

**STATE BOARD OF TECHNICAL EDUCATION & TRAINING::AP,  
VIJAYAWADA**



**DIPLOMA IN CIVIL ENGINEERING**

**III SEMESTER**

**MATERIAL TESTING PRACTICE (C-309) MANUAL**

**(AS PER C-20 CURRICULUM)**

## **INDEX**

<b>S.No</b>	<b>CONTENTS</b>	<b>PAGE No.</b>
	<b>TESTS ON BRICKS</b>	
1	Water absorption test on bricks	
2	Crushing Strength test on bricks	
	<b>TESTS ON CEMENT</b>	
3	Fineness Test on cement	
4	Normal Consistency Test on Cement	
5	Setting Time Test on cement	
6	Compressive Strength of cement	
	<b>TESTS ON AGGREGATES</b>	
7	Water absorption test on sand	
8	Test on Bulking of sand	
9	Test on determination of bulk density and percentage of voids in Coarse and Fine aggregate	
10	Sieve analysis of coarse and fine aggregates	
11	Field method to determine fine silt in aggregate	
	<b>TESTS ON METALS</b>	
12	Tension test on mild steel rod	
13	Hardness test on metals	
14	Izod/Charpy Impact test on metals	
15	Deflection test on beam	

## 1.0 INTRODUCTION

The Curriculum of Technical Education should invariably provide for knowledge, attitudes and skills required by the technicians /technologists in the country. In this context the laboratory courses form a vital portion in the entire curriculum of technician education. The laboratory courses shall therefore be so designed and delivered that they help the students acquire attitudes and motor skills that are essential to function effectively as technicians/technologists.

The planning, organization and implementation of lab courses need a detailed description of tasks to be performed by the students. Well thought out instructional objectives to a large extent give these descriptions. The analysis of tasks (by identifying the activities the students are expected to do) help prepare the objectives meticulously. In other words the objectives would be clearer, when the task analysis is done to spell out the sub tasks for each objective.

A survey of the practices currently followed in the technical/technician education shows an urgent need to plug in gaps in instructional procedures. The reasons for these gaps are ambiguity in the minds of the teachers regarding tasks to be performed, levels of competency to be achieved by the students and the weightage to be allocated for each task. This aids in scientific design of instructional plan (optimizing the resources, budgeting the time & content).

The task analysis, teaching points and the structured scheme of evaluation are very important in focusing the instruction on specific skill of desired outcome and in evaluating the same. The Instruction and evaluation in Laboratory courses are different from that of cognitive lessons in the sense that adequate importance and hence weightage needs to be given for all three domains of learning viz. cognitive, psychomotor and affective. Since both training and evaluation of traits of affective domain are practically difficult, a few traits (called values) most relevant and essential to occupations/professions after the Course may be identified for the purpose. It is imperative to integrate these values during instruction and evaluation and also overtly notify the same to the students.

A technician, in addition to performing a skill needs to prepare a report of testing that includes the description of procedure, details of measurements made, reasoning based inferences and so on.,. The current practice of record writing has failed to achieve this purpose as most of the time students end up with making copies of available material.

Therefore, for sensitizing the need for the changes in laboratory instruction, the present hand book has been prepared to meet the above requirements. As such the hand book comprises four parts that intend to :

- Present task analysis, teaching points which can be used for effective design of instruction
- provide a scheme of evaluation with rationally allocated weightage to each significant skill component
- offer a set of questions designed at different levels of competencies for assessment enabling the teacher to set the question paper with balanced levels of competencies
- present preset worksheets that cultivate the habit of systematic recording of observations and writing the technical report.
- Provide all important data related to particular laboratory activity at one point in the form of annexure

### 1.1. STRUCTURE OF THE BOOK

The hand book is presented in four parts viz., Laboratory sheets, Worksheet, Experimental Methodology and Annexure. The description of each part is given in the following sections

#### **Part I. Laboratory Sheet**

The information provided in this part is useful for the teacher for designing the instruction, planning & organization of the experiment and for scientific evaluation of the students. The major features of the Laboratory sheet are further explained below.

##### **1. Objective**

It indicates the **Task** to be performed and completed by the student during the specified duration of time.

##### **2. Task Analysis**

It is the process of identifying the component activities (sub tasks) to be carried out by the student in order to achieve the stipulated objective. As the task analysis aim at fitting the instructional objectives into various classes of behaviour, it would help the teacher to determine

any particular type of behaviour the student has learnt / failed to perform.

The task analysis would help the teacher in identifying the specific activities to be performed by the students. This could also be used as some kind of check list to compare with activities planned for the laboratory. Further it would give clue to the teacher to make students think originally & act independently. It includes both psychomotor learning and the related cognitive information and hence the task analysis is presented as Knowledge and skill parts.

**A. Knowledge Part:** That includes the cognitive aspects of the task.

**B. Skill Part:** That includes Psychomotor & Affective aspects of the task.

### 3. Teaching Points:

This includes the points based on the SKILL identified with suggested duration for each point and total duration which helps the teacher for the time and content budgeting during instruction.

### 4. Need and Scope:

The purpose, application and scope of the task to be performed are normally included in this sub section.

### 5. Planning and Organisation:

It lists actions to be taken to perform various activities and hence useful in planning the instruction and organizing the resources and equipment

### 6. Scheme of Valuation:

The information provided in this section helps the teacher to devise a tool for rational measurement assessment of the competencies accomplished by the student.

## Part II. Work Sheet

It is designed for the student, where in the student enters his personal data of identification, details of the experiment, stepwise procedure, observations made during experiment, a sample calculation, free hand typical graph, graph from experimental data and inference with discussion.

## Part III. Experimental Methodology

This section furnishes information with regard to standard procedure to conduct the experiment along with the description of equipment/apparatus and the basic theory/concept involved in the conduct of the experiment. Thus this section is very useful for both teacher and student as well to conduct the experiment systematically. Thus this section is presented in four sub section as described below:

### ➤ Description

It gives the detailed description of apparatus / tools / equipment / materials to be used for the task.

### ➤ Theory / Concept

It gives the concept of the task to be performed with formulae and units.

### ➤ Procedure

It provides the idea of step wise procedure to perform the task.

### ➤ Observation and Calculation

It includes sample observation, sample graph, sample calculation for reference

## Part IV. Annexure

All important and useful information that may help in accomplishment of tasks like conversion tables for units, technical & scientific data like material properties, standard trend or characteristic curves (graphs) etc are compiled and presented at one place in this section.

## 1.2. WHO IS TO USE AND HOW TO USE.

The hand book is so designed that it can be beneficially used by different sections of the technical education viz., the teacher, the student, the examiner and the administrator convenient to individual's requirements. A few uses of this hand book each stakeholder could make is outlined in the following sections.

## 1. Teacher

**A.** The **laboratory sheet** is designed keeping the teacher in mind for the teacher has key responsibility of imparting the skills to the student and hence the information given in the lab sheets may be useful for planning & organizing the experimental set up and designing an effective instruction. Thus the teacher may

**Plan and organize** as per *section 4*,

**Instruct** the students as per *section 2*,

**Demonstrate** each sub task as per *section 1.B* and

**Evaluate** the students as per *section 5*, according to the level of competency.

**Values:** The **values** in a person are an important personality trait that needs to be nurtured in the learning environment. Further it is also a driving component in any individual to deliver the best and hence this component is also included in the evaluation. However only five key dimensions, that are important in the teaching-learning environment, are taken into consideration for nurturing and evaluation. A little information about these five dimensions is given below as a guideline for the teacher while assessing students.

**1. Co-operation:** It is the voluntary arrangement in which two or more students engage in a mutually beneficial exchange, instead of competition. Cooperation can happen where resources adequate for both students exist or are created by their interaction.

**2. Co-ordination:** It is the unification, integration, synchronization of the effect of group members so as provide unity of action in the pursuit of common goals. It is an integral element and required in each & every function and at each & every stage & therefore it cannot be separated.

**3. Communication;** Communication skill is the set of skills that enables a student to convey information so that it is received and understood.

**4. Sharing:** A part or portion belonging to, distributed to, contributed by, owed by a person or a group **Or** To participate in, use, enjoy or experience jointly or in turns.

**5. Leadership:** Students with the following leadership qualities are almost always the ones that rise above the crowd.

1. Trustworthiness: This refers to integrity.

2. Inspiration: Guides, leads and inspiring others to want to participate in the process of moving towards the vision.

3. Self awareness: It is the individual awareness of him or her self – their abilities and the impact that they have on others.

4. Acceptance of responsibility: True leaders are accepting responsibility for all that comes their way and taking ownership and responsibilities for getting things back on track. Blaming, justifying and excuse making just is not in their responsibility.

**B.** The **Experimental methodology** is designed for both teacher and student. The teacher can refer the experimental methodology for the details of equipment/apparatus/ materials/tools, procedure to be followed, observations to be made, graphs to be drawn and calculations to be done for the task to be performed

## 2. Student

The Worksheet is designed keeping in view the needs, deficiencies and the adolescent characteristics of the student for student.

The students submit the filled in work sheet given by the teacher on the day of experiment after referring to experimental methodology and listening to instructions of teacher. The design of the worksheet is made user friendly and the contents are so logically sequenced that the student finds it easy to understand and develop the skill of recording and report writing skill. It also helps the student to actively participate in skill learning. More importantly the student gets immediate meaningful feedback of his performance since the competency wise assessment is done and that too on the same day.

## 3. Examiner

The examiner may find this hand book very useful as Laboratory sheets and Scheme of evaluation provides information with regard to various competencies (skills) the students is expected to acquire during the course of study and the relative weightages of each competency. This information helps him to design a well balance question paper/measurement tool for assessment.

# ***LABORATORY SHEETS***

## WATER ABSORPTION OF BRICKS

### OBJECTIVE

To perform a test on given sample of bricks to find its water absorption capacity.

### EQUIPMENT/APPARATUS/RESOURCES

1. Ten numbers of burnt clay building brick samples
2. Balance
3. A ventilated oven to heat up to a minimum of 120°C
4. Drying room with a temperature of 20 to 30°C
5. Water.

### 1. TASK ANALYSIS

#### A.KNOWLEDGE

- Raw materials used in the manufacture of bricks.
- Size of brick, Types, Water absorption.
- Porosity.
- Use of balance.
- Use of electric oven.
- Disadvantages of higher % of water absorption by brick.
- Standards of water absorption for different classes as per BIS.

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"><li>• Using of balance to weigh bricks and recording its weight.</li><li>• Placing the specimen/ bricks in an oven at const. temperature.</li></ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"><li>• Giving identification marks to bricks.</li><li>• Immersing the bricks at a given temperature.</li><li>• Wiping out water traces.</li><li>• Placing the whole arrangement in a warm ( for example, 20 to 30°C ) well ventilated room</li></ul>
3. Precise operation /activity	<ul style="list-style-type: none"><li>• Heating the specimen/ bricks in an oven at constant temperature.</li><li>• Calculating % of water absorption.</li></ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Importance of water absorption of burnt clay building brick samples	5
2.	Causes of higher % of water absorption by bricks.	
3.	Standard % of water absorption of bricks as per BIS.	
4.	Ill effects of higher absorption of water of bricks	4
5.	Methods of finding out water absorption of bricks.	
6.	Methods to reduce the water absorption of bricks.	
7.	Reasons for variation in water absorption of various types of bricks	6
9.	Effects of pressing of bricks before burning on the strength and absorption	
10.	Precautions	
	<b>A. Procedural precautions</b> <ul style="list-style-type: none"> <li>• Care should be taken in controlling the temperature when the specimen is kept in oven.</li> <li>• Bricks should be weighed very carefully and accurately.</li> <li>• Proper care should be taken in recording the reading and calculating the average % of water absorption.</li> </ul>	
	<b>B. Safety precautions</b> <ul style="list-style-type: none"> <li>• Care should be taken while keeping the bricks in the oven.</li> </ul>	
	Total	15

### 3. NEED AND SCOPE OF THE EXPERIMENT

#### WATER ABSORPTION

Bricks constitute an important class of building material. Different types of bricks are available for different construction works.

Water absorption of bricks is an important quality parameter. It is often taken as a measure of porosity.

Water absorption is an indicative of

- Possible leakage through the bricks.
- Tendency towards disintegration when the moist bricks are subjected to alternate freezing and thawing.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Operation of the balance.</li><li>2. Working condition of electric oven.</li><li>3. Availability of sufficient quantity of water of potable quality.</li></ol>
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)						
1. Handling of apparatus	A. Using of balance to weigh bricks and recording its weight. B. Placing the specimen/ bricks in an oven at const. temperature.	<table border="1" data-bbox="1002 488 1297 622"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>10</td> </tr> </table>	A	B	Tot	5	5	10	
A	B	Tot							
5	5	10							
2. Manipulation of apparatus	A. Giving identification marks to bricks. B. Immersing the bricks at a given temperature and Wiping out water traces.	<table border="1" data-bbox="1002 913 1241 1048"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>10</td> <td>5</td> <td>15</td> </tr> </table>	A	B	Tot	10	5	15	
A	B	Tot							
10	5	15							
3. Precise Operation/Activity	A. Heating the specimen/ bricks in an oven at const. temperature. B. Calculating % of water absorption.	<table border="1" data-bbox="1002 1451 1241 1585"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>15</td> <td>20</td> </tr> </table>	A	B	Tot	5	15	20	
A	B	Tot							
5	15	20							
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" data-bbox="1102 1765 1281 1899"> <tr> <td></td> </tr> <tr> <td>5</td> </tr> </table>		5					
5									
Total		50							

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Prepare the brick for testing its water absorption and tabulate the initial weight of the bricks.
2. Tabulate observations made for the given bricks and calculate the average water absorption of bricks.

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. Why do you wipe the brick?
2. How much accuracy is necessary for weighing?
3. What is the maximum permissible % of water absorption of brick?
4. Why do you immerse the bricks in water?
5. What were your observations during immersion?
6. At what temperature the oven was set?
7. Is there any limit for temperature in the oven?

## **CRUSHING STRENGTH OF BRICKS**

### **OBJECTIVE**

To perform a test on given sample of bricks to find its crushing strength.

### **EQUIPMENT/APPARATUS/RESOURCES**

1. Compression testing machine,
2. Steel rule,
3. Stop watch,
4. Trowel,
5. Tub of clean water,
6. Five numbers of bricks,
7. Wet gunny bags.

### **1. TASK ANALYSIS**

#### **A. KNOWLEDGE**

- Types of bricks as per NBC, classification of bricks, load carrying capacity of bricks
- Compressive strength.
- Compression testing machine/ UTM.
- Mortar (Cement).

**B. SKILLS**

Category of Skill	Sub task
1. Handling of apparatus/ material	<ul style="list-style-type: none"> <li>• Switching on the CTM.</li> <li>• Placing of bricks in CTM.</li> <li>• Applying of load gradually at the rate of 14 N/mm<sup>2</sup>/min</li> <li>• Switching off the CTM.</li> </ul>
2. Manipulation of Apparatus	<ul style="list-style-type: none"> <li>• Taking adequate no of bricks randomly.</li> <li>• Cleaning the surface of bricks.</li> <li>• Immersing the bricks in clean water tub.</li> <li>• Wiping off the surface of bricks with cloth after taking from water tub.</li> <li>• Applying CM 1:1 on the rough surfaces and filling up the frog with prepared CM.</li> <li>• Storing of plastered bricks under jute bags for 24 hours and immersing in clean water for 3 days.</li> <li>• Wiping off surplus water after removing from clean water.</li> <li>• Operating compression Testing machine / UTM</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Preparing 1:1 cement mortar.</li> <li>• Applying the load gradually at the rate of 14 N/mm<sup>2</sup> per minute till failure occurs.</li> <li>• Recording the load at failure (crushing)</li> <li>• Tabulating the observations.</li> <li>• Calculating the average crushing strength.</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (Min.)
1.	Need for testing bricks for crushing strength.	5
2.	Standard compressive strength of bricks (Min and Max) as per code.	
3.	Comparison between the crushing strength of country bricks and stock bricks.	
4.	Measurement of surface area of bricks.	
5.	Method of applying plaster to surface of bricks.	
6.	Purpose of storing of bricks after plastering.	4
7.	Purpose of placing the bricks between ply wood sheets in the CTM	
8.	Operating the CTM/UTM	
9.	Importance of test	
10.	Calculating the crushing strength of bricks	6
11.	Precautions	
	<b>A. Procedural precautions</b> <ol style="list-style-type: none"> <li>1. Bricks should be randomly selected for testing.</li> <li>2. Surface area should be accurately measured.</li> <li>3. Plastering on surface and frog should be done carefully so that the load is uniformly applied on the entire surface.</li> <li>4. CTM should be handled carefully as per instructions.</li> </ol>	
	<b>B. Safety precautions</b> <ul style="list-style-type: none"> <li>• Care should be taken while keeping the bricks in between the plates of CTM/UTM.</li> <li>• Do not wear loose clothes.</li> </ul>	
Total		15

**3. NEED AND SCOPE OF THE EXPERIMENT**

1. Good bricks for structural purpose should conform to the following requirement under visual inspection:

They should be

- Of Compact, non- laminated structure.
- Reasonably uniform in shape.
- Free from cracks, clipped corner or edger, warpage, kiln marks, large balls of clay and particles of free lime, and not soft as a result of under burning.

2. The Compression test gives fairly accurate information about the crushing strength of bricks which is their most important quality.

**3. PLANNING AND ORGANIZATION**

Action	Activity
Check for	1. Accuracy of the balance. 2. Working condition of CTM/UTM. 3. Gradual application of load at the rate of 14 N/mm <sup>2</sup> /min. 4. Plastering on surface and frog. 5. Availability of sufficient quantity of water.
For design of Instruction	Read the teaching points carefully.

4. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually						Awarded (50)																		
1. Handling of apparatus	A. Switching on the CTM. B. Placing of bricks in CTM. C. Applying of load gradually at the rate of 14 N/mm <sup>2</sup> /min D. Switching off the CTM.																									
		A	B	C	D	Tot																				
		1	3	5	1	10																				
2. Manipulation of apparatus	A. Taking adequate no of bricks randomly. B. Cleaning the surface of bricks. C. Immersing the bricks in clean water tub. D. Wiping off the surface of bricks with cloth after taking from water tub. E. Applying CM 1:1 on the rough surfaces and filling up the frog with prepared CM. F. Storing of plastered bricks under jute bags for 24 hours and immersing in clean water for 3 days. G. Wiping off surplus water after removing from clean water. H. Operating compression Testing machine / UTM	<table border="1" data-bbox="1066 663 1342 734"> <tr><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>3</td><td>3</td></tr> </table> <table border="1" data-bbox="1038 853 1219 925"> <tr><td>G</td><td>H</td><td>Tot</td></tr> <tr><td>1</td><td>4</td><td>15</td></tr> </table>						A	B	C	D	E	F	1	1	1	1	3	3	G	H	Tot	1	4	15	
A	B	C	D	E	F																					
1	1	1	1	3	3																					
G	H	Tot																								
1	4	15																								
3. Precise Operation/Activity	A. Preparing 1:1 cement mortar. B. Applying the load gradually at the rate of 14 N/mm <sup>2</sup> per minute till failure occurs. C. Recording the load at failure (crushing) D. Tabulating the observations. E. Calculating the average crushing strength.	A	B	C	D	E	T ot																			
		3	7	4	3	3	20																			
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" data-bbox="1145 1787 1249 1859"> <tr><td>5</td></tr> <tr><td> </td></tr> </table>						5																		
5																										
Total		50																								

**5. ASSESSMENT QUESTIONS** (Only suggestive)

1. Prepare the brick samples for determining the crushing strength.
2. Determine the crushing strength of the given prepared brick samples.

**6. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. Why are bricks tested for crushing strength?
2. What is frog of bricks?
3. Why do you wet the bricks before actual use?
4. Write the permissible minimum and maximum limits of crushing strengths of bricks.
5. What are the dimensions of nominal brick?
6. What is minimum strength of brick?
7. Why do we plaster the surface of the brick before testing?
8. What are the effects on strength if the brick is not pressed before burning?
9. What is the name of the machine used for testing the crushing strength of brick?

## FINENESS OF CEMENT

### OBJECTIVE

To perform a test on cement to find its fineness by dry sieving method.

### EQUIPMENT/APPARATUS/RESOURCES

1. I.S. Sieve No 9,
2. Tray,
3. Sensitive balance,
4. Bristle Brush.

### 1. TASK ANALYSIS

#### A. KNOWLEDGE

- Finesses of cement.
- Hydration
- Use of gypsum.
- Advantages and disadvantages of finesses of cement.
- Method of finding out finesses of cement.
- Weight of residue that should retain on sieve.
- Sieve required,
- Balance

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Selecting the required IS sieve No. 9.</li> </ul>
2.Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Weighing cement.</li> <li>• Sieving of cement.</li> <li>• Weighing of residue after sieving</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Calculating % of residue of cement left on the pan.</li> </ul>

## 2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Important of finesses of cement.	6
2.	Advantages of fine cement and its influence on the behavior of cement.	
3.	Disadvantages of fine cement.	
4.	Quantity of cement used in the test.	
5.	Sieve no used.	7
6.	Methods of finding out finesses of cement.	
7.	Test procedure of finding out fineness of cement.	
8.	Calculating the fineness of cement by dry sieving method.	
9.	Inference on the test result.	
10.	Effect of fineness of cement on the rate of hydration rate of gain of strength and the rate of evolution of heat.	
11.	Precautions	2
	<p><b>Procedural precautions</b></p> <p>1. Care should be taken in weighing the required quantity of cement which is free from air set lumps.</p> <p>2. Proper care should be taken while sieving the cement that there is no splitting of the cement and the cement shall be kept well spaced out on the sieve.</p> <p>3. The weight of the residue should not spill away from the sieve and should be taken after 15 min of sieving.</p>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and also on the rate of evolution of heat. Fine cement offers a great surface area for hydration. Thus the rate of hydration depends on the fineness of cement particles and for a rapid development of strength, more fineness is necessary.

