scale

**FORMULAE**

From the central point loading and deflection, we get

Young's modulus, $E = \frac{WL^3}{48\delta I}$ (N/mm$^2$)

Maximum bending stress, $f = \frac{M}{I} y$ (N/mm$^2$)

Where,

M = Maximum bending movement = $\frac{WL}{4}$ (N-mm)

I = Moment of Inertia = $\frac{BD^3}{12}$ (mm$^4$)

W = Load applied in N

L = Span of beam in mm

**OBSERVATION**

Length of the beam = ---------------------- mm

**Table 1: To find breadth and depth of the beam**

| S.No. | Description | M.S.R (mm) | V.S.R (Div) | V.S.R × L.C (mm) | T.R = M.S.R + (V.S.R × L.C) (mm) |
|---|---|---|---|---|---|
| **1.**<br>**2.**<br>**3.** | **Breadth, B** | | | | **Mean:** |
| **1.**<br>**2.**<br>**3.** | **Depth, D** | | | | **Mean:** |

$$I = \frac{BD^3}{12} \ (mm^4)$$

**Table 2: To find Young's modulus and Maximum bending stress of the material**

Least count of the deflect meter = 0.01 mm

| S.No. | Load (kN) | Deflectmeter reading (Deflection, δ) | | | | Young's modulus, $E = \frac{WL^3}{48\delta I}$ (N/mm²) | Maximum bending stress, $f = \frac{M}{Y}y$ (N/mm²) |
|---|---|---|---|---|---|---|---|
| | | Loading (Divisions) | Unloading (Divisions) | Mean (Divisions) | Deflection (mm) | | |
| 1 | 2 | | | | | | |
| 2 | 4 | | | | | | |
| 3 | 6 | | | | | | |
| 4 | 8 | | | | | | |
| 5 | 10 | | | | | | |
| 6 | 12 | | | | | | |
| 7 | 14 | | | | | | |
| 8 | 16 | | | | | | |
| 9 | 18 | | | | | | |
| 10 | 20 | | | | | | |

**Mean:**

$\delta$ = Deflection in mm

B = Breadth of beam in mm

D = Depth of beam in mm

y = Distance of extreme fibre of the cross section from neutral axis in mm

**PROCEDURE**

1. The span of the beam is adjusted as per the bending test arrangement in U.T.M.
2. The cross sectional dimensions of the given specimen are measured with the help of vernier caliper.
3. The required span is marked on the beam specimen. The beam specimen is placed centrally on the supports.
4. The deflectometer is placed under the beam specimen at the centre of the span.
5. The central load is applied gradually up to a maximum of 20 kN. The deflectometer readings are recorded while loading and unloading at every 2 kN loading intervals.
6. The results are tabulated.

**GRAPH**

The graph is drawn for load W versus deflection $\delta$, taking deflection $\delta$ in X-axis and load W in Y-axis. If the graph is not passing through the origin, a line is drawn parallel to the previous line passing through the origin. The slope of this line is substited in the formulae to find the Young's modulus of the material.

