SCHEME : K

Name : _____

Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

LABORATORY MANUAL FOR

STRENGTH OF MATERIALS

(313308)

CIVIL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)

VISION:

To ensure that the Diploma Level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION:

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY:

We, at MSBTE are committed to offer the best-in-class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES:

MSBTE believes in the following:

- Skill development in line with industry requirements
- Industry readiness and improved employability of Diploma holders
- Synergistic relationship with industry
- Collective and Cooperative development of all stake holders
- Technological interventions in societal development
- Access to uniform quality technical education.

A Laboratory Manual

For

STRENGTH OF MATERIAL

(313308)

SEMESER-III

"K-SCHEME"

(AE/ AL/ CE/ CR/ CS/ LE/ ME/ PG)

Maharashtra State

Board of Technical Education, Mumbai.

(Autonomous) (ISO: 9001: 2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education, Mumbai
(Autonomous) (ISO: 9001: 2015) (ISO/IEC 27001:2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai – 400051,
(Printed On July, 2024)

Maharashtra State
Board of Technical Education, Mumbai.

Certificate

This is to certify that Mr. / Ms……

Roll No……of Second semester of Diploma in ……..of Institute,…… ……(Code:……) has completed the term work satisfactorily in course **STRENGTH OF MATERIALS (313308)** for the academic year 20…… to 20…… as prescribed in the curriculum**.**

Place: …… Enrollment No: ……..

Date: …… Exam. Seat No: ……

Subject teacher **Head of the Department** **Principal**

Seal of Institution

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

PREFACE

The primary focus of any engineering laboratory/field work in the technical education system is to develop the much-needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programs with outcome-based education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a 'vehicle' to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'T' scheme laboratory manual development team designed the practical's to focus on the outcomes, rather than the traditional age-old practice of conducting practical's to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

In day-to-day working we come across different types of structures created for different purposes and functions. While designing the structures, analysis of forces and stresses is an important and prerequisite step. Correct analysis is possible only when one knows the types and effects of forces acting on the structures. This course provides the scope to understand Fundamental concepts of laws of mechanics and their applications to different engineering problems. This course is designed to provide basic understanding about the different types of forces, moments and their effects on structural elements, which will analyze different structural systems.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Program outcome (POs)

PO 1. Basic & Discipline specific knowledge: Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the engineering problems.

PO 2. Problem Analysis: Identify and analyze well defined engineering problems using codified standard methods.

PO 3. Design /Development Solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

PO 4. Engineering tools experimentation and testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO 5. Engineering practices for society sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO 6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO 7. Lifelong learning: Ability to analyze individual needs and engage in updating in context of technological changes.

List of Relevant Skills

On the successful completion of the course the students will acquire the required industry relevant skills and they will be able to:

1. Use the given instruments of strength of materials laboratory.
2. Enter the observations in the observation table accurately.
3. Compute the strength of materials based on the observations.
4. Read and interpret the results of the practical.
5. Use appropriate method for material testing.

Guidelines to teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each practical.
3. Involve students in performance of each practical.
4. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.

Instructions to Students

1. Organize the work in the group and make record all programs.
2. Students shall develop maintenance skill as expected by industries.
3. Student shall attempt to develop related hand-on skills and gain confidence.
4. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
5. Student shall refer technical magazines.
6. Student should develop habit to submit the practical on date and time.
7. Student should well prepare while submitting write-up of exercise.
8. Attach /paste separate papers wherever necessary.

Practical Course outcome matrix:

- CO1 - Calculate the M.I. of the given object using relevant formulae & methods.
- CO2 - Analyse the structural behaviour of the given structural components under various loading conditions.
- CO3 - Draw SFD and BMD for the given structural element under given loading conditions.
- CO4 - Determine the bending and shear stresses in beams under different loading conditions.
- CO5 - Analyse the direct & bending stresses in the structural members under eccentric loading conditions.

Pr. No.	Title of the Practical	Mapped Course Outcome				
		CO 01	CO 02	CO 03	CO 04	CO 05
01	*Conduct sample compressive and tensile tests on metal using Universal Testing Machine along with introduction to machine & other tests to be conducted on UTM	--	√	--	--	--
02	*Tension test on mild steel as per IS:432(1)	--	√	--	--	--
03	Tension test on Tor steel as per IS:1608, IS:1139	--	√	--	--	--
04	*Compression test on any two metals like Mild Steel, Brass, Al etc. using Compression Testing Machine	--	√	--	--	--
05	*Izod Impact test on any two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1598	--	√	--	--	--
06	Charpy Impact test on two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1757	--	√	--	--	--
07	Compressive strength of dry and wet bricks as per IS:3495(part I), IS:1077	--	√	--	--	--
08	*Single Shear and double shear test on any two metals like Mild steel/ brass/ Al / copper / cast iron etc. as per IS:5242	--	√	--	√	--
09	Compression test on timber section along the grain and across the grain as per IS:2408	√	√	--	--	--
10	*Shear force and Bending Moment diagrams of cantilever, simply supported and overhanging beams for different types of loading (02 problems on each type of beam)	--	--	√	--	--
11	*Flexural test on timber beam on rectangular section in both orientations as per IS:1708, IS:2408	√	--	--	√	--
12	a) Prepare PPT of minimum 05 slides on the concept of Strain Energy & instantaneous stress induced in a material due to gradual, Sudden & impact load. b) Prepare PPT of minimum 04 slides on Thermal Stresses & Thermal Strains.	--	√	--	--	--
13	Flexure test on floor tiles IS:1237, IS:13630 or roofing tiles as per IS:654, IS:2690	--	--	--	√	--
14	Rockwell Hardness Test on any two Metals like Mild Steel, Brass Copper, Aluminum etc.	--	√	--	--	--
15	Brinell hardens test on any two metals like Mild Steel, Brass Copper, Aluminum etc.	--	√	--	--	--

CONTENT PAGE

List of Practical's and Formative Assessment sheet.

Pr. No	Title of the Practical	Page No.	Date of perfor mance	Date of Submis sion	Assess ment marks	Dated sign of teacher	Remarks (if any)
01	*Conduct sample compressive and tensile tests on metal using Universal Testing Machine along with introduction to machine & other tests to be conducted on UTM	01					
02	*Tension test on mild steel as per IS:432(1)	09					
03	Tension test on Tor steel as per IS:1608, IS:1139	17					
04	*Compression test on any two metals like Mild Steel, Brass, Al etc. using Compression Testing Machine	24					
05	*Izod Impact test on any two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1598	28					
06	Charpy Impact test on two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1757	33					
07	Compressive strength of dry and wet bricks as per IS:3495(part I), IS:1077	38					
08	*Single Shear and double shear test on any two metals like Mild steel/ brass/ Al / copper / cast iron etc. as per IS:5242	43					
09	Compression test on timber section along the grain and across the grain as per IS:2408	48					
10	*Shear force and Bending Moment diagrams of cantilever, simply supported and overhanging beams for different types of loading (02 problems on each type of beam)	52					
11	*Flexural test on timber beam on rectangular section in both orientations as per IS:1708, IS:2408	65					
12	a) Prepare PPT of minimum 05 slides on the concept of Strain Energy & instantaneous stress induced in a material due to gradual, Sudden & impact load. b) Prepare PPT of minimum 04 slides on Thermal Stresses & Thermal Strains.	69					

Pr. No	Title of the Practical	Page No.	Date of perfor mance	Date of Submis sion	Assess ment marks	Dated sign of teacher	Remarks (if any)
13	Flexure test on floor tiles IS:1237, IS:13630 or roofing tiles as per IS:654, IS:2690	72					
14	Rockwell Hardness Test on any two Metals like Mild Steel, Brass Copper, Aluminum etc.	**77**					
15	Brinell hardens test on any two metals like Mild Steel, Brass Copper, Aluminum etc.	81					
Total marks :							

These marks are to be transferred in pro-forma published by MSBTE.

- '*' Marked Practical (LLOs) are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

Practical No: 01 **Conduct sample compressive and tensile tests on metal using Universal Testing Machine along with introduction to machine & other tests to be conducted on UTM.**

I. Practical Significance:

To suggest any material for its use one must be aware of all the properties of that material. Various properties of the material com be found/calculated in the laboratory can be performing different tests on it. In general, the important properties are tensile strength, compressive strength, shear strength, flexural strength etc. which plays an important role for their use as a material. Universal Testing Machine (UTM) is machine with the help of which one can determine these important properties by performing different tests on it. Instead of having separate machine all the tests can be performed using UTM

II. Industry/Employer expected outcome(s):

- This practical is expected to develop Measurement skill, error estimation skill and select proper cross heads for particular type of load application.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze structural behavior of material under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 1.1 Identify different components of UTM

V. Relevant Affective Domain related Outcome(s):

- Adhere to professional and ethical standards at all times.
- Uphold top-notch hygiene standards.
- Make sure to practice safe behaviors consistently.
- Utilize tools, equipment, and machinery efficiently.

VI. Relevant Theoretical Background:

The material possesses various mechanical properties. These properties determined by conducting different tests on it. To conduct the test instead of using separate machines, one can perform all the important test using UTM along with its attachment

VII. Required resources/equipment:

Sr. No.	Particulars	Specification	Quantity
1	UTM	Universal Testing machine of capacity 1000kN, 600 KN, 400kN, analog type/digital type with all attachments and accessories	01
2	Extensometer	Least count 0.01 mm. maximum extension 25 mm. single dial gauge for 30 mm, 40 mm, 60 mm, 80 mm, 100 mm, 125 mm gauge length.	01
3	Various attachment	Shear block for shear text	01
		Indenter attachment for Hardness test	01
		Roller supports and load pointer for flexure test	01

- **Labeling to the experimental set-up for UTM is to be done by the students:**

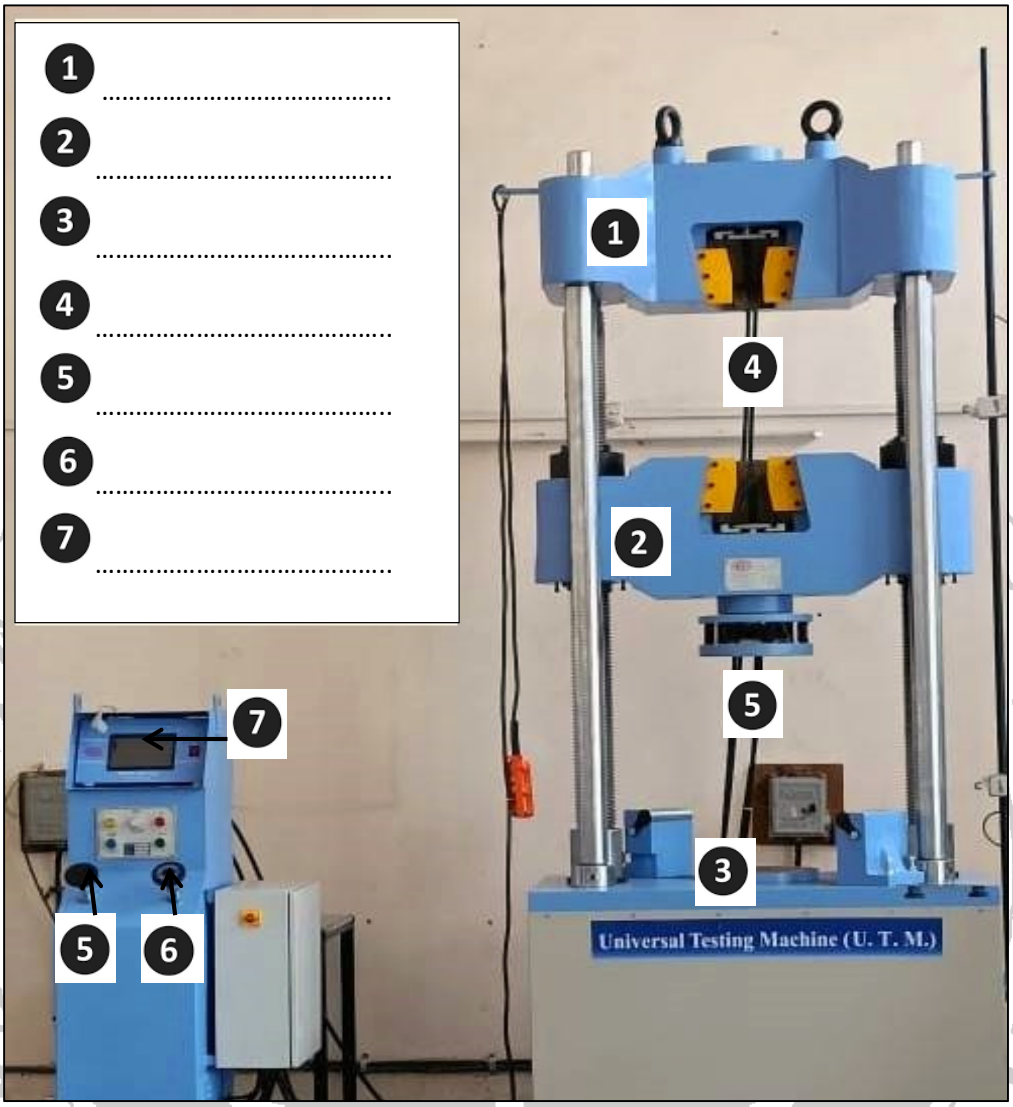


Figure 1.1 Universal Testing Machine

VIII. Precautions to be followed:

1. The reading must be taken and noted down carefully.
2. The specimen should be fixed carefully in to the jaw of machine.
3. Attach Extensometer carefully.
4. Apply the load gradually
5. Extensometer must be removed at the yield point load.

IX. Procedure:

1. Study the control unit and loading unit along with their function
2. Identify the various cross heads of the machine along with all its attachment.
3. Study the working principle of the machine.
4. Ensure that the release valve of the machine is open and control valve is closed.
5. Move the middle crosshead of straining unit rapidly with the help of mechanical motors, there by the space in upper crosshead and middle cross head decreases or increases depending on the make of the machine.

6. Now for hydraulic movement of cross heads close the release valve and slowly open the control valve and observe the slow movement of one of the three cross heads. It is the movable cross head and remaining are the fixed cross heads.
7. Observe the space between two cross heads, if it is decreasing then compressive load can be applied.
8. But if space between these two cross-beads is increasing then tensile load can be applied.

