I

Name _____

Roll No. _____ Year 20____20____

Exam Seat No. _____

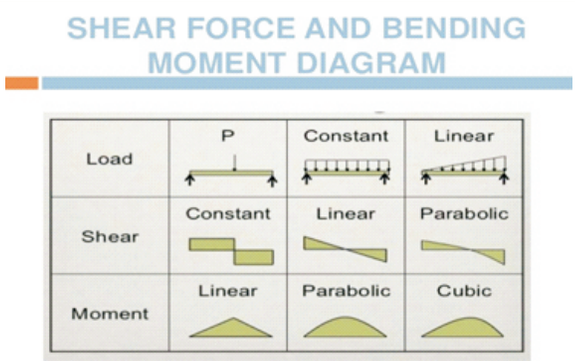
CIVIL GROUP | SEMESTER - III | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

MECHANICS OF STRUCTURES

(22303)



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 changing technological and 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 followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual

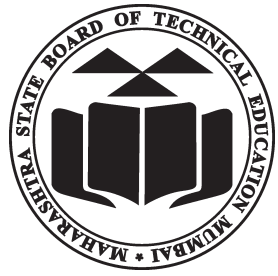
for

Mechanics of Structure

(22303)

Semester-III

(CE/CR/CS)



Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on June, 2018)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms. ……..…… Roll No. ……..…., of Third Semester of Diploma in ……..…… of Institute, ……..……..… (Code: ……...) has completed the term work satisfactorily in course **Mechanics of Structures (22303)** 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

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 programmes 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 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals 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 analyse 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.

Programme Outcomes (POs) to be achieved through Practical of Course:-

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

PO 4. Engineering tools: Apply Mechanics related technologies and tools with its limitations.

PO 5. The engineer and society: Assess social, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Engineering mechanics.

PO 6. Environment and sustainability: Apply basic engineering solutions also for sustainable development practices in social and environmental contexts using Laws of Mechanics.

PO 7. Ethics: Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of Engineering mechanics.

PO 8. Individual and team work: Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO 9. Communication: Communicate effectively in oral and written form.

PO 10. Life-long learning: Engage in independent and life-long learning activities in the context of technological changes in the engineering and allied industries.

PSO2. Construction Execution and Maintenance: Execute civil engineering construction and maintenance using relevant material and equipment.

Practical- Course Outcome matrix

Course Outcomes (COs):

a. Articulate practical applications of moment of inertia of symmetrical and unsymmetrical structural sections.
b. Interpret structural behaviour of materials under various loading conditions.
c. Select material considering engineering properties for various structural applications.
d. Interpret shear force and bending moment diagrams for various types of beams and loading conditions.
e. Determine the bending and shear stresses in beams under different loading conditions.
f. Analyse the column for various loading and end conditions.

Sr. No.	Title of the Practical	CO a.	CO b.	CO c.	CO d.	CO e.	CO f.
1	Conduct compression and tension tests on sample test pieces using Universal Testing Machine along with introduction to other tests to be conducted on UTM.	-	√	-	-	-	-
2	Conduct compression test on sample test piece using Compression Testing Machine.	-	√	-	-	-	-
3	Perform Tension test on mild steel as per IS:432(1)	-	√	-	-	-	-
4	Perform tension test on Tor steel as per IS:1608,IS:1139	-	√	-	-	-	-
5	Conduct Izod (IS:1598) Impact test on three metals. E.g. mild steel/ brass /aluminum/ copper /cast iron etc	-	√	-	-	-	-
6	Conduct Charpy (IS:1757) Impact test on three metals. E.g. mild steel/ brass /aluminum / copper /cast iron etc		√				
7	Determine Water Absorption on bricks per IS:3495 (part II), IS:1077 or tile IS:1237	-	√	√	-	-	-
8	Determine Compressive strength of dry and wet bricks as per IS:3495(part I), IS:1077	-	√	√	-	-	-
9	Conduct Abrasion Test on flooring tiles (any one) e.g. Mosaic tiles, Ceramic Tiles as per IS: 13630(part7), Cement Tile as per IS: 1237	-	-	√	-	-	-
10	Perform Single Shear and double shear test on any two metals e.g. Mild steel/ brass/aluminum/copper / cast iron etc as per IS:5242	-	√	-	-	-	√
11	Conduct Compression test on timber section along the grain and across the grain as per IS:2408	-	√	-	-	-	-

12	Plot Shear force and Bending Moment diagrams of cantilever, simply supported and overhanging beams for different types of loads two problems on each type of beam	-	-	-	√	-	-
13	Conduct Flexural test on timber beam on rectangular section in both orientation as per IS:1708, IS:2408	√	√	√	-	-	-
14	Conduct Flexure test on floor tiles IS:1237,IS:13630 or roofing tiles as per IS:654,IS:2690	-	√	√	-	-	-
15	Field test on TMT bars	-	-	√	-	-	-

List of Industry Relevant Skills

The practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented relevant skills*** associated with the above mentioned competency.

1 Identify the various types of machines along with their working available for testing of materials.
2 Select the relevant machine(s) for given testing of materials.
3 Determine unknown properties of materials using these machines.
4 Study the working principle, style of operation, capacity, LC of various machines.
5 Apply the theoretical knowledge for finding various properties of materials by verifying their actual behaviour under different conditions of loading.
6 Compare the results with standard values as per IS code for selection or rejection of material for their use in actual practice.

Guidelines to Teachers

Teachers shall discuss the following points with students before start of practical of the subjects.

1. **Learning Overview:** To develop better understanding of importance of the subject through intellectual skills and motor skills.
2. **Know your laboratory work:** To understand the layout of laboratory, specifications of equipment/instrument/materials, procedure, working in groups, planning time etc. also to know total amount of work to be done in the laboratory.
3. Teachers shall ensure that required equipment are in working condition before start each experiment, also keep operating instruction manual available.
4. Explain prior concepts to the students before starting of each experiment.
5. While taking reading /observation each student shall be given a chance to perform/observe the experiment.
6. Teachers shall allot the question to the students from the list given at the end of experiment/exercise.
7. If the experiment set up has variations in the specifications of the experiment, the teachers are advised to make the necessary changes, wherever needed.
8. Time to Time continuous assessment of the students should be done.

9. Teacher should ensure that the respective skills are developed in the students after the completion of the practical exercise.
10. Focus should be given on development of enlisted skills rather than theoretical knowledge.
11. Teachers should organized Group discussions/brain storming sessions/seminars to facilitate the exchange of knowledge amongst the students.

Instructions for Students

Students shall read the points given below for understanding the theoretical concepts and practical applications.

1. Student shall undergo study visit of the laboratory for types equipment, instrument, material to be used, before performing experiments.
2. Organize the work in the group and make a record of all observations.
3. Students should not hesitate to ask any difficulty faced during conduct of practical hours if possible or afterwards but immediately.
4. Write the answers of questions given in the laboratory manual and practice to write the answers to these questions.
5. Student should develop the habit of pear discussions/group discussion related to the experiment/exercise so that exchanges of knowledge /skills could take place.
6. Student shall attempt to develop related hands-on skills and gain confidence.
7. Students shall visit the nearby workshop, workstation, industries, laboratories, technical exhibitions, trade fair etc. even not included in the lab manual .In short, students should have exposure to the area of work right in the student hood.
8. Students should develop the habit of not to depend totally on teachers but to develop self-learning techniques.
9. Student should develop habit to submit the practical exercise continuously and progressively on the scheduled dates and should get the assessment done.

List of Practicals and Progressive Assessment Sheet

Sr. No.	Title of the practical	Page No.	Date of performance	Date of submission	Assessment marks (25)	Dated sign. of Teacher	Remarks (if any)
1.	Conduct compressive and tensile tests on sample test pieces using Universal Testing Machine along with introduction to other tests to be conducted on UTM.	1					
2.	Conduct compression test on sample test piece using Compression Testing Machine.	10					
3.	Perform Tension test on mild steel as per IS:432(1)	16					
4.	Perform tension test on Tor steel as per IS:1608,IS:1139	25					
5	Conduct Izod (IS:1598) Impact test on three metals. E.g. mild steel/ brass/aluminum/ copper /cast iron etc	34					
6	Conduct Charpy (IS:1757) Impact test on three metals. E.g. mild steel/ brass/aluminum/ copper /cast iron etc	41					
7	Determine Water Absorption on bricks per IS:3495 (part II), IS:1077 or tile IS:1237	48					
8	Determine Compressive strength of dry and wet bricks as per IS:3495(part I), IS:1077	54					
9	Conduct Abrasion Test on flooring tiles (any one) e.g. Mosaic tiles, Ceramic Tiles as per IS: 13630(part7), Cement Tile as per IS: 1237	61					
10	Perform Single Shear and double shear test on any two metals e.g. Mild steel/ brass/aluminum/copper / cast iron etc as per IS:5242	67					
11	Conduct Compression test on timber section along the grain and across the grain as per IS:2408	77					
12	Plot Shear force and Bending Moment diagrams of cantilever, simply supported and overhanging beams for different types of loads two problems on each type of beam	79					
13	Conduct Flexural test on timber beam on rectangular section in both orientation as per IS:1708, IS:2408	93					

14	Conduct Flexure test on floor tiles IS:1237,IS:13630 or roofing tiles as per IS:654,IS:2690	99					
15	Field test on TMT bars	106					
Total							

- ***To be transferred to Proforma of CIAAN-2017***

Practical No. 01: Introduction to UTM & study of various parts of UTM in laboratory.

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 can be found/calculated in the laboratory by 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 a 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 Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

1) To determine the various tests which can be performed on UTM.
2) To understand the working and handling of UTM.
3) To improve hands on skill performance.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Select proper cross heads for particular type of load application.

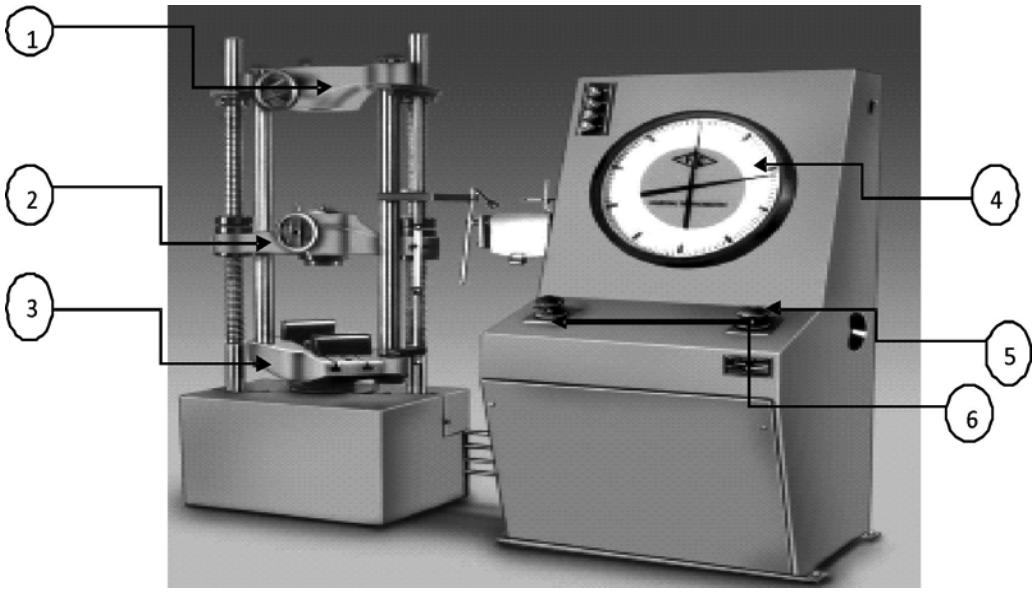
VI Relevant Affective domain related

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

VII Minimum Theoretical Background

The material possesses various mechanical properties. These properties are 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 alongwith its attachment.