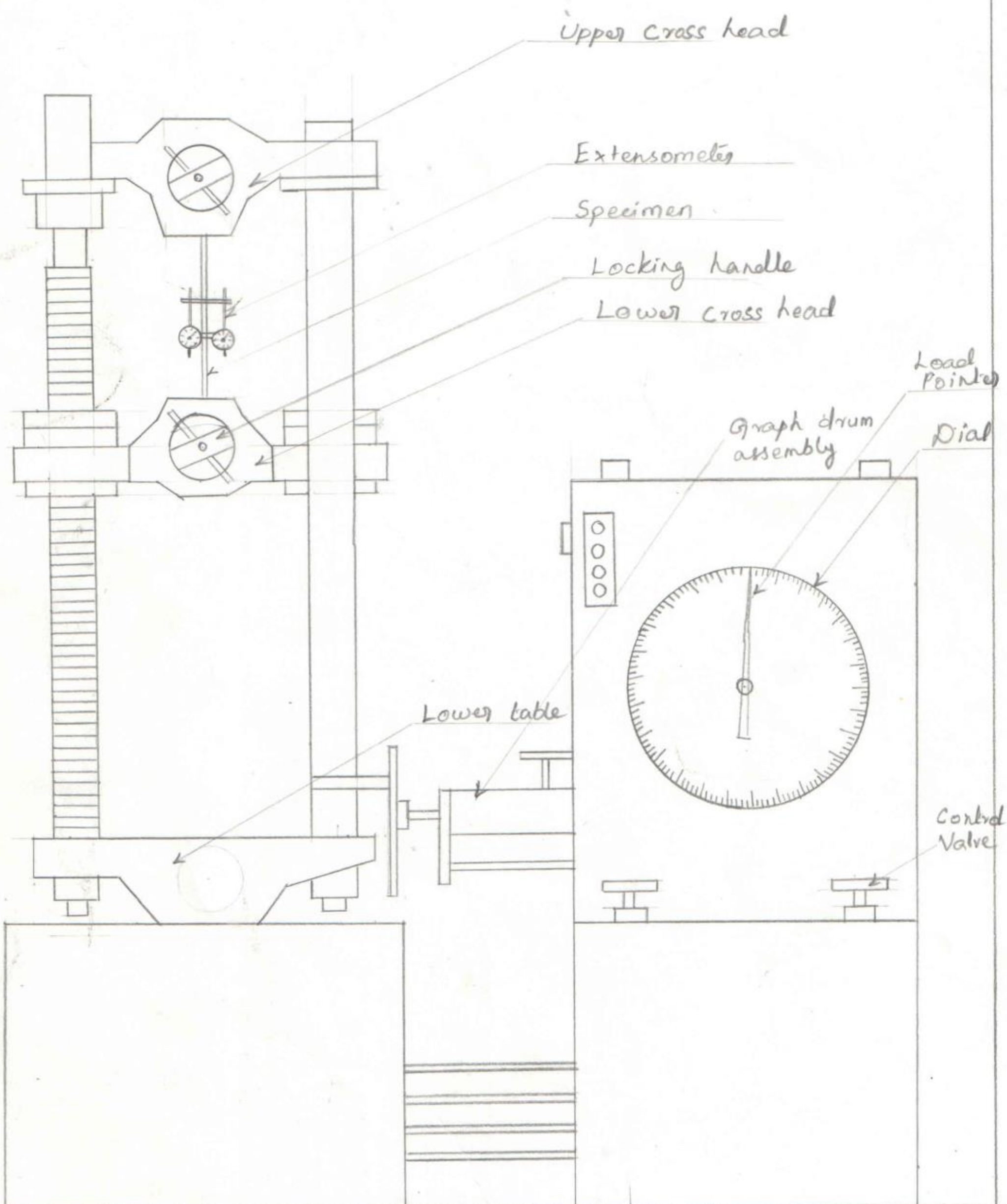
**RESULT**

Young's modulus, E = ------------------------------ $N/mm^2$ (from calculation)

= ------------------------------ $N/mm^2$ (from graph)

Maximum bending stress, $f_{max}$ = ------------------------------ $N/mm^2$

**INFERENCE**




UNIVERSAL TESTING MACHINE

## 10. TENSION TEST ON MILD STEEL

**Ex. No.:** **Date:**

**AIM**

To conduct tension test on the given steel specimen for determining the following:

1. Stress at yield point
2. Ultimate stress
3. Nominal breaking stress
4. Actual breaking stress
5. Percentage reduction in area
6. Percentage elongation in length
7. Young's modulus

**BASIC CONCEPT**

When a mild steel bar is subjected to increasing tensile stress, it passes from elastic range to plastic range before it reaches the ultimate load.

**APPARATUS**

1. Universal Testing Machine

2. Extensometer

3.Vernier caliper

4.Scale

**FORMULAE**

Stress = Load / Cross sectional area ($N/mm^2$)

Strain = Elongation / Initial gauge length

Young's modulus = Stress / Strain ($N/mm^2$)