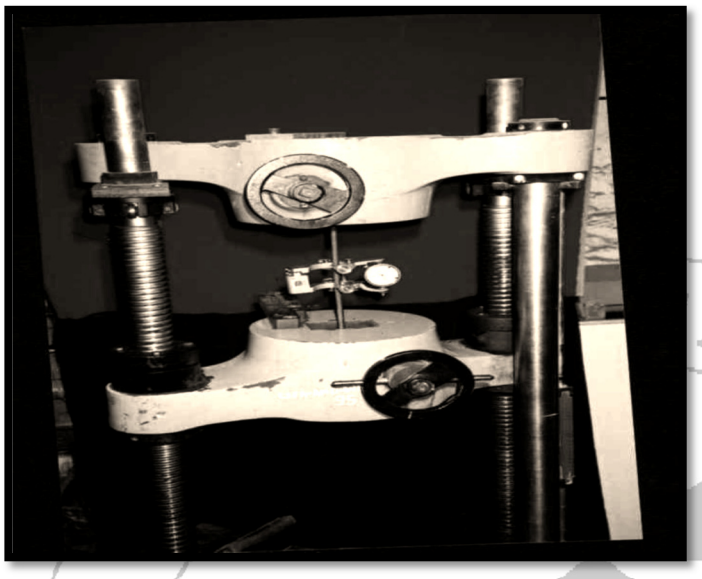
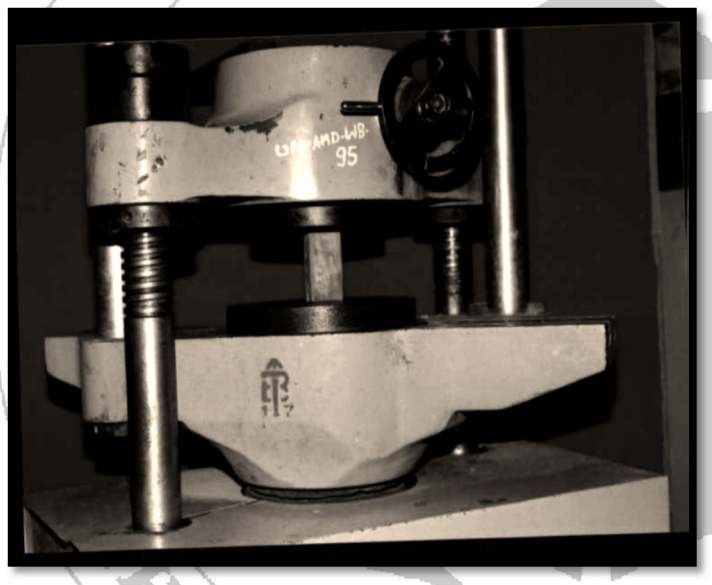
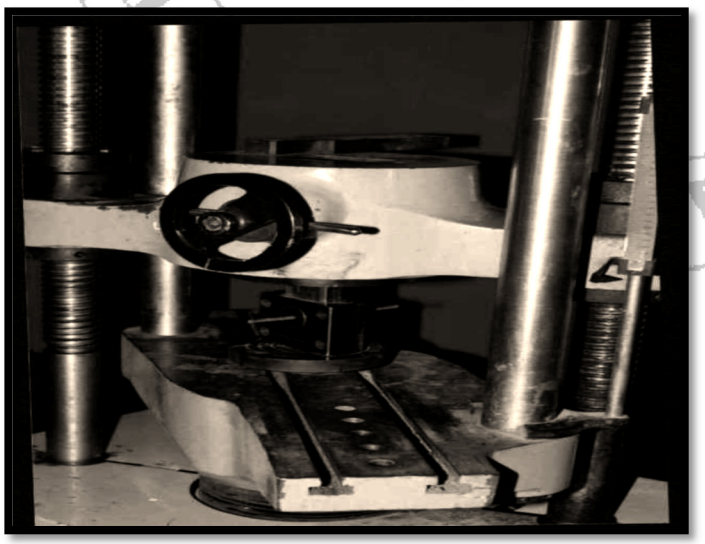
(A) Procedure for sample compression test:

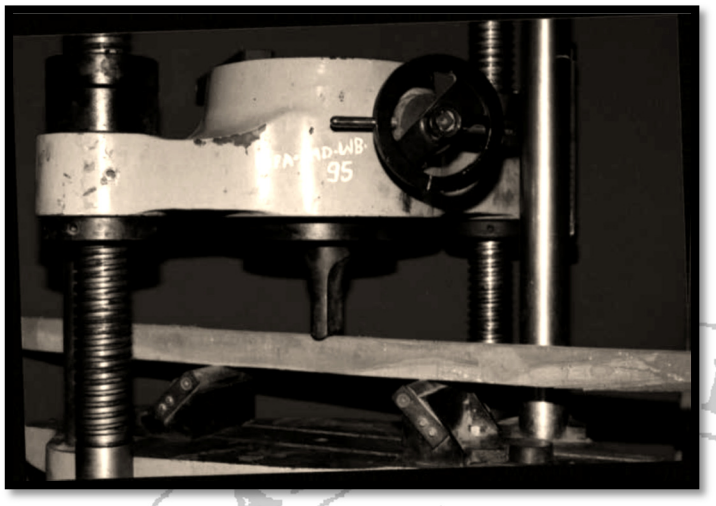
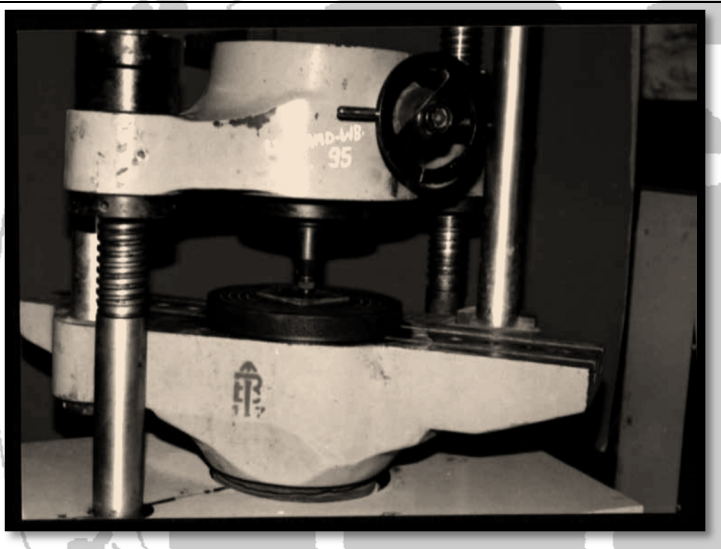
1. Put off the machine. Open the release valve and close the control valve.
2. Adjust the position of middle cross head with the help of mechanical movement for application of compressive load mortar cube/concrete cube/timber suitable sample
3. Ensure that cross head are touching the specimen. After selecting suitable range on load dial gage close the release valve and open slowly the control valve
4. For the selected range of load note the least count of load dial gauge, observe the movement of pointer. In of electronic unit the values of digital display increase. Note the gradual application of load
5. Note the readings of load at different instants.
6. Apply the load till failure takes place that is the maximum load or failure load
7. Teacher may differentiate the stress & strain at this stage.

(B) Procedure for sample tensile test:-

1. Put off the machine. Open the release valve. Note the backflow of hydraulic oil and lowering of the crosshead, close the control valve.
2. Adjust the loading range of UTM and select the loading interval.
3. Set the Load pointer of the dial gauge to zero.
4. Fix the specimen between the grips of top and middle cross head of the loading frame.
5. Adjust the gauge length on extensometer and fix the same at the middle portion of the bar. Switch on the UTM.
6. Observe hesitations in the movement of load pointer at yield point. Here the load pointer moves somewhat to and fro. It gives upper yield load and lower yield load. Record these values.
7. When the specimen enters in plastic range, the extensometer reading changes rapidly with little change in load. Remove the extensometer at this instant.
8. Further elongation of the bar is observed from extension measuring device, fixed on the loading frame.
9. Apply the load continuously till the specimen breaks. Observe the ultimate and breaking load and also neck formation.

X. Observation and Calculations:

1		Test Conducted: ……... Jaw or Cross Head used: 1 …… 2 …… Attachment used (if any): ……... Load at Failure: ……...
2		Test Conducted: ……... Jaw or Cross Head used: 1 …… 2 …… Attachment used (if any): ……... Load at Failure: ……...
3		Test Conducted: ……... Jaw or Cross Head used: 1 …… 2 …… Attachment used (if any): ……... Load at Failure: ……...

4		Test Conducted: ……... Jaw or Cross Head used: 1 …… 2 …… Attachment used (if any): ……... Load at Failure: ……...
5		Test Conducted: ……... Jaw or Cross Head used: 1 …… 2 …… Attachment used (if any): ……... Load at Failure: ……...

XI. Result:

1. Tensile Strength Test: Load at Failure = …… kN.
2. Compressive Strength Test (Timber or Concrete): Load at Failure = …… kN.
3. Single or Double Strength Test: Load at Failure = …… kN.
4. Flexural (Bending) Strength Test: Load at Failure = …… kN.
5. Compressive Strength Test (Metal): Load at Failure = …… kN.

XII. Interpretation of results:

XIII. Conclusions:

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the maximum capacity of UTM you have used.
2. State the least count of machine for the measurement of load.
3. Can we set up this machine other than ground floor? Justify your answer.

Space for Answer

XV. References / Suggestions for further Reading:

1. Brochure supplied with the machine.
2. I.S. 1608. 2005 and LS. 432 (Part I) 1982 R 1995.
3. https://sm-nitk.vlabs.ac.in/exp/tensile-test-mild-steel/videos.html
4. https://sm-nitk.vlabs.ac.in/exp/compression-test-mild-steel/videos.html
5. https://sm-nitk.vlabs.ac.in/exp/direct-shear-test-steel-rod/videos.html

XVI. Assessment Scheme:

Sr. No	Performance Indicators	Weightage (%)
	Process related: 15 Marks	**60%**
1	Handling of the machine.	10%
2	Following of precautions	10%
3	Applying load and taking observations.	20%
4	Identifying the nature of failure of the specimen.	10%
5	Calculation of parameters concerned.	10%
	Product related: 10 Marks	**40%**
1	Error estimation.	5%
2	Interpretation of result	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 02 **Tension test on mild steel as per IS:432(1).**

I. Practical Significance:

Loading causes reinforced cement concrete members to experience both tensile stress and compressive stress. Mild steel and tor steel are commonly used in various R.C.C. members during construction. Mild steel is specifically chosen to withstand tension within the structure. Therefore, it is crucial to determine the tensile strength of mild steel before incorporating it into the structure. The stress-strain curve for mild steel under tension displays important points that help in understanding the material's ductile behavior.

II. Industry/Employer expected outcome(s):

- This practical is expected to develop Measurement skill, Error estimation skill and plotting the graph related to tensile test.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 2.1 Perform Tension test on mild steel as per IS:432(1)

V. Relevant Affective Domain related Outcome(s):

- Adhere to professional and ethical standards at all times.
- Make sure to practice safe behaviors consistently.
- Utilize tools, equipment, and machinery efficiently.

VI. Relevant Theoretical Background:

The material displays a range of mechanical characteristics. Mild steel exhibits elasticity, ductility, malleability, and strength. Determining the tensile strength of mild steel is essential for utilizing it in different construction items. The tensile strength of mild steel contributes to enhancing the product's strength. During a tension test, it is crucial to observe the limit of proportionality, elastic limit, yield point, ultimate point, and breaking point. Measuring the initial gauge length, final gauge length, reduction in diameter, and observing the formation of a neck is necessary.

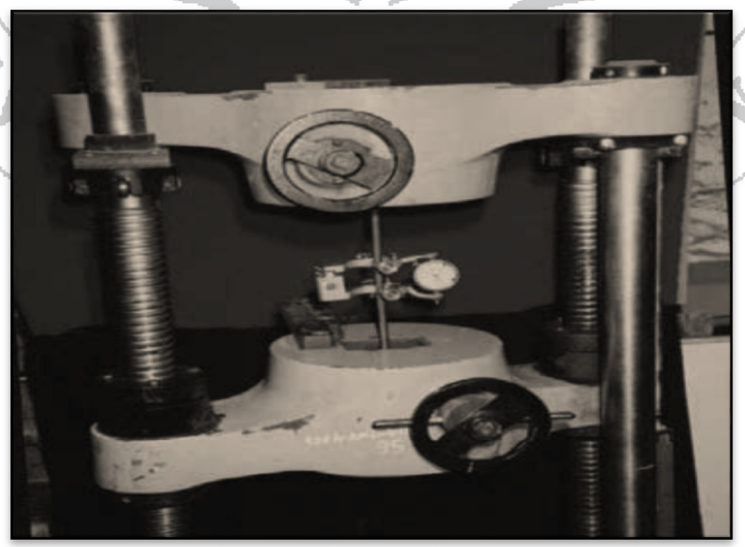


Figure 2.1: Tension Test

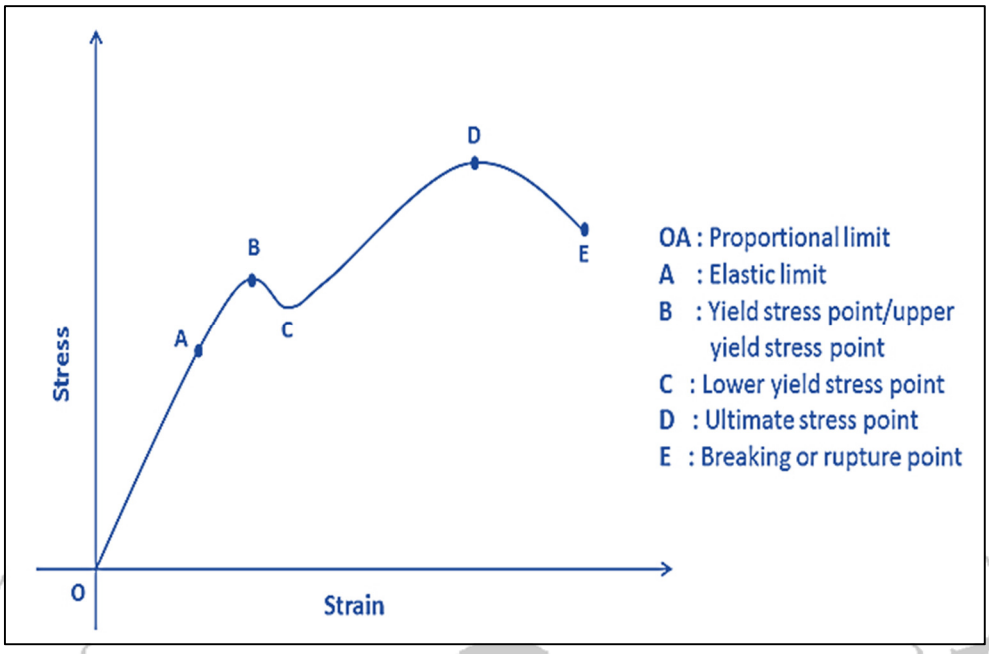


Figure 2.2: Typical Stress - Strain Curve for Mild Steel

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	UTM	Universal Testing machine of capacity 1000kN, 600 KN, 400kN, analog type/digital type with all attachments and accessories.	2 nos.
02	Extensometer	Least count 0.01 mm. maximum extension 25 mm. Single dial gauge for 30 mm, 40 mm, 60 mm, 80 mm, 100 mm, 125 mm gauge length.	1 nos.
03	Specimen	Mild steel.	1 per batch
04	Vernier caliper	Least count of 0.02 mm & measuring range of 0.02 mm to 150mm.	1

VIII. Precautions to be followed:

1. The reading must be taken and noted down carefully.
2. The specimen should be fixed carefully in to the jaw of machine
3. Attach extensometer carefully.
4. Apply the load gradually.
5. Extensometer must be removed at the yield point load.

IX. Procedure:

1. Measure the diameter of the specimen at three different sections. Calculate the original diameter by taking average of three readings. The minimum overall length of the specimen shall be 20 times diameter plus 200 mm.
2. Mark the gauge points over the grip length such that the gauge point's distance is half the gauge length i.e. half of $5.65\sqrt{So}$ where so is the cross-sectional area.
3. Fix up the bar in the appropriate crossheads so that it is subjected to tensile load.
4. Attach the extensometer on the bar at the central portion of the bar with appropriate distance

between upper & lower pivots of extensometer.

5. Select a suitable loading range depending on the diameter of specimen.
6. Switch on the machine and open the control valve so that the load is increased gradually and at the required rate.
7. Record the load at suitable interval from the digital display unit or the load dial. Corresponding to loads note the readings of Extensometer.
8. For initial few observations load and extension are in pace with each other. Record the yield point load by observing the hesitation of load pointer reading. The extension reading are faster at this moment.
9. Remove the extensometer, and start to measure extension of gauge length by divider or suitable scale. Stop measurement when maximum load has reached.
10. Record the maximum load. Observe the decrease in load and neck formation on the specimen.
11. Record the load at fracture and put off the machine.
12. Remove the specimen. Observe the cone & cup formation at the fracture point.
13. Rejoin the two pieces, measure the final gauge length and the reduced diameter.
14. Plot the graph of Stress verses strain for mild steel and determine the modulus of elasticity.