An increase in fineness increase the amount of gypsum required to retard the quick setting of cement. The water content of a paste of standard consistency is greater for the fine cement. But conversely the increase in the fineness of cement is slightly improves workability of concrete mix. This fineness is a vital property of cement and has to be carefully controlled.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Accuracy of the balance.</li><li>2. Selecting correct IS sieve.</li><li>3. Weighing required quantity of cement free from lumps.</li><li>4. Sieving cement as per the procedure.</li><li>5. Collecting and weighing the residue carefully.</li></ol>
For design of instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)								
1. Handling of apparatus	<p>A. Weighing 100 g of cement to the nearest 0.01 g and place it the clean and dry 90 microns IS sieve (IS Sieve no: 9) with pan attached.</p> <p>B. Continuously sieving the sample by holding the sieve in the both hands for 15 minutes with gentle wrist motion.</p> <p>C. Slightly brush underside of the sieve after every 5 minutes of sieving.</p>	<table border="1" data-bbox="927 392 1326 526"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>Tot</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>10</td> <td>2</td> <td>15</td> </tr> </tbody> </table>	A	B	C	Tot	3	10	2	15	
A	B	C	Tot								
3	10	2	15								
2. Manipulation	<p>A. Breakdown any air set lumps in the cement sample with fingers.</p> <p>B. While sieving it, ensure that there is no spilling of the cement and cement shall be kept well spread out on the sieve.</p>	<table border="1" data-bbox="999 983 1241 1117"> <thead> <tr> <th>A</th> <th>B</th> <th>Tot</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>5</td> <td>10</td> </tr> </tbody> </table>	A	B	Tot	5	5	10			
A	B	Tot									
5	5	10									
3. Precision	<p>A. Recording the observations.</p> <p>B. Find the weight of residue on the sieve and calculate the value as a percentage of the original sample taken.</p>	<table border="1" data-bbox="1003 1339 1246 1473"> <thead> <tr> <th>A</th> <th>B</th> <th>Tot</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>10</td> <td>20</td> </tr> </tbody> </table>	A	B	Tot	10	10	20			
A	B	Tot									
10	10	20									
4. Values	<p>A. Co-operation</p> <p>B. Co-ordination</p> <p>C. Communication</p> <p>D. Sharing</p> <p>E. Leadership</p>	<table border="1" data-bbox="1031 1608 1209 1742"> <tbody> <tr> <td style="text-align: center;">5</td> </tr> </tbody> </table>	5								
5											
Total		50									

**6. Assessment questions** (Only suggestive)

1. Select the apparatus required for finding out the fineness of cement and weigh the required quantity of cement.
2. Find out the fineness of the given quantity of cement and write your inference.

**7. Viva Questions**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. Define "fineness" of cement.
2. State the importance of fineness of cement.
3. What is size of the sieve used for finding out the fineness of cement?
4. What is the permissible limit of fineness of cement?
5. What is the quantity of cement required for finding out the fineness of cement?
6. If fineness is more, what is its effect on property of cement?
7. Why is the sieve to be rotated and not shaken in a vertical motion?
8. Is finer cement stronger?
9. Does setting and hardening refer to the same property of cement?

## NORMAL CONSISTENCY OF CEMENT

### OBJECTIVE

To conduct a test on cement to find its normal consistency.

### EQUIPMENT/APPARATUS/RESOURCES

1. Vicats apparatus with plunger,
2. A Balance,
3. Tray,
4. Measuring jar,
5. Gauging trowels.

### 1. TASK ANALYSIS

#### A.KNOWLEDGE

- Definition, importance of normal consistency.
- Normal consistency of cement.
- Vicat apparatus with plunger.
- Gauging time.
- Properties of cement.
- Balance

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Weighing of cement.</li> <li>• Transferring of cement into non-absorbent tray.</li> <li>• Using of stop watch.</li> <li>• Measuring the required % of water.</li> <li>• Reading of Vicat’s scale/noting down the plunger penetration and recording.</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Mixing cement with water and transferring the paste into mould within gauge time.</li> <li>• Releasing of Vicat’s plunger to penetrate into the paste.</li> <li>• Reading of Vicat’s scale/noting down the plunger penetration and recording.</li> </ul>
3.Precise operation /activity	<ul style="list-style-type: none"> <li>• Reading of Vicat’s scale/noting down the plunger penetration and recording.</li> <li>• Repeating the process varying % of water and noting the penetration of plunger from the bottom of the mould till the penetration value is between 5-7 mm.</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	<ul style="list-style-type: none"> <li>Need for normal consistency.</li> </ul>	4
2.	<ul style="list-style-type: none"> <li>Use of normal consistency of cement for conducting the other experiments.</li> </ul>	
3.	<ul style="list-style-type: none"> <li>Description of Vicat's apparatus.</li> </ul>	
4.	<ul style="list-style-type: none"> <li>Making the cement paste for the given % of water.</li> </ul>	5
5.	<ul style="list-style-type: none"> <li>Handling the apparatus and filling the cement paste into the mould.</li> </ul>	
6.	<ul style="list-style-type: none"> <li>Importance of gauge time.</li> </ul>	
7.	<ul style="list-style-type: none"> <li>Demonstration of Vicat's scale correction/worn-out scale/incorrect graduation.</li> </ul>	
8.	<ul style="list-style-type: none"> <li>Reason for lower/higher values of normal consistency.</li> </ul>	6
9.	<ul style="list-style-type: none"> <li>Use of cement with less/high value of normal consistency.</li> </ul>	
10.	<ul style="list-style-type: none"> <li>Necessity for repeating the test.</li> </ul>	
11.	Precautions	
	<p><b>B. Procedural precautions</b></p> <ul style="list-style-type: none"> <li>Care should be taken in measuring the cement and water.</li> <li>Gauging time should be observed carefully.</li> <li>Thorough mixing should be done.</li> <li>Careful filling of cement paste into the mould is necessary and should be flushed with top of mould.</li> <li>Gentle release of plunger is to be taken care.</li> <li>Plunger penetration is to be noted not from the top of the mould but from the bottom.</li> </ul>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

1. The relationship between water to be added and cement in mortar and concrete is known as water/cement ratio and this ratio controls the strength of the mix.
2. The consistency test helps us to find the quantity of water to be added to produce a cement paste of standard fluidity.
3. The IS code 4031-1968 specifies the requirements for standard consistency which in turn used for finding the consistency of cement paste for other tests.

### 4. PLANNING AND ORGANIZATION

Action	ACTIVITY
Check for	<ol style="list-style-type: none"><li>1. Accuracy of the balance.</li><li>2. Working condition of Vicat's apparatus.</li><li>3. Availability of cement and Ennore sand.</li></ol>
For design of instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually				Awarded (50)		
1. Handling of apparatus	A. Taking 300gm of cement sample and place it on a non-absorbent plate. B. Taking 25% of water by weight of cement as first trial and mix it thoroughly with cement using gauging trowels. Ensure that the time of gauging shall be within 3 to 5 minutes. The time of gauging shall be reckoned from the instant water is added to cement to that the paste is filled in the mould. C. Keeping the mould on a non absorbent plate. Applying a thin coat of oil inside the mould.							
		A	B	C	Tot			
		5	8	2	15			
2. Manipulation of apparatus	A. Filling the Vicat's mould with cement paste at a stretch and tamp the mould so as to make the cement spread uniformly in the mould. B. Fixing the plunger of 10mm dia X 50 mm long to the plunger holder of the apparatus. Gently lowering the plunger to touch the mould's top surface and leave it quickly.							
		A	B	Tot				
		10	10	20				
3. Precise Operation/Activity	A. Reading the Vicat's scale. B. Repeating the above process with varying % of water and noting down the penetration of plunger till the penetration value is 5 to 7 mm.	A	B	Tot				
		4	6	10				
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">5</td></tr> </table>					5	
5								

**6. Assessment questions** (Only suggestive)

1. Prepare the cement paste required for finding out the normal consistency of cement.
2. Tabulate observations made for the given cement and determine the normal consistency of cement.

**7. Viva Questions**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What do you mean by standard consistency of cement?
2. What is the importance of the normal consistency test?
3. Name the type of needle used for finding out normal consistency of cement.
4. What is the permissible penetration value of plunger from the bottom of the mould?
5. What is the gauge time?
6. What is the importance of gauge time?
7. What precautions do you observe in performing the test?

## INITIAL AND FINAL SETTING TIMES OF CEMENT

### OBJECTIVE

To conduct a test on cement to find its initial and final setting times.

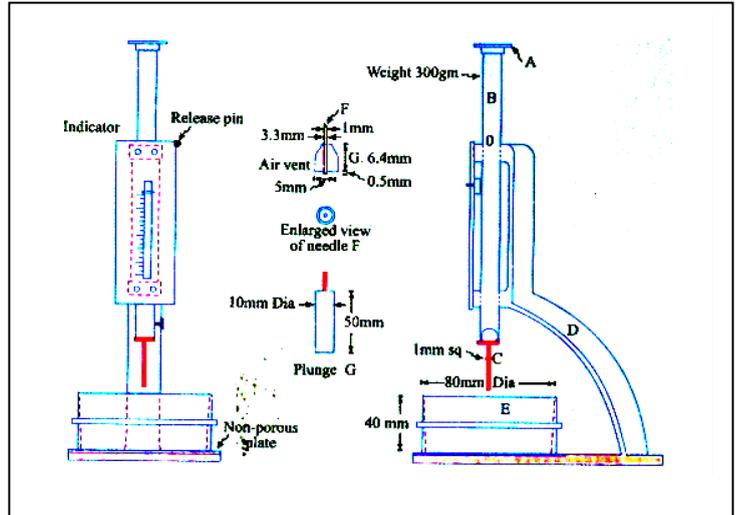
### EQUIPMENT/APPARATUS/RESOURCES

1. Vicat apparatus,
2. Gauge trowel,
3. Measuring jar,
4. Balance,
5. Stop watch,
6. Mixing trays,
7. Glass plate, and
8. Sample of cement.

### 1. TASK ANALYSIS

### B. KNOWLEDGE

- Normal consistency
- Initial and final setting times of cement.
- Vicat apparatus with needle.
- Gauging time.
- Properties of cement.
- Balance



**B.SKILLS**

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"><li>• Weighing of cement.</li><li>• Transferring cement into non-absorbent tray.</li><li>• Using of stop watch.</li><li>• Measuring the required % of water.</li></ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"><li>• Mixing cement with water and transferring the paste into mould within gauge time.</li><li>• Releasing of Vicat's needle to penetrate into the paste</li></ul>
3. Precise operation /activity	<ul style="list-style-type: none"><li>• Reading of Vicat's scale/noting down the needle penetration and recording.</li><li>• Repeating the procedure until the needle, when brought in contact with the cement block and released, fails to pierce the block between 5-7 mm measured from the bottom of the mould.</li></ul>

## 2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1	<ul style="list-style-type: none"> <li>Need for finding out the setting times of cement.</li> </ul>	6
2	<ul style="list-style-type: none"> <li>Use of normal consistency of cement for finding out the setting times of cement</li> </ul>	
3	<ul style="list-style-type: none"> <li>Description of Vicat's apparatus.</li> </ul>	
4	<ul style="list-style-type: none"> <li>Making the cement paste for the given % of water.</li> </ul>	
5	<ul style="list-style-type: none"> <li>Handling the apparatus and filling the cement paste into the mould.</li> </ul>	7
6	<ul style="list-style-type: none"> <li>Importance of gauge time.</li> </ul>	
7	<ul style="list-style-type: none"> <li>Demonstration of Vicat's scale correction/worn-out scale/incorrect graduation.</li> </ul>	
8	<ul style="list-style-type: none"> <li>Reason for lower/higher values of setting times of cement.</li> </ul>	
9	<ul style="list-style-type: none"> <li>Use of cement with less/high value of setting times.</li> </ul>	
	Precautions	2
	<p><b>C. Procedural precautions</b></p> <p>A. The test is to be conducted at a temperature of <math>27 \pm 2^{\circ}</math> C and at a relative humidity of 90%.</p> <p>B. Care should be taken in measuring the cement and water.</p> <p>C. After adding water, thoroughly mix the cement paste for at least one minute with fingers and press it into mould mounted on a nonporous plate.</p> <p>D. Release the plunger without pressure or jerks after it is brought down to touch the surface of the test block</p> <p>E. Needle penetration is to be noted not from the top of the mould but from the bottom.</p>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

Setting indicates the setting of cement paste. It refers to a change from a fluid state to a rigid state. Although during setting, the paste acquires some strength, for practical purposes it is convenient to distinguish from hardening which refers to the gain of strength of a set cement due to strength.

For cement paste, mortar or concrete certain time is required for mixing, transporting, placing, compacting and finishing. During this time cement paste, mortar or concrete should be in plastic condition. The time interval for which the cement products remain in plastic condition is known as initial setting time.

In practice the terms initial set and final set are desirable arbitrarily chosen stages of setting and has got no relations with the setting or hardening of actual concrete. This test is used to detect the deterioration of cement due to storage.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Accuracy of the balance.</li><li>2. Working of Vicat's apparatus.</li><li>3. Selecting correct Vicat's needle.</li><li>4. Weighing required quantity of cement free from lumps.</li></ol>
For design of instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)								
1. Handling of apparatus	A. Weighing of 300 g of cement and transferring cement into non-absorbent tray. B. Using of stop watch. C. Measuring the required % of water.	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>Tot</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>5</td> <td>5</td> <td>15</td> </tr> </tbody> </table>	A	B	C	Tot	5	5	5	15	
A	B	C	Tot								
5	5	5	15								
2. Manipulation of apparatus	A. Mixing cement with water and transferring the paste into mould within gauge time. B. Releasing of Vicat needle to penetrate into the paste	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>Tot</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>5</td> <td>15</td> </tr> </tbody> </table>	A	B	Tot	10	5	15			
A	B	Tot									
10	5	15									
3. Precision	A. Reading the Vicat's scale. B. Repeating the above process of penetration of needle and noting down, the penetration value is 5 to 7 mm.	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>Tot</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>10</td> <td>15</td> </tr> </tbody> </table>	A	B	Tot	5	10	15			
A	B	Tot									
5	10	15									
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1"> <tbody> <tr> <td style="text-align: center;">5</td> </tr> </tbody> </table>	5								
5											
Total		50									

**6. Assessment questions** (Only suggestive)

1. State the need for the setting time test on cement and describe the standard procedure.
2. Conduct the setting time test for the given sample of cement and give the inference.

**7. Viva Questions**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What are the initial and final setting times for ordinary Portland cement as per the B.I.S code?
2. What is meant by hydration?
3. Is it necessary that the concrete be laid inside formwork before initial setting time?
4. What is the size of the needle C given in the code?
5. What is the reason for taking the consistency of sample paste as 0.85 standard consistency?
6. What is the specified standard value for room temperature for testing laboratories?
7. What is the reading to be got on the index scale as per the B.I.S specifications?
8. Is it necessary that the needle be allowed to penetrate the sample paste at the same position?
9. Which constituent of cement controls the setting of cement?
10. What causes the decrease in the actual penetration of the Vicat needle as time elapses?
11. In the initial setting time test, what should be done if the reading on the index scale shows 6 mm?
12. If the setting time of the given sample of cement is less than the standard time specified by the code, what does it signify?

## COMPRESSIVE STRENGTH OF CEMENT

### OBJECTIVE

To conduct a test on cement to find its compressive strength.

### EQUIPMENT/APPARATUS/RESOURCES

1. Compression Testing Machine.
2. Cube moulds of size 70.6 mm.
3. Balance
4. Measuring jars.
5. Gauging towels.
6. Tray for mixing.
7. Clean water container for curing.
8. Oil.
9. Standard cement mortar vibrator

### 1. TASK ANALYSIS

#### A.KNOWLEDGE

- Grade of cement.
- Compressive strength of cement.
- Ennore sand and zones of sand.
- Characteristic compressive strength of cement.
- Size of cube moulds used.
- Cement mortar vibrating machine.
- Compression testing machine.
- Sensitive balance.

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Using of stop watch.</li> <li>• Operating the vibrating machine for uniform compaction</li> <li>• Operating the compression testing machine</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Transferring the cement into non-absorbent tray.</li> <li>• Mixing cement with water and transferring the paste into mould within gauge time.</li> <li>• Filling of mixed cement mortar into standard mould.</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Weighing of cement.</li> <li>• Mixing of 3 grades of Ennore sand.</li> <li>• Measuring of water (P/4 +3.5) % of combined weight of cement and sand.</li> <li>• Reading the compressive strength of cubes and recording.</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	<ul style="list-style-type: none"> <li>Significance of the test „Compressive strength of cement’.</li> </ul>	4
2.	<ul style="list-style-type: none"> <li>Percentage of water required for preparing 1:3 cement mortar.</li> </ul>	
3.	<ul style="list-style-type: none"> <li>Size of the mould used</li> </ul>	
4.	<ul style="list-style-type: none"> <li>Permissible minimum number of specimens to be made for each age of testing.</li> </ul>	5
6.	<ul style="list-style-type: none"> <li>Importance of gauge time.</li> </ul>	
7.	<ul style="list-style-type: none"> <li>Demonstration of compression testing machine.</li> </ul>	6
8.	<ul style="list-style-type: none"> <li>Particles sizes of Zone I, II, &amp; III as per IS 650.</li> </ul>	
10.	<ul style="list-style-type: none"> <li>Reasons for using Ennore Sand only for the test</li> </ul>	
11	<ul style="list-style-type: none"> <li>Use of vibrating machine for uniform compaction.</li> </ul>	
	<ul style="list-style-type: none"> <li>Precautions</li> </ul>	
	<p><b>D. Procedural precautions</b></p> <ul style="list-style-type: none"> <li>Care should be taken in measuring the cement and water.</li> <li>Gauging time should be observed carefully.</li> <li>Thorough mixing should be done.</li> <li>Careful filling of cement paste into the mould is necessary and should be flushed with top of mould.</li> <li>Care should be taken in calculating the quantity of water to be added to the cement in preparing CM 1:3.</li> <li>Curing of test specimen should be done as per procedure.</li> <li>Moulds should be oiled in order to easily demould the specimen.</li> <li>Proper compaction of mortar should be done with standard tamping rod/table vibrator.</li> </ul>	
	<p><b>Safety precautions</b></p> <ul style="list-style-type: none"> <li>Care should be taken while keeping the bricks in between the plates of CTM/UTM.</li> <li>Do not wear loose clothes.</li> </ul>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

Compressive strength of the cement is necessary to know the grades of cement available for OPC. Normally 33 and 43 grades of cements are used for general buildings where as 53 grade cement is used for structures requiring high strength concrete.

Factors that influence the compressive strength of cement include the W/C ratio, cement/sand ratio, types and grading of sand, manner of mixing and demoulding specimen, curing conditions, loading conditions and age.

### 4. PLANNING AND ORGANIZATION

Action	Action
Check for	<ol style="list-style-type: none"><li>1. Accuracy of the balance.</li><li>2. Working condition of compression testing machine .</li><li>3. Availability of cement and Ennore sand.</li><li>4. Working condition of cubes.</li><li>5. Availability of oil for moulds.</li></ol>
For design of instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually					Awarded (50)	
1. Handling of apparatus	A. Weighing 100 g of cement and 555 g (185 g each of grade-1, grade- 2 , grade - 3) of standard sand and place them on a non-absorbent plate. B. Operating the vibrating machine for uniform compaction C. Operating the compression testing machine							
		A	B	C	Tot			
		4	3	3	10			
2. Manipulation of apparatus	A. Mixing cement with water and transferring the paste into mould within gauge time. Filling of mixed cement mortar into standard mould B. Demoulding the cubes. C. Curing of cubes							
		A	B	C	Tot			
		10	3	2	15			
3. Precision	A. Measuring quantity of water B. Applying load steadily and uniformly at the rate of 35 N/ mm <sup>2</sup> per minute till the cube fails. C. Recording the observations. D. Calculating average compressive strength of the mortar cubes separately for 3, 7 and 28 days curing							
		A	B	C	D	Tot		
		3	6	4	7	20		
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 50px;">5</td></tr> </table>					5	
5								
<b>Total</b>		50						

**6. Assessment questions**(Only suggestive)

1. Prepare the 1:3 cement mortar required for preparing cubes. (Lower order).
2. Prepare the cubes with the given cement mortar.
3. Determine the average compressive strength of cement, given the cement cubes.

**7. Viva Questions**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. Significance of the test „Compressive strength of cement‘.
2. What is the importance of gauge time?
3. What do you mean by grade of cement?
4. What percentage of water required for preparing 1:3 cement mortar.
5. What is the size of the mould used?
6. Why do you use Ennore sand in determining the Compressive strength of cement?
7. How many grades of sands are used in preparing cement mortar cubes?
8. How do you compact the cement mortar?
9. What precautions do you observe in performing the test?

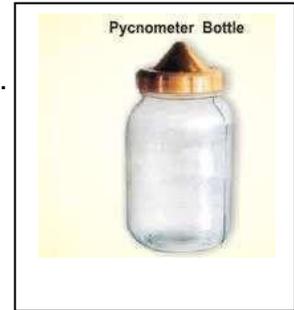
## WATER ABSORPTION OF SAND

### OBJECTIVE

To perform a test on sand to determine its water absorption.

### EQUIPMENT/APPARATUS/RESOURCES

1. A balance not less than 3kgs capacity as to permit the pycnometer containing the sample to be suspended and weighed in water.
2. A well ventilated oven to maintain a temperature of 100oC to 110oC.
3. A pycnometer of one kg cap filled with conical cap with rubber washer.
4. Two dry soft absorbent cloth pieces.
5. A shallow tray.
6. Filter paper and funnel.