**OBSERVATIONS**

Initial diameter of the rod = --------------------- mm

Diameter of the rod at neck = --------------------- mm

Initial area of c/s = --------------------- $mm^2$

Area of c/s at neck = --------------------- $mm^2$

Percentage reduction in area = --------------------- %

Original length (Initial gauge length) = --------------------- mm

Length of the rod after the test (Final gauge length) = --------------------- mm

Percentage elongation in length = --------------------- %

Yield point load = --------------------- kN

Ultimate load = --------------------- kN

Breaking load = --------------------- kN

Stress at yield point load = --------------------- $N/mm^2$

Ultimate stress = --------------------- $N/mm^2$

Nominal breaking stress = --------------------- $N/mm^2$

Actual breaking stress = --------------------- $N/mm^2$

## PROCEDURE

1. The probable ultimate load for the specimen is calculated assuming the probable ultimate stress. The UTM is adjusted for that selected range.
2. The specimen having convenient length is taken and centre is marked. From the centre, the gauge length is marked
3. The diameter of the given mild steel specimen is measured at different places with the help of vernier calipers and then the average diameter of the specimen is determined.
4. The specimen is mounted in the grip of the movable and fixed cross head and the extensometer is fixed.
5. The load stabilizer is adjusted, machine is started and the inlet valve is opened slightly. When the load pointer just kicks it, it indicates that the rod is held tight between the grips.
6. The load is applied at a steady uniform rate, and the extension is noted within elastic limit. Then the extensometer is removed.
7. At a particular stage, there is a pause in the increase of load. Load at this point is noted down as 'Yield point load'.
8. The load is applied continuously. When the load reaches the maximum value both the actual pointer and the dummy pointer which has been companying it will remain stationery. The maximum load reached is recorded as 'Ultimate load'.
9. After sometime the actual pointer returns slowly. At this stage, a neck is formed in the specimen and the specimen breaks. The position of actual pointer during breaking is noted and that is recorded as 'Breaking load'.
10. After breaking, the specimen is removed from the grips and the final gauge length and the final diameter of the specimen is measured. For mild steel, a typical cup and cone fracture is observed.

## GRAPH

The graph is drawn between stress (Y-axis) and strain (X-axis). From the graph, for a chosen stress, the corresponding strain is read.

**TABULATION**

**Table 1: To determine the young's modulus of the material**

Least count of the Extensometer = 0.01 mm

| S.No. | Load (kN) | Stress ($N/mm^2$) | Extensometer reading | | Strain | Young's modulus, E ($N/mm^2$) |
|---|---|---|---|---|---|---|
| | | | Elongation (Divisions) | Elongation (mm) | | |
| 1 | 2 | | | | | |
| 2 | 4 | | | | | |
| 3 | 6 | | | | | |
| 4 | 8 | | | | | |
| 5 | 10 | | | | | |
| 6 | 12 | | | | | |
| 7 | 14 | | | | | |
| 8 | 16 | | | | | |
| 9 | 18 | | | | | |
| 10 | 20 | | | | | |