X. Observations and Calculations (Use blank sheet provided if space not sufficient)

a] Original diameter (Average) (d) =.....mm

(A)=.....mm^2

b] Original gauge length (g) =.....mm

c] Gauge length of extensometer = ...mm

d] Least count of extensometer (L.C). =.....mm

XI. Calculation table:

Sr. No.	Load (P) in (N)	Extensometer reading in divisions EMD	Extension = L.C. x EMP (mm)	Stress=$\frac{P}{A}$ (N/mm^2)	Strain Extension / gauge length of extensometer

Sr. No.	Load (P) in (N)	Extensometer reading in divisions EMD	Extension = L.C. x EMP (mm)	Stress=$\frac{P}{A}$ (N/mm^2)	Strain Extension / gauge length of extensometer

Observation after test:

1] Final gauge length = g' =.....mm

2] Reduced diameter d' =.....mm

Calculations:

a] Original area A= *n/4* x d^2 =..... mm^2

Reduced area A' = *n/4* xd^2 =..... mm^2

b] Gauge length of g = 5.65√S0 or 5d (for round bars)

c] Stress σ = load/ Original cross - sectional area

d] Strain = £ = Extension/ Gauge length of the Extensometer

e] Modulus of Elasticity E = $\frac{\sigma}{\varepsilon}$ = ...N/mm^2

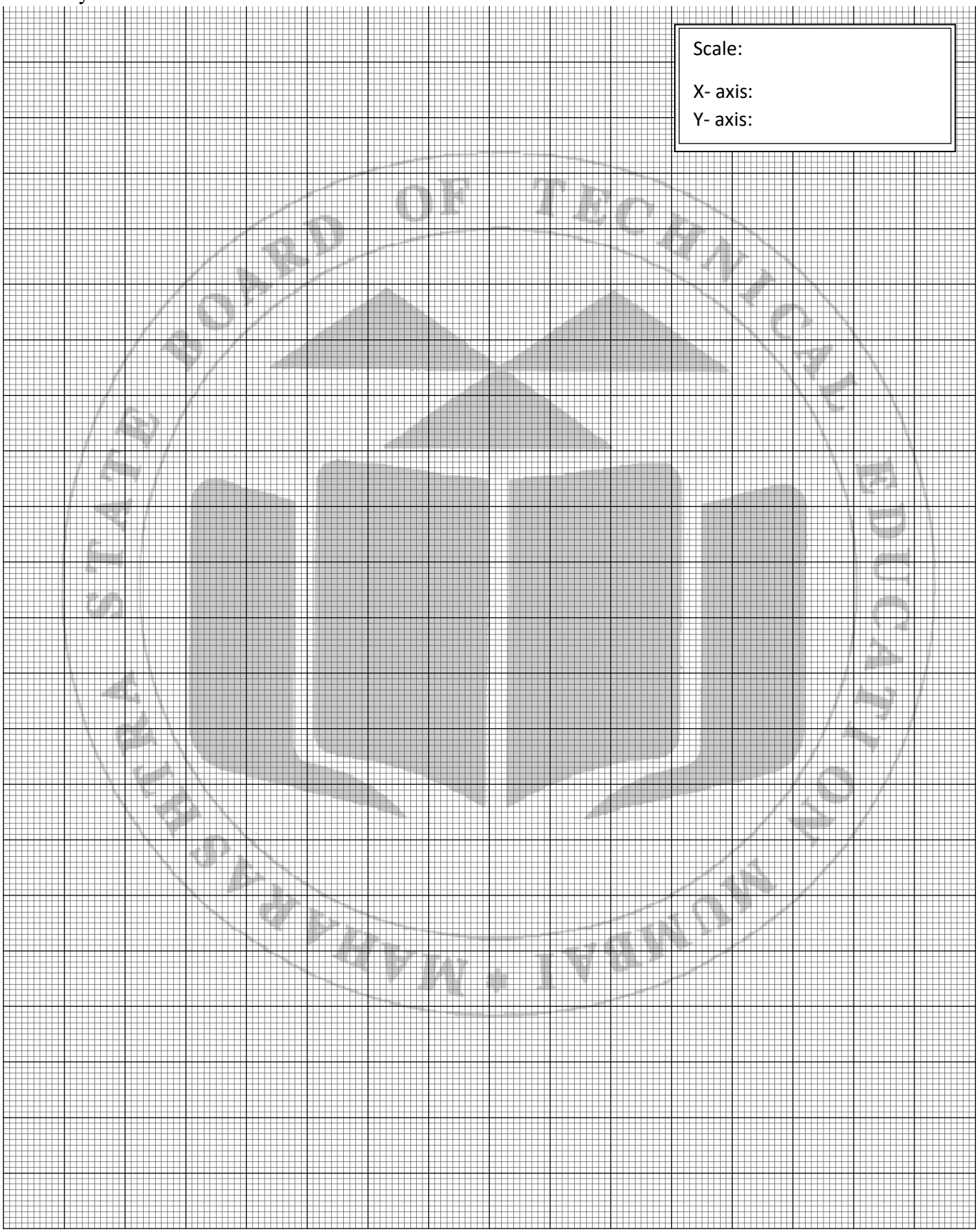
(Within Elastic limit)

f] Percentage elongation= [(g- g') I g] x 100 =

g] Percentage reduction in area= [(A -A')/ A] x 100 =

Graph:

Plot the graph of stress V/s strain and locate the important points on it. Calculate Modulus of Elasticity.



XII. Results:

a] Yield Stress:_____

b] Tensile Strength:_____

c] Nominal breaking Stress: _____

d] Percentage elongation: _____

e] Modulus of elasticity (By graph):_____

(By calculation):_____

XIII. Interpretation of results (Give meaning of the above obtained results)

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Identify the different points on the stress -strain curve and state their importance.
2. State the type of failure you have observed.
3. What do you mean by neck formation? Have you observed this phenomena in this test?

Space for Answer

XV. References / Suggestions for further Reading:

1. Brochure supplied with the machine.
2. I.S. 1608. 2005 and LS. 432 (Part I) 1982 R 1995.
3. https://sm-nitk.vlabs.ac.in/exp/tensile-test-mild-steel/videos.html.

XVI. Assessment Scheme:

Sr. No	Performance Indicators	Weightage (%)
	Process related: 15 Marks	**60%**
1	Handling of the machine.	10%
2	Following of precautions	10%
3	Applying load and taking observations.	20%
4	Identifying the nature of failure of the specimen.	10%
5	Calculation of parameters concerned.	10%
	Product related: 10 Marks	**40%**
1	Error estimation.	5%
2	Interpretation of result	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 03 **Tension test on Tor steel as per IS:1608, IS:1139**

I. Practical Significance:

Loading causes reinforced cement concrete members to experience both tensile stress and compressive stress. Mild steel and tor steel are commonly used in various R.C.C. members during construction. Mild steel is specifically chosen to withstand tension within the structure. Therefore, it is crucial to determine the tensile strength of mild steel before incorporating it into the structure. The stress-strain curve for mild steel under tension displays important points that help in understanding the material's ductile behavior.

II. Industry/Employer expected outcome(s):

- This practical is expected to develop Measurement skill, Error estimation skill and plotting the graph related to tensile test.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 3.1 Perform tension test on Tor steel as per IS:1608, IS:1139

V. Relevant Affective Domain related Outcome(s):

- Adhere to professional and ethical standards at all times.
- Uphold top-notch hygiene standards.
- Make sure to practice safe behaviors consistently.
- Utilize tools, equipment, and machinery efficiently.

VI. Relevant Theoretical Background:

The material exhibits a range of mechanical characteristics. Tor steel demonstrates elasticity, ductility, malleability, and strength. In order to incorporate tor steel into different construction items, it is essential to determine its tensile strength. The tensile strength of tor steel plays a crucial role in enhancing the overall strength of the product.

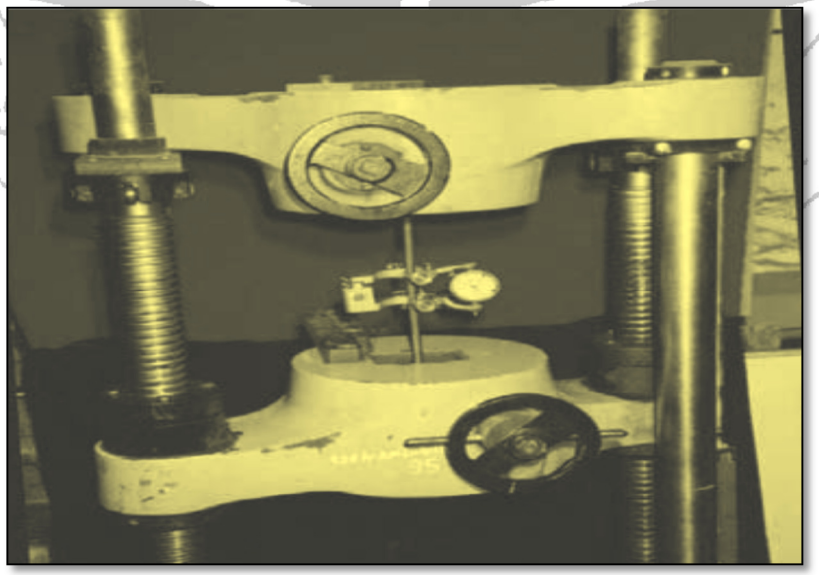


Figure 3.1: Tension Test

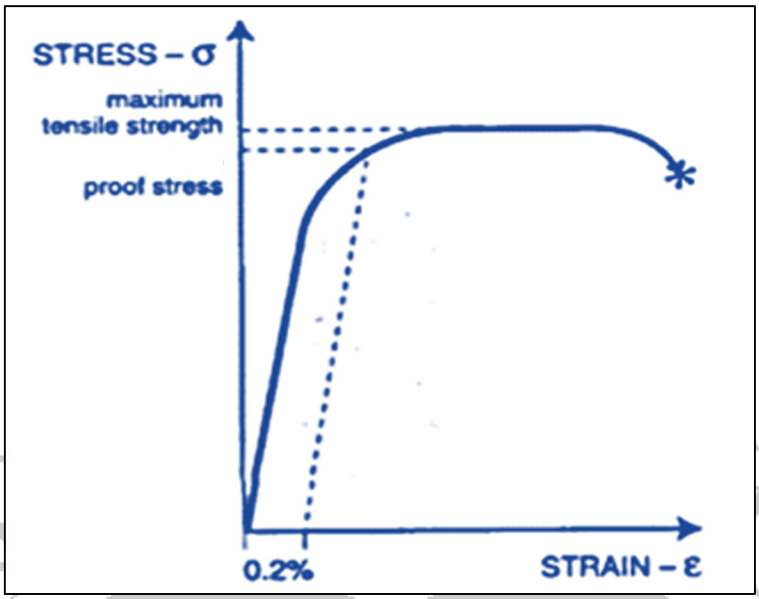


Figure 3.2: Typical Stress - Strain Curve for Tor Steel

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1	UTM	Universal Testing machine of capacity 1000kN, 600 KN, 400kN, analog type/digital type with all attachments and accessories	2 nos.
2	Extensometer	Least count 0.01 mm. maximum extension 25 mm. Single dial gauge for 30 mm, 40 mm, 60 mm, 80 mm, 100 mm, 125 mm gauge length.	1 nos.
03	Specimen	Mild steel	1 per batch
04	Vernier caliper	Least count of 0.02 mm & measuring range of 0.02 mm to 150mm.	1

VIII. Precautions to be followed:

1. The reading must be taken and noted down carefully.
2. The specimen should be fixed carefully in to the jaw of machine
3. Attach extensometer carefully.
4. Apply the load gradually.
5. Extensometer must be removed at the yield point load.

IX. Procedure:

1. Determine the weight of the bar.
2. Indicate the length at a distance of 10 times the diameter of the bar from each end for securing the bar in grips.
3. Mark the gauge length at intervals of $5.65\sqrt{S_0}$ times the diameter of the bar. (Where S_0 = Cross-sectional area of the bar = $\pi\ d_n^2 / 4$)
4. Set the loading range of the UTM and choose the rate of loading.
5. Zero the Load pointer and dummy pointer of the dial gauge.

6. Secure the specimen between the grips of the top and middle cross head of the loading frame.
7. Adjust the gauge length on the extensometer and secure it at the middle marked gauge distance of the bar. To secure the extensometer, ensure the bar at the point of fixation is flat by filling and creating a slight groove with a punch to accommodate the knife edge of the extensometer.
8. Turn on the UTM. Take regular extensometer readings at load intervals and record them in the observation table.
9. Continue the process until the extensometer readings change rapidly, indicating the bar has entered the plastic zone. Remove the extensometer from the bar at this point.
10. Record the further extension of the bar from the extension measuring device attached to the loading frame.
11. Apply a continuous load until the specimen breaks. Examine the cross-section of the bar at failure and sketch it.
12. Rejoin the two broken pieces of the bar and measure the final gauge length. This measurement is used to calculate the percentage elongation of the bar.
13. Repeat the test if the rupture occurs within the grips.
14. Plot the stress versus strain graph and determine the proof stress, ultimate stress, and breaking stress from it.

- **Method of determination of proof stress:-**
  The stress-strain curve of deformed bar does not show a clear yield point like mild steel. Instead, the concept of proof stress is used to identify the yield point. This involves drawing a tangent at the beginning of the curve, then drawing a line parallel to the tangent at a strain value of 0.02 (0.2%) and extending it to intersect the curve. The stress value at this intersection is considered the proof stress. The Modulus of Elasticity of the bar material can be calculated using the stress and strain values below the proof stress point on the curve.

X. Observations and Calculations (Use blank sheet provided if space not sufficient)

a] Length of bar, L = ...

b] Weight of bar, W= .....

c] Nominal diameter of bar:

$$a)\ d_n = \sqrt{\frac{4W}{\pi . L . \gamma}}$$

$$b)\ S_0 = \frac{\pi d_n^2}{4}$$

d] Gauge length

i) Initial gauge length: …… mm

ii) Final gauge length: …… mm

e] Least count of extensometer: .....mm

f] Range of loading: .....

g] Rate of loading: ….....