VIII Labeling to the Experimental set-up for UTM is to be done by the students:-



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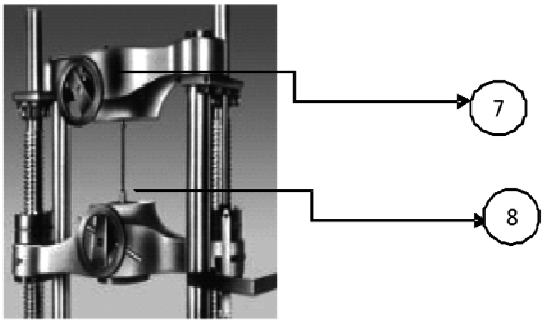

Arrangement for tension test

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IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	U T M	Universal Testing machine of capacity 1000kN, 600 kN/400kN, analog type/digital type with all attachments and accessories.	1	
2	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.	1	
3	Various attachment	Shear block for shear test	1	
		Roller supports and load pointer for flexure test	1	
		Indenter attachment for Hardness test	1	

X Procedure

1) Study the control unit and loading unit along with their functions.
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 crosshead decreases or increases depending on the make of the machine.
6) Now for hydraulic movement of crossheads close the release valve and slowly open the control valve and observe the slow movement of one of the three crossheads. It is the movable crosshead and remaining are the fixed crossheads.
7) Observe the space between two crossheads, if it is decreasing then compressive load can be applied.
8) But if space between these two cross-heads 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 crosshead with the help of mechanical movement for application of compressive load on mortar cube/concrete cube/timber or on suitable sample.
3) Ensure that crossheads are touching the specimen. After selecting suitable range on load dial gauge 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 case of electronic unit the values of digital display increases. 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 some what 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.

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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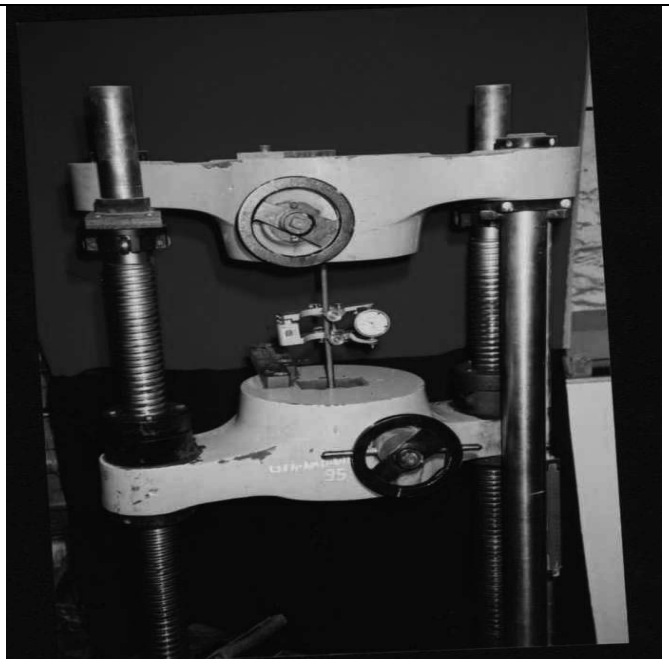
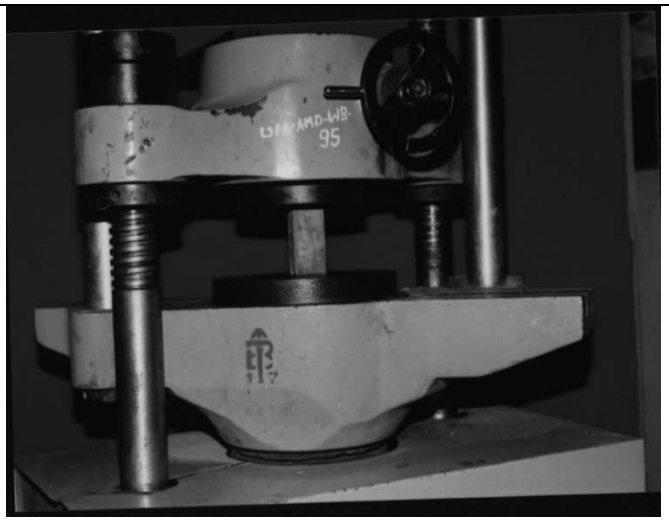
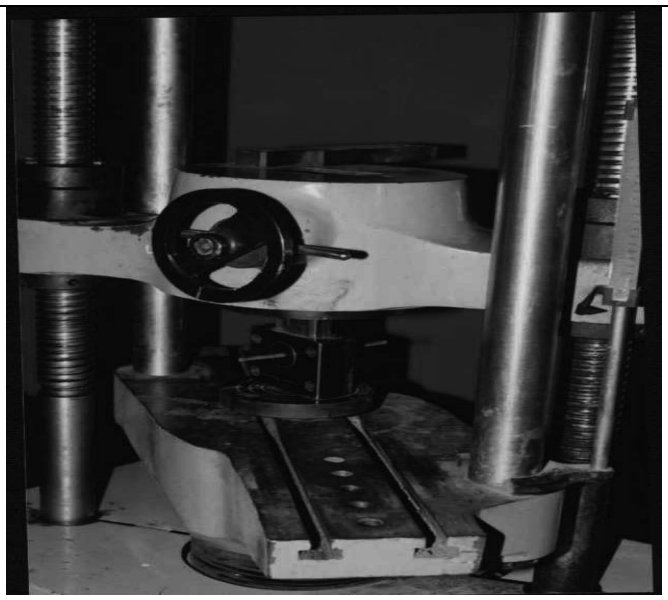
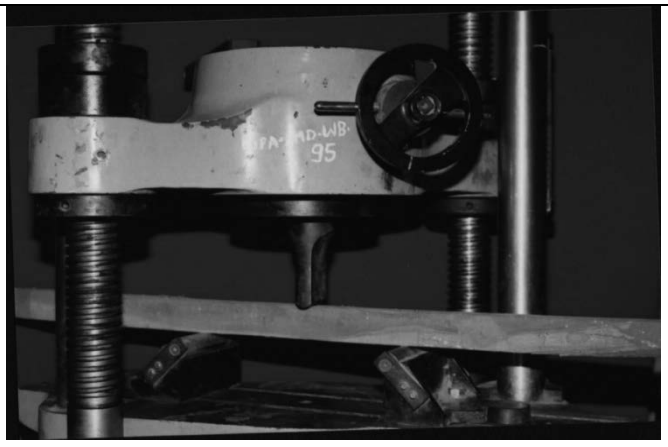
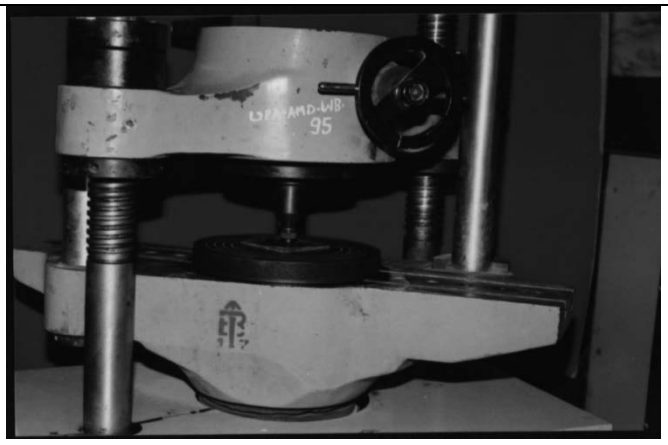
XV Observations and Calculations (Use blank sheet provided if space not sufficient)

1		Test Conducted …… Cross Head/Jaw used 1……. 2…… Attachment used if any …… …… Load at failure ……..
2		Test Conducted …… Cross Head/Jaw used 1…….. 2…….. Attachment used if any …… …… Load at failure …….

3		Test Conducted …… Cross Head/Jaw used 1…… 2…… Attachment used if any …… …… Load at failure ……
4		Test Conducted …… Cross Head/Jaw used 1…….. 2…… Attachment used if any …… …… Load at failure ……
5		Test Conducted …… Cross Head/Jaw used 1…….. 2…… Attachment used if any …… …… Load at failure ……

XVI Results

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XVII Interpretation of results

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XVIII Conclusions and Recommendations (if any)

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XIX 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. Write answers of minimum three questions.*

1) State the working principle of machine.
1) State the maximum capacity of UTM you have used.
2) State the least count of machine for the measurement of load.
3) State the least count of machine for the measurement of displacement.
4) State the type of oil used in the machine.
5) State the capacity of oil tank for the machine.
6) State the area(considering working area) required for the installation of the machine
7) Can we set up this machine other than ground floor. Justify your answer.

[Space to Write Answer]

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XX References / Suggestions for further Reading

1. https:/www.youtube .com /watch?v=D8U4G5kcpcM for tension test on mild steel.
2. Brochure supplied with the machine.
3. I.S. 1608. 2005 and I.S. 432 (Part I) 1982 R 1995.

XXI Suggested Assessment Scheme

S. No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Following of precautions	10%
3	Applying load and taking observations.	20%
4	Identifying the parts of the machine & function	10%
5	Handle different fixtures and attachments	10%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Students Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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

Practical No. 02: Conduct compression test on sample test piece using compression testing machine (CTM).

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 Relevant Program Outcomes (POs) (from programme Structure)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

1) To determine compressive strengths of Mild steel, Copper, Aluminum and Cast iron.
2) To compare compressive strengths of different materials

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

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

VII Minimum 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.

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-

IX Resources required

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

X Procedure

A. 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.

XI Precautions to be followed

1 The reading must be taken and noted down carefully.
2 The distance between the jaw of machine must be adjusted as per the height of specimen using available spacer plates.
3 Apply the load gradually.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV 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 st. $\sigma = P/A$ in N/mm^2
1	Mild steel				
2	Cooper				
3	Aluminium				

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

2) Sample Calculations:

For Material …… $\sigma = P/A =$

For Material …… $\sigma = P/A =$

For Material …… $\sigma = P/A =$

XVI Results

1. Compressive strength of timber specimen is .....
2. Compressive strength of brick specimen is .....
3. Compressive strength of metal(……) specimen is .....

XVII Interpretation of results

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XVIII Conclusions and Recommendations (if any)

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XIX 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. Write answers of minimum three questions.*

1) State the working principle of machine.
2) State the maximum capacity of CTM you have used.
3) State the loading range available in the machine along with its least count.
4) State the type of oil used in the machine.
5) State the capacity of oil tank for the machine.

6) State the area(considering working area) required for the installation of the machine
7) Can we set up this machine other than ground floor. Justify your answer.

(Space to Write Answers)

XX References / Suggestions for further Reading

1. Uniaxial Tension and Compression Testing of Materials by Nikita Khlystov and others

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Students Team Members

1. …….
2. …….
3. ……..
4. ……..
5. …….

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

Practical No. 03: Perform tension test on mild steel as per IS: 432(1)

I Practical Significance

In Reinforced cement concrete members tensile stress and compressive stress are developed due to loading. Mild steel and tor steel are used in various R.C.C. members in the construction of structures. Mild steel is used to resist the tension developed in the structure. Determination of tensile strength of mild steel is necessary before its use in the structure. Stress- strain curve for mild steel under tension shows all significant points which helps to understand the basic concept of ductile behavior of material.

II Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of tensile strength of tor steel and other parameters such as limit of proportionality, elastic limit, yield load, ultimate load and breaking load are observed from the stress –strain curve as per IS:432(1)

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

VI Relevant Affective domain related

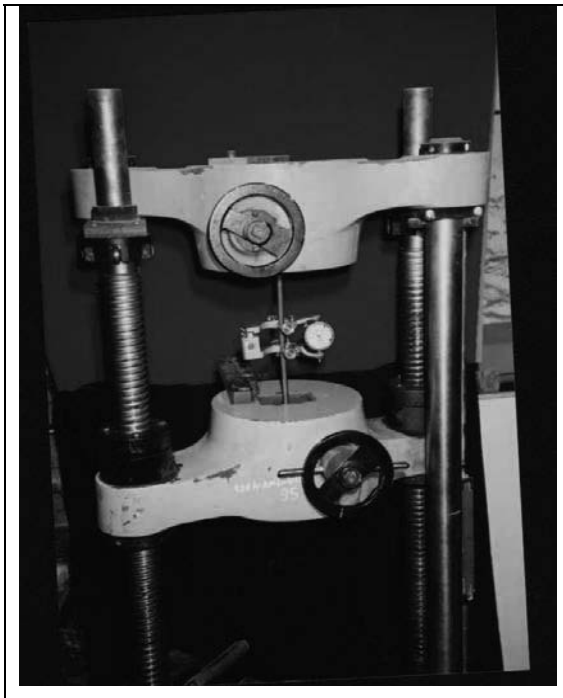
a. Follow safety practices and precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum Theoretical Background

The material possesses various mechanical properties. Mild steel has elasticity, ductility, malleability and strength. To use mild steel in various construction products determination of tensile strength of mild steel is necessary. Tensile strength of mild

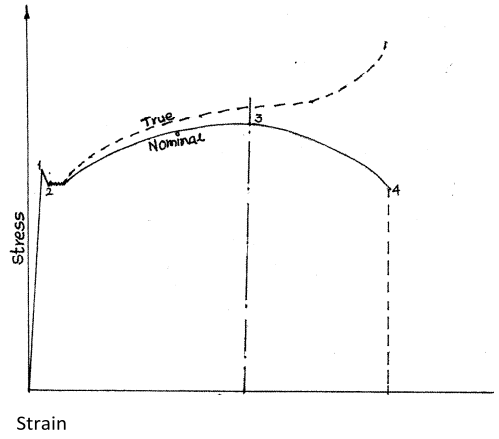
steel helps to increase the strength of the product. In tension test observation of limit of proportionality, elastic limit, yield point, ultimate point and breaking point is important. Measurement of initial gauge length, final gauge length, reduction in diameter and observation of formation of neck in necessary.

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-



Bar Fixed in cross heads with Extensometer.

Fig. No. 1:- Tension Test



Typical Stress – Strain Curve for Mild Steel

Fig. No. 2

1.Upper Yield Point 3.Lower Yield Point

2. Ultimate Point 4.Break Point

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	U T M	Universal Testing machine of capacity 1000kN, 600 kN; 400kN_analog type/digital type with all attachments and accessories.	1	
2	Extensometer	Least count - 0.01 mm,Max.Extension = 25 mm. Single dialgauge for 30 mm,40 mm. 60 mm, 80 mm, 100 mm, 125 mm gauge length.	1	
3	Specimen	Mild steel	1 per batch	
4	Vernier caliper	Least count of 0.02 mm & measuring range of 0.02 mm to 150mm.	1	

X Procedure

a] 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.

b] Mark the gauge points over the grip length such that the gauge points distance is half the gauge length i.e. half of $5.65\sqrt{S_O}$ where so is the cross-sectional area.

c] Fix up the bar in the appropriate crossheads so that it is subjected to tensile load.

d] Attach the extensometer on the bar at the central portion of the bar with appropriate distance between upper & lower pivots of extensometer.

e] Select a suitable loading range depending on the diameter of specimen

f] Switch on the machine and open the control valve so that the load is increased gradually and at the required rate.

g] Record the load at suitable interval from the digital display unit or the load dial.

h] Corresponding to loads note the readings of Extensometer.

i] 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.

j] Remove the extensometer, and start to measure extension of gauge length by divider or suitable scale. Stop measurement when maximum load has reached.

k] Record the maximum load. Observe the decrease in load and neck formation on the specimen.

l] Record the load at fracture and put off the machine.

m] Remove the specimen. Observe the cone & cup formation at the fracture point. Rejoin the two pieces, measure the final gauge length and the reduced diameter.

n] Plot the graph of Stress verses strain for mild steel and determine the modulus of elasticity.

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

.....
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XV 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

Observation 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
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

15					
16					
17					
18					
19					
20					

f] Observation after test

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

2] Reduced diameter d^1 = ...mm

Calculations :

a] Original area = $A = \pi/4 \times d^2$ = ...…mm^2

reduced area = $A^1 = \pi/4 \times d^2$ = ...mm^2

b] Gauge length of g = $5.65\sqrt{S_O}$ or 5d (for round bars)

c] Stress 6 = load / Original cross - sectional area

d] Strain = ε = 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') / 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.

XVI Results

a] Yield Stress =

b] Tensile Strength =

c] Nominal breaking Stress =

d] Percentage elongation =

e] Modulus of elasticity (By graph) =

(By calculation) =

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations

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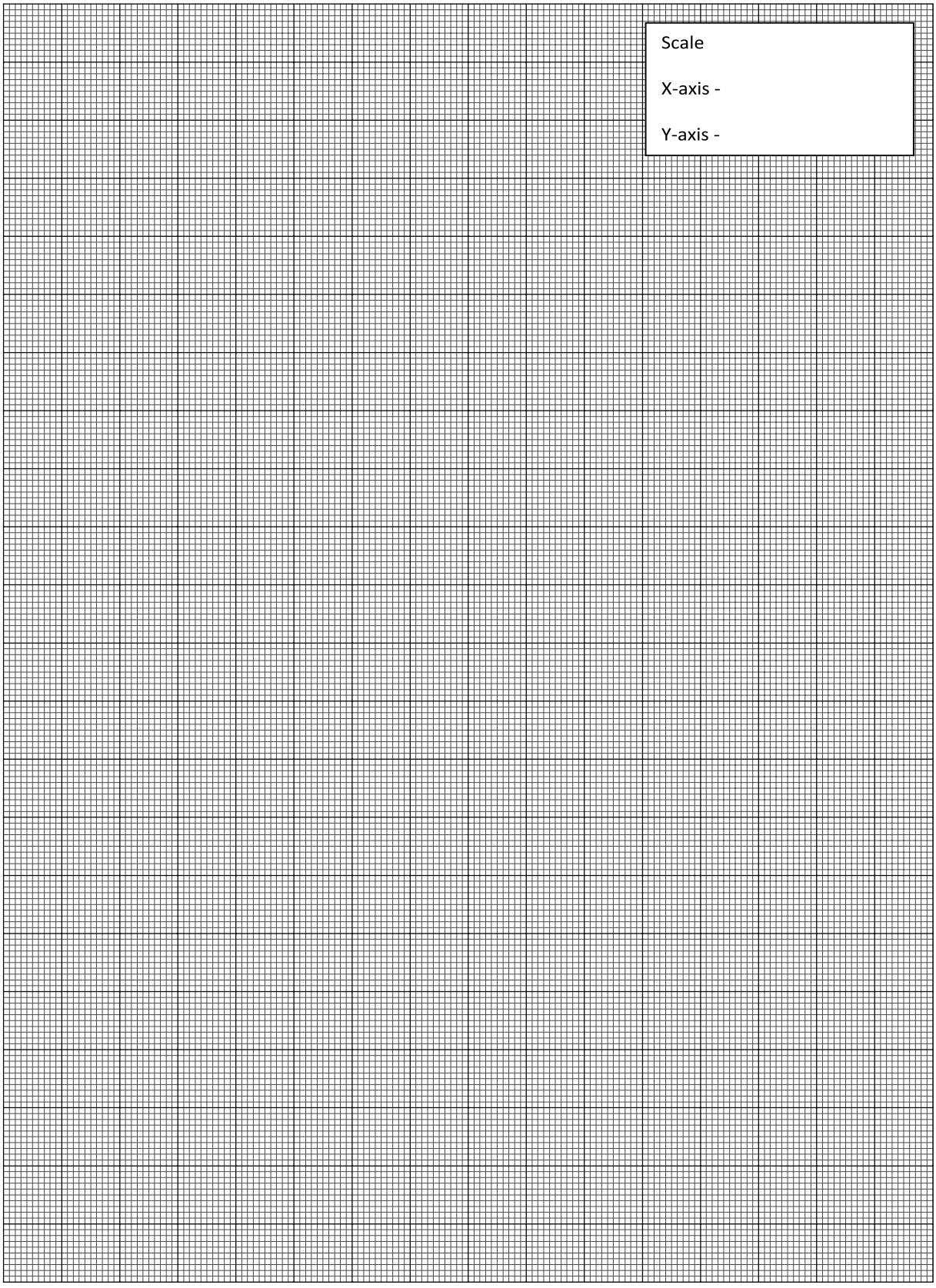

XIX Practical Related Questions

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

1. State the use of extensometer.
2. State different types of extensometer along with their least count.
3. Identify the different points on the stress –strain curve and state their importance.
4. Identify the different zones in the stress –strain curve.
5. State the type of failure you have observed.
6. Which grip should be fastened/tightened first out of upper or lower grip.
7. What do you mean by neck formation? Have you observed this phenomena in this test.

Space to Write Answers

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XX References / Suggestions for further Reading

1. https:/www.youtube .com /watch?v=D8U4G5kcpcM for tension test on mild steel.
2. Brochure supplied with the machine.
3. I.S. 1608. 2005 and I.S. 432 (Part I) 1982 R 1995.

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Students Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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

Practical No. 04: Perform Tension test on Tor Steel Specimen as Per IS 1608, IS:1139.

I Practical Significance:

In Reinforced cement concrete members, the tensile and compressive stresses are developed due to loading. Mild steel and tor steel are used in various R.C.C. members in the construction of structures. Tor steel is used to resist the tension developed in the structure. Determination of tensile strength of tor steel is necessary before its use in the structure.

II Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse the structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of tensile strength of tor steel and other parameters such as proof stress yield stress, ultimate stress, percentage elongation to be observed from the stress – strain curve as per IS.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Plotting graphs

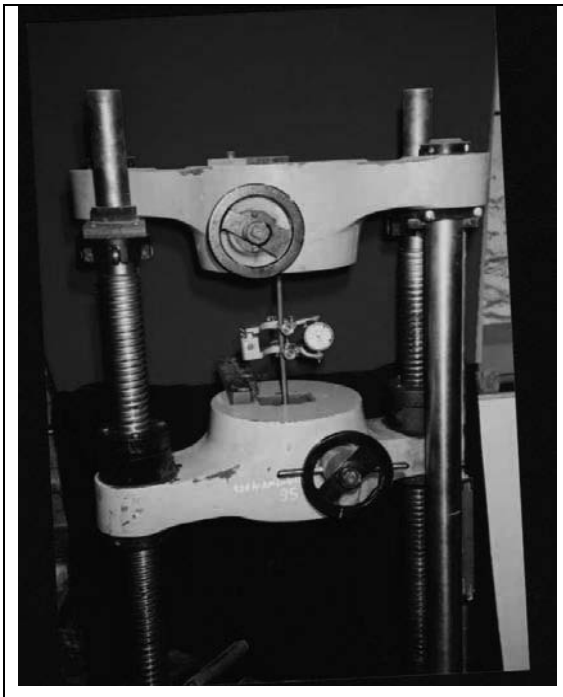
VI Relevant Affective domain related

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

VII Minimum Theoretical Background

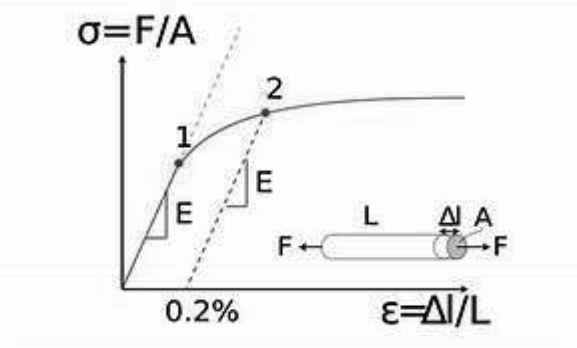
The material possess various mechanical properties. Tor steel has elasticity, ductility, malleability and strength. To use tor steel in various construction products-determination of tensile strength of tor steel is necessary. Tensile strength of tor steel helps to increase the strength of the product.