### 1. TASK ANALYSIS

#### A. KNOWLEDGE

- Meaning of amount of water absorbed by sand in different weather conditions.
- Sampling of sand, type of sand i.e. fine sand, medium sand, coarse sand.
- Sand condition in particular weather.
- Operation of Electric oven, adjustments of temperature in electric oven.
- Calculations in terms of percentage.
- Importance of water absorption of building material.

**B. SKILLS**

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Taking appropriate quantity of fine aggregate (sand) and clean it thoroughly by washing it thorough 75<math>\mu</math> sieve till the fine dust is fully removed.</li> <li>• Finding weight of sand in pyconometer and pouring distilled water till sand in inundated. Cleaning the pyconometer on its outside surface and finding its weight after 24 hours saturation and let the weight be „A'.</li> <li>• Emptying the pyconometer and filling it with distilled water only. Taking its weight „B'.</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Cleaning the aggregate with soft clothes until the aggregate become saturated surface dry and let its weight be „C'.</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Keeping the aggregate in oven for drying at a temperature of 110oc for period of 24 hours.</li> <li>• Removing the aggregate from the oven, cooling to room temperature in the air tight desiccators and let the weight be „D'</li> <li>• Repeating the entire procedure for second sample also.</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Need for testing of sand in view of water absorption.	5
2.	Differentiating water absorption and moisture content.	
3.	Sampling methods.	
4.	Need for water absorption in field condition.	
5.	Operation of electric oven in standard manner.	4
6.	Limits of water absorption level.	
7.	Vacuum desiccators operation.	
8.	Precautions	
	<b>Procedural precautions</b> <ul style="list-style-type: none"> <li>• No particle should be lost while filling and emptying the jar.</li> <li>• Mixing of water into sand should be uniform.</li> </ul>	
	<b>B. Safety precautions</b> <ul style="list-style-type: none"> <li>• Care should be taken while keeping the sand in the oven.</li> </ul>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

The strength of concrete and mortar depends mainly on the water content and hence when the sand is mixed with cement the water in sand must be known. The difference in the weight of air- dried sand and oven dried sand gives the weight of the absorbed water. This weight of water expressed as a percentage of the oven dried sample is known as the percentage water absorption of sand.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Working condition of electric oven.</li><li>2. Availability of sufficient quantity of sand and water.</li><li>3. Availability of pycnometer</li></ol>
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)												
1. Handling of apparatus	A. Cleaning and washing the sand B. Filling the pycnometer with sand and water C. Keeping the aggregate in oven and dry it at a temperature of 100 to 110 degrees C for a period of 24 hours.	<table border="1" data-bbox="1062 602 1394 736"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>Tot</td> </tr> <tr> <td>4</td> <td>3</td> <td>3</td> <td>10</td> </tr> </table>	A	B	C	Tot	4	3	3	10					
A	B	C	Tot												
4	3	3	10												
2. Manipulation of apparatus	A. Emptying the pycnometer and filling it with distilled water only. B. Cleaning the pycnometer on its outside surface and find its weight after 24 hours saturation C. Cleaning the wet aggregate with soft clothes until the aggregate becomes saturated surface dry. D. Removing the sand from the oven and cool to room temperature in the air-tight desiccators	<table border="1" data-bbox="1062 994 1394 1169"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>D</td> <td>Tot</td> </tr> <tr> <td>3</td> <td>4</td> <td>4</td> <td>4</td> <td>15</td> </tr> </table>	A	B	C	D	Tot	3	4	4	4	15			
A	B	C	D	Tot											
3	4	4	4	15											
3. Precise Operation/Activity	A. Finding the weight of pycnometer, sand and distilled water „A'. B. Finding the weight of pycnometer and distilled water „B'. C. Finding the weight of surface dry sand „C'. D. Finding the weight of oven dried and cooled sand „D'. E. Calculating percentage of water absorption of sand using $(C-D)/DX100$	<table border="1" data-bbox="1062 1408 1394 1659"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>D</td> <td>E</td> <td>T O t</td> </tr> <tr> <td>4</td> <td>4</td> <td>4</td> <td>4</td> <td>4</td> <td>20</td> </tr> </table>	A	B	C	D	E	T O t	4	4	4	4	4	20	
A	B	C	D	E	T O t										
4	4	4	4	4	20										
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" data-bbox="1163 1765 1342 1899"> <tr> <td>5</td> </tr> </table>	5												
5															
Total		50													

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Determine the percentage water absorption of the given sample of sand.

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is water absorption in the sample of sand?
2. What is the use of water absorption of sand in fields?
3. Why do you keep the sample under water for 24 hours?
4. Is the water completely removed from the surface of sand before finding out weight of the saturated (surface-dry) sample in air ( )C?
5. Why do you require an accuracy of 0.001 g in weighing?
6. How will you use the result of this test in the design of concrete mix?

## **BULKING OF SAND**

### **OBJECTIVE**

To perform a test on fine aggregate to determine its bulking of by field method and laboratory methods.

### **EQUIPMENT/APPARATUS/RESOURCES**

1. Cylindrical container
2. Measuring jars,
3. Mixing tray,
4. Mixing trowel,
5. Oven,
6. Steel rule.

### **1. TASK ANALYSIS**

#### **A. KNOWLEDGE**

- Meaning of bulking of sand.
- Importance of bulking of sand.
- Measuring of initial volume (V1), final volume(V2) and measure volume of water.
- Percentage of water, conversion of % of water to volume of water.
- Experiment procedure.
- Effective mixing of sand and water.

**B. SKILLS**

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Placing of sand in cylindrical container.</li> <li>• Measuring water using graduated glass jar.</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Measuring Initial volume, Final volume of sand and volume of water.</li> <li>• Uniform mixing of water and sand.</li> <li>• Transferring the mixed sand from pan into measuring jar carefully.</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Converting percentage of water into volume of water.</li> <li>• Calculating accurately the % of bulking for every equal increment of water added.</li> <li>• Drawing ordinary Graph with % of water added on X-axis and % of bulking on Y-axis.</li> <li>• Recording maximum percentage of bulking of sand corresponding to the percentage of water added from the curve of the Graph, record.</li> <li>• Calculating the volume of sand required taking into consideration the bulkage.</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Meaning of bulking of sand.	5
2..	Importance of bulking of sand in the construction	
3.	Method of measuring of initial volume(v1), final volume(v2) and measure volume of water	
4.	Standard % of bulking of sand as per IS.	
5.	Effects of addition of excess/less quantity of water to the sand by weight.	4
6.	Range of bulking of Sand for different zones of sand/Types of sand	
7.	Need for oven drying of sand	
8.	Need for plotting readings on a graph	6
9.	Influence of size of sand on bulking of sand	
10.	Use of bulking of sand in the construction field	
11.	Precautions	
	<b>A. Procedural precautions</b> <ul style="list-style-type: none"> <li>• No particle should be lost while filling and emptying the jar.</li> <li>• Mixing of water into sand should be uniform.</li> </ul>	
	<b>B. Safety precautions</b> <ul style="list-style-type: none"> <li>• Care should be taken while keeping the sand in the oven.</li> </ul>	
Total		15

**3. NEED AND SCOPE OF THE EXPERIMENT**

**THEORY**

**Bulking of Sand** It is an apparent increase in volume of sand due to the presence of moisture. It is expressed as percentage of original dry volume. The extent of „bulking‘ depends on the amount of moisture and fineness of sand. It increases with increase of moisture content up to certain limit and beyond that further increase of moisture content results in the decrease in the volume. At saturation point, there is no sign of bulking. Due to this bulking phenomenon, the quantity of sand proportion would be always less than the actual requirement. Therefore the effect of bulking can be compensated by taking extra volume of sand equal to the extent of bulking. Fine sands exhibits more bulking to coarse sand for the same moisture content.

The tests on determination of bulking of sand involves in

- (a) determination of the % bulking present in the sand at any instant of time, which is known as field method of bulking test of sand,
- (b) determination of bulking characteristics of sand and maximum % of bulking the sand can exhibit, which is nothing but a laboratory test.

**4. PLANNING AND ORGANIZATION**

Action	Activity
Check for	<ol style="list-style-type: none"> <li>1. Working condition of electric oven.</li> <li>2. Availability of sufficient quantity of sand and water.</li> </ol>
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)										
1. Handling of apparatus	A. Placing the sand in an oven at const. temperature. B. Measuring of initial volume(V1), final volume(V2) and measure volume of water	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>4</td> <td>6</td> <td>10</td> </tr> </table>	A	B	Tot	4	6	10					
A	B	Tot											
4	6	10											
2. Manipulation of apparatus	A. Uniform mixing of water and sand. B. Transferring the mixed sand from pan into measuring jar carefully.	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>10</td> </tr> </table>	A	B	Tot	5	5	10					
A	B	Tot											
5	5	10											
3. Precise Operation/Activity	A. Converting percentage of water into volume of water. B. Calculating accurately the % of bulking for every equal increment of water added. C. Drawing ordinary Graph with %of water added on X-axis and % of bulking on Y-axis. D. Recording maximum percentage of bulking of sand corresponding to the percentage of water added from the curve of the Graph, record.	<table border="1"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>D</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>8</td> <td>7</td> <td>25</td> </tr> </table>	A	B	C	D	Tot	5	5	8	7	25	
A	B	C	D	Tot									
5	5	8	7	25									
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1"> <tr> <td style="text-align: center;">5</td> </tr> </table>	5										
5													
Total		50											

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Tabulate observations made for the bulking of given sand and calculate the bulking of sand.
2. Given the observations for various percentages of water, obtain the maximum bulking of sand from the graph.

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. In the field if you have only a cylindrical container, how will you assess the bulking of sand?
2. What is the importance of bulking of fine aggregate?
3. Why does bulking occur?
4. on what factors does bulking depend?
5. What were your observations during the addition of water to sand?
6. Where do you use the knowledge of bulking characteristics of sand?
7. Why should the readings be plotted on a graph?
8. Why do you say that the maximum volume is obtained at a particular moisture content?

## BULK DENSITY AND PERCENTAGE OF VOIDS IN COARSE AND FINE AGGREGATES

### OBJECTIVE

To perform tests to determine bulk density and percentage of voids in coarse and fine aggregates.

### EQUIPMENT/APPARATUS/RESOURCES

1. Balance
2. Tamping rod
3. Cylindrical metal measures

### 1. TASK ANALYSIS

#### A.KNOWLEDGE

- Bulk density
- Voids ratio.
- Fine and coarse aggregate functions in concrete.
- Function of cement.
- Tamping rods.
- Balance.
- Cylindrical metal measurement.
- Compaction of fine and coarse aggregate.

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"><li>• Using of balance and recording weight.</li><li>▪ Measuring the volumes of fine and coarse aggregate using cylindrical metal measure in loose and compacted states.</li><li>• Weighing of cylindrical metal measures.</li></ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"><li>• Weighing of cylindrical metal measures.</li><li>• Tamping the aggregate in 25 strokes with tamping rod.</li></ul>
3. Precise operation /activity	<ul style="list-style-type: none"><li>• Calculating of bulk density of coarse and fine aggregates both in loose and completed states.</li></ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Importance of bulk density	5
2.	Procedure of producing the dense concrete	
3.	Reasons for formation of voids in concrete	
4.	Adverse effect of voids in concrete	4
5.	Meaning of loose and compact state of aggregates	
6.	Need for finding out bulk density of aggregate for finding out the % of voids in the coarse and fine aggregate	
7.	Necessity of finding the void contents in a given mass of aggregate	6
9	Precautions	
	<p><b>Procedural precautions</b></p> <ul style="list-style-type: none"> <li>• Measure the dimension of cylindrical metal measures carefully and exactly.</li> <li>• Fill the metal measure with aggregate in three equal layers and tap the aggregate in 25 strokes each with the standard tamping rod carefully without letting out the aggregate from the container.</li> <li>• Weigh the containers carefully and exactly.</li> </ul>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

When the aggregate is measured by volumetric basis, it is necessary to know the conditions under which the aggregate is measured (loosely or compacted). This parameter is useful in determining the void ratio of aggregate.

Void ratio is very important parameter in proportioning the ingredients of concrete to produce dense concrete. The space between coarse aggregate is filled by fine aggregate is filled by cement. So it is necessary to determine the % of voids in aggregate to produce dense mix.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Operation of the balance.</li><li>2. Availability of cylindrical measures</li><li>3. Availability of sufficient quantity of fine and coarse aggregate</li></ol>
For design of Instruction	Read the teaching points carefully.

**5. SCHEME OF EVALUATION**

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)						
1. Handling of apparatus	A. Using of balance to weigh cylindrical measure and recording its weight. B. Filling the metal measure with aggregate in three equal layers	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>10</td> <td>15</td> </tr> </table>	A	B	Tot	5	10	15	
A	B	Tot							
5	10	15							
3. Manipulation of apparatus	A. Tamping the each layer of aggregate in 25 strokes with the standard tamping. B. Striking off the excess material with straightedge	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>15</td> <td>5</td> <td>20</td> </tr> </table>	A	B	Tot	15	5	20	
A	B	Tot							
15	5	20							
4. Precise Operation/Activity	A. Weighing the weight of the container with aggregate. B. Measuring the volume of the container by measuring the internal dimensions.	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>10</td> </tr> </table>	A	B	Tot	5	5	10	
A	B	Tot							
5	5	10							
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1"> <tr> <td></td> </tr> <tr> <td>5</td> </tr> </table>		5					
5									
Total		50							

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Determine the bulk density of the given fine aggregate and coarse aggregate.
2. Determine the percentage of voids in coarse and fine aggregates , for the given bulk densities..

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is bulk density?
2. What is the important of bulk density?
3. What are the factors affecting bulk density of aggregates ?
4. What is the necessity of finding the void contents in a given mass of aggregate?
5. Give the bulk density formula for compacted and loose fine aggregates.

## SIEVE ANALYSIS OF COARSE AND FINE AGGREGATES

### OBJECTIVE

To perform tests on coarse and fine aggregates by sieve analysis to determine the fineness modulus.

### EQUIPMENT/APPARATUS/RESOURCES

1. Balance.
2. Sieve shaker.
3. Set of standard sieves.
4. Shovel.
5. Sieve brush.

### 1. TASK ANALYSIS

#### A.KNOWLEDGE

- Definition of an aggregate.
- Difference between coarse and fine aggregate.
- Meaning of fineness modulus
- Need for the sieve analysis is to be carried out.
- List the series of sieves used for sieve analysis of coarse and fine aggregates.
- Formula for fineness modulus.
- Significance of grading.
- Duration of sieving.

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Using of balance to weigh coarse and fine aggregates and recording their weight.</li> <li>• Arranging the set of sieves used for sieve analysis of coarse aggregate.</li> <li>• Arranging the set of sieves used for sieve analysis of fine aggregate.</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Sieving of coarse and fine aggregate on a machine or sieve shaker</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Calculating the cumulative percentage weight retained for coarse and fine aggregate.</li> <li>• Calculating the fineness modulus of coarse and fine aggregates.</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	<ul style="list-style-type: none"> <li>Significance of fineness modulus of aggregate.</li> </ul>	5
2.	<ul style="list-style-type: none"> <li>Difference between coarse aggregate and fine aggregate.</li> </ul>	
3.	<ul style="list-style-type: none"> <li>Order of series of sieves used for both coarse and fine aggregates</li> </ul>	
4.	<ul style="list-style-type: none"> <li>Significance of grading</li> </ul>	4
5.	<ul style="list-style-type: none"> <li>Permissible limits of fineness modulus</li> </ul>	
6.	<ul style="list-style-type: none"> <li>Method of sieving and its duration.</li> </ul>	
7.	<ul style="list-style-type: none"> <li>Weighing of retained aggregate on sieves.</li> </ul>	6
8.	<ul style="list-style-type: none"> <li>Calculation of fineness modulus.</li> </ul>	
10.	Precautions	
	<p><b>A. Procedural precautions</b></p> <ul style="list-style-type: none"> <li>Each sieve shall be shaken for a period of at least 2 minutes, if hand shaken.</li> <li>Sieving should be in circular clock wise and anti-clock wise direction.</li> <li>If sieving is done in a shaker, at least 10 minutes sieving per test must be done.</li> <li>The sample to be sieved must be in air dry condition.</li> </ul>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

#### Fineness Modulus

The aggregate passing through 4.75mm sieve is called fine aggregate and retained on 4.75mm sieve is called coarse aggregate. It is necessary to find the fineness modulus for the given aggregate for the most economical mix design. The determination of fineness modulus consists in dividing the sample of aggregate into fractions of different sizes by sieving through a set of standard sieves.

The fineness modulus is a numerical index of fineness giving some idea of mean size of particles present in the aggregate. The fineness modulus can be regarded as a weighted average size of sieve on which material is retained and sieves being counted from the bottom. For example a fineness modulus of 5.0 can be interpreted to give an indication that fifth sieve counted from bottom i.e 2.36 as the average size.

Sieve analysis is also useful in deciding the grading zone of aggregate. Sieve analysis is a procedure for the determination of the particle size distribution of aggregate using a series of square or round opening starting with the largest. It is used to determine the grading of aggregates and the fineness modulus and index to the fineness and coarseness and uniformity of aggregates. It is after this analysis is carried out that aggregates are described as well graded, poorly graded, uniformly graded, gap graded etc. Each of the aggregate categories has close association with a range of quality of concrete produced using the aggregate.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"> <li>1. Operation of the balance.</li> <li>2. Availability of coarse and fine aggregates</li> <li>3. Availability of set of sieves for both coarse and fine aggregates sieving</li> </ol>
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)								
1. Handling of apparatus	A. Using of balance to weigh coarse and fine aggregates and recording their weight. B. Arranging the set of sieves used for sieve analysis of coarse aggregate. C. Arranging the set of sieves used for sieve analysis of fine aggregate.	<table border="1" data-bbox="1002 383 1321 517"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>5</td> <td>15</td> </tr> </table>	A	B	C	Tot	5	5	5	15	
A	B	C	Tot								
5	5	5	15								
2. Manipulation of apparatus	A. Sieving of coarse and fine aggregate on a machine or sieve shaker B. Sieving of coarse and fine aggregate in circular clock wise and anti-clock wise direction.	<table border="1" data-bbox="1002 869 1241 1003"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>10</td> <td>5</td> <td>15</td> </tr> </table>	A	B	Tot	10	5	15			
A	B	Tot									
10	5	15									
3. Precise Operation/Activity	A. Weighing the retained aggregate on sieves. B. Calculating the cumulative percentage weight retained for coarse and fine aggregate. C. Calculating the fineness modulus of coarse and fine aggregates.	<table border="1" data-bbox="1002 1267 1321 1402"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>5</td> <td>15</td> </tr> </table>	A	B	C	Tot	5	5	5	15	
A	B	C	Tot								
5	5	5	15								
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" data-bbox="1102 1641 1281 1776"> <tr> <td></td> </tr> <tr> <td>5</td> </tr> </table>		5							
5											
Total		50									

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Perform the gradation of given sample of Coarse aggregates.
2. Determine the particle size distribution of given sample of Coarse aggregates.

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is meant by gradation of aggregates?
2. What is the need for Sieve Analysis of coarse aggregates?
3. Why Sieve analysis test is performed for the given aggregates?
4. What are the different sizes sieves required for Sieve analysis of Coarse aggregates?
5. What are the precautions to be observed during the Sieve analysis of Coarse aggregates?
6. How is the Sieve Analysis test useful in preparation of Cement concrete?
7. How sieving is done when mechanical sieve shaker is not available?

## FIELD METHOD TO DETERMINE FINE SILT IN AGGREGATE

### OBJECTIVE

To perform a test on aggregate to determine fine silt (FIELD METHOD).

### EQUIPMENT/APPARATUS/RESOURCES

1. Graduated cylinder or any glass jar.
2. Dish for taking sample of sand.
3. Sample sand.
4. Funnel.
5. Clean water.

### 1. TASK ANALYSIS

#### A.KNOWLEDGE

- Origin of sand
- Types of sands and origin.
- Types of other materials finer than sand.
- Silt.
- Formula for silt content.
- Permissible limit of silt content which can be used for construction.

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"><li>• Measuring the sand by graduated cylinder/jar.</li></ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"><li>• Measuring the amount of fines forming a separate layer.</li><li>• Adding of correct quantity of water to sand.</li></ul>
3. Precise operation /activity	<ul style="list-style-type: none"><li>• Calculating the silt content.</li></ul>

**2. TEACHING POINTS**

S. No	Teaching points	Suggestive Duration (min.)
1.	Silt in aggregate and its properties	5
2.	Types of sands and sources.	
3.	Repercussions / Adverse effects of other material present in the sand on concrete or mortar.	
4.	Necessity of test on the silt content.	6
5.	Permissible limits of silt in aggregate	
6.	Method of finding out the silt content in aggregate.	
7.	Formula to find silt content.	4
8.	Precautions	
	<b>Procedural precautions</b> <ul style="list-style-type: none"> <li>• Care should be taken in measuring the sand correctly.</li> <li>• Cylinder/jar should not be disturbed after adding water and should be left for about an hour to allow split to settle the layer of the sand.</li> </ul>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

The sand is obtained from glacial, river, lake, marine, residual and wind-blown (very fine sand) deposits which do not provide pure sand and contain dust, loam and clay that are finer than sand. The presence of such material in sand used to make concrete or mortar decreases the bond between the materials to be bound together and hence the strength of the mixture.