XI. Calculation table:

Sr. No.	Load (kN)	Extensometer reading			Elongation from extensometer reading =Le x A	Stress N /mm^2	Strain
		Left	Right	Average			
1	2	3	4	5	6	7	8

XII. Results:

A] 0.2 % Proof Stress: ..... N/mm^2

B] Ultimate yield stress: ..... N/mm^2

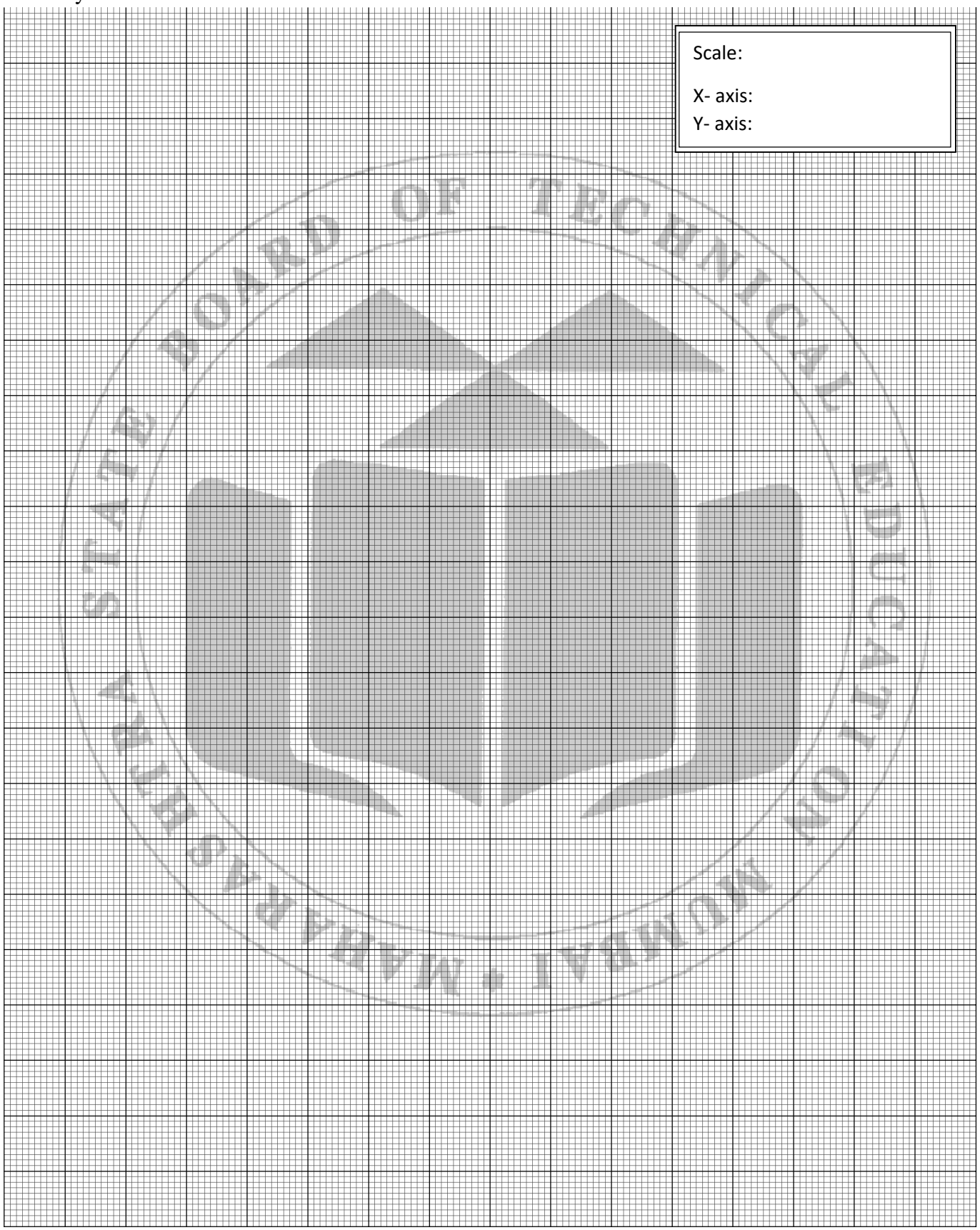
C] Breaking stress: ..... N/mm^2

D] Modulus of elasticity: ..... N/mm^2

E] % elongation: ..... %

Graph:

Plot the graph of stress V/s strain and locate the important points on it. Calculate Modulus of Elasticity.



XIII. Interpretation of results (Give meaning of the above obtained results)

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define Proof Stress. State its importance for deformed steel bars
2. Least the various experiments conducted on machine.
3. Whether the machine is microprocessor or digital?

Space for Answer

XV. References / Suggestions for further Reading:

1. Brochure supplied with the machine.
2. I.S. 1608. 2005 and LS. 432 (Part I) 1982 R 1995.

XVI. Assessment Scheme:

Sr. No	Performance Indicators	Weightage (%)
	Process related: 15 Marks	**60%**
1	Handling of the machine.	10%
2	Following of precautions	10%
3	Applying load and taking observations.	20%
4	Identifying the nature of failure of the specimen.	10%
5	Calculation of parameters concerned.	10%
	Product related: 10 Marks	**40%**
1	Error estimation.	5%
2	Interpretation of result	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 04 **Compression test on any two metals like Mild Steel, Brass, Al etc. using Compression Testing Machine**

I. Practical Significance:

Compressive stress is the stress developed in the material due to the compressive load. In other words, it is the compressive load per unit cross sectional area of the material.

II. Industry/Employer expected outcome(s):

- This practical is expected to develop Measurement skill, Error estimation skill and plotting the graph related to compression test.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 4.1 Conduct compression test on sample test piece using Compression Testing Machine

V. Relevant Affective Domain related Outcome(s):

- Adhere to professional and ethical standards at all times.
- Uphold top-notch hygiene standards.
- Make sure to practice safe behaviors consistently.
- Utilize tools, equipment, and machinery efficiently.

VI. Relevant Theoretical Background:

The material possess various mechanical properties. Compressive stress is the stress developed in the material due to the compressive load. In other words, it is the compressive load per unit cross sectional area of the material. Different materials have different compressive strength.

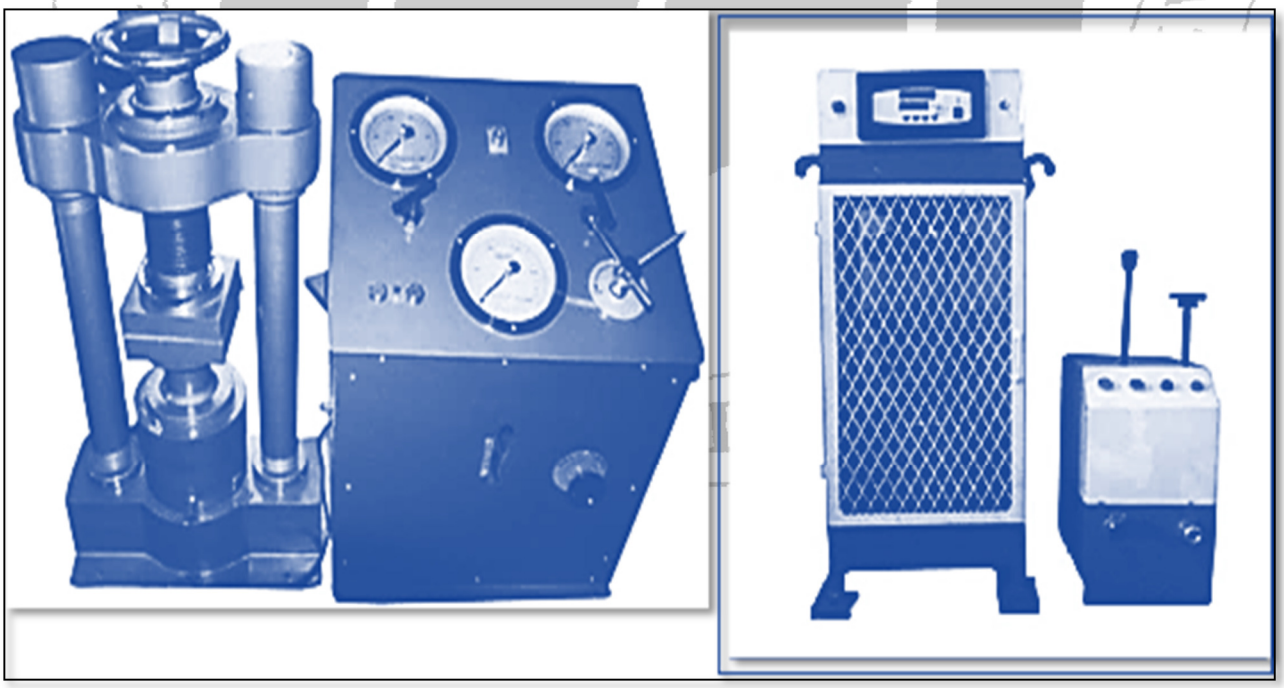


Figure 4.1: Compression Testing Machine

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1	CTM	Compression Testing machine of capacity 2000kN/1000kN/500kN/400kN, analog type/digital type with all attachments and accessories	1 nos.
2	Specimen	Metal/Timber/brick etc.	1 per each group of 4 to 5 students

VIII. Precautions to be followed:

- The reading must be taken and noted down carefully.
- The specimen should be fixed carefully in to the jaw of machine
- Attach extensometer carefully.
- Apply the load gradually.
- Extensometer must be removed at the yield point load.

IX. Procedure:

For mild steel, copper, aluminum and cast iron:

1. Measure the dimensions of the specimen and record in Observation Table.
2. Place the specimen between cross heads of Compression testing Machine.
3. Apply the load gradually till the failure occurs. Record the load at failure.
4. Observe the failure pattern.
5. Calculate the crushing strength.

X. Observations and Calculations (Use blank sheet provided if space not sufficient)

1) Observation Table:

Sr. No.	Specimen	Dimensions of the specimen	C/s area of the specimen (A) in mm^2	Failure load (P) in N	Compressive strength $\sigma = P/A$ in N/mm^2	Remark
1	Mild steel					
2	Copper					
3	Aluminum					

2) Sample Calculations:

Compressive Strength for Material ( ) = $\sigma = P/A$ = ... N/mm^2

Compressive Strength for Material ( ) = $\sigma = P/A$ = ... N/mm^2

Compressive Strength for Material ( ) = $\sigma = P/A$ = ... N/mm^2

XI. Result:

1. Compressive strength of metal (.....) specimen is ..... N/mm^2
2. Compressive strength of metal (.....) specimen is ..... N/mm^2
3. Compressive strength of metal (.....) specimen is ..... N/mm^2

XII. Interpretation of results:

XIII. Conclusions:

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the maximum capacity of CTM you have used.
2. State the loading range available in the machine along with its least count.
3. State the type of oil used in the machine.

Space for Answer

XV. References / Suggestions for further Reading:

1. Uniaxial Tension and Compression Testing of Materials by Nikita Khlystov and others.
2. https://sm-nitk.vlabs.ac.in/exp/compression-test-mild-steel/videos.html
3. https://sm-nitk.vlabs.ac.in/exp/compression-test-cast-iron/videos.html

XVI. Assessment Scheme:

Sr. No	Performance Indicators	Weightage (%)
	Process related: 15 Marks	**60%**
1	Handling of the machine.	10%
2	Following of precautions	10%
3	Applying load and taking observations.	20%
4	Identifying the nature of failure of the specimen.	10%
5	Calculation of parameters concerned.	10%
	Product related: 10 Marks	**40%**
1	Error estimation.	5%
2	Interpretation of result	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 05 **Izod Impact test on any two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1598**

I. Practical Significance:

The material possesses various mechanical properties. Toughness is one of the important property of the material. Toughness of Material is ability of material to absorb energy during plastic deformation before it fractures. Tough materials absorb a lot of energy, whilst brittle materials tend to absorb very little energy prior to fracture. In its working life, structural members may undergo dynamic fracture under rapidly applied loads which are generally produced by impact. In comparison to static loading, dynamic conditions involve loading rates which are higher than those encountered in conventional tensile testing or fracture mechanic's test.

II. Industry/Employer expected outcome(s):

- This practical is expected to develop Measurement skill, Error estimation skill and Observation skill.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 5.1 Conduct Izod Impact test on given metals as per IS:1598

V. Relevant Affective Domain related Outcome(s):

- Adhere to professional and ethical standards at all times.
- Uphold top-notch hygiene standards.
- Make sure to practice safe behaviors consistently.
- Utilize tools, equipment, and machinery efficiently.

VI. Relevant Theoretical Background:

Toughness depends fundamentally on strength and ductility and would appear to be independent of type of loading. It is a fact, however, that the rate at which the energy is absorbed may affect the behavior of material, and thus different measures of toughness may be obtained from impact loading than from static loading. All materials do not respond in the same way to variations in speed of load applications.

There are several different test methods which are used in the evaluation of dynamic fracture resistance. Most common tests are Charpy Test and Izod Test. The test measures the impact energy, or the energy absorbed prior to fracture. Impact energy is a measure of the work done to fracture a test specimen. When the striker impacts the specimen, the specimen will absorb energy until it yields. At this point, the specimen will begin to undergo plastic deformation at the notch. The test specimen continues to absorb energy and work hardens at the plastic zone at the notch. When the specimen can absorb no more energy, fracture occurs.

Izod Impact test:

In this test the metal specimen is used as a vertical cantilever fixed at the bottom and free at the top. A blow of hammer is given to the free end of the specimen. The blow should be sufficient to bend or break the specimen. The striking energy should be 165 Joules. The energy spent in bending or breaking the specimen is taken as 'Izod Impact Value'

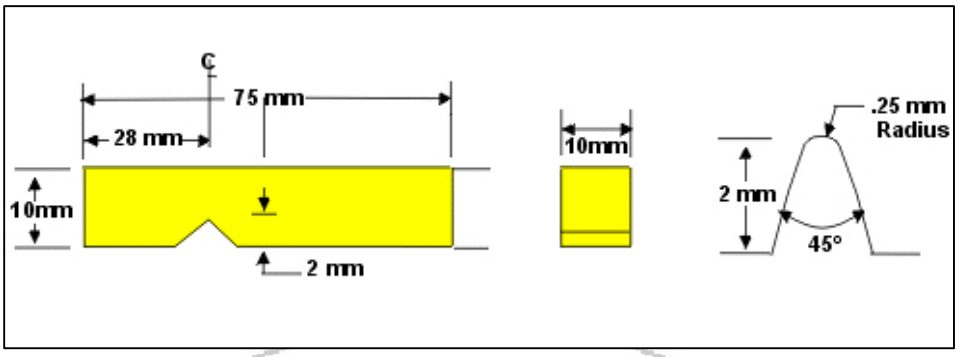


Figure 5.1: Izod Impact Test Specimen

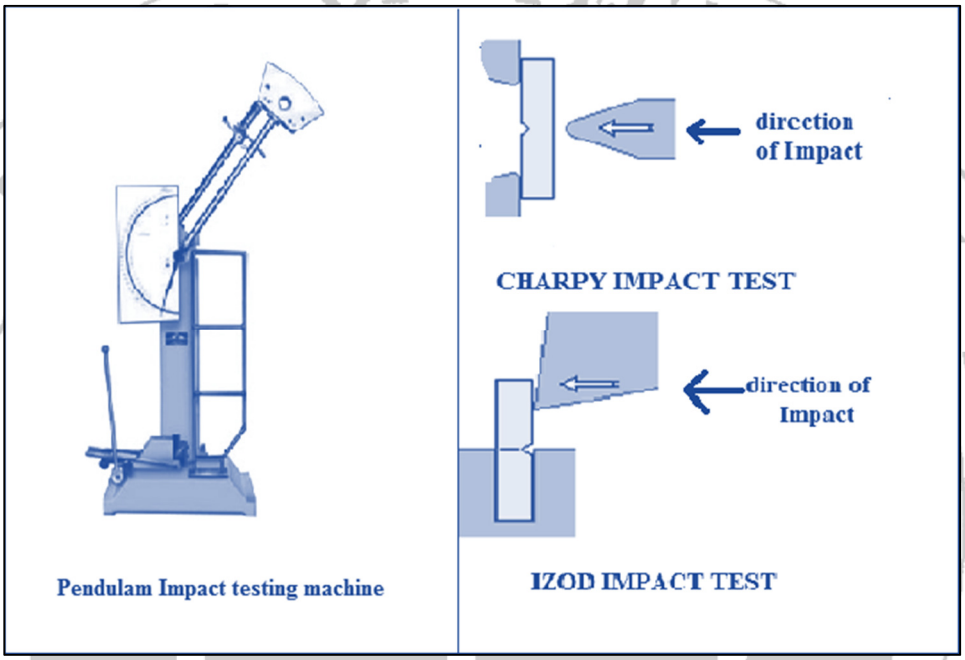


Figure 5.2: Impact Testing Machine

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Pendulum Impact Testing Machine.	Izod/Charpy impact testing machine confirming to IS: 1757.	1 nos.
02	Specimen	Mild steel/brass /aluminum /copper /cast iron	Any three specimen for Izod test each

VIII. Precautions to be followed:

- The reading must be taken and noted down carefully.
- The specimen should be fixed carefully in to the jaw of machine.
- Notch should be placed according to the instructions.
- See that the hammer is clamped properly and nobody should touch the release mechanism. moreover path of free swing should be free from all obstacles.
- Safety rules should be followed strictly while releasing the hammer

IX. Procedure:

1. Observed and study the different parts of impact testing machine
2. Draw the sketch showing the dimension of the specimen as per LS.
3. Set the pointer to maximum energy on the scale when the pendulum is freely suspended. In this test the striking energy used is about (160 to 165 joules). Raise the pendulum hammer to the required height. Release it allowing a free swing and observe the initial energy.
4. Raise the pendulum again to the same height as before and clamp it and set the pointer to maximum energy on the scale.
5. In this test the specimen is used as a vertical cantilever fixed at the bottom and fix at the top in such a way that the notch faces the hammer and is half inside and half above the top surface of the anvil.
6. Release the hammer by operating the release mechanism. The hammer strikes the specimen and note final reading.
7. Repeat the procedure for different specimens.
8. Calculate the shock absorbing capacity and note down in the table which is taken as the Izod impact value.