**Mean:**

**RESULT**

The yield stress of the material = --------------------- $N/mm^2$

The ultimate stress of the material = --------------------- $N/mm^2$

The nominal breaking stress of the material = --------------------- $N/mm^2$

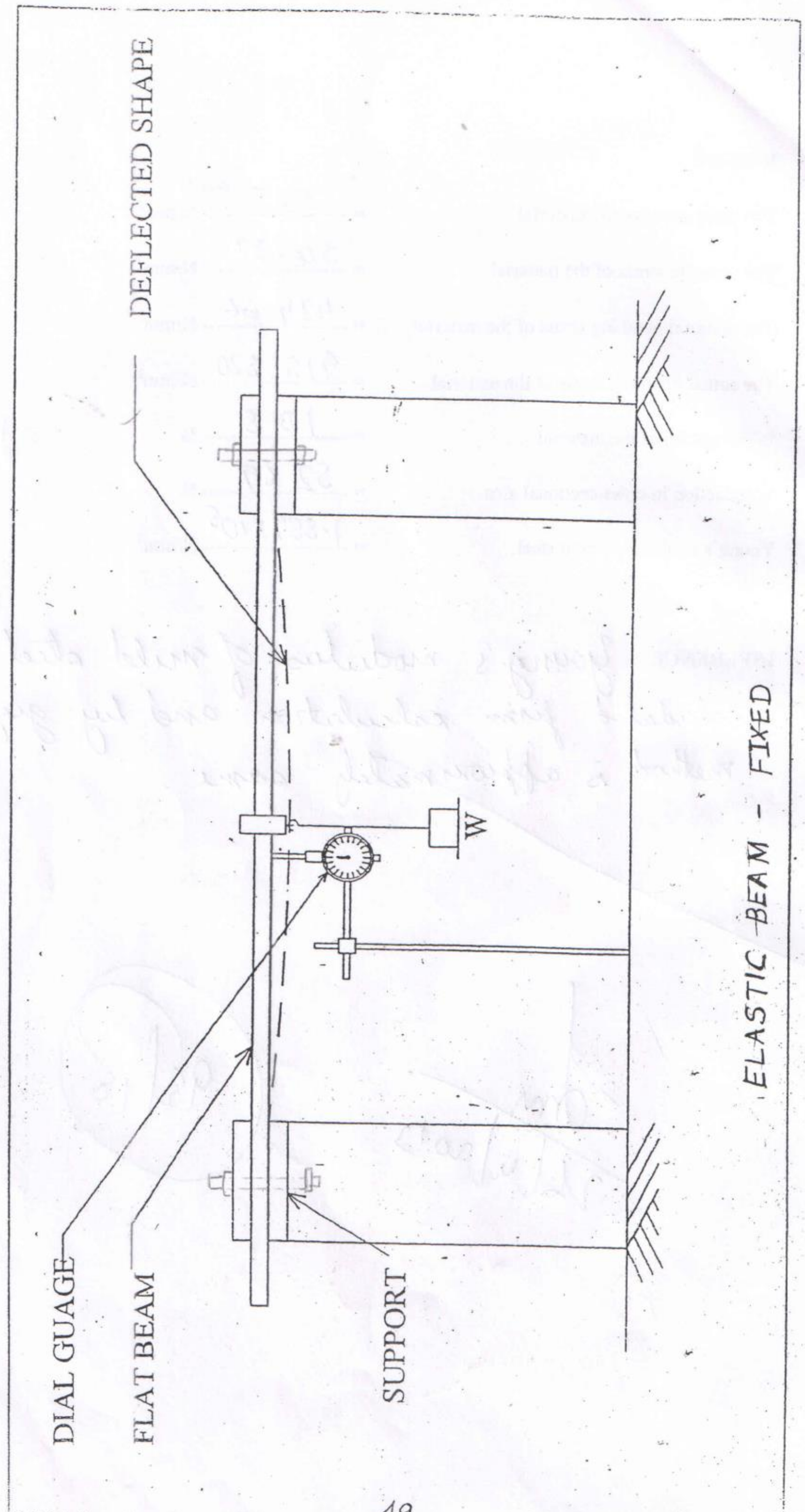
The actual breaking stress of the material = --------------------- $N/mm^2$

% elongation of the material = --------------------- %

% reduction in cross-sectional area = --------------------- %

Young's modulus of mild steel = --------------------- $N/mm^2$

**INFERENCE**


DEFLECTED SHAPE
W
ELASTIC BEAM - FIXED
DIAL GUAGE
FLAT BEAM
SUPPORT

## 11. ELASTIC BEAM – FIXED

**Ex. No.:** **Date:**

**AIM**

To determine the young's modulus of the fixed beam material

**BASIC CONCEPT**

The amount of deflection at any point of a fixed beam with the concentrated load within the span depends on the Young's modulus of the beam material, the span, width and depth of the beam, the distance at which the deflection is measured and position of load placement.

**FORMULAE**

Young's modulus, $E = \frac{WL^3}{192\delta I}$ $(N/mm^2)$

Moment of inertia, $I = \frac{BD^3}{12}$ $(mm^4)$

Where,

W = Load applied in N

L = Span of beam in mm

δ = Deflection in mm

B = Breadth of beam in mm

D = Depth of beam in mm

**APPARATUS**

1. Deflection bench arrangement

2. Deflectometer

3.Vernier caliper

4.Scale

**OBSERVATION**

Length of the beam = ---------------------- mm

**Table 1: To measure breadth and depth of the beam.**

Least count of the vernier caliper = 0.02 mm

| **S.No.** | **Description** | **M.S.R (mm)** | **V.S.R** | | **T.R = M.S.R + V.S.R (mm)** |
|---|---|---|---|---|---|
| | | | **(Divisions)** | **(mm)** | |
| **1.**<br>**2.**<br>**3.** | **Breadth, B** | | | | **Mean:** |
| **1.**<br>**2.**<br>**3.** | **Depth, D** | | | | **Mean:** |