The finer particles do not only decrease the strength but also the quality of the mixture produced resulting in fast deterioration, Therefore, it is necessary that one make a test on the silt content and checks against permissible limits.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Measuring cylinder/glass jar.</li><li>2. Availability of sufficient quantity of aggregate with fines.</li></ol>
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)								
1. Handling of apparatus	A. Using Measuring cylinder/glass jar B. Pouring the aggregate in the cylinder/glass jar.	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>10</td> </tr> </table>	A	B	Tot	5	5	10			
A	B	Tot									
5	5	10									
2.Manipulation of apparatus	A. Measuring aggregate using glass jar. B. Filling the glass jar with water. C. Shaking glass jar vigorously.	<table border="1"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>Tot</td> </tr> <tr> <td>10</td> <td>5</td> <td>5</td> <td>20</td> </tr> </table>	A	B	C	Tot	10	5	5	20	
A	B	C	Tot								
10	5	5	20								
3.Precise Operation/Activity	A. Allowing the silt to settle on the layer of the aggregate. B. Calculating % of silt content	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>10</td> <td>15</td> </tr> </table>	A	B	Tot	5	10	15			
A	B	Tot									
5	10	15									
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1"> <tr> <td></td> </tr> <tr> <td>5</td> </tr> </table>		5							
5											
Total		50									

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Using the field method, determine the fine silt in the given aggregate.
2. Given the observations made in determining the silt content in the aggregate, calculate the percentage of silt content.

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is the origin of sand?
2. What are the types of sands?
3. Are there any other materials available finer than sand?
4. What do you mean by silt?
5. What is the permissible limit of silt in aggregate to use in the construction?
6. What happens when the silt content in sand is more than permissible limit which is to be used to prepare concrete or mortar?

## **TENSION TEST ON MILD STEEL**

### **OBJECTIVE**

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

1. Yield stress
2. Ultimate stress
3. Nominal breaking stress
4. Percentage elongation
5. Percentage reduction in area
6. Young's Modulus.

### **EQUIPMENT/APPARATUS/RESOURCES**

1. Universal testing machine – Description of UTM
2. Vernier calipers/Micro meter
3. Scale
4. Dot punch
5. Hammer

### **1. TASK ANALYSIS**

#### **A.KNOWLEDGE**

- Procedure for measuring the diameter and length.
- Procedure for mounting the specimen in grips.
- Extensometer selection over gauge length.
- Description of UTM and its components.
- Meaning and concept of
  - Yield point
  - Ultimate load.
  - Breaking point.
  - % of elongation
  - % of reduction in area.
  - Young's modulus.
- Precaution to be taken.
- Description of least count of Vanier calipers.

**B.SKILLS**

Category of Skill	Sub Task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Mounting the specimen in the grips of movable and fixed heads of UTM.</li> <li>• Adjusting the load points to zero, after jaws hold the specimen firmly.</li> <li>• Keeping left valve in open position and right valve closed position.</li> <li>• Switch off the instrument.</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Measuring the diameter of the rod.</li> <li>• Making specimen of convenient length.</li> <li>• Applying the load slowly and gradually.</li> <li>• Removing the specimen from the grips.</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Marking the center point</li> <li>• Measuring the gauge length.</li> <li>• Keeping the left valve in closed position after completion of the experiment</li> <li>• Observing the load decreasing and neck formation.</li> <li>• Noting the yield point, ultimate load and breaking point.</li> <li>• Plot the stress and strain graph</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Need for importance of conducting tension test.	5
2.	Explain the meaning of yield points, ultimate load, breaking load, % of elongation, % of reduction in area.	
3.	Procedure for applying the load and operation of value.	
4.	Functions of components of UTM.	4
5.	Setting and reading of extensometer over gauge length.	
6.	Procedure for applying the load and operation of valve.	
7.	Drawing of graphs a. Stress vs strain. b. Load vs extension.	6
9.	Calculating yield load from the graph.	
10.	Precautions	
	<b>B. Procedural precautions</b> <ul style="list-style-type: none"> <li>Care should be taken in measuring the gauge length of the M.S.rod.</li> <li>Fix the specimen in between the two middle crossheads by operating the clamping devices very carefully and accurately.</li> <li>Proper care should be taken in applying the load at specified rate and recording the readings.</li> </ul>	
	<b>B. Safety precautions</b> <ul style="list-style-type: none"> <li>Care should be taken while keeping the specimen in between the two middle heads.</li> <li>Wearing loose clothes should be avoided</li> </ul>	
Total		15

**3. NEED AND SCOPE OF THE EXPERIMENT**

Mild steel and deformed/twisted bars (HYSD bars) are commonly used as reinforcement in concrete structures to withstand tensile stresses, as such it is essential to test their tensile strength properties. During tension test the material passes through elastic, elastic-plastic stage and plastic stage and finally leads to failure by fracture. We now investigate experimentally the behavior of M.S.rod under tension.

**4. PLANNING AND ORGANIZATION**

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Availability of mild steel rods and punch, steel rule.</li><li>2. Working condition of Universal Testing Machine.</li><li>3. Availability of graph sheets, pencil.</li></ol>
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)														
1. Handling of apparatus	<p>A. Mounting the specimen in the grips of movable and fixed heads of UTM.</p> <p>B. Adjusting the load points to zero, after jaws bold the specimen firmly.</p> <p>C. Keeping left valve in open position and right valve I closed position.</p>	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>Tot</th> </tr> </thead> <tbody> <tr> <td>4</td> <td>4</td> <td>2</td> <td>10</td> </tr> </tbody> </table>	A	B	C	Tot	4	4	2	10							
A	B	C	Tot														
4	4	2	10														
2. Manipulation of apparatus	<p>A. Measuring the diameter of the rod.</p> <p>B. Making specimen of convenient length.</p> <p>C. Applying the load slowly and gradually.</p> <p>D. Removing the specimen from the grips.</p>	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>To t</th> </tr> </thead> <tbody> <tr> <td>2</td> <td>2</td> <td>3</td> <td>3</td> <td>10</td> </tr> </tbody> </table>	A	B	C	D	To t	2	2	3	3	10					
A	B	C	D	To t													
2	2	3	3	10													
3. Precise Operation/Activity	<p>A. Marking the center point</p> <p>B. Measuring the gauge length.</p> <p>C. Keeping the left valve in closed position after completion of the experiment</p> <p>D. Identifying the load decreasing and neck formation.</p> <p>E. Noting the yield point, ultimate load and breaking point.</p> <p>F. Plot the graph stress Vs strain.</p>	<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>T O t</th> </tr> </thead> <tbody> <tr> <td>2</td> <td>4</td> <td>4</td> <td>5</td> <td>5</td> <td>5</td> <td>25</td> </tr> </tbody> </table>	A	B	C	D	E	F	T O t	2	4	4	5	5	5	25	
A	B	C	D	E	F	T O t											
2	4	4	5	5	5	25											
4. Values	<p>A. Co-operation</p> <p>B. Co-ordination</p> <p>C. Communication</p> <p>D. Sharing</p> <p>E. Leadership</p>	<table border="1"> <tbody> <tr> <td style="text-align: center;">5</td> </tr> </tbody> </table>	5														
5																	
Total		50															

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. (a) Mount the M.S.rod specimen in the U.T.M. for conducting a tension test.
2. (b) Draw stress strain curve for the given values obtained in tension test.
3. Tabulate observations made for the given M.S.rod and calculate the stress at yield point, ultimate tensile stress, breaking stress, % elongation and % reduction in area.

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is gauge length?
2. Why gauge length is considered in the calculation of percentage elongation?
3. Why should we find the diameter of the rod at three places?
4. What is the pressure medium for loading in the U.T.M?
5. What do you mean by elasticity?
6. If percentage of elongation is very small, what does that signify?
7. What will happen to the elongation, if the load is removed/released at the elastic limit stage?
8. How is it that the rod fails at a lower load and not at the ultimate load?
9. How do you identify yield point?
10. What are different grades of steel available?
11. The units of (i) strain is \_\_\_\_\_
  - i. (ii) Stress is \_\_\_\_\_
  - ii. (iii) Young's modulus is \_\_\_\_\_
12. What does the slope of stress-strain graph represent?

## HARDNESS TEST

### OBJECTIVE

To measure the hardness of different materials like (1) Hard steel (2) Mild steel (3) Aluminum (4) Cast iron (5) Brass etc., by conducting Rockwell or Brinnells hardness test.

### EQUIPMENT/APPARATUS/RESOURCES

1. Rockwell Hardness testing machine
2. Brinnells Hardness test
3. Specimen: Mild steel, Cast iron, Brass, Aluminum
4. Emery paper
5. Indenters: Ball indenter and Diamond indenter

### 1. TASK ANALYSIS

#### A.KNOWLEDGE

- Importance and meaning of measuring hardening
- Purpose of measuring hardness of metals
- Various methods employed.
- Advantages of Rockwell test over others.
- Meaning of minor load and why do we apply.
- Using of micro scope

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Keeping the specimen ready for testing</li> <li>• Setting of dial to zero</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Identifying Ball and diamond indenters</li> <li>• Identifying A, B, and C scale</li> <li>• Applying minor load</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Reading of hardness number using micro scope</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Importance and meaning of measuring hardening	5
2.	Purpose of measurement of hardness of metals	
3.	Various methods employed.	
4.	Advantages of Rockwell test over others.	4
5.	Meaning of minor load and why do we apply	
6.	Setting of dial to zero	
7.	Using of micro scope	6
9.	Procedure of reading of hardness number using micro scope	
10.	Precautions	
	<b>A.Procedural precautions</b> <ul style="list-style-type: none"> <li>• In every case the final movement of the hand wheel is to raise elevating screw, never to lower it.</li> <li>• Before starting a test, one or two preliminary tests shall be made whose readings shall be disregarded so as to eliminate the errors due to the sluggishness of the spring inside the machine.</li> <li>• As both diamond and ball indenters are liable for deformation, they should be checked from time to time.</li> </ul>	
	<b>B. Safety precautions</b> <ul style="list-style-type: none"> <li>• Care should be taken while indenting the specimen</li> </ul>	
Total		15

**3. NEED AND SCOPE OF THE EXPERIMENT**

It is most essential to determine the hardness of material for the Engineering Materials cutting tools. This experiments asses the hardness of the metal directly in terms of number as per hardness number.

We can know wear and tear resistance and life of utility.

Ball and diamond indenters and their scale are used to determine the hardness number.

**4. PLANNING AND ORGANIZATION**

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Availability of different specimen and emery paper</li><li>2. Working condition of hardness testing machines.</li><li>3. Availability of indenters</li></ol>
For design of Instruction	Read the teaching points carefully.

**5. SCHEME OF EVALUATION**

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)								
1. Handling of apparatus	A. Keeping the specimen ready for testing B. Setting of dial to zero	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>10</td> </tr> </table>	A	B	Tot	5	5	10			
A	B	Tot									
5	5	10									
2. Manipulation of apparatus	A. Identifying Ball and diamond indenters B. Identifying A, B, and C scale C. Applying minor load	<table border="1"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>10</td> <td>20</td> </tr> </table>	A	B	C	Tot	5	5	10	20	
A	B	C	Tot								
5	5	10	20								
3. Precise Operation/Activity	A. Reading of hardness number using micro scope	<table border="1"> <tr> <td>A</td> <td>Tot</td> </tr> <tr> <td>15</td> <td>15</td> </tr> </table>	A	Tot	15	15					
A	Tot										
15	15										
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1"> <tr> <td>5</td> </tr> </table>	5								
5											
Total		50									

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Measure the hardness of given Mild steel specimen by conducting Rockwell hardness test.
2. Measure the hardness of given brass specimen by conducting Rockwell hardness test.

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is the importance of hardness test?
2. What is the use of emery paper?
3. List five types of metals used to find out the hardness.
4. Name two types of indenters.
5. Why do we apply minor load?
6. Why do you set the dial gauge to zero?
7. What are the various hardness scales in use?
8. What are the uses of standard test blocks?
9. What are the different types of hardness tests in use?

## IMPACT TEST ON METALS

### OBJECTIVE

To perform a test on metals to determine the impact resistance of materials using “Izod Type” specimens in impact testing machine.

### EQUIPMENT/APPARATUS/RESOURCES

1. Impact testing machine -- Izod type.
2. Vernier Calipers
3. Scale
4. Standard test piece.

### 1. TASK ANALYSIS

#### A. KNOWLEDGE

- Describing of Izod impact test machine and their components.
- Standard dimension of test specimen.
- Specimen position.
- Height of the position of the pendulum.
- Notch face relative to the striking pendulum.
- Types of loads.
- Material properties.
- Procedure for setting the work piece.
- Precaution to observe while doing the test.
- Taking the readings.

#### B. SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Preparing the standard specimen and fixing the specimen in the position of anvil.</li> <li>• Clutching the striking hammer.</li> <li>• Adjusting the pointer.</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Fixing the specimen in the position of anvil.</li> <li>• Adjusting the pointer.</li> <li>• Releasing pendulum to strike the specimen by taking safety precaution</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Preparing the standard specimen</li> <li>• Recording down the reading by observing the appropriate scale.</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Importance of Impact test on metals	5
2.	Describing of Izod impact test machine and their components.	
3.	Standard dimension of test specimen.	6
4.	Specimen position.	
5.	Height of the position of the pendulum.	
6.	Notch face relative to the striking pendulum.	
7.	Types of loads.	
8.	Material properties.	
9.	Procedure for setting the work piece.	4
10.	Precautions	
	<b>A.Procedural precautions</b> <ul style="list-style-type: none"> <li>Care should be taken in preparing the standard specimen and fixing the specimen in the position of anvil.</li> </ul>	
	<b>B. Safety precautions</b> <ul style="list-style-type: none"> <li>Loose garments should not be used while conducting the experiment.</li> </ul>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

Many machine parts are commonly subjected to dynamic loads. The performance of the parts depends on the properties of the component materials under such applied loads. A load which falls from height on the member is known as impact load. Many parts of structures and machines are expected to take impact loading ex: Forging machines, machine bases, hooks of cranes, crane chains etc.

In doing an impact test, load may be applied in flexure, Torsion, compression or tension. Flexure loading is the most common one. The impact test is conducted on cantilever specimen or simply supported beam specimen. The first one is called Izod test and the latter a Charpy test. After impact, the energy absorbed by the material is known as impact value which represents the toughness of the material.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"><li>1. Working condition of Impact testing machine.</li><li>2. Availability of test specimen</li></ol>
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)								
1. Handling of apparatus	A. Preparing the standard specimen. B. Clutching the striking hammer. C. Adjusting the pointer	<table border="1"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>5</td> <td>5</td> <td>15</td> </tr> </table>	A	B	C	Tot	5	5	5	15	
A	B	C	Tot								
5	5	5	15								
2.Manipulation of apparatus	A. Fixing the specimen in the position of anvil. B. Adjusting the pointer. C. Releasing pendulum to strike the specimen by taking safety precaution	<table border="1"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>Tot</td> </tr> <tr> <td>6</td> <td>3</td> <td>6</td> <td>15</td> </tr> </table>	A	B	C	Tot	6	3	6	15	
A	B	C	Tot								
6	3	6	15								
3.Precise Operation/Activity	A. Measuring the dimensions of specimen using vernier B. Recording down the reading by observing the appropriate scale	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>7</td> <td>8</td> <td>15</td> </tr> </table>	A	B	Tot	7	8	15			
A	B	Tot									
7	8	15									
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1"> <tr> <td></td> </tr> <tr> <td>5</td> </tr> </table>		5							
5											
Total		50									

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Conduct the Izod test for the given brass and steel specimen in the impact testing machine and compare the values.

**7.VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the context of examination)

1. What is toughness?
2. What is the difference in deformation between ductile failure and brittle failure?
3. In a tension test of mild steel bar what is the type of failure?
4. What is the law of conservation of energy?
5. Does the velocity of the pendulum change after the specimen is broken by it?
6. Why is the Izod test known as the cantilever test and the Charpy test known as Beam test?
7. Why does cast iron have a very low impact value as compared to mild steel?
8. Why does mild steel break with a brittle fracture in the impact test although it behaves a ductile material in the tension test?
9. What is the name of the impact stress using cantilever specimen?
10. What types of specimen will be used in the Charpy test?
- 11.State the example where impact stress is developed material?

## DEFLECTION TEST

### OBJECTIVE

To perform a test on wooden beam to determine the Young's modulus and bending stress.

### EQUIPMENT/APPARATUS/RESOURCES

1. UTM with transverse testing attachment.
2. Dial-gauge of 0.01mm least count to measure vertical deflection.
3. A magnetic dial gauge stand to hold the gauge.

### 1. TASK ANALYSIS

#### A. KNOWLEDGE

- Structure of timber (C.S & L.S.).
- Types of timber.
- Uses of wood in the building construction.
- Characteristics of timber.
- Defects of timber.
- UTM operations.
- Deflection.
- Span of a beam.

#### B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	<ul style="list-style-type: none"> <li>• Operating UTM.</li> <li>• Fixing and reading of dial gauge</li> </ul>
2. Manipulation of apparatus	<ul style="list-style-type: none"> <li>• Placing of specimen over the brackets centrally.</li> <li>• Selection of load range for the test.</li> <li>• Adjusting the load gauge and deflectometer to zero.</li> </ul>
3. Precise operation /activity	<ul style="list-style-type: none"> <li>• Applying of load at the rate of 2.5 mm per minute.</li> <li>• Noting down the deflection for each increment of load.</li> <li>• Drawing of graph between load vs deflection.</li> <li>• Calculating of Young's modulus from the graph.</li> </ul>

## 2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Important of the deflection test in design of timber members.	5
2.	Essential mechanical properties of materials	
	Factors on which the design parameters vary	
3.	Types of the stresses developed in the specimen in the bending test	6
4.	Need for applying the centrally concentrated load during the Test	
5.	Use of extensometer	
6.	Procedure of placing the specimen on the bending brackets of UTM.	
7.	Operation of the UTM to apply load on specimen	
8.	Method of adjusting the load gauge and deflectometer to read zero before starting	
9.	Method of maintaining constant rate of load gradually at 2.5mm per min till the specimen fractures	
10.	Drawing method of the graph between load vs deflection	
11.	Procedure of obtaining the deflection corresponding to any load within the limit of proportionality to calculate the Young's Modulus	
12.	Procedure for calculation of bending stress	
13.	Precautions	
	<b>A.Procedural precautions</b> <ul style="list-style-type: none"> <li>• The dimension of the specimen should be carefully measured and placed centrally over the bending brackets.</li> <li>• Care should be taken the roller on the bending pan should touch the specimen before applying load.</li> <li>• Load gauge and defectometer should be adjusted to read zero before starting.</li> <li>• Test load should gradually be applied at a constant rate of 2.5 mm per minute.</li> </ul>	
	<b>B. Safety precautions</b> <ul style="list-style-type: none"> <li>• Loose garments should not be used while conducting the experiment.</li> </ul>	
Total		15

### 3. NEED AND SCOPE OF THE EXPERIMENT

Timber is extensively used in building construction as ornamental material as well as structural material. As a structure member it is to carry compression, tension, shear and flexural loads. For design of timber members for any loads, it is essential to determine the mechanical properties like compressive, tensile and flexural strengths. In this test the flexural strength of timber in terms of „modulus of rupture“ is determined. The design parameters of this material are found to vary with in wide ranges depending upon

- a) The type of wood
- b) The defects such as knots & shakes
- c) The treatments gives to it
- d) The condition of the atmosphere in which it is used, especially in respect to the moisture content.

The design parameters can therefore be fixed only through standardized test. I.S.1708-1970 gives the code of practice for the design of structural timber in building.

### 4. PLANNING AND ORGANIZATION

Action	Activity
Check for	<ol style="list-style-type: none"> <li>1. Working condition of Universal Testing Machine.</li> <li>2. Working condition of dial gauge.</li> <li>3. Availability of test specimen.</li> </ol>
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level Individually	Awarded (50)										
1. Handling of apparatus	A. Operating UTM. B. Fixing and reading of dial gauge	<table border="1"> <tr> <td>A</td> <td>B</td> <td>Tot</td> </tr> <tr> <td>10</td> <td>5</td> <td>15</td> </tr> </table>	A	B	Tot	10	5	15					
A	B	Tot											
10	5	15											
2. Manipulation of apparatus	A. Placing of specimen over the brackets centrally. B. Selection of load range for the test. C. Adjusting the load gauge and deflectometer to zero.	<table border="1"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>Tot</td> </tr> <tr> <td>4</td> <td>3</td> <td>3</td> <td>10</td> </tr> </table>	A	B	C	Tot	4	3	3	10			
A	B	C	Tot										
4	3	3	10										
3. Precise Operation/Activity	A. Applying of load at the rate of 2.5 mm per minute. B. Noting down the deflection for each increment of load. C. Drawing of graph between load vs deflection. D. Calculating of Young's modulus from the graph.	<table border="1"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>D</td> <td>Tot</td> </tr> <tr> <td>5</td> <td>4</td> <td>6</td> <td>5</td> <td>20</td> </tr> </table>	A	B	C	D	Tot	5	4	6	5	20	
A	B	C	D	Tot									
5	4	6	5	20									
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1"> <tr> <td>5</td> </tr> </table>	5										
5													
Total		50											

**6. ASSESSMENT QUESTIONS** (Only suggestive)

1. Given the values of loads and corresponding deflections, draw the graph between load (Y-axis) Vs deflection (X-axis). Calculate the slope of the curve and then calculate the value of N, C or G.
2. Determine the Young's modulus and bending stress for the given wooden beam.

**7. VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the context of examination)

1. Name two defects in timber.
2. What do mean by span of the beam?
3. What is measurement of the cross section of the specimen used?
4. Name the loads that a beam can carry.
5. State the bending equation?
6. State the important of deflection test?
7. The type of stress developed due to bending of beams is \_\_\_\_\_
8. What is meant by modulus of rupture?
9. Why do we apply centrally concentrated load at the centre of the beam?
- 10 .Give formula for finding out M.I of a rectangular beam.
11. Write the formula for finding out the deflection at the centre of the given simply supported beam.