X. Observations and Calculations (Use blank sheet provided if space not sufficient)

1) Observation Table for lzod test:

Sr. No.	Material	Initial energy in Joules	Final energy in Joules	Shock absorbing capacity in Joules	Remark
01	M.S.				
02	Brass				
03	Aluminum				
04	Copper				
05	Cast Iron				

Note: *Write specifically in remark column whether the specimen purely bends, partially bend & break:*

2) Sample Calculations:

Energy absorbed= Final energy - Initial energy

For Material .....…….…… Energy absorbed =

3) Observation after test

1. Material that bends-.....
2. Material that break-.....

XI. Results:

1. Energy absorbed by mild steel/brass/aluminum/copper/cast iron .....Joules
2. Energy absorbed by mild steel/brass/aluminum/copper/cast iron.....Joules
3. Energy absorbed by mild steel/brass/aluminum/copper/cast iron .....Joules

XII. Interpretation of results:

XIII. Conclusions:

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define gradually applied load, suddenly applied load and Impact load.
2. Write significance of the notch on the specimen?
3. Notch is kept facing striker in case of lzod impact Test. Justify.

Space for Answer

XV. References / Suggestions for further Reading:

1. IS: 1598- 1977 Indian standard Method for Izod Impact Test on Metallic Materials.
2. https://sm-nitk.vlabs.ac.in/exp/izod-impact-test/videos.html

XVI. Assessment Scheme:

Sr. No	Performance Indicators	Weightage (%)
Process related: 15 Marks		**60%**
1	Handling of the machine.	10%
2	Following of precautions	10%
3	Applying load and taking observations.	20%
4	Identifying the nature of failure of the specimen.	10%
5	Calculation of parameters concerned.	10%
Product related: 10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 06 **Charpy Impact test on two metals like mild steel/ brass/aluminum/ copper /cast iron etc. as per IS:1757**

I. Practical Significance:

The material possesses various mechanical properties. Toughness is one of the important property of the material. Toughness of Material is ability of material to absorb energy during plastic deformation before it fractures. Tough materials absorb a lot of energy, whilst brittle materials tend to absorb very little energy prior to fracture. In its working life, structural members may undergo dynamic fracture under rapidly applied loads which are generally produced by impact. In comparison to static loading, dynamic conditions involve loading rates which are higher than those encountered in conventional tensile testing or fracture mechanic's test.

II. Industry/Employer expected outcome(s):

- This practical is expected to develop Measurement skill, Error estimation skill and Observation skill.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 6.1 Conduct Charpy Impact test on given metals as per IS:1757

V. Relevant Affective Domain related Outcome(s):

- Adhere to professional and ethical standards at all times.
- Uphold top-notch hygiene standards.
- Make sure to practice safe behaviors consistently.
- Utilize tools, equipment, and machinery efficiently.

VI. Relevant Theoretical Background:

Toughness depends fundamentally on strength and ductility and would appear to be independent of type of loading. It is a fact, however, that the rate at which the energy is absorbed may affect the behavior of material, and thus different measures of toughness may be obtained from impact loading than from static loading. All materials do not respond in the same way to variations in speed of load applications.

There are several different test methods which are used in the evaluation of dynamic fracture resistance. Most common tests are Charpy Test and Izod Test. The test measures the impact energy, or the energy absorbed prior to fracture. Impact energy is a measure of the work done to fracture a test specimen. When the striker impacts the specimen, the specimen will absorb energy until it yields. At this point, the specimen will begin to undergo plastic deformation at the notch. The test specimen continues to absorb energy and work hardens at the plastic zone at the notch. When the specimen can absorb no more energy, fracture occurs.

Charpy Impact test:

In this test the specimen is used as a simply supported beam and blow of hammer is given at the mid-span. The striking energy is used as 300 Joules. The energy spent in breaking the specimen is taken as 'Charpy Impact Value'

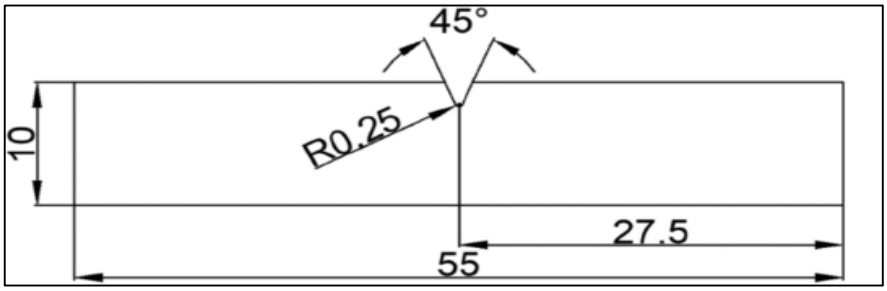


Figure 6.1: Charpy Impact Test Specimen

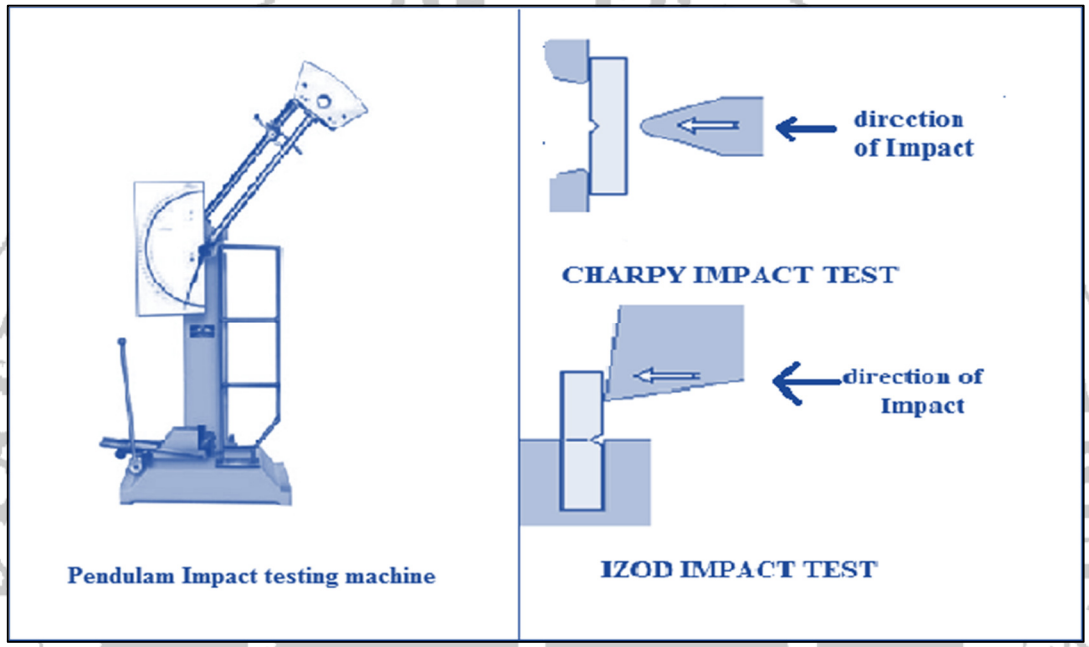


Figure 6.2: Impact Testing Machine

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Pendulum Impact Testing Machine	Izod/Charpy impact testing machine confirming to IS: 1757	1 nos.
02	Specimen	Mild steel/brass /aluminum /copper /cast iron	Any three specimen for Charpy test each

VIII. Precautions to be followed:

- The reading must be taken and noted down carefully.
- The specimen should be fixed carefully in to the jaw of machine.
- Notch should be placed according to the instructions.
- See that the hammer is clamped properly and nobody should touch the release mechanism. Moreover path of free swing should be free from all obstacles.
- Safety rules should be followed strictly while releasing the hammer.

IX. Procedure:

1. Study the impact testing machine.
2. Draw the sketch showing the dimensions of specimen

3. Set the pointer to maximum energy on the scale when the pendulum is freely suspended. In this test the striking energy is used about 300 Joules. Raise the pendulum hammer to the required height. Release it allowing a free swing and observe the initial reading on the dial
4. Raise the pendulum again to the same height as before and clamp it and set the pointer to maximum energy on the scale.
5. The specimen is used as a simply supported beam and is placed on supports or anvil so that the blow of hammer is opposite to the notch.
6. Release the hammer by operating the release mechanism. The hammer strikes the specimen and note final readings.
7. Repeat the procedure for different specimens.
8. Calculate the shock absorbing capacity and note down in the table which is taken as the Charpy impact value.

X. Observations and Calculations (Use blank sheet provided if space not sufficient)

1) Observation Table for lzod test:

Sr. No.	Material	Initial energy in Joules	Final energy in Joules	Shock absorbing capacity in Joules	Remark
01	M.S.				
02	Brass				
03	Aluminum				
04	Copper				
05	Cast Iron				

Note: Write specifically in remark column whether the specimen purely bends, partially bend & break.

2) Sample Calculations:

Energy absorbed= Final energy - Initial energy

For Material……. Energy absorbed =

3) Observation after test

1) Material that bends-.....

2) Material that break-.....

XI. Results:

4. Energy absorbed by mild steel/brass/aluminum/copper/cast iron .....Joules
5. Energy absorbed by mild steel/brass/aluminum/copper/cast iron.....Joules
6. Energy absorbed by mild steel/brass/aluminum/copper/cast iron .....Joules

XII. Interpretation of results:

XIII. Conclusions:

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Notch is kept opposite to the striker in Charpy impact Test. Justify.
2. How the specimen is tested in case of Charpy and Izod impact test.
3. Differentiate between Charpy and Izod impact test.

Space for Answer

XV. References / Suggestions for further Reading:

1. IS: 1757 - 1988: Indian Standard Method for Charpy Impact Test on Metallic Materials.
2. https://sm-nitk.vlabs.ac.in/exp/charpy-impact-test/videos.html

XVI. Assessment Scheme:

Sr. No	Performance Indicators	Weightage (%)
	Process related: 15 Marks	**60%**
1	Handling of the machine.	10%
2	Following of precautions	10%
3	Applying load and taking observations.	20%
4	Identifying the nature of failure of the specimen.	10%
5	Calculation of parameters concerned.	10%
	Product related: 10 Marks	**40%**
1	Error estimation.	5%
2	Interpretation of result	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 07 **Compressive strength of dry and wet bricks as per IS:3495(part I), IS:1077**

I. Practical Significance:

The bricks used in the construction of wall in case of load bearing structure are subjected to compressive forces, hence determination of compressive strength of bricks is important. Compressive strength test on bricks are carried out to determine the load carrying capacity of bricks under compression. This test is carried out with the help of compression testing machine. Bricks are generally used for construction of load bearing masonry walls, columns and footings. These load bearing masonry structures experiences mostly the compressive loads. Thus, it is important to know the compressive strength of bricks to check for its suitability for construction.

II. Industry/Employer expected outcome(s):

- This practical is expected to develop Measurement skill, Error estimation skill and Observation skill.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 7.1 Determine Compressive strength of dry and wet bricks

V. Relevant Affective Domain related Outcome(s):

- Adhere to professional and ethical standards at all times.
- Uphold top-notch hygiene standards.
- Make sure to practice safe behaviors consistently.
- Utilize tools, equipment, and machinery efficiently.

VI. Relevant Theoretical Background:

Toughness In case of load bearing structure the load of structure is transferred through the wall. The bricks used in the wall are subjected to compressive force.

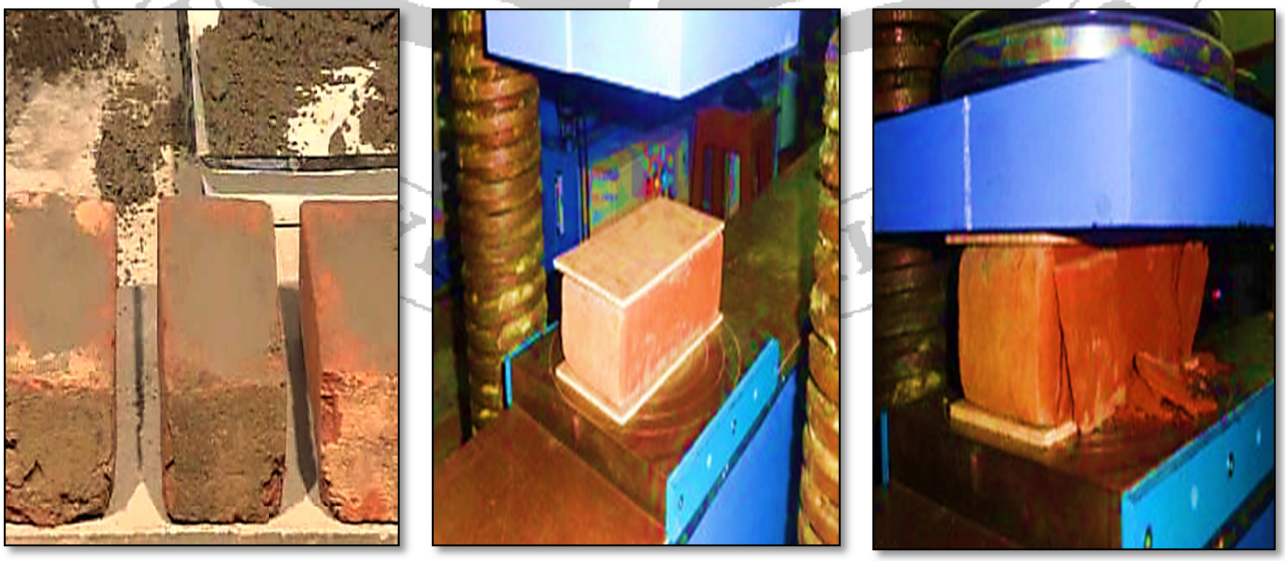


Figure 7.1: Bricks used for compression test

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	CTM	Compression Testing machine of capacity 2000kN/1000kN/500kN/400kN, analog type/digital type with all attachments and accessories.	01 nos.
02	Specimen	Metal/Timber/brick etc.	01 per each group of 4 to 5 students

VIII. Precautions to be followed:

- Frog and all voids shall be filled properly with cement-sand mortar.
- Bricks shall be immersed in water for specific number of days.
- Use plywood sheets around the bricks before applying loads

IX. Procedure:

A] Dry Test:

1. Measure the exact dimensions (nearest to 1mm) of each brick specimen.
2. Place the specimen in loading frame of UTM/CTM with flat surface horizontal and the mortar filled with sand face upward between two - three plywood sheets of 3mm thickness.
3. Apply load at a uniform rate of 14 N/mm2 per minute till failure occurs.
4. Record the maximum load at failure in Observation Table.