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-



Bar Fixed in cross heads with Extensometer.

Fig. No. 1:- Tension Test



Strain

Typical Stress – Strain Curve for Tor Steel

Fig. No. 2

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	U T M	Universal Testing machine of capacity 1000kN, 600 kN: 400kN_analog type/digital type with all attachments and accessories.	1	
2	Extensometer	Least count - 0.01 mm. Max. Extension = 25 mm. Single dial gauge for 30,40 mm. 60 mm, 80 mm, 100 mm, 125 mm gauge length.	1	
3	Specimen	Tor steel	1 per batch	

X Procedure

1) Measure the weight of bar.
2) Mark length at a distance of 10 times the dia. of bar from each end. This is for fixing the bar in grips.
3) Mark the gauge length at an interval of 5.65 $\sqrt{S_o}$ times the diameter of bar. (S_o = Cross-sectional area of bar = $\pi\ d_n^2 / 4$)
4) Adjust the loading range of UTM and select the rate of loading.
5) Set the Load pointer and dummy pointer of the dial gauge to zero.
6) Fix the specimen between the grips of top & middle cross head of the loading frame.
7) Adjust the gauge length on extensometer and fix the same on the middle marked gauge distance of the bar. For fixing the extensometer, the bar at point of fixity be made plane by filling and slight groove be made with the help of punch to receive knife edge of the extensometer.
8) Switch on the UTM. Take the extensometer reading at regular load interval and record the same in the observation table.
9) Continue the procedure till the readings on extensometer change rapidly. Here the bar enters in plastic zone. Remove the extensometer from the bar at this stage.
10) Record further extension of the bar from extension measuring device, fixed on the loading frame.
11) Apply the load continuously till the specimen breaks. Observe the cross section of bar at failure and sketch the same.
12) Join the two broken pieces of the bar and measure final gauge length. This is used to calculate percentage elongation of bar.
13) Repeat the test If rupture is within the grips.
14) Plot the graph of stress verses strain and determine the proof stress, ultimate stress and breaking stress from it.

Method of determination of proof stress:-

It is seen from the stress-strain curve of deformed bar that there is no well-defined yield point as in case of mild steel. To locate the yield point in this case, concept of proof stress is introduced. Method of determining proof stress is as follows –

Draw a tangent to stress-strain curve at origin. Draw a straight line parallel to the tangent at a strain value of 0.02 (0.2 %) and project it to meet the curve. The stress corresponding to the point of intersection of 0.2 % strain line with the curve is taken as proof stress.

1) Determine the Modulus of Elasticity of the bar material taking co-ordinates of stress and strain at any point on the curve below proof stress point.

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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

1. Length of bar, L = _____
2. Weight of bar, W = _____
3. Nominal diameter of bar,

   a) $d_n = \sqrt{\frac{4\,W}{\pi\,L\,\gamma}}$ b) $S_o = \pi\, d_n^2 / 4$

   =

4. Gauge length

   i) Initial gauge length = _____ mm
   ii) Final gauge length = _____ mm

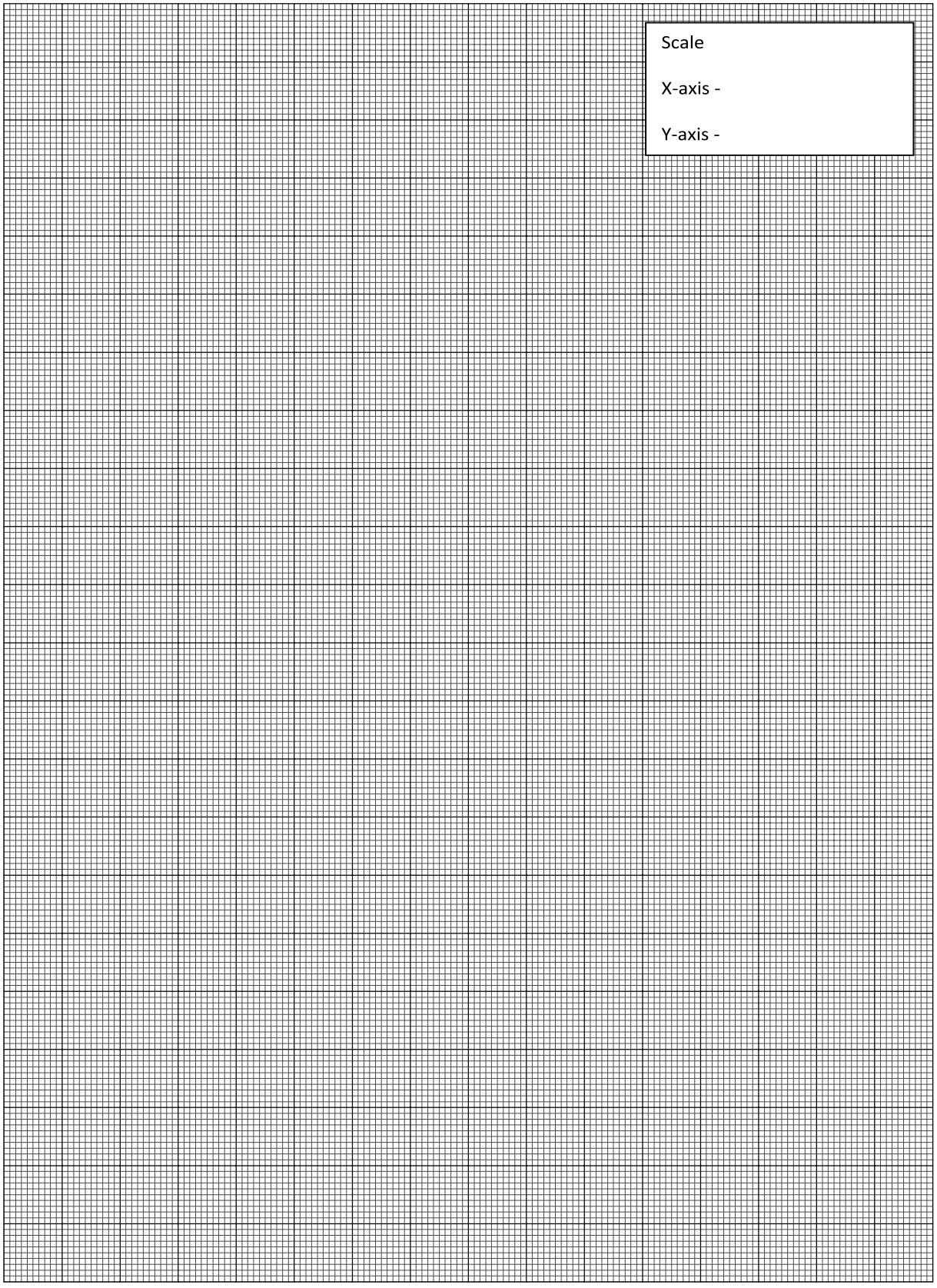
5. Least count of extensometer = _____ mm
6. Range of loading = _____
7. Rate of loading = _____

Observation Table:

Sr. No.	Load (KN)	Extensometer reading			Elongation from extensometer reading = Lc x A	Stress N / mm^2	Strain
		Left	Right	Average			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

Results

Calculated			IS requirements
A] 0.2 % Proof Stress	= _____	N / mm^2	_____ N / mm^2
B] Ultimate yield stress	= _____	N / mm^2	_____ N / mm^2
C] Breaking stress	= _____	N / mm^2	_____ N / mm^2
D] Modulus of elasticity	= _____	N / mm^2	_____ N / mm^2
E] % elongation	= _____	%	_____ %(Min.)


Scale
X-axis -
Y-axis -

XVI Interpretation of results

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XVII Conclusions and Recommendations (if any)

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XVIII 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. Write answers of minimum three questions.*

1) Define Proof Stress. State its importance for deformed steel bars
2) Refer stress-strain curves of Mild steel bar and deformed steel bar under tension and compare their behavior.
3) State the relation between ultimate yield stress and % elongation
4) State the capacity of UTM.
5) State the type of oil used in the machine.
6) State the least count of machine
7) Least the various experiments conducted on machine.
8) Whether the machine is microprocessor or digital ?

Space to Write Answers

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XIX References / Suggestions for further Reading

1. https:/www.youtube .com /watch?v=D8U4G5kcpcM for tension test on mild steel.
2. Brochure supplied with the machine.
3. I.S. 1608. 2005 and I.S. 432 (Part I) 1982 R 1995.

XX Suggested Assessment Scheme:

S. No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

Students Team Members

1. ……..
2. ……..
3. ……..
4. ……...
5. ……..

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

Practical No. 05: Conduct Izod (IS:1598) impact test on three metals.

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 mechanics test.

II Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of impact strength (toughness) of mild steel/brass/aluminum/copper/cast iron as per IS:1598 for Izod test.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Observation skills

VI Relevant Affective domain related

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

VII Minimum Theoretical Background

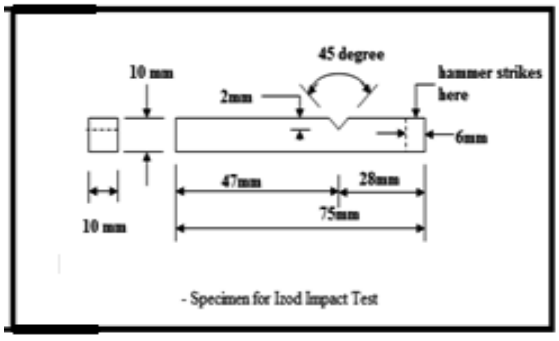
Toughness depends fundamentally on strength and ductility and would appear to be independent of type of loading. It is a fact, however, that the rate at which the energy is absorbed may affect the behavior of material, and thus different measures of toughness may be obtained from impact loading than 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

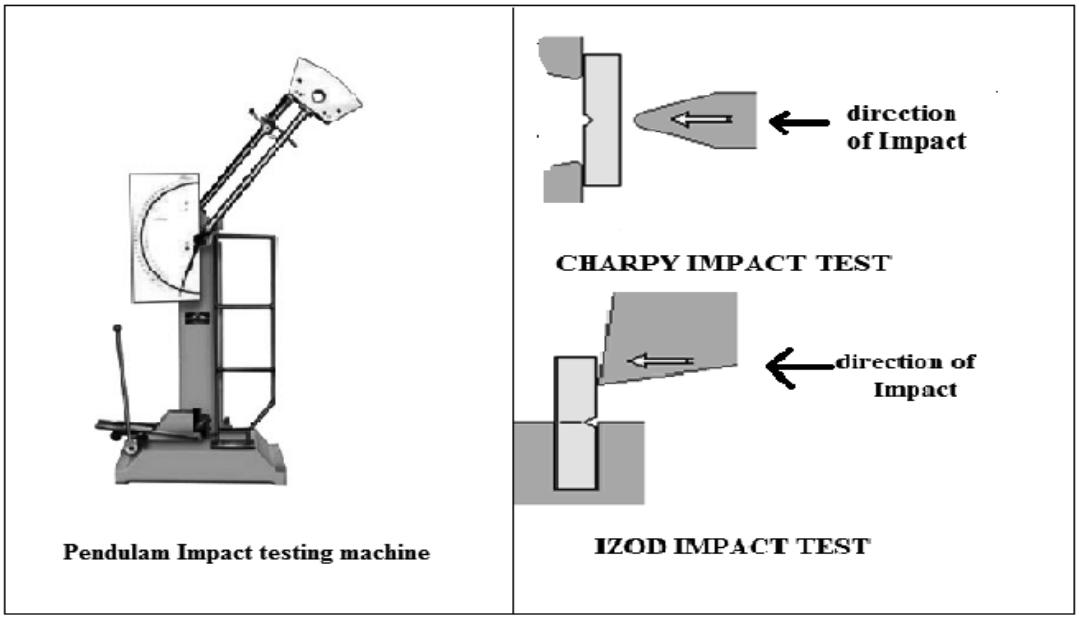
a measure of the work done to fracture a test specimen. When the striker impacts the specimen, the specimen will absorb energy until it yields. At this point, the specimen will begin to undergo plastic deformation at the notch. The test specimen continues to absorb energy and work hardens at the plastic 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'



VIII Labeling to the sketch/Experimental set-up is to be done by the students:-



IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Pendulum Impact Testing Machine	Izod/Charpy impact testing machine confirming to IS: 1757	1	
2	Specimen	Mild steel/brass /aluminum /copper /cast iron	Any three specimen for Izod and Charpy test each	

X Procedure

a) Observed and Study the different parts of impact testing machine
b) Draw the sketch showing the dimension of the specimen as per I.S.
c) 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.
d) Raise the pendulum again to the same height as before and clamp it and set the pointer to maximum energy on the scale.
e) 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.
f) Release the hammer by operating the release mechanism. The hammer strikes the specimen and note final reading.
g) Repeat the procedure for different specimens.
h) Calculate the shock absorbing capacity and note down in the table which is taken as the Izod impact value.