# ***WORK SHEETS***



5. OBSERVATIONS:

S. No.	Sample No.	Weight of oven Dried brick $W_1(N)$	Weight of water absorbed brick $W_2(N)$	Percentage of water absorption $(W_2 - W_1) / W_1 \times 100$
1	A			
2	B			
3	C			

6. RESULT: \_\_\_\_\_

\_\_\_\_\_

7. INFERENCE: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

9. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1. Handling of apparatus	A. Using of balance to weigh bricks and recording its weight. B. Placing the specimen/ bricks in an oven at const. temperature.	<table border="1" style="margin: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
2. Manipulation of Apparatus	A. Giving identification marks to bricks. B. Immersing the bricks at a given temperature and Wiping out water traces.	<table border="1" style="margin: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
3. Precise Operation/Activity	A. Heating the specimen/ bricks in an oven at const. temperature. B. Calculating % of water absorption.	<table border="1" style="margin: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">20</td></tr> </table>		20	
20					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="margin: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
Total		<table border="1" style="margin: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">50</td></tr> </table>		50	
50					

**WORK SHEET**

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

**1. Title of the experiment: CRUSHING STERNGTH OF BRICKS**

**2. Objective of the experiment:** \_\_\_\_\_

\_\_\_\_\_

**3. Apparatus/Tools required:** \_\_\_\_\_

\_\_\_\_\_

**4. Procedure:**

1)
2)
3)
4)
5)
6)
7)
8)

5. OBSERVATIONS AND TABULATIONS:

S.No	Sample No	Dimensions of Sample(mm)	Area of loaded surface( mm <sup>2</sup> )	Crushing load (N)	Crushing Strength (N/mm <sup>2</sup> )
1	I				
2	ii				
3	iii				

6. SPECIMEN CALCULATIONS:

$$\begin{aligned}
 \text{Crushing strength of bricks} &= \frac{\text{Crushing load}}{\text{Surface area of brick}} \\
 &= \frac{60000}{22000} = 2.72 \text{ N/mm}^2
 \end{aligned}$$

7. RESULT: \_\_\_\_\_

8. INFERENCE : \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

9. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

10. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1.Handling of apparatus	A. Switching on the CTM. B. Placing of bricks in CTM. C. Applying of load gradually at the rate of 14 N/mm <sup>2</sup> /min D. Switching off the CTM.	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 40px; height: 20px;"></td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
2.Manipulation of apparatus	A. Taking adequate no of bricks randomly. B. Cleaning the surface of bricks. C. Immersing the bricks in clean water tub. D. Wiping off the surface of bricks with cloth after taking from water tub. E. Applying CM 1:1 on the rough surfaces and filling up the frog with prepared CM. F. Storing of plastered bricks under jute bags for 24 hours and immersing in clean water for 3 days. G. Wiping off surplus water after removing from clean water. H. Operating compression Testing machine / UTM	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 40px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
3. Precise Operation/Activity	A. Preparing 1:1 cement mortar. B. Applying the load gradually at the rate of 14 N/mm <sup>2</sup> per minute till failure occurs. C. Recording the load at failure (crushing) D. Tabulating the observations. E. Calculating the average crushing strength.	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 40px; height: 20px;"></td></tr> <tr><td style="text-align: center;">20</td></tr> </table>		20	
20					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5			
Total		50			
Signature of student		Signature of teacher			

**WORK SHEET 3.2.1**

**WORK SHEET**

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment:

**FINENESS OF CEMENT**

2. Objective of the experiment:

\_\_\_\_\_

3. Apparatus/Tools required:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

4. PROCEDURE:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

**5. OBSERVATIONS:**

S.No	Weight of cement taken $W_1(g)$	Weight of residue $W_2(g)$	% of weight residue $(W_2/W_1) \times 100$
1			
2			
3			

**6. SPECIMEN CALCULATIONS:**

Weight of cement taken ( $W_1$ ) = (g)

Weight of residue ( $W_2$ ) = (g)

Percentage of residue =  $\frac{W_2}{W_1} \times 100$

**7. RESULT:** \_\_\_\_\_

\_\_\_\_\_

**8. INFERENCE:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**9. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

10. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level Individually	Awarded (50)		
1. Handling of apparatus	<p>A. Weighing 100 g of cement to the nearest 0.01 g and place it the clean and dry 90 microns IS sieve (IS Sieve no: 9) with pan attached.</p> <p>B. Continuously sieving the sample by holding the sieve in the both hands for 15 minutes with gentle wrist motion.</p> <p>C. Slightly brush underside of the sieve after every 5 minutes of sieving.</p>	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
2. Manipulation of Apparatus	<p>A. Breakdown any air set lumps in the cement sample with fingers.</p> <p>B. While sieving it, ensure that there is no spilling of the cement and cement shall be kept well spread out on the sieve.</p>	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
3. Precise Operation/Activity	<p>A. Recording the observations.</p> <p>B. Find the weight of residue on the sieve and calculate the value as a percentage of the original sample taken.</p>	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">20</td></tr> </table>		20	
20					
4. Values	<p>A. Co-operation</p> <p>B. Co-ordination</p> <p>C. Communication</p> <p>D. Sharing</p> <p>E. Leadership</p>	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
<b>Total</b>		<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">50</td></tr> </table>		50	
50					
Signature of student:		Signature of Teacher:			



**5. OBSERVATIONS:**

Trial No.	Quantity of water added		Readings on Vicat's scale in (mm)		Penetration from Bottom of Mould
	%	ml	Initial	Final	Col(5)- Col(4)
(1)	(2)	(3)	(4)	(5)	(6)
1					
2					
3					
4					

**6. SAMPLE CALCULATIONS:**

7. RESULT: \_\_\_\_\_  
 \_\_\_\_\_

8. INFERENCE: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

9. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awar ded (50)				
1. Handling of Apparatus	<p>A. Taking 300gm of cement sample and place it on a non-absorbent plate.</p> <p>B. Taking 25% of water by weight of cement as first trial and mix it thoroughly with cement using gauging trowels. Ensure that the time of gauging shall be within 3 to 5 minutes. The time of gauging shall be reckoned from the instant water is added to cement to that the paste is filled in the mould.</p> <p>C. Keeping the mould on a non absorbent plate. Applying a thin coat of oil inside the mould.</p>	<table border="1"> <tr><td> </td></tr> <tr><td>15</td></tr> </table>		15			
15							
2. Manipulation of Apparatus	<p>A. Filling the Vicat's mould with cement paste at a stretch and tamp the mould so as to make the cement spread uniformly in the mould.</p> <p>B. Fixing the plunger of 10mm dia X 50 mm long to the plunger holder of the apparatus. Gently lowering the plunger to touch the mould's top surface and leave it quickly.</p>	<table border="1"> <tr><td> </td></tr> <tr><td>20</td></tr> </table>		20			
20							
3. Precise Operation/Activity	<p>A. Reading the Vicat's scale.</p> <p>B. Repeating the above process with varying % of water and noting down the penetration of plunger till the penetration value is 5 to 7 mm.</p>	<table border="1"> <tr><td> </td></tr> <tr><td>10</td></tr> </table>		10			
10							
4. Values	<p>A. Co-operation</p> <p>B. Co-ordination</p> <p>C. Communication</p> <p>D. Sharing</p> <p>E. Leadership</p>	<table border="1"> <tr><td> </td><td> </td></tr> <tr><td>5</td><td> </td></tr> </table>			5		
5							
Total		<table border="1"> <tr><td> </td><td> </td></tr> <tr><td> </td><td>50</td></tr> </table>				50	
	50						
Signature of student		Signature of teacher					



**WORK SHEET 3.2.3**

**INITIAL AND FINAL SETTING TIMES OF CEMENT**

**5. OBSERVATIONS AND TABULATIONS:**

(A) Initial setting time:

Weight of the cement sample = g.

Weight of water to be added =  $0.85 p \times \text{wt. of cement} / 100 =$

Where,  $p$  = Standard consistency of cement =

Trial No.	1	2	3	4	5	6
Initial Reading (mm)						
Final Reading (mm)						
Penetration (mm)						
Time elapsed = Initial setting time (Minutes)						

(B) Final Setting time:

Final Setting time=

**CALCULATIONS:**

SAMPLE: Sample OPC

Water required to prepare a cement paste of standard consistency=

Weight of cement required for 1 mould = g

Weight of water added to cement =  $0.85 p \times \text{Wt. of cement} / 100 \text{ ml} =$  ml

(A) INITIAL SETTING TIME:

Time elapsed since the water is added to cement = Min

Initial reading on Vicat apparatus (a) = mm

Final reading on Vicat apparatus (b) = mm

Penetration of Vicat needle measured from the bottom

Of mould in mm (b-a) =

FINAL SETTING TIME:

Trial No.	1	2	3	4	5	6
Final setting time (minutes)						

**6. RESULT:** \_\_\_\_\_  
\_\_\_\_\_

**7. INFERENCE:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level Individually	Awarded (50)		
1. Handling of apparatus	A. Weighing of 300 g of cement and transferring cement into non-absorbent tray. B. Using of stop watch. C. Measuring the required % of water.	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
3. Manipulation of apparatus	A. Mixing cement with water and transferring the paste into mould within gauge time. B. Releasing of Vicat needle to penetrate into the paste	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
4. Precision Operation/Activity	A. Reading the Vicat"s scale. B. Repeating the above process of penetration of needle and noting down the penetration value is 5 to 7 mm.	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
Total		<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">50</td></tr> </table>		50	
50					
Signature of the student:		Signature of the teacher:			

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: **COMPRESSIVE STRENGTH OF CEMENT**

2. Objective of the experiment: \_\_\_\_\_  
\_\_\_\_\_

3. Apparatus/Tools required: \_\_\_\_\_  
\_\_\_\_\_

4. PROCEDURE:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

**5. OBSERVATIONS:**

Trial No.	Crushing load (kN)			Compressive Strength at the age of (N/mm <sup>2</sup> )		
	3 days	7 days	28 days	3 days	7 days	28 days
1						
2						
3						
4						

**6. SPECIMEN CALCULATIONS:**

Area of the cube (A) =                    mm<sup>2</sup>

Crushing load (W) =                    N

Compressive strength =  $W/A$  =                    N/ mm<sup>2</sup>

**7. RESULT:** \_\_\_\_\_

\_\_\_\_\_

**9. INFERENCE:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**10. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

11. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Weighing 100 g of cement and 555 g (185g each of grade-1, grade- 2 , grade -3) of standard sand and place them on a non-absorbent plate. B. Operating the vibrating machine for uniform compaction C. Operating the compression testing machine	<div style="border: 1px solid black; width: 80px; height: 60px; margin: auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 24px;">10</span> </div>	
2. Manipulation of Apparatus	A. Mixing cement with water and transferring the paste into mould within gauge time. Filling of mixed cement mortar into standard mould B. Demoulding the cubes. C. Curing of cubes	<div style="border: 1px solid black; width: 80px; height: 60px; margin: auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 24px;">15</span> </div>	
3. Precise Operation/Activity	A. Measuring quantity of water B. Applying load steadily and uniformly at the rate of 35 N/ mm <sup>2</sup> per minute till the cube fails. C. Recording the observations. D. Calculating average compressive strength of the mortar cubes separately for 3, 7 and 28 days curing	<div style="border: 1px solid black; width: 80px; height: 60px; margin: auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 24px;">20</span> </div>	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<div style="border: 1px solid black; width: 80px; height: 60px; margin: auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 24px;">5</span> </div>	
Total		<div style="border: 1px solid black; width: 80px; height: 60px; margin: auto; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 24px;">50</span> </div>	
Signature of student		Signature of teacher	



**5. OBSERVATIONS AND TABULATIONS:**

- A = Weight of pycnometer containing sample filled with distilled water
- B = Weight of pycnometer with distilled water only.
- C = Weight of saturated surface-dry sample.
- D = Weight of the oven dry sample.

Sl. No.	Description of items	Test Reading	
		Sample1	Sample2
1	Weight of pycnometer filled with sample and distilled water = (A) ... g		
2	Weight of pycnometer filled with distilled water = (B) ... g		
3	Weight of saturated surface dry sample = (C) ... g		
4	Weight of oven dry sample = (D) ... g		
5	Percentage of water absorption = (C-D)/DX100		

**SPECIMEN CALCULATION:**

$$\text{Percentage of water absorption} = \frac{(C-D)}{D} \times 100 =$$

**6. RESULT:** \_\_\_\_\_  
 \_\_\_\_\_

**7. INFERENCE:** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

9. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level Individually	Awarded (50)
1. Handling of apparatus	A. Cleaning and washing the sand B. Filling the pycnometer with sand and water C. Keeping the aggregate in oven and dry it at a temperature of 100 to 110 degrees C for a period of 24 hours.	<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; margin: auto;"> <div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em;">10</span> </div> </div> </div>	
2. Manipulation of Apparatus	A. Emptying the pycnometer and filling it with distilled water only. B. Cleaning the pycnometer on its outside surface and find its weight after 24 hours saturation C. Cleaning the wet aggregate with soft clothes until the aggregate becomes saturated surface dry. D. Removing the sand from the oven and cool to room temperature in the air-tight desiccators	<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; margin: auto;"> <div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em;">15</span> </div> </div> </div>	
3. Precise Operation/Activity	A. Finding the weight of pycnometer, sand and distilled water „A'. B. Finding the weight of pycnometer and distilled water „B'. C. Finding the weight of surface dry sand „C'. D. Finding the weight of oven dried and cooled sand „D'. E. Calculating percentage of water absorption of sand using F. $(C-D)/DX100$	<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; margin: auto;"> <div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em;">20</span> </div> </div> </div>	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; margin: auto;"> <div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em;">5</span> </div> </div> </div>	
Total		<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; margin: auto;"> <div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <span style="font-size: 1.2em;">50</span> </div> </div> </div>	
Signature of the student:		Signature of the teacher:	



**5. OBSERVATIONS AND TABULATIONS:**

S.NO	Original volume of sand (ml)	% of water added	Fine volume (ml)	Increase in volume(bulking) (ml)	Percentage bulking
1					
2					
3					
4					
5					
6					
7					
8					

**SPECIMEN CALCULATIONS:**

Initial volume of sand =  $V_1$  ml = ml

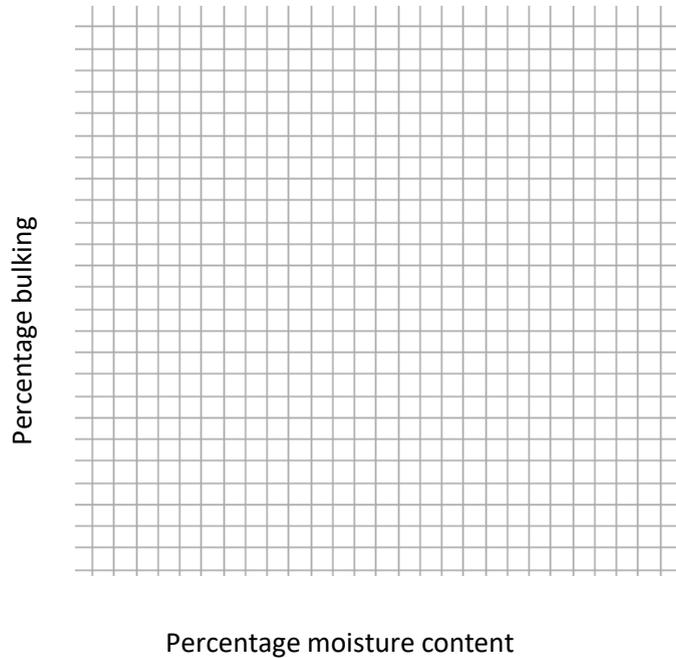
Max volume of sand observed =  $V_2$  ml = ml

$$\% \text{ of bulking of sand} = \left[ \frac{V_2 - V_1}{V_1} \right] \times 100 =$$

% of bulking =

GRAPH:

Draw a smooth graph with percentage moisture content as abscissa and percentage increase in volume (percentage bulking) as ordinates through all the points plotted.



6. RESULT: \_\_\_\_\_

\_\_\_\_\_

7. INFERENCE: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS: \_\_\_\_\_

\_\_\_\_\_

9. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1. Handling of apparatus	A. Placing the sand in an oven at const. temperature. B. Measuring of initial volume(V1), final volume(V2) and measure volume of water	<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
2. Manipulation of apparatus	A. Uniform mixing of water and sand. B. Transferring the mixed sand from pan into measuring jar carefully.	<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
3. Precise Operation/Activity	A. Converting percentage of water into volume of water. B. Calculating accurately the % of bulking for every equal increment of water added. C. Drawing ordinary Graph with %of water added on X-axis and % of bulking on Y-axis. D. Recording maximum percentage of bulking of sand corresponding to the percentage of water added from the curve of the Graph, record.	<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">25</td></tr> </table>		25	
25					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
Total		<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">50</td></tr> </table>		50	
50					
Signature of the student:		Signature of the teacher:			



5. OBSERVATIONS AND TABULATIONS:

Trial No.	Wt of Container w1	Wt of container with Compacted aggregate (w2)	Wt. of Container with loosely Filled aggregate	Bulk Density (g/cc)		Percentage of voids		Remarks
			W <sub>L</sub>	γ <sub>C</sub>	γ <sub>L</sub>	V <sub>C</sub>	V <sub>L</sub>	

6. SPECIMEN CALCULATIONS

Bulk density (compacted) γ<sub>C</sub> = 
$$\frac{W_2 - W_1}{V}$$

Bulk density (Loose) γ<sub>L</sub> = 
$$\frac{W_L - W_1}{V}$$

Percentage of voids in compacted state

$$V_C = \frac{(G_s - \gamma_C)}{G_s} \cdot 100$$

Percentage of voids in loose state

$$V_L = \frac{(G_s - \gamma_L)}{G_s} \cdot 100$$

Where G<sub>s</sub> = Specific gravity of fine aggregate  
 γ<sub>C</sub> = Compacted bulk density (gm/cc)  
 γ<sub>L</sub> = Loose bulk density (gm/cc)

**7. RESULT:** \_\_\_\_\_

\_\_\_\_\_

**8. INFERENCE:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**9. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

10. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1. Handling of apparatus	A. Using of balance to weigh cylindrical measure and recording its weight. B. Filling the metal measure with aggregate in three equal layers	<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 15px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
5. Manipulation of apparatus	A. Tamping the each layer of aggregate in 25 strokes with the standard tamping. B. Striking off the excess material with straightedge	<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 15px;"></td></tr> <tr><td style="text-align: center;">20</td></tr> </table>		20	
20					
6. Precise Operation/Activity	A. Weighing the weight of the container with aggregate. B. Measuring the volume of the container by measuring the internal dimensions.	<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 15px;"></td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 15px;"></td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
Total		<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 15px;"></td></tr> <tr><td style="text-align: center;">50</td></tr> </table>		50	
50					
Signature of the student:		Signature of the teacher:			



5. OBSERVATIONS AND TABULATIONS:

Coarse aggregate					Fine aggregate			
IS Sieve size (mm)	Wt retained (g)	Cum. Wt. retained (g)	Cum. % Wt. retained X	Cum. % passing N=(100-X)	Wt. retained (g)	Cum/retained (g)	Cum. % retained (X)	Cum. % passing N= (100-X)
80								
40								
20								
10								
4.75								
2.36								
1.18								
0.60								
0.30								
0.15								

C. SPECIMEN CALCULATIONS:

$$\text{Fineness modules} = \frac{\text{Sum of cumulative percentage weight retained}}{100}$$

6. RESULT: \_\_\_\_\_  
 \_\_\_\_\_

7. INFERENCE: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS: \_\_\_\_\_  
 \_\_\_\_\_

9. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1. Handling of apparatus	A. Using of balance to weigh coarse and fine aggregates and recording their weight. B. Arranging the set of sieves used for sieve analysis of coarse aggregate. C. Arranging the set of sieves used for sieve analysis of fine aggregate.	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
2. Manipulation of Apparatus	A. Sieving of coarse and fine aggregate on a machine or sieve shaker B. Sieving of coarse and fine aggregate in circular clock wise and anti-clock wise direction.	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
3. Precise Operation/Activity	A. Weighing the retained aggregate on sieves. B. Calculating the cumulative percentage weight retained for coarse and fine aggregate. C. Calculating the fineness modulus of coarse and fine aggregates.	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
Total		<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td style="width: 100px; height: 20px;"></td></tr> <tr><td style="text-align: center;">50</td></tr> </table>		50	
50					
Signature of the student:		Signature of the teacher:			



**5. OBSERVATIONS AND TABULATIONS**

Amount of silt deposited above the sand= V1 =

Amount of clean sand = V2 =

S.No	Amount of silt deposited above the sand V <sub>1</sub> (ml)	Amount of clean sand V <sub>2</sub> (ml)	Percentage of fine silt $\frac{V_1}{V_2} \times 100$
1			
2			

**6. SPECIMEN CALCULATIONS:**

Percentage of fine silt=  $\frac{V_1}{V_2} \times 100 =$

**7. RESULT:** \_\_\_\_\_

\_\_\_\_\_

**8. INFERENCE:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**9. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

10. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1. Handling of apparatus	A. Using Measuring cylinder/glass jar B. Pouring the aggregate in the cylinder/glass jar.	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
2. Manipulation of Apparatus	A. Measuring aggregate using glass jar. B. Filling the glass jar with water. C. Shaking glass jar vigorously.	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">20</td></tr> </table>		20	
20					
3. Precise Operation/Activity	A. Allowing the silt to settle on the layer of the aggregate. B. Calculating % of silt content	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
Total		<table border="1" style="margin: auto;"> <tr><td style="width: 50px; height: 20px;"></td></tr> <tr><td style="text-align: center;">50</td></tr> </table>		50	
50					
Signature of the student:		Signature of the teacher:			



5. OBSERVATIONS AND TABULATIONS

S.NO	Diameter of rod			Average diameter of rod D=(D <sub>1</sub> + D <sub>2</sub> + D <sub>3</sub> )/3 (mm)	Original length (gauge length) of rod (L <sub>1</sub> ) mm	Yield point load (kN)	Ultimate load (kN)	Breaking Load (kN)
	Trial I D <sub>1</sub>	Trial II D <sub>2</sub>	Trial III D <sub>3</sub>					
1								
2								
3								
4								
5								
6								

6. SPECIMEN CALCULATIONS:

Original area of cross section (A) =  $\pi D^2/4$  mm<sup>2</sup>

Stress at yield point =  $P_y/A$  N/mm<sup>2</sup>

Ultimate tensile stress =  $P_u/A$  N/mm<sup>2</sup>

Breaking stress =  $P_b/A$  N/mm<sup>2</sup>

% elongation =  $\frac{L_2 - L_1}{L_1} \times 100 =$

% reduction in area =  $\frac{A_1 - A_2}{A_1} \times 100$

Where

L<sub>1</sub> = Original length (gauge length) of rod in mm

L<sub>2</sub> = Final length (gauge length) of rod at fracture in mm

A<sub>1</sub> = Original area of cross section

A<sub>2</sub> = Final area of cross section at fracture

(Out of cup and cone formation, cone part area may be taken)

GRAPH:

Plot the graph stress Vs strain.