B] Wet Test:

1. Measure the dimensions nearest to 1mm of each brick specimen.
2. Immerse the bricks in water at normal room temperature for 21 hours.
3. Remove the bricks from water and drain out excess moisture.
4. Fill the frog (where provided) and all voids in the bed face flush with cement mortar (1 cement, clean coarse sand of grade 3 mm and down).
5. Store the bricks under the damp jute bags for 24 hours followed by immersion in clean water for 3 days.
6. Remove, and wipe out any traces of moisture.
7. Place the specimen in loading frame of UTM/CTM with flat surface horizontal and the mortar filled with sand face upward between two - three plywood sheets of 3mm thickness.
8. Apply load at a uniform rate of 14 N/mm2 per minute till failure occurs.
9. Record the maximum load at failure in Observation Table.

X. Observations and Calculations (Use blank sheet provided if space not sufficient)

A] Dry bricks:-

Idetification Mark	Dimensions			Area, A=Lx B (mm^2)	Crushing Load p (N)	Crushing Strength σ_o= (P / A) N/mm^2	Average Crushing Strength in N/mm^2
	L(mm)	B(mm)	H(mm)				

Sample Calculations:

σ_o = P/A =

Av. Strength =

B] Wet bricks:-

Iden. Mark	Dimensions			Area, A=Lx B (mm^2)	Crushing Load p (N)	Crushing Strength σ_o= (P / A) N/mm^2	Average Crushing Strength in N/mm^2
	L(mm)	B(mm)	H(mm)				

Sample Calculations:

σ_o = P/A =

Av. Strength =

XI. Results:

The average compressive strength of the given brick sample

For Dry state =

For Wet State =

XII. Interpretation of results:

XIII. Conclusions:

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the necessity of filling of frog in the bricks.
2. Compare the load resisted by the bricks in wet and dry condition.
3. State the necessity of use of plywood around the bricks for application of load.

Space for Answer

XV. References / Suggestions for further Reading:

1. IS: 3495(part I) and IS: 1077 for bricks.
2. https://www.youtube.com/watch?v=w3CXwcBlHX4
3. https://www.civilengicon.com/2022/12/determination-of-compressive-strength-of-bricks.html?m=1

XVI. Assessment Scheme:

Sr. No	Performance Indicators	Weightage (%)
	Process related: 15 Marks	**60%**
1	Handling of the machine.	10%
2	Following of precautions	10%
3	Applying load and taking observations.	20%
4	Identifying the nature of failure of the specimen.	10%
5	Calculation of parameters concerned.	10%
	Product related: 10 Marks	**40%**
1	Error estimation.	5%
2	Interpretation of result	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 08 **Single Shear and Double Shear test on any two metals like Mild steel/brass/Al/ Copper / cast iron etc. as per IS: 5242.**

I. Practical Significance:

In structural members shear stresses are developed due to action of loads when in service or by design. Members like beams and slabs in RCC structures and bolts, welds, certain fasteners and joints are designed to withstand shear forces. Determination of shear strength is necessary as shear failure occurs suddenly i.e. without prior warning. Concept of single shear, double shear and failure pattern helps to understand behavior of material and the resistance offered by it against shear.

II. Industry/Employer expected outcome(s):

- Enhancing the skills of Measurement, error estimation and observations.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.
- CO 4-Determine the bending and shear stresses in beams under different loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 8.1 – Perform single shear and double shear test on given metals as per IS: 5242.

V. Relevant Affective Domain related Outcome(s):

- Using Safe behaviors effectively.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

The material possesses various mechanical properties such as elasticity, ductility, malleability and strength. Shear strength of the material is important as shear failure is sudden i.e. without any prior warning. In R.C.C structures bond depends on shear strength. Proper placement of shearing reinforcement in members makes the structure safe. In the design of bolted and welded joints concept of single shear and double shear is required.

VII. Experimental set up:

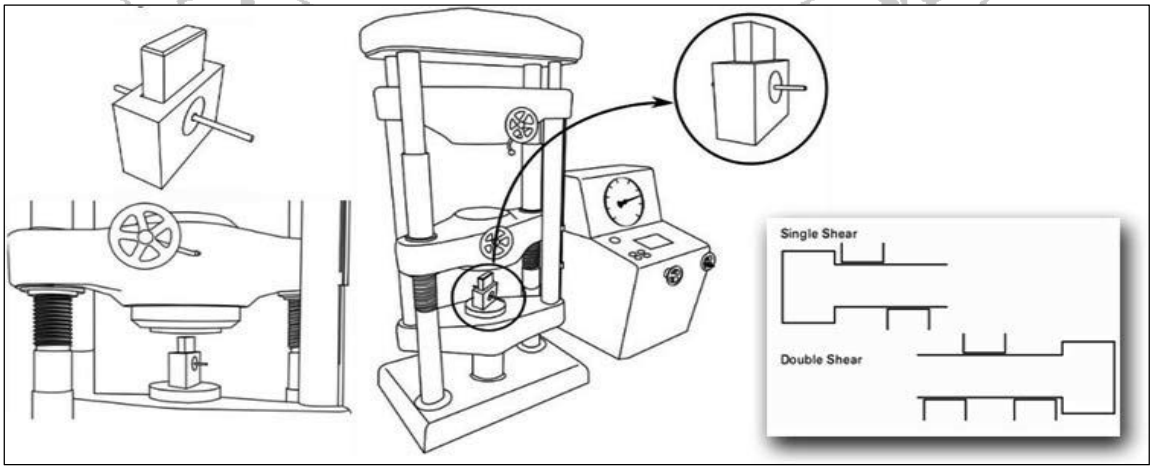


Figure 8.1 Single Shear test on metal

Figure 8.2 Shear Attachment

VIII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	UTM	Universal Testing machine of capacity l000kN, 600 kN/400kN, analog type/digital type with all attachments and accessories.	01
02	Shear box with internal and external cutters.	----	01
03	Vernier caliper.	Least count of 0.02 mm and measuring range of 0.02 mm to 150mm	01
04	Specimen	Mild steel/brass/aluminum/copper/cast iron	03 each for single shear & double Shear test.

IX. Precautions to be followed:

1. The reading must be taken and noted down carefully.
2. The specimen should be fixed carefully in the shear box with proper attachments and shear box should be carefully fixed to the jaw of machine
3. Apply the load gradually.
4. Note the sound at sudden failure.

X. Procedure:

1. Measure the nominal diameter (d) of the given specimen.
2. Insert the specimen through a round hole of middle hardened steel bush and into the middle plate. Insertion of remaining two side bushes depends upon whether the shear strength is in single or double action. Use Suitable side bushes for different sizes of specimens to be tested.
3. Determine shear strength in single action.
4. Place the shear attachment along with the specimen using only one side bush.
5. Apply the load gradually and increase the rate such that separation of cross heads at any moment during the test shall not be greater than 10 mm per minute until complete failure occurs.
6. Note the maximum load to shear off the specimen.
7. Calculate the strength of the specimen in single shear.
8. Repeat the same procedure by inserting two side bushes on either side to ensure double shear action.
9. Follow the same procedure to determine the shear strength of the other metals.

XI. Observation Table:

Sr. No.	Metals	Diameter of specimen (in mm) (d)	c/s area (in mm^2) (A)	Max. Load in N (V1)	Max. Stress in N/mm^2 (T_1)	Max. Load in N (V2)	Max. Stress in N/mm^2 (T_2)
01							
02							
03							

- **Sample Calculations:**

  Strength of material in Single Shear = $T_1 = \frac{V_1}{A}$ =_____ N/mm^2

  Strength of material in Double Shear = $T_2 = \frac{V_2}{2A}$ =_____ N/mm^2

XII. Result:

Sr. No.	Metals	Max. stress in Single Shear (T_1) N/mm^2	Max. stress in Double Shear (T_2) N/mm^2
01			
02			
03			

XIII. Interpretation of results:

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State at least three parts/components where the shear strength plays an important role in our day to day life.
2. Sketch failure pattern of bolted connection in single shear and double shear.
3. For the different diameter of specimen having same metal whether shear strength will be same or not give reason.

Space for Answer

XVI. References/Suggestions for further reading.

- IS 5242: Method of test for determining shear strength of metals.
- https://www.youtube.com/watch?v=sLZeR7RMGFA
- https://www.youtube.com/watch?v=jjw-PG0cfru

XVII. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Handling of the machine	10%
2.	Following of precautions	10%
3.	Applying Load and taking observations.	20%
4.	Identifying the nature of failure of the specimen.	10%
5.	Calculation of parameter concerned	10%
B.	**Product Related (10 marks)**	**40%**
1.	Error Estimation.	5%
2.	Interpretation of results	10%
3.	Conclusions and Recommendations	10%
4.	Answers to practical related questions.	10%
5.	Submission of report on time.	5%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 09 **Compression Test on Timber section along the grain and across the grain as per IS 2408.**

I. Practical Significance:

Timber logs can be used horizontally as well as vertically in the construction as per situation. Its compressive strength along the grain and across the grain is different. When the load is applied parallel to the grains the failure of the sample is due to shear failure, which results in cracks at edges, but when load is applied perpendicular to grains the failure is also shear failure where fiber have slide over one another. Hence it is determined in both the directions.

II. Industry/Employer expected outcome(s):

- Enhancing the skills of compression test conduction on timber section.

III. Course Level Learning Outcome (COs):

- CO 1- Calculate the M.I. of the given object using the relevant formulae and methods.
- CO 4- Determine the bending and shear stresses in beams under different loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 9.1 – Conduct Compression test on timber section along the grain and across the grain.

V. Relevant Affective Domain related Outcome(s):

- Using Safe behaviors effectively.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

When the load is applied parallel to the grains the failure of the sample is due to shear failure, which results in cracks at edges and during load applied perpendicular to grains the failure is also shear failure where fiber have slide over one another.

VII. Experimental set up:

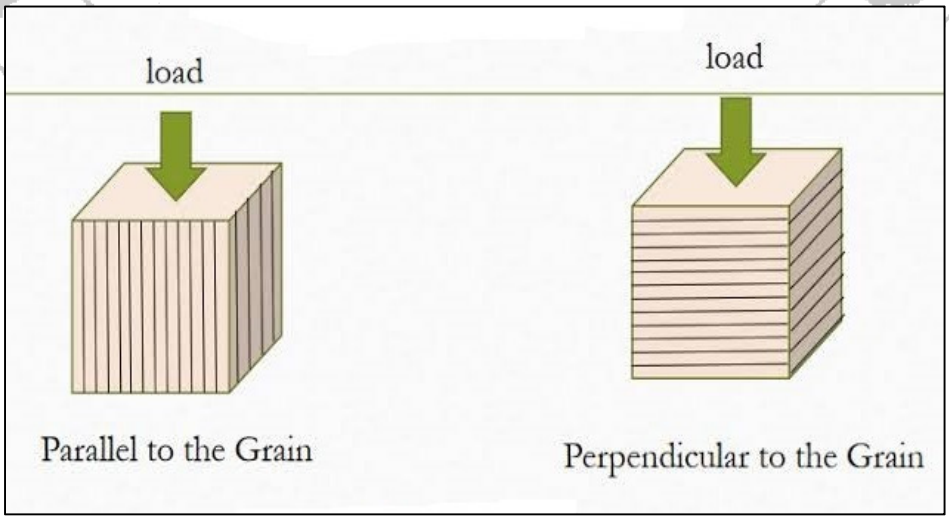


Figure 9.1 Wooden section along and across the grain loading.

VIII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	UTM	Universal Testing machine of capacity l000kN, 600 kN/400kN, analog type/digital type with all attachments and accessories.	01
02	Extensometer	Least count - 0.01 mm. Max. Extension = 25 mm. Single dial gauge for 30 mm,40 mm, 60 mm, 80 mm, 100 mm, 125 mm gauge length.	01
03	Specimen	Timber Log	01 per batch.

IX. Precautions to be followed:

1. The specimen should be placed properly.
2. The load should be applied gradually.
3. Observe the load at cracking.

X. Procedure:

1. Measure the actual dimensions of the specimen.
2. Place the specimen along the grains between lower and middle cross heads of Universal Testing Machine.
3. Apply the load gradually till the failure of specimen. Record the load at failure in Observation Table no 1.
4. Observe the vibration of the pointer, which vibrates at cracking of the specimen (If available).
5. Place another specimen across the grain on the platform of Universal Testing Machine and repeat the procedure. (Steps 1 to 3) Enter the load at failure in the Observation Table no 1

XI. Observation Table:

Sr. No.	Position of specimen	Cross sectional Dimensions (mm x mm)	c/s area (mm^2) (A)	Load at Failure (P) (N)	Crushing Strength =P/A (N/mm^2)
01					
02					
03					

- **Sample Calculations:**

Crushing Strength of specimen $= \frac{P}{A}$ =_____N/mm^2

Crushing Strength of specimen $= \frac{P}{A}$ =_____N/mm^2

XII. Result:

1. Strength of given timber specimen when loaded along the grain is _____ N/mm^2
2. Strength of given timber specimen when loaded across the grain is_____ N/mm^2

XIII. Interpretation of results:

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State two situations where you can use the conclusion of this practical.
2. If the surfaces of the specimen are not plain, Comment on failure pattern of the specimen.
3. If we test the metals like steel, brass, aluminum etc. does they will show the difference in strength when tested like timber specimen?
4. If the height of the specimen is three times the width of the specimen. Comment on the failure pattern.

Space for Answer

XVI. References/Suggestions for further reading:

- IS: 2408 for Compression Test on Timber.
- https://www.tesrresources.net/applications/test-types/flexura I-test/

XVII. Assessment Scheme:

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Handling of the machine	10%
2.	Following of precautions	10%
3.	Applying Load and taking observations.	20%
4.	Identifying the nature of failure of the specimen.	10%
5.	Calculation of parameter concerned	10%
B.	**Product Related (10 marks)**	**40%**
1.	Error Estimation.	5%
2.	Interpretation of results	10%
3.	Conclusions and Recommendations	10%
4.	Answers to practical related questions.	10%
5.	Submission of report on time.	5%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 10 **Shear Force and Bending Moment Diagrams of cantilever, simply supported and overhanging beams for different types of loading (02 problems on each type of beam)**

I. Practical Significance:

When any member is subjected to the load, shear force and bending moment will get induced in it. Study of Shear force and bending moment diagrams for different types of beams with different types of loading are important to find the maximum shear force and maximum bending moment. These parameters are useful at the time of design of these structural elements.

II. Industry/Employer expected outcome(s):

- This practical is expected to develop the following skills for the industry identified competency.
  a. To plot SF and BM ordinates at different section as per the sign convention adopted.
  b. To join the SF ordinates and BM ordinates in appropriate manner depending upon type of loading.

III. Course Level Learning Outcome (COs):

- CO 3- Draw SFD and BMD for the given structural element under given loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 10.1 –Plot Shear Force and Bending Moment Diagrams for the beams subjected to different types of loads.

V. Relevant Affective Domain related Outcome(s):

- Follow sign convention.
- Working as a leader/a team member.
- Expertise in use of calculator.

VI. Relevant Theoretical Background:

Shear Force (SF): The shear force at a cross-section of a beam is the unbalanced vertical force to the left or to the right of the section. The rate of change of SF at the cross-section is equal to the intensity of loading at that section.

Bending Moment (BM): The bending moment at the cross-section of a beam is the algebraic sum of the moments of forces or moments, to the right or left of the section. The rate of change of BM is equal to the shear force at the section.

Shear Force Diagram (SFD): The variation in the values of shear force, at different cross sections of a loaded beam, shown graphically by plotting the SF as ordinate against the position of section as abscissa is known as Shear force diagram.(SFD) Or A diagram showing the variation of shear force along the length of the beam.