XI 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 Notch should be placed according to the instructions.
4 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.
5 Safety rules should be followed strictly while releasing the hammer

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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

1) Observation Table

Izod test

Sr. No	Material	Initial energy in Joules	Final energy in Joules	Shock absorbing capacity in Joules	Remark
1	M.S.				
2	Brass				
3	Aluminum				
4	Copper				
5	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-……..

XVI 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

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.

1. Write significance of the notch on the specimen?
2. Define gradually applied load, suddenly applied load and Impact load.
3. State the magnitude of stress and strain induced due to gradually applied load, suddenly applied load and Impact load.
4. Notch is kept facing striker in case of Izod impact Test. Justify.
5. Mention the property, which is co-related with toughness.
6. Write machine components in industries, which are subjected to impact.

Space to Write Answers

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XX References / Suggestions for further Reading

1. https://www.youtube.com/watch?v=l20kF6fhScA
2. IS : 1598- 1977 Indian standard Method for Izod Impact Test on Metallic Materials.

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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

Practical No. 06: Conduct Charpy (IS:1757) impact test on three metals.

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 mechanics test.

II Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of impact strength (toughness) of mild steel/brass/aluminum/copper/cast iron as per IS:1757 for Charpy test.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Observation skills

VI Relevant Affective domain related

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

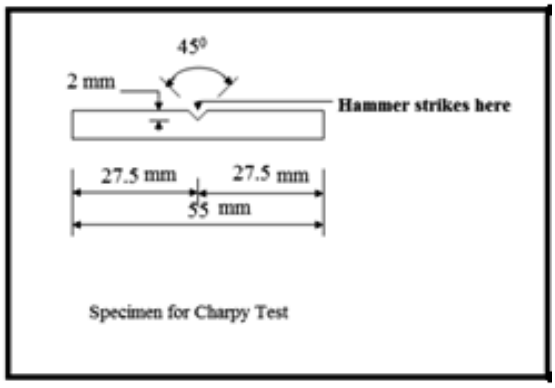
VII Minimum Theoretical Background

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.

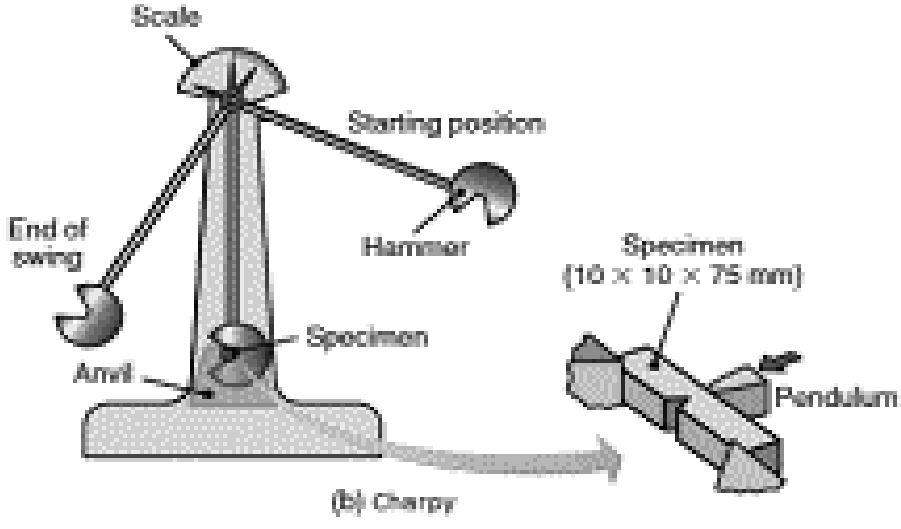
There are several different test methods which are used in the evaluation of dynamic fracture resistance. Most common tests are Charpy Test and Izod Test. The test measures the impact energy, or the energy absorbed prior to fracture. Impact energy is a measure of the work done to fracture a test specimen. 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'



VIII Labeling to the sketch/Experimental set-up is to be done by the students:-



CHARPY IMPACT TEST

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Pendulum Impact Testing Machine	Izod/Charpy impact testing machine confirming to IS: 1757	1	
2	Specimen	Mild steel/brssaluminum/copper/cast iron	Any three specimen for Izod and Charpy test each	

X Procedure

a) Study the impact testing machine.
b) Draw the sketch showing the dimensions of specimen
c) 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
d) Raise the pendulum again to the same height as before and clamp it and set the pointer to maximum energy on the scale.
e) 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.
f) Release the hammer by operating the release mechanism. The hammer strikes the specimen and note final readings.
g) Repeat the procedure for different specimens.
h) Calculate the shock absorbing capacity and note down in the table which is taken as the Charpy impact value.

XI 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 Notch should be placed according to the instructions.
4 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.
5 Safety rules should be followed strictly while releasing the hammer

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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

1) Observation Table

Charpy test

Sr. No	Material	Initial energy in Joules	Final energy in Joules	Shock absorbing capacity in Joules	Remark
1	M.S.				
2	Brass				
3	Aluminum				
4	Copper				
5	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-……..

XVI 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

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.

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.
4. 'Metal breaks or bends after impact test.' Comment.
5. Compare toughness of three metals other than you have tested in the lab.
6. State the least count of Impact Testing machine in your laboratory.

Space to Write Answers

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XX References / Suggestions for further Reading

1. IS : 1757 – 1988 : Indiann Standard Method for Charpy Impact Test on Metallic Materials.
2. https://www.youtube.com/watch?v=tpGhqQvftAo

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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

Practical No. 07: Determine water absorption of bricks as Per IS: 3495 (Part II), IS: 1077or tile IS: 1237

I **Practical Significance**:

Bricks and tiles are porous materials. The strength of the them depends upon their porosity. The strength is less if the materials are porous. Hence determination of porosity is most important.

This water is needed for the proper hydration of cement where the mortar comes in the contact of brick. The power of a brick to absorb water is measured by the initial rate of absorption. Low suction bricks need a leaner mortar to give good bond. Usually this is done by increasing the proportion of washed sand in the mix.

II **Relevant Program Outcomes (POs)**

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III **Relevant Course Outcomes**

Analyse behaviour of materials under different environment conditions.

IV **Practical Outcome**

Determination of Water absorption of bricks as per IS: 3495(part II),IS :1077or for tile IS:1237

V **Competency and Practical Skills**

This practical is expected to develop the following skills for the industry identified competency.

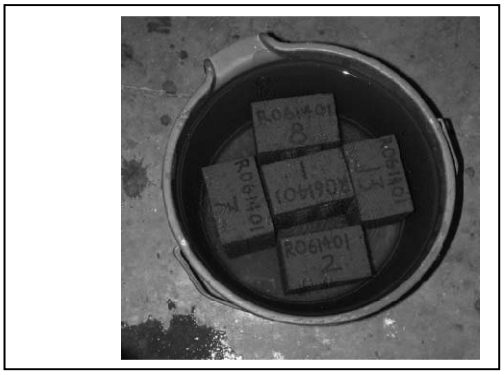
a. Measurement skill
b. Error estimation skill
c. Observation skills

VI **Relevant Affective domain related**

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

VII **Minimum Theoretical Background:** Porosity means material with more voids and more voids reduce the unit weight of material and strength of the material.

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-



IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Weigh balance	Digital weigh balance with max. cap of 10Kg and LC of 1gm.	1	
2	Oven	Power controlled oven	1	
3	Specimen	brick	1 per each group of 4 to 5 students	

X Procedure

1) Dry the samples of bricks and floor tiles in an oven at 110^0 C to 115^0 C to a constant weight.
2) Take out the bricks from oven and allow them to cool till they attain room temperature.
3) Weigh each brick. Make identification marks by numbers.
4) Immerse dry specimen completely in a tank filled with water at 15^0 C to 30^0 C for 24 hours.
5) After 24 hours remove the specimen. Wipe off the excess of surface water by a dry cloth.
6) Weigh each specimen record the exact readings within three minutes after removal of specimen from the tank.

XI Precautions to be followed

i) Bricks and tiles must dry at specified temperature.

ii) Allow the bricks and floor tiles to dry before taking dry weight.

iii) Do not take the weight of brick and tile immediately after removing from water.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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

Sample identification	Size of specimen in cm	Dry weight W_D in gm.	Wet weight W_W in gm.	Percentage water absorption $= \frac{W_W - W_D}{W_D} \times 100$	Av. % of water absorbed
Brick 1					
Brick 2					
Brick 3					
Tile 1					
Tile 2					
Tile 3					

Sample Calculations :

A] Percentage water absorption

The percentage water absorption is given by following equation -

$$\frac{\text{Wet weight} - \text{Dry weight}}{\text{Dry weight}} \times 100 =$$

XVI Results

1) The percentage absorption for the bricks/tiles is within / not within permissible limits specified by IS and the bricks/tiles have class _____.

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.*

1) State the reason for drying the brick samples before testing for water absorption.
2) State the importance of determination of water absorption for bricks and floor tiles
3) State the necessity of immersion of brick and floor tile for 24 hours.
4) Why the excess water to be removed before taking the weight of bricks and tiles.

Space to Write Answers

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XX References / Suggestions for further Reading

1. IS: 3495(part II) and IS :1077 for bricks
2. IS:1237 for tiles

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……...
5. ……..

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

Practical No. 08: Compression test on 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 Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome:

Determination of compressive strengths of dry and wet bricks.

V Competency and Practical Skills:

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Observation skills

VI Relevant Affective domain related

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

VII Minimum Theoretical Background:

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.

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	C T M	Compression Testing machine of capacity 2000kN /1000kN /500kN/400kN, analog type/digital type with all attachments and accessories.	1	
2	Specimen	brick	1 per each group of 4 to 5 students	

X 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/mm^2 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/mm^2 per minute till failure occurs.
9) Record the maximum load at failure in Observation Table.

XI Precautions to be followed:

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

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations

A) Dry bricks :-

Iden. Mark	Dimensions			Area,A = LxB (mm^2)	Crushing Load P (N)	Crushing Strength σ = (P / A) N/ mm^2	Average Crushing Strength σ_D N/mm^2
	L (mm)	B(mm)	H(mm)				

Sample Calculations :

σ_D = P / A =

Av. Strength =

B) Wet bricks:-

Iden. Mark	Dimensions			Area A = L x B mm^2	Crushing Load P (N)	Crushing Strength σ = P / A N/ mm^2	Average Crushing Strength σ N/mm^2
	L (mm)	B(mm)	H (mm)				

Sample Calculations :

σ_W = P / A =

Av. Strength =

XVI Results

The average compressive strength of the given brick sample

For Dry state =

For Wet State =

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.*

i) State the necessity of filling of frog in the bricks.

ii) Compare the load resisted by the bricks in wet and dry condition.

iii) State the necessity of use of plywood around the bricks for application of load.