7.RESULT:\_\_\_\_\_

---

---

---

8.INFERENCE: \_\_\_\_\_

---

---

9.DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS: \_\_\_\_\_

---

---

SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1. Handling of apparatus	A. Mounting the specimen in the grips of movable and fixed heads of UTM. B. Adjusting the load points to zero, after jaws bold the specimen firmly. C. Keeping left valve in open position and right valve I closed position.	<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
2. Manipulation of apparatus	A. Measuring the diameter of the rod. B. Making specimen of convenient length. C. Applying the load slowly and gradually. D. Removing the specimen from the grips.	<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
3. Precise Operation/Activity	A. Marking the center point B. Measuring the gauge length. C. Keeping the left valve in closed position after completion of the experiment D. Identifying the load decreasing and neck formation. E. Noting the yield point, ultimate load and breaking point. F. Plotting the graph stress Vs strain.	<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">25</td></tr> </table>		25	
25					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
Total		<table border="1" style="width: 100%; height: 100%;"> <tr><td style="height: 20px;"> </td></tr> <tr><td style="text-align: center;">50</td></tr> </table>		50	
50					
Signature of the student:		Signature of the teacher:			



**5. OBSERVATIONS:**

S. No.	Material	Trail No.	Minor Load in kg	Major Load in kg	Indenter used
1	Hardened Steel	1	10	140	Diamond
		2			
		3			
		4			
2	Mild steel	1	10	90	1.58mm dia. ball
		2			
		3			
		4			
3	M.S. Rod	1	10	90	1.58mm dia. ball
		2			
		3			
		4			
4	Brass	1	10	90	1.58mm dia. ball
		2			
		3			
		4			

**6. RESULT:** \_\_\_\_\_  
\_\_\_\_\_

**7. INFERENCE:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

9. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1. Handling of apparatus	A. Keeping the specimen ready for testing B. Setting of dial to zero	<table border="1" style="width: 100%; height: 100%; text-align: center;"> <tr><td style="height: 20px;"> </td></tr> <tr><td>10</td></tr> </table>		10	
10					
2. Manipulation of Apparatus	A. Identifying Ball and diamond indenters B. Identifying A, B, and C scale C. Applying minor load	<table border="1" style="width: 100%; height: 100%; text-align: center;"> <tr><td style="height: 20px;"> </td></tr> <tr><td>20</td></tr> </table>		20	
20					
3. Precise Operation/Activity	A. Reading of hardness number using micro scope	<table border="1" style="width: 100%; height: 100%; text-align: center;"> <tr><td style="height: 20px;"> </td></tr> <tr><td>15</td></tr> </table>		15	
15					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="width: 100%; height: 100%; text-align: center;"> <tr><td style="height: 20px;"> </td></tr> <tr><td>5</td></tr> </table>		5	
5					
Total		<table border="1" style="width: 100%; height: 100%; text-align: center;"> <tr><td style="height: 20px;"> </td></tr> <tr><td>50</td></tr> </table>		50	
50					
Signature of the student:		Signature of the teacher:			



**3. OBSERVATIONS:**

S.No	Material of Specimen	Size of the Specimen	Energy absorbed to break the specimen (N-m)
1	Steel	10 mm square section 72 mm long	

**4. RESULT:** \_\_\_\_\_

\_\_\_\_\_

**5. INFERENCE:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**6. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

7. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Preparing the standard specimen. B. Clutching the striking hammer. C. Adjusting the pointer	<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;">                     15                 </div> </div> </div>	
2. Manipulation of Apparatus	A. Fixing the specimen in the position of anvil. B. Adjusting the pointer. C. Releasing pendulum to strike the specimen by taking safety precaution	<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;">                     15                 </div> </div> </div>	
3. Precise Operation/Activity	A. Measuring the dimensions of specimen using vernier B. Recording down the reading by observing the appropriate scale	<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;">                     15                 </div> </div> </div>	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;">                     5                 </div> </div> </div>	
Total		<div style="border: 1px solid black; width: 100%; height: 100%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80%; height: 80%; display: flex; align-items: center; justify-content: center;">                     50                 </div> </div> </div>	
Signature of the student:		Signature of the teacher:	



5. OBSERVATIONS:

Span of the beam = Mm  
 Size of the beam = Mm  
 Moment of inertia(I) = mm<sup>4</sup>  
 Least count of dial gauge = Mm

S.No	Load W "N"	Deflectometer Readings			Deflection (δ) in mm	Youngs modulus (E) N/mm <sup>2</sup>
		Initial	Final	Difference		
1						
2						
3						
4						
5						
6						
7						
8						

SPECIMEN CALCULATION:

For a simply support beam of span „l' with a central load „W' and deflection is measured at mid span.

Deflection at center, δ =  $\frac{WL^3}{48EI}$

Where I = moment of Inertia =  $\frac{bd^3}{12}$

Where E= Young's Modulus =  $\frac{WL^3}{48 \times \delta \times I}$

From the bending equation  $\frac{M}{I} = \frac{\sigma}{Y}$

Where E = Young's modulus of the material .....N/mm<sup>2</sup>  
 I = Moment of inertia of the cross- section. „mm<sup>4</sup>  
 M = bending moment .....KN m  
 σ = Bending stress.....N/mm<sup>2</sup>

Bending Stress σ =  $\frac{MY}{I} = \frac{WL \times d \times 12}{4 \times 2 \times bd^3} = \frac{1.5 WL}{bd^2}$

6. RESULT: \_\_\_\_\_

\_\_\_\_\_

7. INFERENCE: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**9. SCHEME OF EVALUATION:**

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)		
1. Handling of apparatus	A. Operating UTM. B. Fixing and reading of dial gauge	<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 20px;"></td></tr> <tr><td style="text-align: center;">15</td></tr> </table>		15	
15					
2. Manipulation of Apparatus	A. Placing of specimen over the brackets centrally. B. Selection of load range for the test. C. Adjusting the load gauge and deflectometer to zero.	<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 20px;"></td></tr> <tr><td style="text-align: center;">10</td></tr> </table>		10	
10					
3. Precise Operation/Activity	A. Applying of load at the rate of 2.5 mm per minute. B. Noting down the deflection for each increment of load. C. Drawing of graph between load vs deflection. D. Calculating of Young's modulus from the graph.	<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 20px;"></td></tr> <tr><td style="text-align: center;">20</td></tr> </table>		20	
20					
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	<table border="1" style="width: 100px; height: 40px;"> <tr><td style="height: 20px;"></td></tr> <tr><td style="text-align: center;">5</td></tr> </table>		5	
5					
Total		50			
Signature of student		Signature of teacher			

# ***EXPERIMENTAL METHODOLOGY***

## WATER ABSORPTION OF BRICKS

### (1) WATER ABSORPTION OF BRICKS

#### B. PROCEDURE

1. **Keep** the bricks in an oven and maintain a constant temperature of 105°C to 115°C until they attained constant weight.
2. Provide identification marks on each brick and allow all the bricks to cool down to a room temperature.
3. Take the weight of each brick. Let it be  $W_1$  newtons.
4. Immerse all the bricks in water tank at room temperature for 24 hours.
5. Take out each brick from water tank and wipe off all surfaces with the dry cloth.
6. Take the wet weight of all the bricks individually. Let it be  $W_2$  newtons.
7. Enter all the observations in the tabular form.
8. Calculate the percentage of water absorption every sample and find the average of all samples.

#### B. OBSERVATIONS AND TABULATIONS

S. No	Sample No	Weight of oven Dried brick $W_1$ (kg)	Weight of water absorbed brick $W_2$ (kg)	Weight of water absorbed brick $W_2$ (kg)	Percentage of water absorption $(W_2 - W_1) / W_1 \times 100$
1	A	27.5	32	4.5	16.36
2	B	28	31.5	3.5	12.5
3	C	25	29	4.0	16.0

#### C. SPECIMEN CALCULATIONS

$$\begin{aligned} \text{Percentage of water absorption} &= \frac{(W_2 - W_1)}{W_1} \times 100 \\ &= \frac{32 - 27.5}{27.5} \times 100 = 16.36\% \end{aligned}$$

#### D. RESULT

$$\text{Average percentage of water absorption of brick} = \frac{\text{Sum of the percentage of water absorption}}{\text{No. of samples}}$$

#### A. INFERENCE \_\_\_\_\_

---



---



---

**(2) EFFLORESCENCE OF BRICKS (Not in syllabus)****THEORY**

Efflorescence is a whitish powder of cristalization on brick masonry walls caused by water soluble salts deposited on the surface upon evaporation of water. Efflorescence appears if there are soluble salts in the wall materials and moisture to carry these salts to the surface. To overcome efflorescence, it is necessary to check types of bricks, quantity and quality of water used, type of mortar and particularly the type of admixture(if used).

**A. EXPERIMENTAL PROCEDURE**

1. Place the **end** of the **bricks** in the **dish**, the **depth of immersion** in **water** being **25 mm**.

**2. THEORY**

Efflorescence is a whitish powder of cristalization on brick masonry walls caused by water soluble salts deposited on the surface upon evaporation of water. Efflorescence appears if there are soluble salts in the wall materials and moisture to carry these salts to the surface. To overcome efflorescence, it is necessary to check types of bricks, quantity and quality of water used, type of mortar and particularly the type of admixture(if used).

**B. PROCEDURE**

1. Place the **end** of the **bricks** in the **dish**, the **depth** of immersion in **water** being **25 mm**.

2. Place the whole **arrangement** in a **warm** ( for example, 20 to 30°C ) well **ventilated room** until all the **water** in the **dish** is **absorbed** by the **specimens**. and the **surplus water evaporates**.

3. Cover the **dish** containing the brick **with** suitable **glass cylinder** so that **excessive evaporation** from the dish may **not occur**.

4. When the **water** has been **absorbed** and **bricks appear** to be **dry**, place a similar **quantity** of **water** in the **dish** and **allow** it to **evaporate** as before.

5. Examine the **bricks** for **efflorescence** after the **second evaporation** and report the results.

**C. OBSERVATIONS AND TABULATIONS**

S.No.	Appearance	Efflorescence
1.	When there is no perceptible deposit of efflorescence.	Nil
2.	When not more than 10 percent of the exposed area of the brick is covered with a thin deposit of salts.	Slight
3.	When there is a heavier deposit than under „slight’ and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.	Moderate
4.	When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.	Heavy
5.	When there is a heavy deposit of salts accompanied by powdering and/or flaking of the exposed surfaces.	Serious

**D.RESULT**

---

**E.INFERENCE**

---

## CRUSHING STRENGTH OF BRICKS

### A. PROCEDURE

1. **Clear** the **surface** of the **brick** with the **cloth**.
2. **Immerse** the **bricks** in **water** for **24** hours at **room temperature**.
3. **Take out** the **bricks** from the **water** and **wipe off** all the **surfaces** with **dry cloth**.
4. **Prepare 1:1 cement mortar**.
5. **Apply** cement **plaster** in 1:1, on all **rough surfaces** and **fill** up the **frog** with cement **mortar**. Ensure that the **loading faces** are **smooth** and **level**.
6. **Keep** them **under damp jute bags** for **24** hours and there after **immerse** in clear **water** for **three days**.
7. **Remove** the **bricks** and **wipe off** surplus moisture with dry cloth.
8. **Measure** the **dimensions** of the **bricks**.
9. **Place** the **bricks** with **flat surfaces horizontal** and the **mortar filled frog face upwards** **between** the two, 3 mm **ply wood** sheets in **compression testing machine**.
10. The brick should be kept in such a position that the **loading** should be **axial**.
11. **Apply** the **load gradually** at the rate of **14 N/mm<sup>2</sup>** per minute till failure occurs.
12. **Record** the **load at failure** (crushing)
13. **Repeat** the above **procedure** for remaining bricks and tabulate the observations.
14. **Calculate** the **average crushing strength**.



### B. OBSERVATIONS AND TABULATIONS

S.No	Sample No	Dimensions of Sample(mm)	Area of loaded surface( mm <sup>2</sup> )	Crushing load (N)	Crushing Strength (N/mm <sup>2</sup> )
1	I	220x100x70.5	22000	60000	2.72
2	ii	220.5x100x70	22500	70000	3.11
3	iii	230x100x70.5	23000	80000	3.47

**C.SPECIMEN CALCULATIONS**

$$\text{Crushing strength of bricks} = \frac{\text{Crushing load}}{\text{Surface area of brick}}$$

$$= \frac{60000}{22000} = 2.72 \text{ N/mm}^2$$

**D. RESULT**

$$\text{Average Crushing strength of bricks} = \frac{\text{Sum of the Crushing strength of bricks}}{\text{No. of samples}}$$

**E. INFERENCE**

As per IS 1077 – the samples of bricks can be classified as I class/II class/ III class. For the above range of Crushing strength ,the bricks belong to \_\_\_\_\_class.

## FINENESS OF CEMENT

### A. PROCEDURE

- A. **Breakdown** any air set **lumps** in the cement sample **with fingers**.
- B. **Weigh** 100 g of **cement** to the nearest 0.01 g and **place** it on the clean and dry **90 microns IS sieve** (IS Sieve no:9) with pan attached.
- C. Continuously **sieve** the sample by holding the sieve in the both hands for **15 minutes** with gentle **wrist motion**.
- D. While sieving it, **ensure** that there is **no spilling** of the **cement** and cement shall be kept well spread out on the sieve.
- E. Slightly **brush underside** of the **sieve** after every **5 minutes** of sieving.
- F. **Find** the **weight** of **residue** on the **sieve** and **calculate** the **value** as a **percentage** of the **original sample** taken.



### B. OBSERVATION AND TABULATIONS

S.No	Weight of cement taken W1 (g)	Weight of residue W2(g)	% of weight residue (W2/W1)x100
1	100	9	9
2			

### C. SPECIMEN CALCULATIONS

Weight of cement taken (W1) = (g)

Weight of residue (W2) = (g)

Percentage of residue =  $\frac{W2}{W1} \times 100$

**D.RESULT**

$$\text{Fineness of given sample} = (W1) - \% \text{residue}$$
$$(\% \text{passing}) =$$

**E.INFERENCE**





## INITIAL AND FINAL SETTING TIMES OF CEMENT

### THEORY

Setting indicates the setting of cement paste. It refers to a change from a fluid state to a rigid state. Although during setting, the paste acquires some strength, for practical purposes it is convenient to distinguish from hardening which refers to the gain of strength of a set cement due to strength.

For cement paste, mortar or concrete certain time is required for mixing, transporting, placing, compacting and finishing. During this time cement paste, mortar or concrete should be in plastic condition. The time interval for which the cement products remain in plastic condition is known as initial setting time.

In practice the terms initial set and final set are desirable arbitrarily chosen stages of setting and has got no relations with the setting or hardening of actual concrete. This test is used to detect the deterioration of cement due to storage.

### A. PROCEDURE

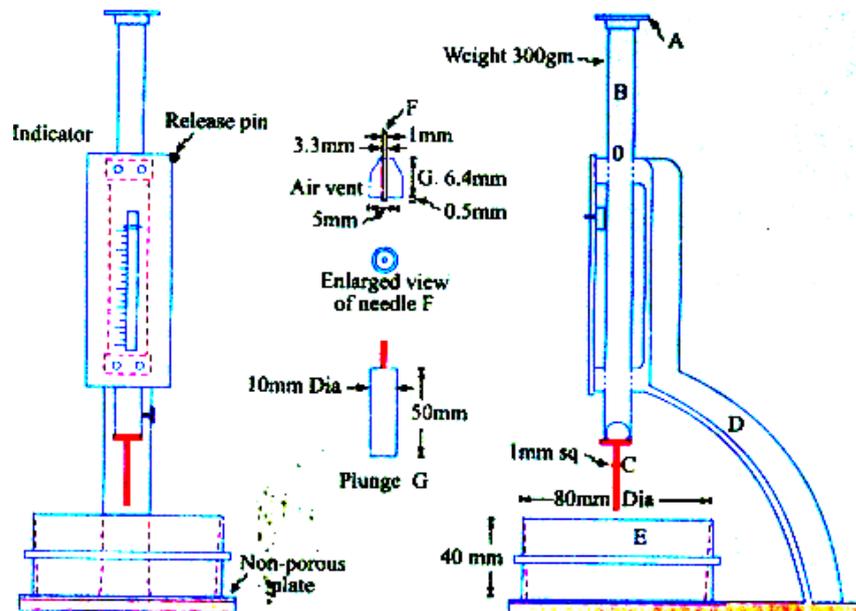
1. **Prepare** a neat **cement paste** by mixing the cement **with 0.85 times the water** required to give a paste of **standard consistency**.
2. **Start a stop watch** at the instant **when the water is added to cement**.
3. Thoroughly **mix** cement and water using gauging towels **till** required **uniformity** is attained in mixing.
4. **Fill** the **Vicat mould**, which is **resting** on the **non-porous plate** with cement **paste** prepared.
5. **Fill** the mould **completely** and **smoothen the surface** of the paste by making it **level** with **top** of the mould. The cement block thus prepared in the mould is the test block.

### NOTE:

1. Clean appliance shall be used for mixing.
2. All apparatus shall be free from vibration during the test.
3. Care shall be taken to keep the needle straight.

**(A) Initial setting time:**

1. Place the test block with porous plate at bottom, under the rod bearing the needle (C) as shown in the fig.



2. Lower the needle gently until it comes in contact with the surface of test block and quickly release allowing it to penetrate into test block.
3. Repeat this procedure at regular intervals of time until the needle, when brought in contact with the test block and released as above fails to pierce the block for 5 to 7mm measured from the bottom of the mould.
4. The period elapsed between the time when the water is added to the cement and the time at which the needle fails to pierce the test block to a point 5 to 7mm measured from the bottom of the mould shall be reported as initial setting time.

**(B) Final setting time:**

1. Replace the needle C of Vicat apparatus by an annular attachment.
2. Prepare the test block according to the procedure given above.
3. The cement shall be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression there while the attachment fails to do so.
4. The period elapsing between the time when the water is added to the cement and the time at which the needle makes an impression on the surface of the test block while the attachment fails to do so shall be the final setting time.

**B. OBSERVATIONS AND TABULATIONS**

**1. Initial setting time**

Weight of the cement sample = 300g.

Weight of water to be added =  $0.85 \times 31 \times 300g / 100 = 79ml$

Where,  $p$  = Standard consistency of cement = 31%.

Trial No.	1	2	3	4	5	6
Initial Reading (mm)	22	19	12	6		
Final Reading (mm)	20	17	11	6		
Penetration (mm)	1	2	1	0		
Time elapsed = Initial setting time (Minutes)	25	40	50	60		

**2. Final Setting time**

Final Setting time= \_\_\_\_\_

**C. SPECIMEN CALCULATIONS**

SAMPLE: Sample OPC

Water required to prepare a cement paste of standard consistency = 31 %

Weight of cement required for 1 mould = 300g

Weight of water added to cement =  $0.85 \times 31 \times 300 / 100 \text{ ml} = 79 \text{ ml}$

**(B) INITIAL SETTING TIME**

Time elapsed since the water is added to cement = 5 min

Initial reading on Vicat apparatus in min (a) = mm

Final reading on Vicat apparatus in min (b) = mm

Penetration of Vicat needle measured from the bottom

Of mould in mm (b-a) =

**(C) FINAL SETTING TIME:**

<b>Trial No.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
Final setting time (minutes)	300	420	480	540	600	

**D. RESULT**

- (A) Initial setting time for the given cement sample = 60 min.  
(B) Final setting time for the given cement sample = 600 min.

**E. INFERENCE**

## COMPRESSIVE STRENGTH OF CEMENT

### THEORY

Strength of cement depends upon the strength of the ingredients. For standard strength of aggregates, the strength of concrete depends on the strength of the binding material i.e., the cement mortar matrix but not plain cement alone. As such the compressive strength of cement is determined as the strength of standard cement mortar cubes using standard sand, standard mixing, casting and testing methods. As per IS 4031, standard sand conforming to IS: 650 shall be used in three grades of equal quantities. The compressive strength of such mortar cubes after 28 days curing is called as the characteristic strength of cement. Based on the compressive strength of cement, three grades of cement are available for OPC, viz: 33,43 and 53 grades. Normally 33 and 43 grades of cements are used for general buildings whereas 53 grade cement is used for structures requiring high strength concrete. As the grade of cement is higher, drying shrinkage cracks will be spread up unless proper care is taken for continuous curing.