Bending Moment Diagram (BMD): The variation in the values of bending moments, at different cross sections of a loaded beam, shown graphically by plotting the BM as ordinate against the position of section as abscissa is known as bending moment diagram.(BMD) Or A diagram showing the variation of bending moment along the length of the beam. Point of zero shear: The point where SF is zero or crosses the base line. At this point the BM is maximum.

Point of contra flexure: The point where BM is zero or changes its sign from positive to negative or vice versa and crosses the base line.

VII. Experimental set up:

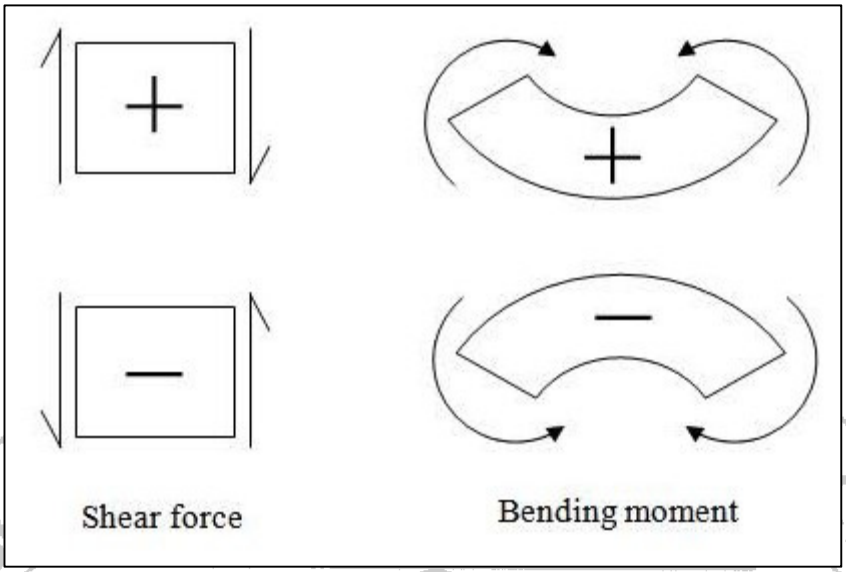


Figure 10.1 Sign Conventions

VIII. Required resources/equipment:

Sr. No.	Knowledge of	Remark
01	Types of support, types of beam, types of load. Law of moment, Equations of equilibrium.	

IX. Precautions to be followed:

1. Always draw the sign convection near the beam, to be available all the time.
2. The values of calculated reactions must be checked once again before calculating SF and BM ordinates.
3. Always consider a section where there is change of loading.
4. Draw diagram of beam, SFD and BMD one below the other.
5. Plot the SF and BM ordinates as per their sign convection i.e. +ve ordinates above the base line and -ve ordinate below the base line.
6. When there is no load on the beam SFD will be a straight line.
7. When there is point load on the beam SFD will be vertical at that point.
8. When there is UDL on the beam SFD will be inclined line and BMD will be a curve.
9. To locate the point of zero shear equate generalized equation of SF of that portion to zero.
10. To locate the point of contra flexure equates generalized equation of BM of that portion to zero.

X. Procedure:

1. For cantilever start solving from the free end without calculating the reactions.
2. For the given beam loaded externally calculate the support reaction if the beam is simply supported.
3. Adopt universally accepted sign convention for SF and BM.
4. Select a section of a beam and calculate the SF, which is the algebraic sum of all the vertical forces on either side of the section.
5. Calculate the BM at that section by taking the sum of moment of all the forces on either side of section about that section.

6. To suitable scales (horizontal and vertical) draw the beam with given supporting condition and the loads on the given graph paper.
7. To the selected scale plot the SF and BM ordinates on separate baselines.
8. Connect the ordinates of SF as per the type of loads acting to get the shear force diagram.
9. Observe the point of zero shear force (Point of contra shear) in the SF diagram if any. Locate its position either using geometry or from the general equation of SF at the section.
10. Calculate the bending moment at the point of zero shear force.
11. Connect the ordinates of BM as per the type of loads to get final BM diagram.
    a. Give three problems of cantilever beam such that beam subjected to combination of point load and couple, UDL and Couple and point load and UDL.
12. Give three problems of simply supported beam such that beam subjected to combination of point load and couple, UDL and Couple and inclined point load and UDL ie hinged beam.
13. Give three problems of overhanging beam such that beam subjected to combination of point load and UDL with overhang on left hand side, on right hand side and on both the side.

1) Draw SFD and BMD for a Cantilever beam subjected to combination of point load and couple. (Space for diagram of beam, SFD and BMD showing all details.)

2) Draw SFD and BMD for a Cantilever beam subjected to combination of UDL and couple.

3) Draw SFD and BMD for a Cantilever beam subjected to combination of point load and UDL.

1) Draw SFD and BMD for a simply supported beam subjected to combination of point load & couple.

2) Draw SFD and BMD for a simply supported beam subjected to combination of inclined point load and UDL i.e. hinged beam.

1) Draw SFD and BMD for an overhanging beam subjected to combination of point load and UDL with overhang on left hand side.

2) Draw SFD and BMD for an overhanging beam subjected to combination of point load and UDL with overhang on right hand side.

3) Draw SFD and BMD for an overhanging beam subjected to combination of point load and UDL with overhang both the side.

XI. Conclusions:

XII. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State relation between load, SF and BM.
2. Draw SFD and BMD for a simply supported beam of span 1 carrying anticlockwise couple of magnitude M kNm at its center.
3. Draw SFD and BMD for a cantilever of span 1 carrying upward point load of P kN at its free end.

Space for Answer

XIII. Assessment Scheme:

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Analysis of load and	10%
2.	Steps to construct SFD & BMD	20%
3.	Impact of loading	10%
4.	Interpretation of SFD & BMD	10%
5.	Calculation of parameter concerned.	10%
B.	**Product Related (10 marks)**	**40%**
1.	Error Estimation.	10%
2.	Conclusions and Recommendations.	10%
3.	Answers to practical related questions.	10%
4.	Submission of report on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 11 **Flexural test on timber beam on rectangular section in both orientations as per IS: 1708, IS: 2408.**

I. Practical Significance:

Flexural strength testing of Wood is accomplished with three-point bend fixtures. Wood products are a common engineering material used in the construction and furniture industry. The strength of wood is influenced by factors, including the specific type of wood, loading type, loading direction and duration, moisture content and temperature. Test Standards cover testing methods to determine properties including flexure strength, tensile strength and shear strength. To ensure that failure of the specimen arises from tensile or compressive stress, and not shear stress, many testing standards require a minimum span-to-depth ratio of 14.The material possess various mechanical properties. Timber has some elasticity, and it can resist bending stresses up to certain limit. Timber can be used as horizontal member in the timber structure of the building. Hence determination of its flexural strength is necessary.

II. Industry/Employer expected outcome(s):

- Enhancing the understanding of effects of flexure on any horizontal member.

III. Course Level Learning Outcome (COs):

- CO 1- Calculate the M.I. of the given object using the relevant formulae and methods.
- CO 4- Determine the bending and shear stresses in beams under different loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 11.1 – Conduct flexural test on timber beam on rectangular section.

V. Relevant Affective Domain related Outcome(s):

- Follow safety practices and precautions.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VI. Relevant Theoretical Background:

Timber member is used in the structure of building in case of timber frame structure. It can be a horizontal member or vertical member. When it is loaded as horizontal member it is subjected to bending moment. Hence its flexural strength is important. When it is used as vertical member, it is subjected to compressive force and timber is strong in resisting compressive stress.

VII. Experimental set up:

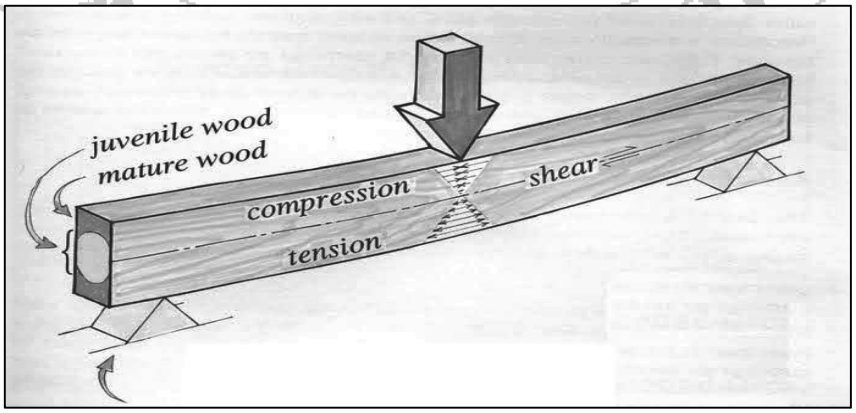


Figure 11.1 Compression test on timber beam.

VIII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	UTM	Universal Testing machine of capacity l000kN, 600 kN/400kN, analog type/digital type with all attachments and accessories.	01
02	Extensometer	Least count - 0.01 mm. Max. Extension = 25 mm. Single dial gauge for 30 mm,40 mm, 60 mm, 80 mm, 100 mm, 125 mm gauge length.	01
03	Specimen	Timber specimen	01 per batch.

IX. Precautions to be followed:

1. The reading must be taken and noted down carefully.
2. The load must be applied at the center of the specimen.
3. Apply the load gradually.

X. Procedure:

1. Measure the cross-sectional dimensions of the test specimen
2. Place beam assembly on lower cross head of UTM.
3. Fix point load attachment on middle cross head of UTM.
4. Adjust the required span (300 mm) and place the specimen on roller supports.
5. Lower the middle cross head so that point load just touches the beam at mid-span.
6. Apply the load at the center of specimen at constant rate till the specimen fails. Note down the load at failure.
7. Repeat the test with two more specimen

XI. Observation Table:

Sr. No.	Breadth (b) in mm	Depth (d) in mm	Span (L) in mm	Load at Failure (W) in N	Compression (at top)	Tension (at bottom)
01						
02						

- **Sample Calculations:**

Bending Moment (M) $= \frac{W\,x\,l}{4}$ =_____N.mm

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

Bending Stress $(\sigma) = \frac{M\,x\,Y}{I}$ = _____ N/mm^2

XII. Result:

1. Maximum bending stresses for the given sample are found to be= _____ N/mm^2

XIII. Interpretation of results:

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. If the point load is not applied at the center, comment on the failure pattern.
2. In case of rectangular section b x d to have the maximum load carrying capacity, the specimen should be placed such that b>d or b<d. Justify the answer.
3. Sketch the bending stress distribution diagram showing all details in it.
4. State the shape of the end support used in this practical. Why it is like so?
5. If the shape of the end support is other than what you have used, comment on the effect.

Space for Answer

XVI. References/Suggestions for further reading:

- IS: 2408 for Compression Test on Timber.
- https://www.tesrresources.net/applications/test-types/flexura I-test/

XVII. Assessment Scheme:

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Handling of the machine	10%
2.	Following of precautions	10%
3.	Applying Load and taking observations.	20%
4.	Identifying the nature of failure of the specimen.	10%
5.	Calculation of parameter concerned	10%
B.	**Product Related (10 marks)**	**40%**
1.	Error Estimation.	5%
2.	Interpretation of results	10%
3.	Conclusions and Recommendations	10%
4.	Answers to practical related questions.	10%
5.	Submission of report on time.	5%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 12

a) **Prepare PPT of minimum 05 slides on the concept of strain energy and Instantaneous stress induced in a material due to gradual, sudden & impact load.**
b) **Prepare PPT of minimum 04 slides on Thermal stresses & Thermal Strains.**

I. Practical Significance:

a) When a body is subjected to gradual, sudden or impact load, the body deforms and work is done upon it. If the elastic limit is not exceeded, his work is stored in the body. This work done or energy stored in the body is called strain energy.
b) When a body is subjected to temperature variation is produces the expansion or contraction in dimension and results in thermal strains and stresses.

II. Industry/Employer expected outcome(s):

- Developing the understanding of Strain energy due to different type of loading and thermal Stress and Strain.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 12.1 - Prepare PPT on Strain Energy.
- LLO 12.2 – Prepare PPT on Thermal Stresses & Thermal Strains.

V. Relevant Affective Domain related Outcome(s):

- Expertise in use of calculator.
- Understand the work done over body.
- Understand the temperature variation.

VI. Relevant Theoretical Background:

- Strain Energy: Energy stored in the body when it goes under the elastic deformation due to the work done over it.

  Strain Energy (U) = work done on a body.

  $U = \frac{\sigma^2}{2E} \; x \; V$

  Where, U= Strain Energy, σ = Stress, V= Volume of body

- Thermal Stress: Stress caused due to change in temperature is defined as thermal stress.

  $\epsilon = \alpha \, (\delta \, t)$

  Where, α = Coefficient of thermal expansion. δ = Change in dimension. t=change in temperature.

- Thermal Strain: It is the property of material/body which allows to contract or expand freely with increase or decrease in temperature.

VIII. Required resources/equipment:

Sr. No.	Knowledge of	Remark
01	Different types of loading, Strain Energy, Thermal Stress and Thermal Strains.	----

X. Procedure:

1. Understand the concept of loading and its different types.
2. Understand the concept of strain energy and solve at least one numerical with each type of loading.
3. Understand the concept of Thermal stress and thermal Strain and solve at least one numerical.

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the four practical example of strain energy stored due to work done over the body.
2. State the four practical situations where thermal stress and strains will be induced.

Space for Answer

XVI. References/Suggestions for further reading:

Sr. No.	Author	Title	Publisher with ISBN Number
01	Khurmi R.S., Khurmi N.	A textbook of strength of materials	S Chand and co. ltd. New Delhi,2019 ISBN 9789352833979
02	Ramamrutham S.	Strength of Materials	Dhanpat rai and Sons, New Delhi,2015 ISBN 9788187433545
03	Rattan S.S.	Mechanics of Materials	Laxmi Publications (p) Ltd. New Delhi 2017, ISBN-13:978-9385965517

XVII. Assessment Scheme:

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Clarity of content	20%
2.	Relevance of engineering considerations	20%
3.	Examples and applications	20%
B.	**Product Related (10 marks)**	**40%**
1.	Error Estimation.	10%
2.	Explanation of stress	10%
3.	Conclusions and Recommendations	10%
4.	Professional Design and layout of PPT	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 13 **Flexure test on floor tiles IS: 1237, IS: 13630 or roofing tiles as per IS: 654, IS: 2690.**

I. Practical Significance:

Bending occurs in the beams, slabs and flooring tiles. Flexural strength is a measurement that indicates a material's resistance to deforming when it is placed under a load. Flexural strength, also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexure test. The transverse bending test is most frequently employed, in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of yield.

II. Industry/Employer expected outcome(s):

- Enhancing the skills of failure pattern observation and understanding of IS code.

III. Course Level Learning Outcome (COs):

- CO 4-Determine the bending and shear stresses in beams under different loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 13.1 –Conduct Flexure test on floor tiles/roofing tiles.

V. Relevant Affective Domain related Outcome(s):

- Using Safe behaviors effectively.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment’s and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

Flexural strength is a measure of the tensile strength of concrete beams or slabs and tiles. Flexural strength identifies the amount of stress and force an unreinforced material can withstand such that it resists any bending failures. Flexural strength is also known as bending strength or modulus of rupture or fracture strength. The flexural modulus of a material is a physical property denoting the ability for that material to bend. It is the ratio of stress to strain during a flexural deformation, or bending. It relates to the amount of weight a material can handle when used as a structural support.

VII. Experimental set up:

Figure 13.1- Flexural Test on flooring or roofing tile.