$I = \frac{BD^3}{12}$ ($mm^4$)

**Table 2: To determine the young's modulus of the material**

Least count of the deflectmeter = 0.01 mm

| S.No. | Load in | | Deflectmeter reading (Deflection, δ) | | | | Young's modulus, $E = \frac{WL^3}{192\delta I}$ ($N/mm^2$) |
|---|---|---|---|---|---|---|---|
| | kg | N | Loading (Divisions) | Unloading (Divisions) | Mean (Divisions) | Deflection (mm) | |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |

**Mean:**

**PROCEDURE**

1. The length, breadth and depth of the given beam are measured.
2. The dial gauge which measures the deflection is placed at the centre of the beam i.e., at L/2 distance from the support.
3. Load the beam at mid-span at an uniform rate and measure the corresponding deflection.
4. Decrement the load at the same uniform rate and measure the corresponding deflection.
5. Draw a load versus deflection graph.

**GRAPH**

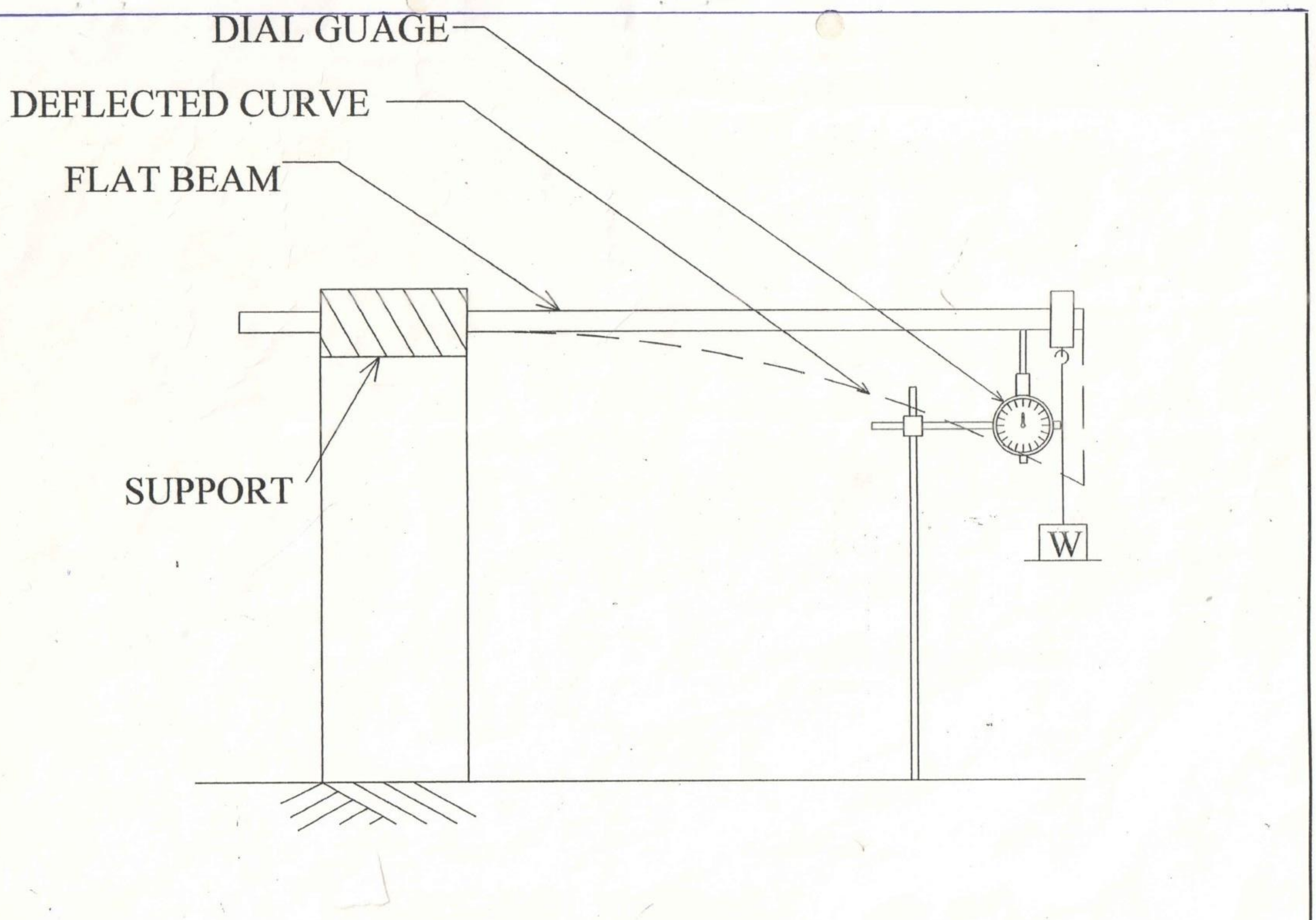
The graph is drawn for load W versus deflection δ, taking deflection δ in X-axis and load W in Y-axis. If the graph is not passing through the origin, a line is drawn parallel to the previous line passing through the origin. The slope of this line is substituted in the formulae to find the Young's modulus of the material.