### A.PROCEDURE

#### (a) Preparation of test cubes

The following quantities of materials required for each cube.

- A) Cement : 185 g
- B) Standard sand : 555 g (185 g each of grade-1, grade- 2, grade -3)
- C) Water :  $(p/4 + 3)\%$  of combined weight of cement and sand, where P is the percentages of water required to produce a paste of standard consistency.

1. **Weigh** the required proportions of **cement** and **standard sand** of three grades and **place** them **on a non-absorbent plate**.
2. **Mix** the ingredients in dry condition using gauging **trowels**. **Add** the measured quantity of **water** to the dry matrix and mix them **thoroughly** applying sufficient pressure **till uniform consistency** is **achieved**. Ensure the **time taken** for **mixing** shall **not exceed four minutes**.
3. **Place** the entire quantity of **motor** into the **mould** and **tamp** the mould using **12mm dia tamping rod** by **25 times**. **Place** the **mould** on the **mould housing** unit of the cement mortar vibrator as shown in figure and **clamp** all the **check nuts** and spring washers **tightly**.
4. **Vibrate** the **cube** for a period of **two minutes**. **Remove** the **mould** from the **vibrator** and keep it on a dry area. **Repeat** the **process** for casting totally nine cubes.
5. **Demould** the **cubes** after **24 hrs** and **transfer** them **into curing tank**. **Keep** the cubes in **curing tank** for **28 days** with **change** of **water** for every **7 days**.
6. **Test** the **cubes** as per the standard procedure at the **age of 3, 7 and 28 days**.

**NOTE:** Standard sand shall confirm to I.S.650 consists of three grades viz. Zone I, Zone II, Zone III.

Zone-I particle size 2 mm-1mm

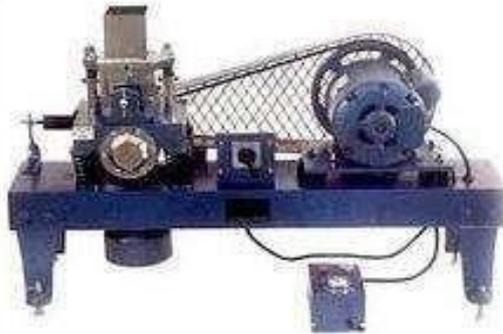
Zone -II particle size 1mm- 0.5 mm

Zone -III particle size 0.5 mm- 0.09 mm (500 micron – 90 microns)

Standard sand is available at Ennore in Tamil Nadu Minerals Limited, Chennai where the sand is processed for Chemical purity and Physical purity.

### b) Testing

1. The test cubes are placed on the platform of the compression testing machine.
2. The load is applied steadily and uniformly at the rate of 35 N/ mm<sup>2</sup> per minutetill the cube fails.
3. In the same way, the experiment is repeated for other cubes at their specified age.
4. The compressive strength for each cube is calculated. Finally the average compressive strength of the mortar cubes are worked out separately for 3, 7 and 28 days curing.



### B.OBSERVATIONS AND TABULATIONS

Weight of cement,  $w_c$  = 185 g

Ennore sand of zone I = 185 g

Ennore sand of zone II = 185g

Ennore sand of zone III = 185 g

Total wt. of sand,  $w_s$  = 555 g

Weight of water =  $\left(\frac{P}{4} + 3\right)\%$  of  $(w_c + w_s)$

= ( ) % of 740

=

= ml of water

Immersion of mould = 7 days



## WATER ABSORPTION OF SAND

### THEORY

Water absorption can be defined as the amount of water required to bring the aggregate from oven dry condition to the saturated surface dry condition. This is expressed as a percentage on dry weight basis. It is also nothing but internal moisture absorbed by aggregate. Porosity will make the fine aggregate particles to absorb the water. Porosity and absorption will affect the water-cement ratio, and hence the workability of concrete. Hence the effective water available for hydration of cement is lost. As such corrective measures are to be taken to compensate the loss.

### A. PROCEDURE

1. **Take 500g of sand** (the quantity shall be in such a way that it should fill the **pycnometer** up to **two thirds** of its **volume**) and **clean** it thoroughly by **washing** it through 75 microns sieve **till the fine dust** is fully **removed** and the **sand** is **free** from all **physical impurities**.
2. **Fill the sand** in **pycnometer** and **pour** distilled water **till the sand** is **inundated**. Clean the Pycnometer on its outside surface and find its weight after 24 hours saturation and let the weight be „A’
3. **Empty** the **pycnometer** and **fill** it with **distilled water** only and let its weight be „B’
4. **Clean** the **wet sand** with **soft clothes** until the **sand becomes** saturated surface **dry** and let its weight be „C’
5. **Keep** the **sand** in **oven** and **dry** it at a **temperature** of 100 to 110 degrees C for a **period** of **24 hours**.
6. **Remove** the **sand** from the **oven** and **cool** to **room temperature** in the air-tight **desiccators** and let the weight be „D’
7. **Repeat** the **entire procedure** for second sample also.

### B. OBSERVATIONS AND TABULATIONS

A = Weight of pycnometer containing sample filled with distilled water

B = Weight of pycnometer with distilled water only.

C = Weight of saturated surface-dry sample.

D = Weight of the oven dry sample.

Sl. No.	Description of items	Test Reading	
		Sample1	Sample2
1	Weight of pycnometer filled with sample and distilled water = (A) ... g		
2	Weight of pycnometer filled with distilled water = (B) ... g		
3	Weight of saturated surface dry sample = (C) ... g		
4	Weight of oven dry sample = (D) ... g		
5	Percentage of water absorption = (C-D)/DX100		

### C. SPECIMEN CALCULATION

$$\text{Percentage of water absorption} = \frac{(C-D)}{D} \times 100 =$$

## D. RESULT

Mean value of percentage of water absorption =

## E. INFERENCE

---

---

---

## BULKING OF SAND

### THEORY

#### Bulking of Sand

It is an apparent increase in volume of sand due to the presence of moisture. It is expressed as percentage of original dry volume. The extent of 'bulking' depends on the amount of moisture and fineness of sand. It increases with increase of moisture content up to certain limit and beyond that further increase of moisture content results in the decrease in the volume. At saturation point, there is no sign of bulking. Due to this bulking phenomenon, the quantity of sand proportion would be always less than the actual requirement. Therefore the effect of bulking can be compensated by taking extra volume of sand equal to the extent of bulking. Fine sands exhibit more bulking to coarse sand for the same moisture content.

a) The tests on determination of bulking of sand involves determination of the % bulking present in the sand at any instant of time, which is known as field method of bulking test of sand:

b) Determination of bulking characteristics of sand and max % of bulking the sand can exhibit, which is nothing but a laboratory test.

### A. PROCEDURE

1. **Take the dry sand** sample and **pour** it into the **glass jar** up to **250ml mark**.
2. **Remove the sand** from glass jar and **pour** it in **mixing pan**.
3. **Add 2%** (5ml) of water, **by volume, to sand** and **mix** it thoroughly.
4. **Place this sand** gently in the **measuring jar** and **note the graduation**. This will be slightly **more than the initial reading** of **250ml** mark.
5. **Repeat the steps 3 and 4** with **increase water content** and **note down the observations**. It can be observed that **increase in moisture** content shall **make the sand to increase in volume up to certain limit**. Thereafter, **further increase in moisture** content **decrease the volume of sand**.
6. The **addition of water** at **uniform rate is 2%** (5ml) will be **continued until the original volume** of **250ml mark** is **obtained**.
7. The **moisture content** or **percentage of water** at which **maximum increase in volume** of **sand** occurs shall be **taken to calculate percentage of bulking of sand**.

**B.OBSERVATIONS AND TABULATIONS**

S.NO	Original volume of sand (ml)	% of water added	Final volume (ml)	Increase in volume(bulking) (ml)	Percentage bulking
1	250	2	257	7	2.5
2	250	2	351	101	40.4
3	250	2	355	105	42
4	250	2	357	107	42.8
5	250	2	354	104	41.6
6	250	2	300	50	20
7	250	2	254	4	1.6
8	250	2	250	0	0

**C.SPECIMEN CALCULATIONS**

Initial volume of sand =  $V_1$  ml = 250 ml

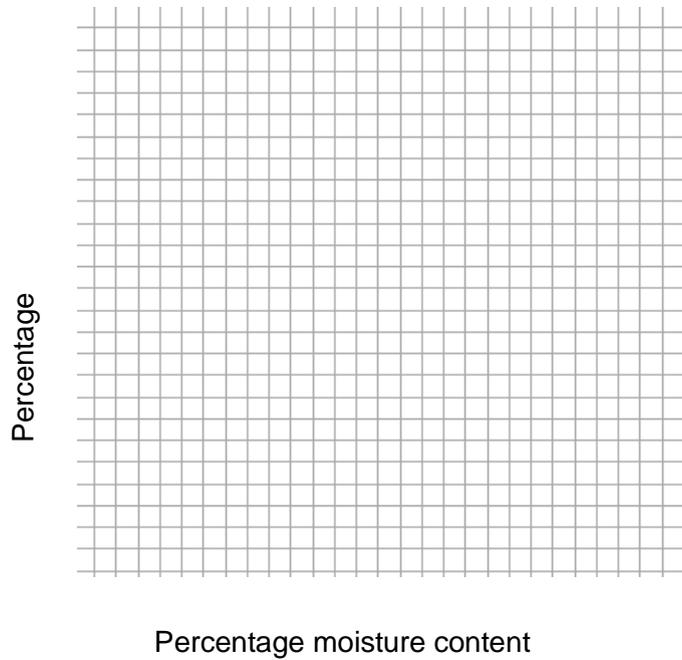
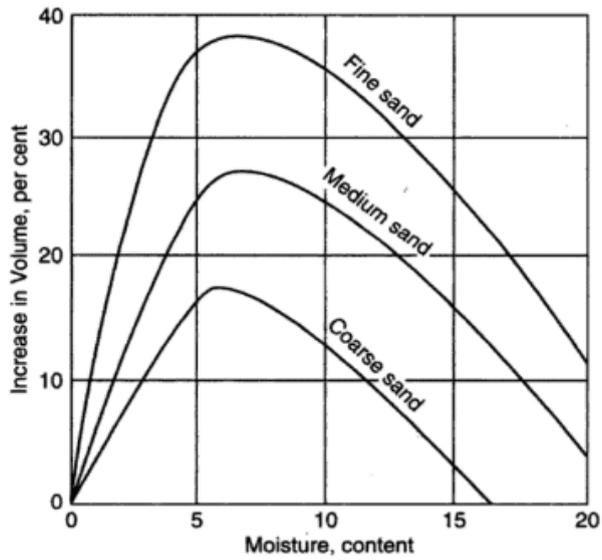
Max volume of sand observed =  $V_2$  ml = 357 ml

$$\% \text{ of bulking of sand} = \left[ \frac{V_2 - V_1}{V_1} \right] \times 100 = \left[ \frac{357 - 250}{250} \right] \times 100 = 42.8\%$$

$$\% \text{ of bulking} = \left[ \frac{50}{250 \times 100} \right] = 20\%$$

**D.GRAPH**

Draw a smooth graph with percentage moisture content as abscissa and percentage increase in volume (percentage bulking) as ordinates through all the points plotted.



**E. RESULT**

**F. INFERENCE**



**C. SPECIMEN CALCULATIONS**

$$\text{Bulk density (compacted) } \gamma_c = \frac{W_2 - W_1}{V}$$

$$\text{Bulk density (loose) } \gamma_L = \frac{W_L - W_1}{V}$$

Percentage of voids in compacted state

$$V_c = \frac{(G_s - \gamma_c)}{G_s} \times 100$$

Percentage of voids in loose state

$$V_1 = \frac{(G_s - \gamma_L)}{G_s} \times 100$$

Where  $G_s$  = Specific gravity of fine aggregate

$\gamma_c$  = Compact bulk density (g/cc)

$\gamma_L$  = Loose bulk density (g/cc)

**D. RESULT** (The voids percentage shall be given to nearest whole number)

---



---

**E. INFERENCE**

---



---

## **SIEVE ANALYSIS OF COARSE AND FINE AGGREGATES**

### **THEORY**

It is an index number numerically equal to the sum of cumulative percentage of material retained on a set of ten sieves divided by 100.

#### **Fineness Modulus**

The aggregate passing through 4.75mm sieve is called fine aggregate and retained on 4.75mm sieve is called coarse aggregate. It is necessary to find the fineness modulus for the given aggregate for the most economical mix design. The determination of fineness modulus consists in dividing the sample of aggregate into fractions of different sizes by sieving through a set of standard sieves.

The fineness modulus is a numerical index of fineness giving some idea of mean size of particles present in the aggregate. The fineness modulus can be regarded as a weighted average size of sieve on which material is retained and sieves being counted from the bottom. For example a fineness modulus of 5.0 can be interpreted to give an indication that fifth sieve counted from bottom i.e., 2.36 as the average size.

Sieve analysis is also useful in deciding the grading zone of aggregate.

### **A. PROCEDURE**

1. **Dry** the given **sample of aggregate** by **keeping** it in **oven** at a **temperature of 100 to 110°C** for a period of **24 hours**.
2. **Take** the **weight of air-dry sample**. **Keep** the weighed **sample of aggregate** in the **top most sieve** of the set **with large size at top** and **lower at bottom**. Care shall be taken to ensure that the **sieves are clean before use**.
3. **Each sieve** shall be **shaken** over a **clean tray** for a **period of not less than 2 minutes**.
4. The **shaking** is **done** with a **varied motion backwards** and **forwards, left** and **right, clock-wise** and **anti clock-wise** so that the **material** is kept **moving over the surface** in **frequently changing direction**.
5. **Find** the **weight of aggregates retained on each sieve** taken in **order**.
6. If sieving is carried out with a set of **sieves on a machine**, not less than **10 minutes sieving** will be **required for each test**.



**SET OF IS SIEVES**

**B. OBSERVATIONS AND TABULATIONS**

Coarse aggregate					Fine aggregate			
IS Sieve size (mm)	Wt retained (g)	Cum. Wt. retained (X)	Cum. % Wt. retained X	Cum. % passing	Wt. retained (g) N=(100-x)	Cum/retained (g)	Cum. % retained (X)	Cum. % N= (100-X)
80	0	0	0	100				
40	0	0	0	100				
20	347	347	34.7	65.3				
10	646	993	99.3	0.7				
4.75	6	999	99.9	0.1	17	17	1.7	98.3
2.36					30	47	4.7	95.3
1.18					231	278	27.8	72.2
0.60					123	401	40.1	59.9
0.30					472	873	87.3	12.7
0.15					103	976	97.6	2.4
			Total					

**C. SPECIMEN CALCULATIONS**

Wight of sample taken = 1000 grams

Sum of cumulative percentage weight retained  
 Fineness modules =  $\frac{\dots\dots\dots}{100}$

$= \frac{233.9}{100} = 2.339$

$\frac{259.2}{100} = 2.592$   
 Fine aggregate =  $\dots\dots\dots = 2.592$

**D. RESULT**

Fineness modules of fine aggregate = 2.592

Fineness modules of coarse aggregate = 2.338

**E. INFERENCE**

Grading zone of the fine aggregate=

**EXPERIMENTAL METHODOLOGY 4.3.5**

**FIELD METHOD TO DETERMINE FINE SILT IN AGGREGATE**

**THEORY**

Sand is a product of natural or artificial disintegration of rocks and minerals. The sand is obtained from glacial, river, lake, marine, residual and wind-blown (very fine sand) deposits which do not provide pure sand and contain dust, loam and clay that are finer than sand. The presence of such material in sand used to make concrete or mortar decreases the bond between the materials to be bound together and hence the strength of the mixture. The finer particles do not only decrease the strength but also the quality of the mixture produced resulting in fast deterioration, Therefore, it is necessary that one make a test on the slit content and checks against permissible limits.

**A. PROCEDURE**

1. **Take** graduated **cylinder** or jar having a **capacity** of greater than **100 ml**.
2. **Pour** 30 ml **sand** in to the cylinder.
3. **Fill** approximately  $\frac{3}{4}$  of the **cylinder** with **water**.
4. **Shake** the **cylinder** vigorously for about a **minute**.
5. **Leave** the **cylinder** for about an **hour** to **allow** the **silt** to **settle** on the **layer** of the **sand**.
6. **Measure** the **amount** of **finer** forming a **separate layer** on the **top** of the **washed sand**.

**B.OBSERVATIONS AND TABULATIONS**

Amount of silt deposited above the sand= V1 =

Amount of clean sand = V2 =

S.No	Amount of silt deposited above the sand  V1 (ml)	Amount of clean sand  V2 (ml)	Percentage of fine silt  $\frac{V_1}{V_2} \times 100$
1			

**C.SPECIMEN CALCULATIONS**

Percentage of fine silt=  $\frac{V_1}{V_2} \times 100 =$

**D. RESULT**

Percentage of fine silt \_\_\_\_\_

**E. INFERENCE** \_\_\_\_\_

\_\_\_\_\_

## TENSION TEST ON STEEL

### THEORY

Mild steel and deformed/twisted bars (HYSD bars) are commonly used as reinforcement in concrete structures to withstand tensile stresses. As such it is essential to test their tensile strength properties. During tension test the material passes through elastic, elastic-plastic stage and plastic stage and finally leads to failure by fracture. The following properties are determined in this test.

#### 1. Yield Stress

The stress at which elongation first occurs in the piece without increasing the load.

#### 2. Ultimate tensile stress

It is the maximum stress the material has attained. At this point the material starts necking and consequently reduction in cross-sectional area takes place, which leads to reduction in the load carrying capacity. This feature can be observed on stress-strain diagram as well as on loading panel of UTM.

#### 3. Breaking stress

The stress at which the specimen breaks down.

#### 4. Percentage Elongation

It is defined as the ratio of final elongation to its original gauge length expressed as percentage.

$$\% \text{ Elongation} = \frac{L_2 - L_1}{L_1} \times 100$$

Where  $L_1$  = Initial gauge length

$L_2$  = Final gauge length at fracture

#### 5. Percentage reduction in area

It is defined as the ratio of decrease in area to the original area of cross section expressed as percentage.

$$\% \text{ reduction in area} = \frac{A_1 - A_2}{A_1} \times 100 =$$

Where

$A_1$  = Original area of cross section

$A_2$  = Final area of cross section at fracture

#### 6. Young's Modulus

It is defined as the ratio of stress and strain within the proportionality limit.

### A. PROCEDURE

#### a) For Mild steel specimen

1. **Calculate** the probable **ultimate load** for the given specimen **assuming** the probable **ultimate stress** of **420 N/mm<sup>2</sup>**. **Adjust** the **U.T.M** for that **selected range**.
2. **Take** a convenient **length** (approximately **400mm to 500mm**) of the **specimen** and **mark** the **center points**. From the center point, **mark** the **gauge length**.
3. **Measure** the **diameter** of the given mild steel **specimen** at the **different places** with the help of the **micrometer**; **determine** the **average diameter** of the **specimen**. In case of **HYSD bars** **determine** the **diameter** of bar **from weight basis**.
4. **Mount** the **specimen** in the **grips** of moveable and fixed **cross heads** of **UTM**. **Fix extensometer** to the rod **over** the selected **gauge length**. **Note** the **reading of extensometer** to **measure** the **elongation** up to **yield point**.
5. **Apply** an **initial load** so as to initiate **ram movement** of **UTM**, and to firmly **hold** the **specimen** in the **grips**. **Adjust** the **load** and dummy pointers to **read Zero**.
6. **Apply** the **load** at a **steady & uniform rate**. **Identify** the **yield point** corresponding to the **point** at which there appears as **oscillating movement** of **pointers** to **read zero**.
7. **At the yield point**, **progressive deformation** will be **found** at almost **slight increase of load**.
8. **Apply** the **load continuously**; when the **load reaches** the **maximum value**, a **crack** is **initiated** in the **specimen** **resulting** the **fall of load continuously**. The **diameter of specimen** **decreases** and a **neck formation** starts. The **load pointer** **moves back** indicating the **phenomenon** of **neck formation**. Finally the **specimen** **breaks** at a **load** very nearly **equal to load at yield point**. **Record** the **load at fracture** and also the **ultimate load reached**.
9. **After breaking**, **remove** the **specimen** from the **grips** and **measure** the **final gauge length** and the **final diameter**. For **mild steel**, a typical **cup and cone fracture** is **observed**.

## B. OBSERVATIONS AND TABULATIONS

Diameter of rod	... Trial I	=	mm
	... Trial II	=	mm
	... Trial III	=	mm
Average diameter of rod (D)		=	mm
Original length (gauge length) of rod (L <sub>1</sub> )		=	mm
Yield point load		=	kN
Ultimate load		=	kN
Breaking Load		=	kN

## C. CALCULATIONS

Original area of cross section (A)	=	$\pi D^2/4$	mm <sup>2</sup>
Stress at yield points	=	$P_y/A$	N/mm <sup>2</sup>
Ultimate tensile stress	=	$P_u/A$	N/mm <sup>2</sup>

$$\% \text{ elongation} = \frac{L_2 - L_1}{L_1} \times 100 =$$

$$\% \text{ reduction in area} = \frac{A_1 - A_2}{A_1} \times 100 =$$

Where

Where  $L_1$  = Initial gauge length

$L_2$  = Final gauge length at fracture

$A_1$  = Original area of cross section

$A_2$  = Final area of cross section at fracture

(Out of cup and cone formation, cone part area may be taken)



UNIVERSAL TESTING MACHINE

## D. RESULT

- |                        |   |                   |
|------------------------|---|-------------------|
| 1. Ultimate stress     | = | N/mm <sup>2</sup> |
| 2. Yield               | = | N/mm <sup>2</sup> |
| 3. Breaking stress     | = | N/mm <sup>2</sup> |
| 4. % Elongation        | = |                   |
| 5. % Reduction in area | = |                   |

## E. INFERENCE

## **HARDNESS TEST**

### **THEORY**

Hardness may be defined as resistance to penetration or resistance to abrasion. The test involves in determining the depth of impression caused by the penetration of certain standard load on the specimen. The following are the various methods of hardness tests available:

1. Rockwells direct reading hardness test.
2. Brinnells Hardness test
3. Vickers hardness test

Out of the above tests, Rockwell hardness test is more extensively used in all engineering applications because of its simple testing procedure, lack of in-depth calculations, direct reading access of hardness number etc.,

This principle is introduced by Stanly Rockwell in 1919. The principle consists in application of a small initial load to the penetrator to eliminate any effect due to surface imperfections. The major load is then added and the depth of penetration produced by the total load is taken as a measure of hardness. The reading is inversely proportional to the depth of penetration so that the greater the penetration, the lower the hardness number and vice-versa.