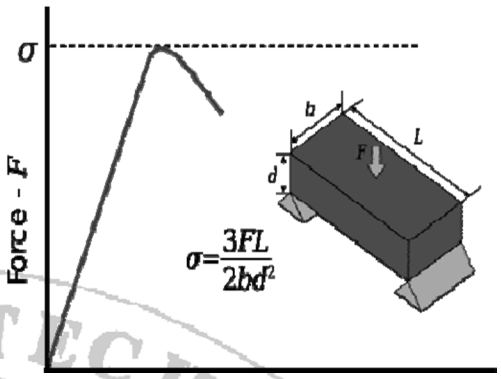


Figure 13.2- Typical Stress -Strain Curve for Flexure test

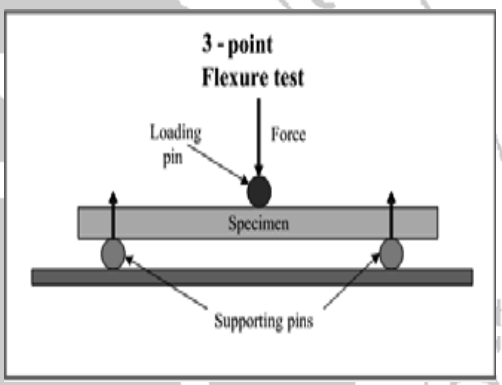


Figure 13.3- Three Point Loading

VIII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Tile Flexural testing machine.	Tile flexural testing machine confirming to IS: 654, capacity 200Kg with uniform loading rate of 45 to 55 Kg/minute provided with lead shots.	01
02	Vernier caliper.	Least count of 0.02 mm and measuring range of 0.02 mm to 150mm	01
03	Specimen	Flooring/Roofing Tile	03 for dry test 03 for wet test

IX. Precautions to be followed:

1 The reading must be taken and noted down carefully.
2 The specimen should be fixed carefully in of machine
3 Apply the load gradually.

X. Procedure:

A) For Dry Test:

1. Measure the breadth and thickness of the Floor Tile.
2. Adjust the span equal to that specified in table and place the Tile horizontally on bearers with its

wearing surface uppermost and its sides parallel to the bearers. The length of the bearers and of the loading bar shall be longer than the width of the tile and their contact faces shall be rounded to a diameter of 25mm.

3. Place a plywood packing, 3mm thick and 25mm wide between the tile and the bearers shall be self-aligning.
4. Starting from zero, increase the load steadily and uniformly at a rate not exceeding 200 kg/m width (measured along the bearer) per minute up to the specified maximum load.

B) For Dry Test:

1. Immerse the other Floor Tiles for 24 hours in water and repeat the procedure for dry test from steps 1 to 4.

XI. Observation Table:

A) For Dry Test:

Sr. No.	Breadth (mm)	Thickness (mm)	Span (mm)	Breaking Load (W in N)	Average (N)
01					
02					
03					

B) For Dry Test:

Sr. No.	Breadth (mm)	Thickness (mm)	Span (mm)	Breaking Load (W in N)	Average (N)
01					
02					
03					

- **Sample Calculations:**

Bending Moment (M) $= \frac{W\ x\ l}{4}$ =_____N.mm

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

Bending Stress $(\sigma) = \frac{M\ x\ Y}{I}$ = _____ N/mm^2

XII. Result:

A) The average bending stress in Dry floor/roofing tile is =_____ N/mm^2

B) The average bending stress in Wet floor/roofing tile is =_____ N/mm^2

XIII. Interpretation of results:

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the reason of performing flexural test on flooring tiles.
2. State the type of loading applied on flooring tiles.
3. Write the significance of conducting bending test on dry as well as wet tile?
4. State the relation between flexural strength and thickness of tile.
5. Compare the flexural strength of dry and wet tiles.

Space for Answer

XVI. References/Suggestions for further reading.

- IS: 1237 & IS: 13630 for flooring tiles.
- IS: 654 & IS: 2690 for roofing tiles.

XVII. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Handling of the machine	10%
2.	Following of precautions	10%
3.	Applying Load and taking observations.	20%
4.	Identifying the nature of failure of the specimen.	10%
5.	Calculation of parameter concerned	10%
B.	**Product Related (10 marks)**	**40%**
1.	Error Estimation.	5%
2.	Interpretation of results	10%
3.	Conclusions and Recommendations	10%
4.	Answers to practical related questions.	10%
5.	Submission of report on time.	5%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 14 **Rockwell hardness Test on any two metals like Mild Steel, Brass, Copper, Aluminum etc.**

1. Practical Significance:

Hardness is defined as the resistance of a metal to plastic deformation against Indentation, scratching, abrasion of cutting.

II. Industry/Employer expected outcome(s):

- Enhance the understanding of material behavior and reaction against machining processes.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 14.1 –Determine hardness number for given metal using Rockwell Hardness Tester.

V. Relevant Affective Domain related Outcome(s):

- Using Safe behaviors effectively.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

The hardness of a material by this Rockwell hardness test method is measured by the depth of Penetration of the indenter. The depth of Penetration is inversely proportional to the hardness.

There are three scales on the machine for taking hardness readings.

Scale "A" with load 60 kgf or 588.4 N and diamond indenter is used for performing tests on thin steel and shallow case hardened steel. Scale "B" with load 100 kgf or 980.7 N and 1.588 mm diameter ball indenter is used for performing tests on soft steel, malleable iron, copper and aluminum alloys.

The Rockwell hardness is derived from the measurement of the depth of the impression. This method of test is suitable for finished or machined parts of simple shapes.

VII. Experimental set up:

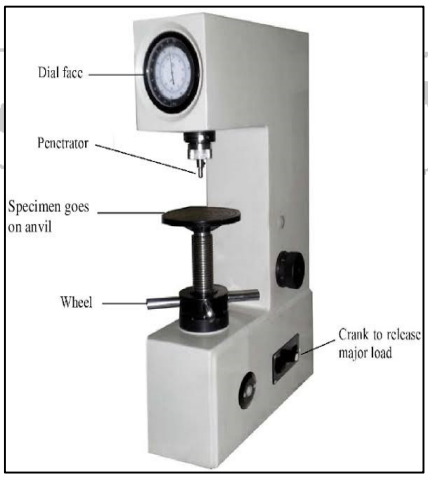


Figure 14.1 Rockwell Hardness apparatus.

VIII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Rockwell Hardness Apparatus	Rockwell Hardness Apparatus of capacity minimum 3N to maximum30/45 N analog/digital type.	01
02	Vernier caliper.	Least count of 0.02 mm and measuring range of 0.02 mm to 150mm	01
03	Specimen	Mild steel/brass/aluminum/copper	02 type/batch

IX. Precautions to be followed:

1. For testing cylindrical test specimen, use V-type platform.
2. Calibrate the machine occasionally using standard test blocks.
3. For thin metal prices place another sufficiently thick metal piece between the test specimen and the platform to avoid any damage which may likely occur to the platform.
4. After applying Major load, wait for some time to allow the needle to come to rest. The waiting time vary from 2 to 8 seconds.
5. The surface of the test piece should be smooth and even and free from oxide scale and foreign matter.
6. Test specimen should not be subjected to any heating or cold working.
7. The thickness of test piece or of the layer under test should be at least 8 times the permanent increase of depth of "E".
8. The distance between the centers of two adjacent indentation should be at least 4 indentations to the edge of the test piece should be at least 2.5 times the diameter of the indentation.

X. Procedure:

1. Select the load by rotating the Knob and fix the suitable indenter.
2. Clean the test-piece and place the special anvil or work table of the machine.
3. Turn the capstan wheel to elevate the test specimen into contact with the indenter point.
4. Further turn the wheel for three rotations forcing the test specimen against the indenter. This will ensure that the Minor load of 98.07 N has been applied.
5. Set the pointer on the Scale dial at the appropriate position.
6. Push the lever to apply the Major load. A Dash Pot provided in the loading mechanism to ensure that the load is applied gradually.
7. As soon as the pointer comes to rest pull the handle in the reverse direction slowly. This releases the Major, but not Minor load. The pointer will now rotate in the reverse direction.
8. The Rockwell hardness can be read off the scale dial, on the appropriate scale, after the pointer comes to rest.

XI. Observation Table:

- Material of test piece =
- Thickness of test piece =
- Hardness Scale used =
- Minor Load =
- Major Load =

Test No.	01	02	03	01	02	03
Material						
Hardness Value						
Average						

XII. Result:

a) The average hardness value of material_____ is _____

b) The average hardness value of material_____ is _____

XIII. Interpretation of results:

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Applications of Rockwell Hardness A-Scale, B-Scale, C-Scale.
2. Size of the Ball to be used in Ball Indenter of Rockwell Hardness Test.

Space for Answer

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Handling of the machine	10%
2.	Following of precautions	10%
3.	Applying Load and taking observations.	20%
4.	Identifying the nature of failure of the specimen.	10%
5.	Calculation of parameter concerned	10%
B.	**Product Related (10 marks)**	**40%**
1.	Error Estimation.	5%
2.	Interpretation of results	10%
3.	Conclusions and Recommendations	10%
4.	Answers to practical related questions.	10%
5.	Submission of report on time.	5%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 15 **Brinell hardness test on any two metals like Mild steel, brass Copper, Aluminum etc.**

I. Practical Significance:

Indentation Hardness is a number related to the area or to the depth of the impression made by an indenter or fixed geometry under a known fixed load.

II. Industry/Employer expected outcome(s):

- Enhance the understanding of material behavior and reaction against machining processes.

III. Course Level Learning Outcome (COs):

- CO 2- Analyze the structural behavior of the given structural components under various loading conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 15.1 – Determine the hardness number for given metals using Brinell hardness tester..

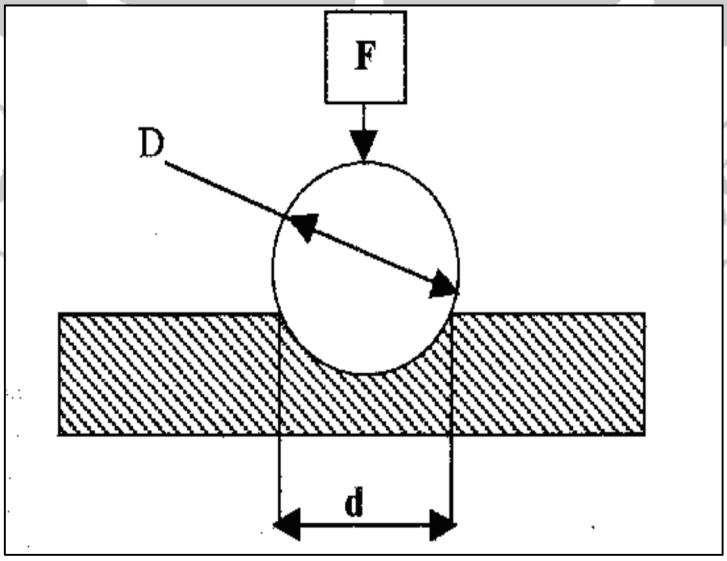
V. Relevant Affective Domain related Outcome(s):

- Using Safe behaviors effectively.
- Maintain high standards of hygiene.
- Efficient application of tools, equipment's and machinery.
- Professional and ethical standards.

VI. Relevant Theoretical Background:

This method consists of indenting the surface of the metal by a hardened steel ball of specified diameter D mm under a given load F (kgf) and measuring the average diameter d mm of the impression with the help of Brinell microscope fitted with a scale. The Brinell hardness HB is defined, as the quotient of the applied force F divided by the spherical area of the impression.

HB = Test load in kgf/surface area of indentation.



$$= \frac{2F}{\pi D\,(D-\sqrt{D^2-d^2}} \text{ kN/mm}^2$$

VII. Experimental set up:

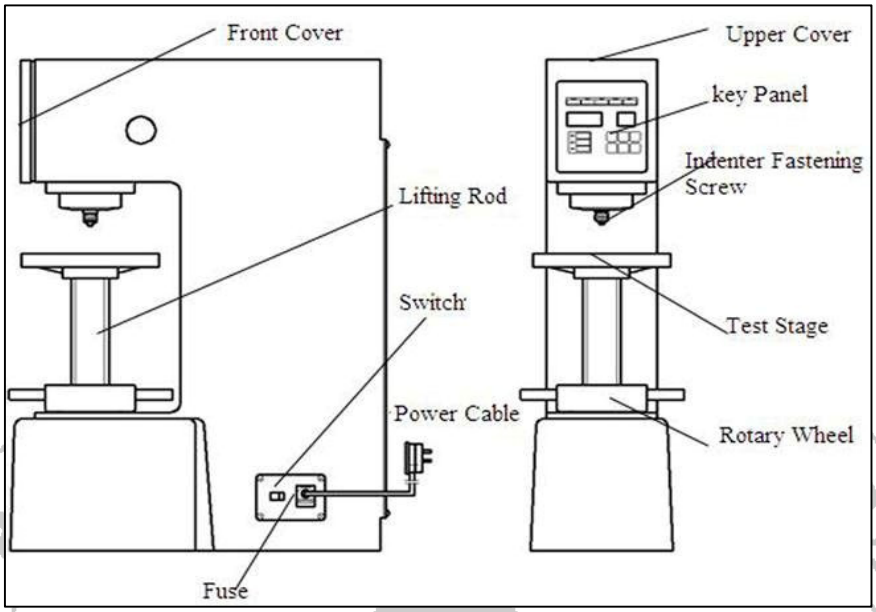


Figure 15.1 Brinell hardness Apparatus

VIII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Brinell Hardness apparatus	Brinell Hardness apparatus analog type/digital type with all attachments and accessories.	01
02	Vernier caliper.	Least count of 0.02 mm and measuring range of 0.02 mm to 150mm	01
03	Specimen	Mild steel/brass/aluminum/copper	02 type/batch

IX. Precautions to be followed:

1. The surface of the test piece should be clean.
2. The testing machine should be protected throughout the test from shock or vibration.
3. The test should be carried out at room temperature.
4. The distance of the center of the indentation from the edge of the test piece should be at least 2.5 times the diameter of the indentation and the distance between the centers of two adjacent indentations should be at least 4 times the diameter of the indentation.
5. The diameter of each indentation should be measured in two directions at right angles and the mean value of the two readings used for the purpose of determining the hardness number.

X. Procedure:

1. Select the proper size of the ball and load to suit the material under test.
2. Clean the test specimen to be free from any dirt and defects or blemishes.
3. Mount the test piece surface at right angles to the axis of the ball indenter plunger.
4. Turn the platform so that the ball is lifted up.
5. By shifting the lever apply the load and wait for some time.
6. Release the load by shifting the lever.
7. Take out the specimen and measure the diameter of indentation by means of the Brinell microscope.

8. Repeat the experiment at other positions of the test piece.
9. Calculate the value of HB

XI. Observation Table:

- Test Piece Material =
- Diameter of Ball "D" =
- Load selection F/D^2 =
- Test Load F =
- Load application time =
- Least count of Brinell Microscope =

Sr. No.	d_1	d_2	$\frac{d_1 + d_2}{2}$	F in kN	T in Sec	D in mm	HB kN/mm^2
01							
02							
03							
04							

- **Sample Calculations:**

$$HB=\frac{2F}{\pi D\,(D-\sqrt{D^2-d^2})} = \text{----------} \text{ kN/mm}^2$$

XII. Result:

XIII. Interpretation of results:

XIV. Conclusions:

XV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State at Selection of Load in Brinell hardness Test.
2. State Diameters of the different Balls used in Brinell Hardness Test.

Space for Answer

XVII. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Handling of the machine	10%
2.	Following of precautions	10%
3.	Applying Load and taking observations.	20%
4.	Identifying the nature of failure of the specimen.	10%
5.	Calculation of parameter concerned	10%
B.	**Product Related (10 marks)**	**40%**
1.	Error Estimation.	5%
2.	Interpretation of results	10%
3.	Conclusions and Recommendations	10%
4.	Answers to practical related questions.	10%
5.	Submission of report on time.	5%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			**Dated sign of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	