Space to Write Answers

XX References / Suggestions for further Reading

1. IS: 3495(part I) and IS :1077 for bricks

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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

Practical No. 09: Abrasion test on flooring tiles (any one) e.g. mosaic tiles, ceramic tiles as per IS: 13630(Part-7), cement tiles as per IS: 1237 or any other

I Practical Significance:

Abrasion resistance is the capacity of the surface of tiles to resist the wear caused by foot movement or by mechanical equipment. The wear action is strictly linked to the material carried on to the surface. Mosaic tiles, ceramic tiles, or cement tiles are used as flooring materials. They are continuously subjected to abrasion and wearing action due to movement of users. Its durability depends upon resistance to abrasion. Hence determination of abrasion test of tiles is important.

II Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of Abrasion Test On Flooring Tiles (any one)e.g.
Mosaic tiles, Ceramic tiles as per IS: 13630(Part-7), Cement tiles as per IS: 1237.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency. Identify the resistance to the abrasion by the different type of tile

VI Relevant Affective domain related

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

VII Minimum Theoretical Background: Tile is one of the important building material and it has different properties. Abrasion means reduction in the thickness of the tile due to continuous wearing of surface .

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Abrasion Testing Machine		1	
2	Specimen	Tile	1 per each group of 4 to 5 students	

X Procedure

1) Prepare six square shaped test specimen of size 70.6 x 70.6 mm (i.e. 5000 mm^2 in area), one from each tile. [Ready made prepared specimen should be provided to students.]
2) Dry the specimen at $110^0 \pm 5^0$ C for 24 hours and then weigh it nearest to 0.1 gm.
3) Measure the thickness of specimen by thickness measuring apparatus (dial gauge).
4) Strew the grinding path of the disc of the abrasion-testing machine evenly with 20 gm of abrasive powder.
5) Fix the specimen in the holding device with the surface to be ground facing the disc and apply the load at the centre with 300 N net force.
6) Put the grinding disc in motion at a speed of 30 rev/min and feed the abrasive powder continuously on the grinding path, so that it remains uniformly distributed in a track corresponding to the width of test piece.
7) After every 22 revolutions stop the disc, remove the abraded tile powder and the remainder of the abrasive powder from the disc, and apply fresh abrasive powder in quantities of 20 gm each time.
8) After every 22 revolutions, turn the specimen about the vertical axis through an angle of 90^0 in the clockwise direction and repeat the process 9 times, thereby giving total of 220 numbers of revolutions.

9) After abrasion is over, reweigh the specimen to the nearest 0.1 gm.
10) Place it in the thickness measuring apparatus once again and record the final thickness.
11) Determine the wear from the difference in the thickness of the tile specimen.
12) Check the value of wear, with the average loss in the thickness calculated by equation (A).
13) Report the average wear and the wear on individual specimen.
14) Decide the suitability of the tile specimen from the IS clause.

XI Precautions to be followed

i) Use the abrasive powder in the specified quantity only.
ii) The force to be applied should be as per IS. ,limited to 300N.
iii) Apply the speed of the grinding disc limited to 30 rpm.
iv) No. of revolutions should not be more than 22.
v) Measure the thickness of sample accurately.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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.....
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XV Observations and Calculations

Sr. No.	Initial specimen dimensions			Initial weight W_1 (gm)	Final weight W_2 (gm)	Final thickness t_2	Wear t (mm)		Average wear t (mm)
	Side 1 (mm)	Side 2 (mm)	Thickness t_1 (mm)				By measurement $T = t_1 - t_2$	By formula (A)	
1									
2									
3									
4									
5									
6									

Sample Calculations:

XVI Results

Average wear = _____ mm

XVII Interpretation of results (Give meaning of the above obtained results)

The wear of the given floor tiles is within / not within the limits, as specified by IS clause.

XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.*

i) State the reason of using limited quantity of grinding powder.
ii) State the effect on tile if number of revolutions are increased.
iii) How do you prepare the test specimen of tile?
iv) How do you apply the abrasion to the tile ?

Space to Write Answers

XX References / Suggestions for further Reading

1. IS: 13630 (part 7) for Mosaic & Ceramic tiles.
2. IS:1237 for cement tiles.

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
2	Determination of abrasion value	10%
3	Applying load and determine revolutions.	20%
4	Identify the loss of weight after abrasion in each sample of tile.	10%
5	Calculation of parameters concerned.	10%
6	Working in team.	5%
Product related:10 Marks		**40%**
1	Error estimation.	5%
2	Interpretation of result and graph.	10%
3	Conclusions and Recommendations.	10%
4	Answers to practical related questions.	10%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……...
5. ……...

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

Practical No. 10: Perform single shear and double shear test on any two metals e.g. mild steel/ brass/aluminum/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 Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of shear strength of mild steel/ brass/ Aluminum/ copper/cast iron in single shear and double shear as per IS: 5242.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observational skills

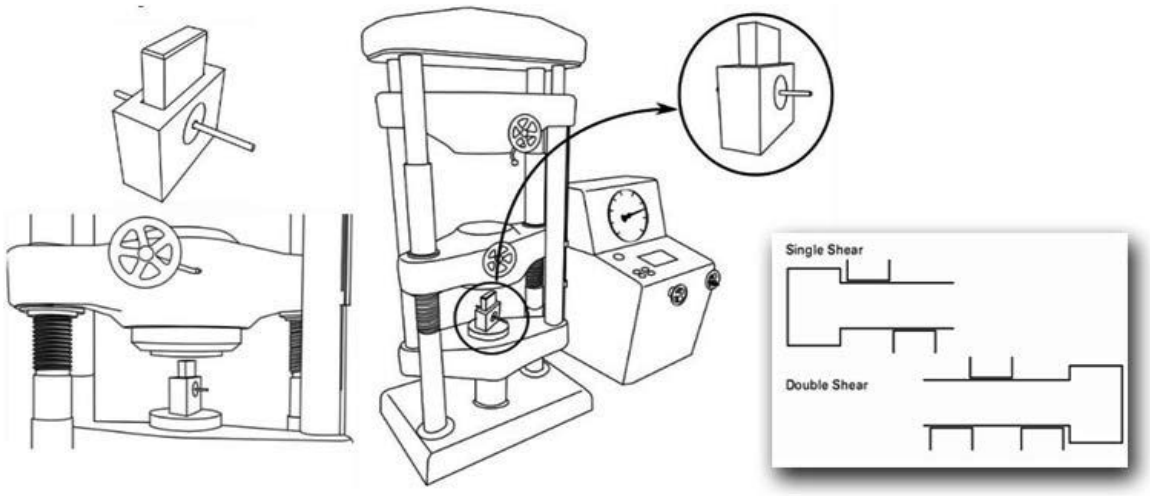
VI Relevant Affective domain related

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

VII Minimum 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.

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-



Single Shear Test on Metals

Shear Attachment

IX Resources required

No.	Particulars	Specification	Quantity	Remark
1	U T M	Universal Testing machine of capacity 1000kN, 600 kN/400kN, analog type/digital type with all attachments and accessories.	1	
2	Shear box with internal & external cutters		1	
3	Vernier caliper	Least count of 0.02 mm and measuring range of 0.02 mm to 150mm.	1	
4	Specimen	Mild steel/brass/aluminum/copper/cast iron	3 each for single shear & double shear test	

X Procedure

a) Measure the nominal diameter (d) of the given specimen.
b) 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.
c) Determine shear strength in single action .
d) Place the shear attachment along with the specimen using only one side bush.
e) 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.
f) Note the maximum load to shear off the specimen.
g) Calculate the strength of the specimen in single shear.
h) Repeat the same procedure by inserting two side bushes on either side to ensure double shear action.
i) Follow the same procedure to determine the shear strength of the other metals.

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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

a] Observation Table :

Sr, No	Metals	Diameter of specimen in mm (d)	C/s area in mm^2 (A)	Single shear		Double shear	
				Max load in N (V_1)	Max stress in N/mm^2 (τ_S)	Max load in N (V_2)	Max stress in N/mm^2 (τ_D)
1							
2							
3							

b] **Observation after test**

Calculations:

Strength of material in

Single shear = $\tau_1 = \frac{V_1}{A}$ = ...= N/mm^2

Double shear = $\tau_2 = \frac{V_2}{2A}$ = ...= N/mm^2

XVI Results

Sr.No	Metals	Max stress in Single shear (τ_S) N/mm^2	Max stress in Double shear (τ_D) N/mm^2
1			
2			
3			

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.*

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.
4) State the ratio of maximum load required for double shear to the single shear. Justify your answer.

Space to Write Answers

XX References / Suggestions for further Reading

1. IS 5242: Method of test for determining shear strength of metals
2. https://www.youtube.com/watch?v=sLZeR7RMGFA
3. https://www.youtube.com/watch?v=jjw-PG0cfJU

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total (25 Marks)		**100%**

List of Student Team Members

1 ……..

2 ……..

3. ……..

4.. ……..

5.. ……..

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

Practical No. 11: Compression test on timber specimen 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 Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of Compression test on timber specimen along the grain and across the grain as per IS: 2408

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Observation skills

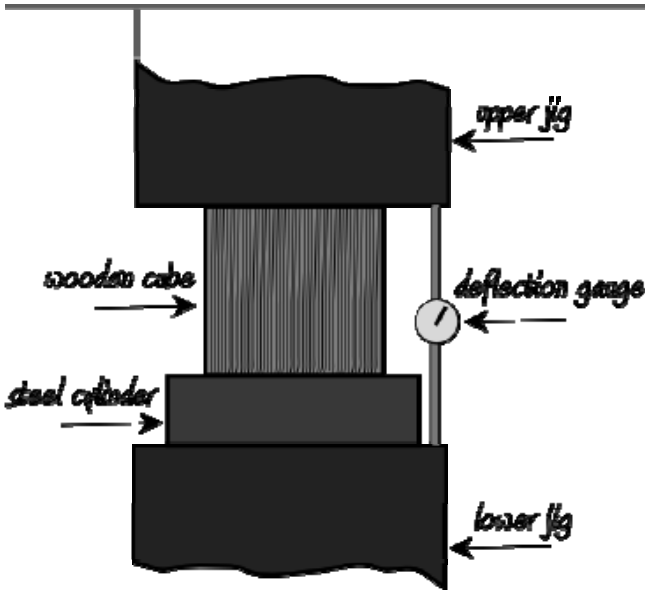
VI Relevant Affective domain related

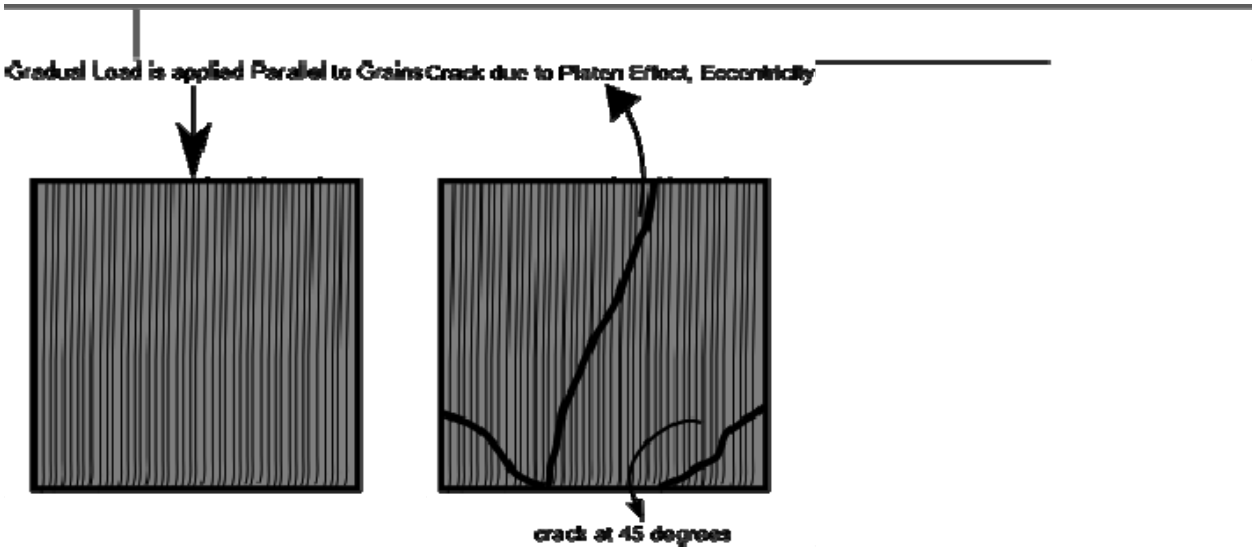
a. Follow safety practices and precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VII Minimum 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.