**RESULT**

Young's modulus, E = ------------------------------ $N/mm^2$ (from calculation)

= ------------------------------ $N/mm^2$ (from graph)

**INFERENCE**




ELASTIC BEAM-CANTILIVER

## 12. TEST ON ELASTIC CANTILEVER BEAM

**Ex. No.:** **Date:**

**AIM**

To conduct deflection test on the given mild steel beam for determining the Young's modulus of the beam material.

**BASIC CONCEPT**

The amount of beam, breadth and depth of the beam, the distance at which the deflection is measured and position of load deflection at any point of a cantilever beam subjected to a point load at the free end depends on the Young's modulus of the beam material, the span of the.

**APPARATUS**

1. Deflection bench arrangement
2. Deflectometer
3. Vernier caliper
4. Scale

**FORMULAE**

From the point load and deflection at free end, we get

Young's modulus, $E = \frac{WL^3}{3\delta I}$ (N/mm$^2$)

I = Moment of Inertia = $\frac{BD^3}{12}$ (mm$^4$)

Where,

W = Concentrated load at the free end in N

L = Length of the beam in mm

$\delta$ = Deflection in mm

B = Breadth of beam in mm

D = Depth of beam in mm

## OBSERVATION

Length of the beam = ---------------------- mm

**Table 1: To measure breadth and depth of the beam.**

Least count of the vernier caliper = 0.02 mm

| S.No. | Description | M.S.R (mm) | V.S.R | | T.R = M.S.R + V.S.R (mm) |
|---|---|---|---|---|---|
| | | | (Divisions) | (mm) | |
| 1. | Breadth, B | | | | |
| 2. | | | | | |
| 3. | | | | | |
| | | | | | Mean: |
| 1. | Depth, D | | | | |
| 2. | | | | | |
| 3. | | | | | |
| | | | | | Mean: |

$$I = \frac{BD^3}{12} \ (mm^4)$$

**Table 2: To determine the Young's modulus of the material**

Least count of the deflectmeter = 0.01 mm

| S.No. | Load in | | Deflectmeter reading (Deflection, δ) | | | | Young's modulus, $E = \frac{WL^3}{3\delta I}$ (N/mm²) |
|---|---|---|---|---|---|---|---|
| | kg | N | Loading (Divisions) | Unloading (Divisions) | Mean (Divisions) | Deflection (mm) | |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |

**Mean:**

## PROCEDURE

1. The length of the given beam specimen is measured.
2. The cross sectional dimensions of the given specimen are measured with the help of vernier caliper.
3. Fix the beam tightly at one end, measure the cantilever length of the beam and place the deflectometer at free end.
4. Load the beam at an uniform rate near the free (unsupported) end from 1 kg to 4 kg and note down the corresponding deflectometer readings.
5. Remove load at the same uniform rate and note down the corresponding deflectometer readings.
6. The results are tabulated.

## GRAPH

The graph is drawn for load W versus deflection $\delta$, taking deflection $\delta$ in X-axis and load W in Y-axis. If the graph is not passing through the origin, a line is drawn parallel to the previous line passing through the origin. The slope of this line is substited in the formulae to find the Young's modulus of the material.

## RESULT

Young's modulus of the material, E = ------------------------------ $N/mm^2$ (from calculation)

= ------------------------------ $N/mm^2$ (from graph)

## INFERENCE