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-





IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	U T M	Universal Testing machine of capacity 1000kN, 600 kN/400kN, analog type/digital type with all attachments and accessories.	1	
2	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.	1	
3	Specimen	Timber Log	1 per batch	

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 Precautions to be followed

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

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations

Sr. No	Position of specimen	Cross sectional Dimensions mm×mm	Area A (mm^2)	Load at failure P (N)	Crushing strength = P/A (N/mm^2)
1	Along the grain				
2	Across the grain				

Sample Calculations:

XVI Results

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

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.*

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 to Write Answers

XX References / Suggestions for further Reading

1. IS:2408 for Compression Test on Timber.
2. https://www.tesrresources.net/applications/test-types/flexural-test/

XXI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Student Team Members

1 ……..

2 ……..

3 ……..

4 ……..

5 ……..

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

Practical No. 12: Plot shear force and bending moment diagrams of cantilever, simply supported and overhanging beams for different types of loads.

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 Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Plotting of Shear Force and bending moment diagrams for cantilever, simply supported and overhanging beams subjected to various types of combinations of loads.

V Competency and Practical Skills

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.

VI Relevant Affective domain related

a. Follow sign convention.

b. Working as a leader/a team member.

c. Expertise in use of calculator.

VII Minimum 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.

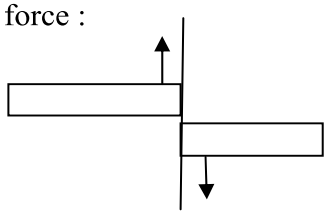
Bending Moment (BM): The bending moment at the cross-section of a beam is the algebraic sum of the moments of forces or moments, to the right or left of the section.

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.

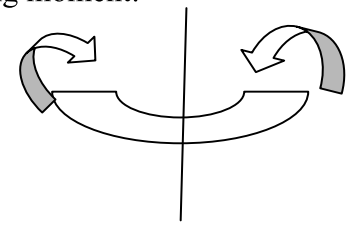
VIII Labeling to the sketch/Experimental set-up is to be done by the students:- Sign conventions

i) Shear force :



Positive Shear

ii) Bending moment:



Positive Bending

IX Resources required

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

X Procedure

a) For cantilever start solving from the free end without calculating the reactions.
b) For the given beam loaded externally calculate the support reaction if the beam is simply supported.
c) Adopt universally accepted sign convention for SF and BM.
d) 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.
e) Calculate the BM at that section by taking the sum of moment of all the forces on either side of section about that section.
f) To suitable scales (horizontal and vertical) draw the beam with given supporting condition and the loads on the given graph paper.
g) To the selected scale plot the SF and BM ordinates on separate baselines.
h) Connect the ordinates of SF as per the type of loads acting to get the shear force diagram.

i) 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.
j) Calculate the bending moment at the point of zero shear force.
k) Connect the ordinates of BM as per the type of loads to get final BM diagram.
l) 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.
m) 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.
n) 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.

XI 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 ie +ive ordinates above the base line and –ive 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.

XII Precautions followed

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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.)

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

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(Space for diagram of beam, SFD and BMD showing all details.)

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

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(Space for diagram of beam, SFD and BMD showing all details.)

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

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(Space for diagram of beam, SFD and BMD showing all details.)

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1) Draw SFD and BMD for a Simply supported beam subjected to combination of UDL and Couple .

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Space for diagram of beam, SFD and BMD showing all details.

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

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Space for diagram of beam, SFD and BMD showing all details.

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

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Space for diagram of beam, SFD and BMD showing all details.

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

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Space for diagram of beam, SFD and BMD showing all details.

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

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Space for diagram of beam, SFD and BMD showing all details.

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XIII Conclusions and Recommendations.

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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. Write answers of minimum three questions.

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

Space to Write Answers

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XV References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Strength of Materials	Khurmi R.S.	S Chand and Co. Ltd. ISBN 978-8121928229
2	Strength of Materials	S. Ramamurtham	Dhanpat Rai and sons ISBN 9788187433545
3	http://nptel.ac.in/courses/112107146/23		

XVI Suggested Assessment Scheme

S.No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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

Practical No. 13: conduct flexural test on timber beam of rectangular section in both orientation 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 Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of flexural strength of timber beam. as per IS:1708, IS: 2408

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Observation skills

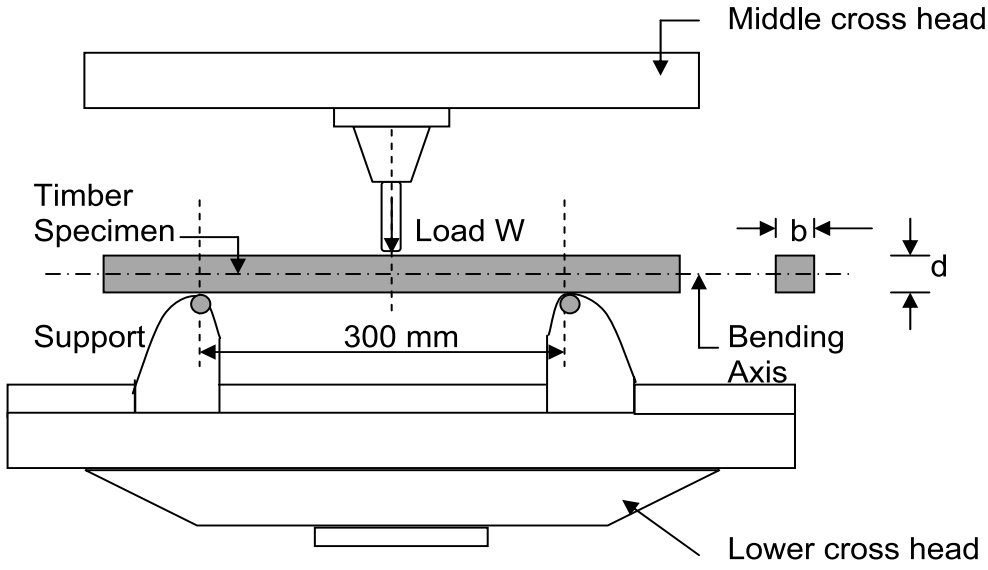
VI Relevant Affective domain related

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

VII Minimum 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.

VIII Experimental Set-up



IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	U T M	Universal Testing machine of capacity 1000kN, 600 kN/400kN, analog type/digital type with all attachments and accessories.	1	
2	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.	1	
3	Specimen	Timber specimen	1 per batch	

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 midspan.

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 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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

Sr. No.	Breadth b (mm)	Depth d (mm)	Span L (mm)	Load at failure W (N)	Extreme fiber stresses	
					Compression (at top)	Tension (at bottom)
1.						
2.						

Sample Calculations :

$$M = \frac{W \times L}{4} =$$

$$I = \frac{b \times d^3}{12} =$$

$$\sigma = \frac{M \times y}{I} =$$

XVI Results

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

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.*

1. If the point load is not applied at the center, comment on the failure pattern.
2. In case of rectangular section bxd 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 to Write Answers

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XX References / Suggestions for further Reading

1.IS 1708-1 to 18 (1986): Methods of testing of small clear specimens of timber [CED 9: Timber and Timber Stores]
2. https://www.scribd.com/doc/242342954/flexural-test-lab-report
3. https://www.testresources.net/applications/test-types/flexural-test/

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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

Practical No. 14: Conduct flexure test on floor tiles as per IS: 1237, IS:13630 or on 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 Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various loading conditions.

IV Practical Outcome

Determination of flexural strength of flooring tile by means of three point loading.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Observation skills

VI Relevant Affective domain related

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

VII Minimum 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.

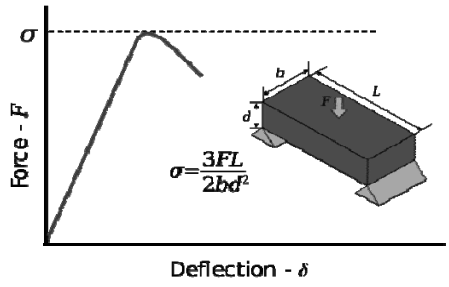
The flexural modulus of a material is a physical property denoting the ability for that material to bend. It is the ratio of stress to strain during a flexural deformation, or

bending. It relates to the amount of weight a material can handle when used as a structural support.

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-

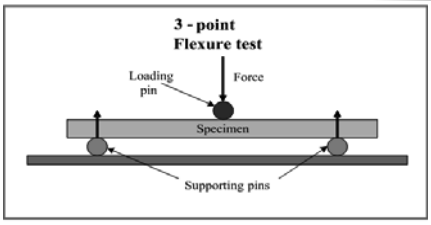
Flexural Test on flooring or roofing tile

Fig. No. 1



Typical Stress – Strain Curve for Flexure test

Fig. No. 2



Three Point Loading

Fig. No. 3

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	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	1	
2	Vernier caliper	Least count of 0.02 mm & measuring range of 0.02 mm to 150mm.	1	
3	Specimen	Flooring tile	3 for dry test 3 for wet test	

X Procedure

A] FOR DRY TEST

a) Measure the breadth and thickness of the Floor Tile.

b) 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.

c) Place a plywood packing, 3mm thick and 25mm wide between the tile and the bearers shall be self aligning.

d) 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 WET TEST

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

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

SR. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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

a] **Observation Table**

A] FOR DRY TEST

Sr.	Breadth b(mm)	Thickness T(mm)	Span L(mm)	Breaking Load W(N)	Average
1					
2					
3					

B] FOR WET TEST

Sr.	Breadth b(mm)	Thickness T(mm)	Span L(mm)	Breaking Load W(N)	Average
1					
2					
3					

Calculations :

i) $M = \frac{W \times L}{4} =$

ii) $I = \frac{b \times t^3}{12} =$

iii) $\sigma = \frac{M \times y}{I} =$

XVI Result

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

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

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.*

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 to Write Answers

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XX References / Suggestions for further Reading

1. IS:1237 & IS:13630 for Flooring tiles.
2. IS:654 & IS:2690 for roofing tiles.

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	5%
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%
6	Working in team.	5%
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%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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

Practical No. 15: Conduct field test on TMT bars.

I Practical Significance

Concrete and Rebars are the two vital components in any reinforced concrete construction. Safety and durability of such constructions is directly dependent on the quality of Concrete and / or Rebars. The main problem in India today, is defective, substandard and fake rebars in the market. The two major types of rebars in Indian Market are: 1.Thermo-Processed (TMT) Rebars and 2. Cold Twisted Deformed (CTD) rebars Thermo-processing technique is essentially 'Controlled water quenching of rebars' by passing Rebars through 'specially designed quenching tubes. The quenching is controlled by appropriate adjustments in temperature, pressure and volume of water in the tube. In CTD rebars, bars are twisted to predetermined pitch, when the strength level gets enhanced to about 450 N/sq.mm. In case of CTD bars, it is fairly easy to visually identify twisted rebars from untwisted or inappropriately twisted rebars, whereas, in case of TMT rebars, it is difficult to identify 'Controlled waterquenched rebar' from a 'non-quenched rebar' or 'inappropriately uenchedrebar'.

II Relevant Program Outcomes (POs)

PO1. Basic knowledge: Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Engineering related problems.

PO2. Discipline knowledge: Apply Laws of Mechanics to solve day to day engineering related problems.

PO3. Experiments and practice: Plan to perform experiments and practices to use the results to solve engineering related problems.

III Relevant Course Outcomes

Analyse structural behaviour of materials under various conditions.

IV Practical Outcome

Identification of quality of TMT bars supplied on site in actual practice.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency.

a. Measurement skill
b. Error estimation skill
c. Observation skills

VI Relevant Affective domain related

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

VII Minimum Theoretical Background

While producing TMT rebars, if the prescribed methods of production are not appropriately adopted, whatever the reasons may be, it results in fake or substandard TMT rebars. It is generally not possible to make out the fake and the substandard rebars by mere physical observations. Standard, Fake and Substandard rebars look alike, misguiding the users.

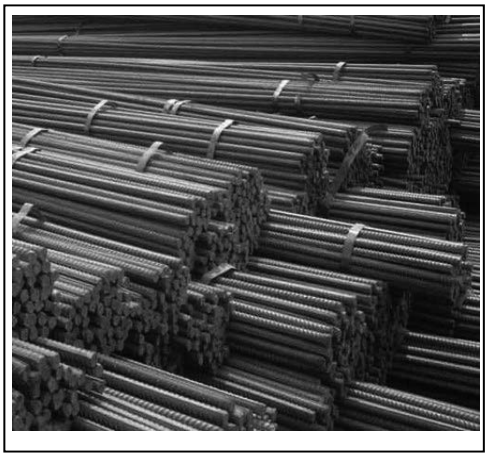
Fake and substandard (TMT) rebars Fake & Substandard (TMT) rebars can be classified into 3 specific categories: 1. TMT rebars with no quenching at all (Fake rebars), 2. TMT rebars with abrupt quenching in water tanks (Fake rebars); and 3. TMT rebars with inadequate / improper quenching in quenching tubes (Substandard rebars).

There has been a continuous search for a simple 'Cursory Field Test' to identify easily these fake or substandard TMT rebars in worksites. Although well-defined laboratory tests are available, they are involved and time consuming. Whereas in case of CTD rebars, physical observation of rebars is good enough to identify substandard rebars.

Whenever a rebar under a high temp is quenched under controlled conditions and cooled in air subsequently, due to metallurgical transformation, two distinct phases (shades) show out. Tempered marten site in the form of a ring with definite width forms the outer case (ring), where as the inner core remains pearlite / ferrite. The outer case (ring) and inner core are distinctly visible, when the cross-section of rebar is etched

VIII Labeling to the sketch/Experimental set-up is to be done by the students:-

Project site engineers and all civil engineers should be able to distinguish and identify good quality rebars. How does one ensure that the rebars have a concentric tempered martensite periphery with a softer ferrite-pearlite structure? A few guidelines are presented here.



Illustrative Guide of the "TMT" rebars available in India:

Fig 6: This photograph provided by HSE Germany, illustrates a good Q & T Thermex rebar. Note the uniform and concentric hardened periphery and the softer core. Such bars will have desired tensile strengths coupled with high elongation as required in seismic zones.

Fig 7: Photo of Thermex rebar provided by HSE Germany. The uniform tempered martensite periphery is clearly visible. Depending on the size and grade, the hardened periphery will be about 20 to 30 % of the bar cross sectional area for good Q & T rebars. Ideal rebar for civil construction.

Fig 8: A picture taken of a 25mm Thermex 500 rebar rolled by Metro Ispat, Maharashtra. Note the uniform tempered martensite periphery. Elongation measured was 19 %. A good rebar for civil construction.

Fig 9: This photograph provided by Dr. C. S. Vishwanath, Bangalore illustrates a highly *over-quenched* rebar. The hardened periphery is about 60% of the total cross-sectional area. Produced by mill personnel who are not fully trained in quenching & tempering technology. *Such bars will have high Yield Strength and very poor ductility and should never be used in civil construction.*

Fig 10: This photograph provided by Dr. C. S. Vishwanath, Bangalore illustrates *improper quenching treatment*. Note non-uniform hard periphery signifying that the quenching has not taken place all round the periphery. Such bars are produced due to incorrect operation by mill personnel. *Such bars should be used only after extensive testing.*

Fig 11: This photograph provided by Dr. C. S. Vishwanath, Bangalore illustrates a bar *produced by a bad quenching & tempering system*. The quenching is not uniform and the test results will be anybody's guess. Such bars are produced mainly by 'hit-and-trial' "TMT" technology and systems. *Such bars should never be used in civil construction as properties will vary from bar to bar.*

Fig 12: This photo, provided by HSE Germany, shows a typical Thermex rebar – very uniform cross-section of hardened periphery with a soft core. *An excellent rebar for civil construction.*

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Cutting Machine or Hack-saw		1	
2	Nitrol Solution	10 % of Conc. Nitric Acid and 90 % of Ethyl Alcohol	25ml	
3	Rough File		1	
4	Specimen	TMT Bar piece	One specimen for each batch	

X Procedure

a) Ensure the mill that has supplied the rebars has a genuine 'quenching & tempering' technology.
b) Check whether the Q and T technology supplied to the mill is by an authorised and competent organisation.
c) Check the licence, if any, issued to the mill for the specific Q and T rebars.
d) A Licence from B.I.S. is an added asset.
e) Always test the rebars for properties instead of merely relying on the name 'TMT
f) Field test the rebars at random. The first thing to be done is filing the surface of the rebars with the help of workers 'rough' hand file. A site worker will easily recognise if the surface is hard or soft. All Q and T rebars have a harder surface than unquenched bars.
g) Cut 'small length samples' from a few randomly selected TMT rebars of any lot, preferably in a cutting machine, if not, by hack-saw cutting.
h) Cross-sections of test samples shall be mirror finished with any suitable polishing device. An ideal polishing device is a unit with rpm of about 3000, where in an emery sheet can be mounted on the rotating circular disc. Polishing of cross-sections shall be done for at least about 10 minutes.
i) The c/s shall be smeared (etched) with drops of 'Nitrol Solution'. It is nothing but a synthesis of '10 % of Conc. Nitric Acid' and '90 % of Ethyl Alcohol'. Soon after etching, two distinct phases (Shades) with uniform thickness are clearly visible on the c/s, if the rebars are 'Genuine TMT Rebars'. If the two phases are not distinct, the rebars are either 'Substandard' or 'Fake' TMT rebars.
j) It is essential that the c/s be examined soon after etching. In case of delay, etching to be redone.

XI Precautions to be followed

1 The specimen should be fixed carefully in to the jaw of machine.
2 The sample cutting must be done carefully.
3 The surface of the bar must be made smooth.
4 Nitrol Solution must be used carefully as it contains concreted acid.
5 Safety rules should be followed strictly while performing the test.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

.....
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.....

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

Observation Table

Sr. No	Material	Two distinct phases (Shades) with uniform thickness are clearly visible on the c/s	Remark
1	Sample no.1	Yes / No	
2	Sample no.1	Yes / No	
3	Sample no.1	Yes / No	

XVI Results

Two distinct phases (Shades) with uniform thickness are clearly visible / not visible on the c/s of the bar.

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write answers of minimum three questions.

1. Give long form of TMT.
2. Give long form of CTD.
3. State the difference between tor steel and TMT bars.
4. State % of elongation as per IS for mild steel, tor steel and TMT..

Space to Write Answers

XX References / Suggestions for further Reading

1. Company broushers of respective Samples

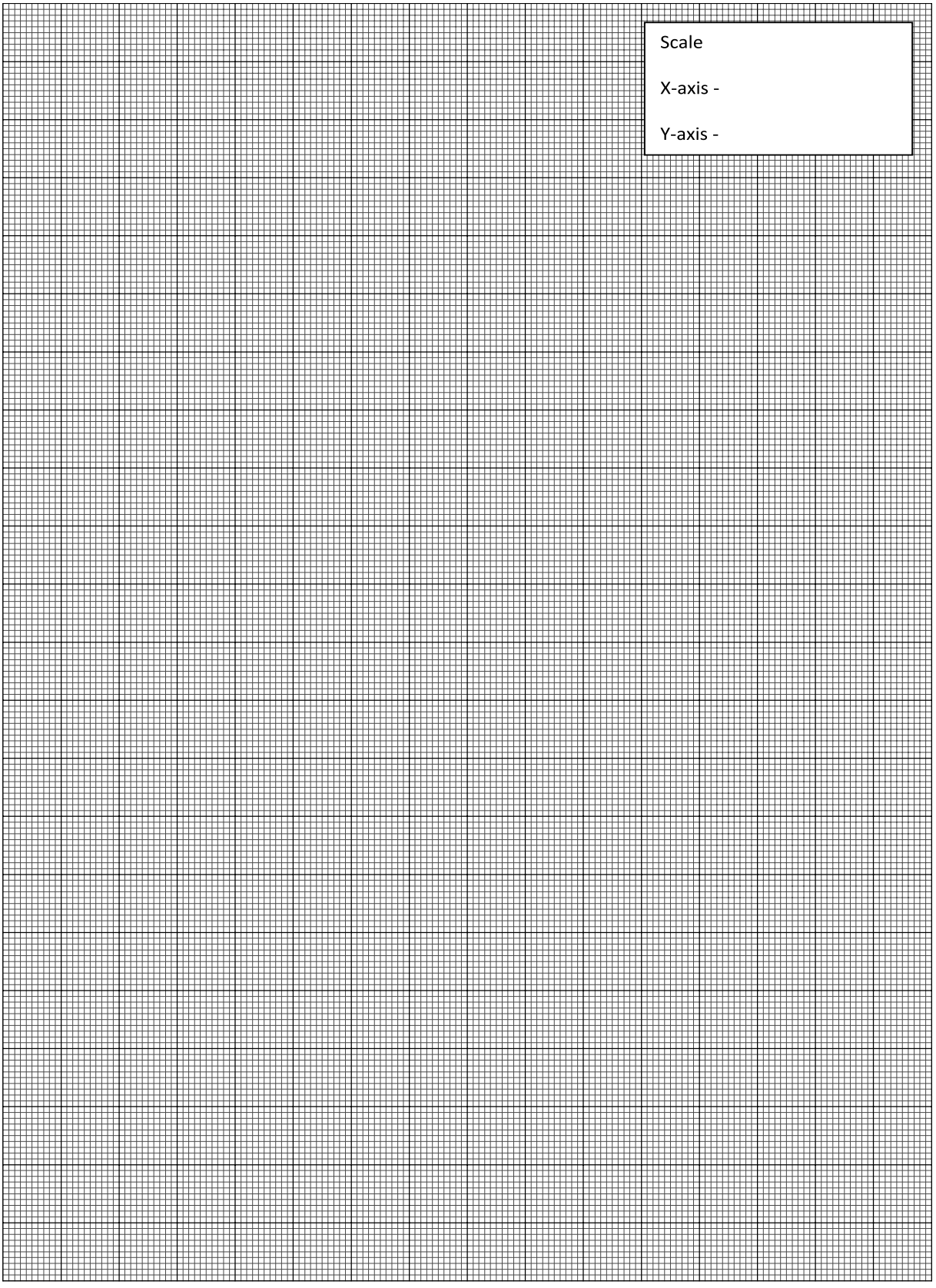
XXI Suggested Assessment Scheme

S. No	Performance Indicators	Weightage (%)
Process related:15 Marks		**60%**
1	Handling of the machine.	10%
2	Following of precautions	10%
3	Preparation of specimen	10%
4	Clear and neat Observation	20%
5	Working in team	10%
Product related:10 Marks		**40%**
1	Interpretation of result	10%
2	Conclusions and Recommendations.	15%
3	Answers to practical related questions.	10%
4	Submission of report in time.	5%
Total: 25 Marks		**100%**

List of Student Team Members

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

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


Scale
X-axis -
Y-axis -

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using 'C'	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
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13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC's	22531
9	Embedded Systems	22532
10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
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10	Advanced Java Programming	17625
11	Mobile Computing	17632
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13	Testing & Maintenance of Electrical Equipments	17637
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24	Industrial Drives	17667
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26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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