The most common scales used are A, B& C.

### **DESCRIPTION OF EQUIPMENT**

#### 1. Rockwell Hardness testing machine:

The machine consists of a dial gauge with red and black scales. A long pointer and short pointer with set indication are contained in machine. Red scale is used for readings obtained with Ball indenter and black scale is used for Diamond indenter. Symbol B and C apply with the major loads 100 and 150 kgs respectively. For both these scales the minor load is 10Kgs. The major loads being 90 and 140 kgs respectively.

#### 2. Tools required:

- a. Emery paper.
- b. Indenters: Ball indenter is of 1.5875mm made of tungsten carbide or Hardened steel. The diamond indenter is having 0.2mm radius tip with an apex angle  $120^{\circ}$ .

### **METHOD OF APPLICATION OF LOAD**

The standard test shall be carried out by selecting proper scale, load and penetrator. The minor load shall be applied gradually and progressively to the specimen in a direction normal to its surface and axially to the penetrator. Without removing the minor load, and the position of specimen undisturbed, the major load shall then be additionally applied gradually and progressively in four to five seconds. As soon as the reading of the indicator becomes steady, the major load shall be gently removed, the minor load being retained and the test specimen remaining undisturbed.

## PROCEDURE

1. **Remove** all mill **scales** from the **surface of specimen** by **rubbing** it with 00-emery paper.
2. **Insert indenter** in the indenter holder and **clamp** it. **Select** suitable **indenter** depending upon the type of material to be tested. **Refer** the **table** given for guidance for **selection of indenter** for a particular material.
3. **Select** the required **load range** either 100kg for **B scale** or 150Kg for **C scale**.
4. **Place** the **specimen** on the **supporting table** and **turn** the **hand wheel** to **raise** the **elevating screw** till **clear contact** is made **with** the **indenter**. **Continue** carefully **rotating** the **hand wheel** until the small pointer on the **dial reaches** the **set position**. Now the specimen is under application of minor load of 10kg automatically.
5. **Push** forward the **loading handle** to **transmit** the **major load** to the **specimen**.
6. **When** the **penetration** is **completed** (wait 5 to 6 seconds for hard material and 6 to 8 seconds for soft material) **release** the **major load** by **pulling** backward **the loading handle**. **Keep** the **initial load** 10 kg still **on** the **specimen**.
7. Then **directly read** the Rockwell „C' or Rockwell „B' **hardness number** on the **dial** and **record** it.
8. **Release** the **minor load** of 10kg by **rotating** the **hand wheel anticlockwise** and lowering the screw.
9. **Repeat** the experiments to obtain **at least four different** sets of **observations** for the **same material**.

## OBSERVATIONS

S.NO	MATERIAL	TRAIL NO	MINOR LOAD IN KG	MAJOR LOAD IN KG	INDENTOR USED	SCALE	R.H.NO
1	Hardened steel	1	10	140	Diamond	C	ERHC
		2					
		3					
		4					
2	Mild steel	1	10	90	1.58mm dia. ball	B	RHB
		2					
		3					
		4					
3	M.S.Rod	1	10	90	1.58mm dia. ball	B	RHB
		2					
		3					
		4					
4	Brass	1	10	90	1.58mm dia. ball	B	RHB
		2					
		3					
		4					

SCALE/SYMBOL	TOTAL LOAD	PENETRATOR	DIAL FIGURES
A	60 – Kg	Diamond cone	Black
B	100 –Kg	1 ---- Ball 16	Red
C	150 – Kg	Diamond cone	Black
D	100-Kg	Diamond cone	Black
E	100-Kg	1 ---- Ball 8	Red
F	60-Kg	1 ---- Ball 16	Red
G	150-Kg	1 ---- Ball 16	Red
H	60-Kg	1 ---- Ball 16	Red



BRINELL HARDNESS TESTER



ROCKWELL HARDNESS TESTER

## MATERIALS FOR WHICH THE ABOVE MENTIONED SCALES ARE USED

Scale Symbol	Penetrator	Total load	Material for which Scale is used
A	Diamond cone	60 – kg	Thin hardened steel strip. Other extremely hard materials when small impressions are required.
B	Steel ball 1 ---- Ball 16	100-kg	All mild and medium carbon steel.  Sheet steel and soft steel bars
C	Diamond cone	150-kg	Hardened steels, hardened and tempered steels, alloy steels, materials harder than B. 100
D	Diamond cone	100-kg	Case hardens steel when a lighter load than 150-kg is advisable.
E	1 ---- Ball 8	100-kg	Cast iron, aluminum and magnesium alloys.
F	1 ---- Ball 16	60-kg	Annealed brass and copper and for Thin sheets.
G	1 ---- Ball 16	150-kg	For material in range B.100 where greater sensitivity is required e.g. beryllium copper, phosphor bronze.
H	1 ---- Ball 8	60-kg	Soft aluminum, non-metallic plastics.

**RESULT****Rockwell Hardness number of Hard steel = RHC**

1. Rockwell Hardness number of mild steel = (51- 56) = 53.5 RHB
2. Rockwell Hardness number of Brass = (39-33) = 36 RHB

**INFERENCE**

## IMPACT TEST ON METALS

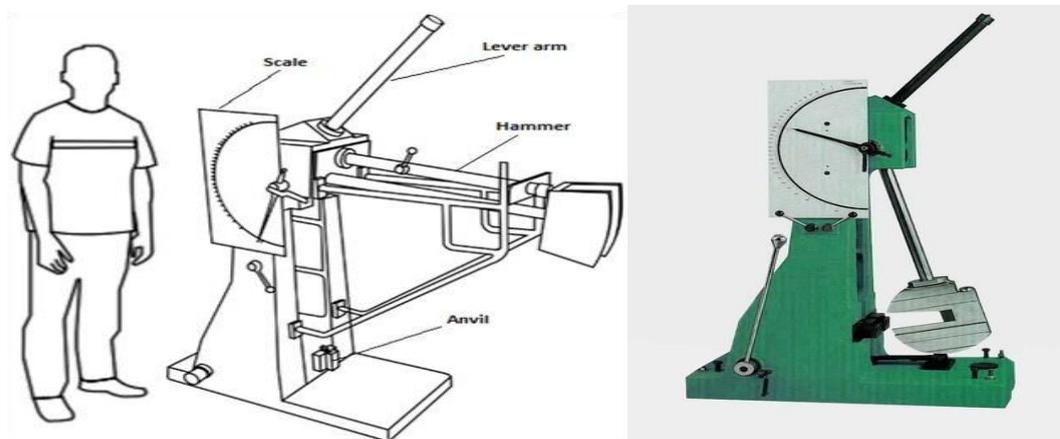
### THEORY

Many machine parts are commonly subjected to dynamic loads. The performance of the parts depends on the properties of the component materials under such applied loads. A load which falls from height on the member is known as impact load. Many parts of structures and machines are expected to take impact loading ex: Forging machines, machines bases, hooks of cranes , crane chains etc.

In doing an impact test, load may be applied in flexure, Torsion, compression or tension. Flexure loading is the most common one. The impact test is conducted on cantilever specimen or simply supported beam specimen. The First one is called Izod test and the later a Charpy test. After impact, the energy absorbed by the material is known as impact value which represents the toughness of the material.

### SPECIFICATIONS OF SPECIMEN

The Izod specimen consists of a round steel rod 11.4 mm dia and 75 mm length with a „v' groove notch cut at a distance of 28 mm from top end. The specimen will be held in grips with top 28 mm cantilevering and the center of notch flush with the top level of grips so that the knife edge of striker will hit the specimen exactly at the center of the notch. The „v' groove is meant for initiating a crack in the specimen, when it is struck by the pendulum for fracturing it with impact. Maximum impact capacity of machine in Izod position is 170N-m.



CHARPY IMPACT TESTING MACHINE

**A. PROCEDURE**

- B. Measure the dimensions of the specimen.**
- C. Rise the pendulum until it is locked in Izod position A.** Small pointer is connected to the pendulum which will show 170N-m reading when pendulum locked into the Izod position. There will be another dummy pointer on the dial case which can be adjusted to be always in contact with main pointer attached to the pendulum.
- D. Adjust the pointer to coincide with initial reading.**
- E. Place the specimen projecting from the support** such that the notch is facing the striker.
- F. Release the pendulum by operating the lever.**
- G. The striking edge strikes against the specimen and ruptures it.** The specimen absorbs a part of the energy due to the fall of the pendulum.
- H. Note the reading** shown by the main pointer attached to the pendulum, which indicates the impact energy absorbed by the specimen.

**B. OBSERVATIONS AND TABULATIONS**

S.No	Material of Specimen	Size of the Specimen	Energy absorbed to break the specimen (N-m)
1	Steel	10 mm square section 72 mm long	12.6 X 10 <sup>3</sup>

- a) Square Test piece – Required
- b) Round test piece

**C. RESULT**

Impact energy absorbed by the specimen =                      kNm

**D. INFERENCE** \_\_\_\_\_

\_\_\_\_\_

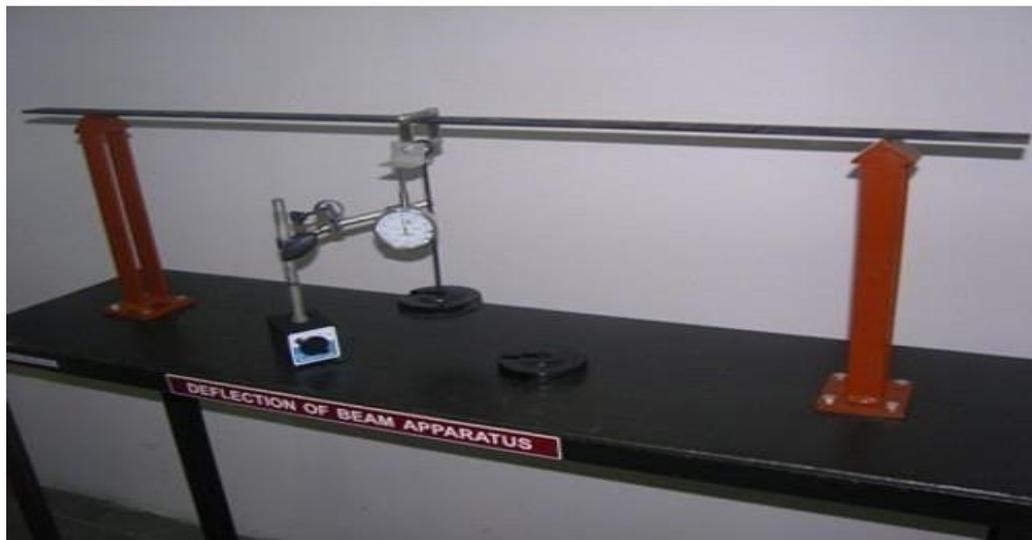
## **DEFLECTION TEST**

### **THEORY**

Timber is extensively used in building construction as ornamental material as well as structural material. As a structural member it is to carry compression, tension, shear and flexural loads. For design of timber members for any loads, it is essential to determine the mechanical properties like compressive, tensile and flexural strengths. In this test the flexural strength of timber in terms of „modulus of rupture“ is determined. The design parameters of this material are found to vary within wide ranges depending upon

- The type of wood
- The defects such as knots & shakes
- The treatments given to it
- The condition of the atmosphere in which it is used, especially in respect to the moisture content.

The design parameters can therefore be fixed only through standardized test. I.S.1708-1970 gives the code of practice for the design of structural timber in building.



**DEFLECTION OF BEAM APPARATUS**

### **SPECIFICATIONS OF SPECIMEN**

The test shall be performed only on clear specimen.

1. I.S.Code suggests a 50 X 50 X 750 mm. Specimen as the standard specimen. It is to be tested under central concentrated loads with a span of 700 mm.
2. In the absence of a standard specimen the test shall be performed on available specimen after making the span 14 times the depth of the specimen.

### **EXPERIMENTAL PROCEDURE**

#### **EQUIPMENT REQUIRED**

1. UTM with transverse testing attachment.
2. Dial-gauge of 0.01mm least count to measure vertical deflection.
3. A magnetic dial gauge stands to hold the gauge.

## EXPERIMENTAL SET UP & PROCEDURE

1. **Install and fasten** the cradle on the bottom crosshead.
2. **Adjust the bending brackets on the cradle** so that **they are equidistant** from the **center** and are **at the required span apart**.
3. **Place the specimen over the brackets centrally. Attach the bending mandrel to the lower side of upper cross head of UTM.**
4. **Lower the upper cross-head with the bending pan attached to it until the latter is a few centimeters above the specimen.**
5. **Switch on the power main.**
6. **Select the lowest (0 to 4 t or 0 to 40kN) load range for the test.**
7. **Switch on the hydraulic drive, regulate the delivery and lift the suspension hydraulically. Finally close the delivery valve when the center of the specimen just touches the roller on the bending pan.**
8. **Adjust the load gauge and deflectometer to read zero before starting.**
9. **Apply the test load gradually at a constant rate of 2.5 mm per minute and note the deflection for each increment of load till the specimen fractures.**
10. **Draw the graph between load Vs deflection. (Load on Y-axis and deflection on X-axis).**
11. **From the graph, obtain deflection corresponding to any load within the limit of proportionality and calculate Young's modulus using the formula shown below:**

**OBSERVATIONS & TABULATIONS**

Span of the beam = Mm  
 Size of the beam = Mm  
 Moment of inertia = mm<sup>4</sup>  
 Least count of dial gauge = Mm

S.No	Load W "N"	Deflectometer Readings			Deflection (δ) in mm	Youngs modulus (E) N/mm <sup>2</sup>
		Initial	Final	Difference		
1						
2						
3						
4						
5						
6						
7						
8						

**SPECIMEN CALCULATION**

For a simply support beam of span „l' with a central load „W' and deflection is measured at mid span.

Deflection at center, δ =  $\frac{WL^3}{48EI}$

Where I = moment of Inertia =  $\frac{bd^3}{12}$

Where E= Young's Modulus =  $\frac{WL^3}{48 \times \delta \times I}$

From the bending equation  $\frac{M}{I} = \frac{\sigma}{Y}$

Where E = Young's modulus of the material .....N/mm<sup>2</sup>  
 I = Moment of inertia of the cross- section. „mm<sup>4</sup>  
 M = bending moment .....kNm  
 σ = Bending stress .....N/mm<sup>2</sup>  
 Y = Distance of Extreme layer from N.A.

Bending Stress σ =  $\frac{MY}{I} = \frac{WL \times d \times 12}{4 \times 2 \times bd^3} = \frac{1.5 WL}{bd^2}$

**RESULT**

Young's modulus of beam material = N/mm<sup>2</sup>  
 Bending stress at the applied maximum load = N/mm<sup>2</sup>

**USING SUSPENDED LOADS**

**EQUIPMENT REQUIRED**

1. Knife edge supports
2. Deflectometer
3. Caliper
4. Scale
5. Slotted weights with hangers

**EXPERIMENTAL PROCEDURE**

1. **Adjust the knife edge support for the required span.**
2. **Place the test beam over the center of support.**
3. **Place the deflectometer under the beam where the deflection is to be measured.**
4. **Suspend the hanger at the point(s) where the beam is to be loaded.**
5. **Note the initial reading of the deflectometer**
6. **Add the loads to the hanger at the rate of 5N(500g)**
7. **Note the corresponding deflectometer reading for each increment of load.**
8. **Observe five sets of reading.**
9. **Remove the loads at the rate of 5N(500g).**
10. **Note the corresponding deflectometer reading for each decrement of load.**
11. **Draw the graph for load 'W' (in N) Vs deflection 'd' (in mm) taking deflection on X-axis and load on Y-axis.**
12. **If the graph is not passing through the origin, draw a line parallel to the graph and passing through the origin.**

**OBSERVATIONS & TABULATION**

Span of the beam (L) =  
 Size of the beam =  
 Moment of inertial (I) =

S.No	Load W /,N'	Deflectometer Readings			Deflection in (δ) in mm	Youngs Modulus (E) N/mm <sup>2</sup> $\frac{WL^3}{48\delta I}$
		Initial	Final	Diff(d)		

**SPECIMEN CALCULATION**

For a simply support beam of span „L“ with a central load „W‘ and deflection is measured at mid span.

Deflection at center,  $\delta = \frac{WL^3}{48EI}$

From the bending equation  $\frac{M}{I} = \frac{\sigma}{Y}$

- Where E = Young's modulus of the material ... N/mm<sup>2</sup>
- I = Moment of inertial of the cross section. „mm<sup>4</sup>
- M= bending moment.....kNm
- $\sigma$  = Blending stress .....N/mm<sup>2</sup>
- Y = Distance of the extreme fiber from the N.A

$\sigma = \frac{MY}{I} = \text{Bending stress.}$

**GRAPH**

Draw the graph between load (Y-axis) Vs deflection (X-axis). Calculate the slope of the curve and then calculate the value of N, C or G.

**RESULT**

Young's modulus of beam material = N/mm<sup>2</sup>  
 Bending stress at the applied maximum load = N/mm<sup>2</sup>

**INFERENCE**

---

**III SEMESTER INTERNAL EXAMINATION  
UNIT TEST - I  
MODEL QUESTION PAPER  
MATERIAL TESTING PRACTICE**

**SCHEME: C-20  
MAX MARKS:60**

**SUB CODE: C-309  
TIME: 3 Hours**

**Instructions:**

- (1) Any one full question of the following shall be allotted to the students on lottery basis.
- (2) All the questions are competency based and are for assessing the candidate's psychomotor skills
- (3) Underpinning knowledge shall be assessed through viva voce- 4 M

1. (a) Prepare the brick for testing its water absorption and tabulate the initial weight of the bricks.9M  
(a) Cast the cubes with the given cement mortar to calculate crushing strength of cement.15M  
(b) Conduct the initial setting time test for the given sample of cement and give the inference.30M
  
2. (a) Select the apparatus required for finding out the fineness of cement and weigh the required quantity of cement. 9M  
(b) Tabulate observations made for the given bricks and calculate the average water absorption of bricks. 15M  
(c) State the need for the setting time test on cement and find out the initial setting time of cement for a given cement sample. 30M
  
3. (a) Prepare the 1:3 cement mortar required for preparing cubes. 12M  
(b) Find out the fineness of the given quantity of cement and write your inference. 17M  
(c) Determine the average compressive strength of cement, given the cement cubes. 25M
  
4. (a) Prepare the cement paste required for finding out the normal consistency of cement.12M  
(b) Prepare the brick samples for determining the crushing strength. 17M  
(c) Determine the average compressive strength of cement, given the cement cubes. 25M
  
5. (a) Prepare the brick for testing its water absorption and tabulate the initial weight of the bricks.11M  
(b) Tabulate observations made for the given cement and determine the normal consistency of cement. 18M  
(c) Determine the average crushing strength of the given prepared brick samples. 25M

III SEMESTER INTERNAL EXAMINATION

UNIT TEST-II

MODEL QUESTION PAPER

MATERIAL TESTING PRACTICE

SCHEME: C-20  
MAX MARKS:60

SUB CODE: C-309  
TIME: 3 Hours

Instructions:

- (1) Any one full question of the following shall be allotted to the students on lottery basis.
- (2) All the questions are competency based and are for assessing the candidate's psychomotor skills
- (3) Underpinning knowledge shall be assessed through viva voce- 4 M

1. (a) Tabulate observations made for the bulking of given sand and calculate the bulking of sand. 9M  
(b) Determine the percentage of voids in coarse and fine aggregates, for the given bulk densities. 15M  
(c) Conduct the Izod test for the given brass and steel specimen in the impact testing machine and compare the values. 30M
2. (a) Mount the M.S. rod specimen in the U.T.M. for conducting a tension test. 12M  
(b) Given the values of loads and corresponding deflections, draw the graph between load (Y-axis) Vs deflection (X-axis). Calculate the slope of the curve and then calculate the value of N, C or G. 16M  
(c) Using the field method, determine the fine silt in the given aggregate. 26M
3. (a) Setup the apparatus for finding the hardness of given brass specimen to conduct Rockwell hardness test. 12M  
(b) Determine the percentage of voids in coarse and fine aggregates, for the given bulk densities. 16M  
(c) Perform the gradation of given sample of Coarse aggregates. 26M
4. (a) Arrange the set of sieves to perform sieve analysis for fine aggregate and coarse aggregate. 10M  
(b) Draw stress strain curve for the given values obtained in tension test. 16M  
(c) Determine the Young's modulus and bending stress for the given wooden beam. 28M
5. (a) Setup the apparatus for finding the Young's modulus and bending stress for the given wooden beam. 10M  
(b) Compute the percentage reduction in cross sectional area for the given broken tension test specimen of 12 mm M.S. rod. 16M  
(c) Perform a test to determine the specific gravity of the given sample of aggregate. 28M

**III SEMESTER EXTERNAL EXAMINATION  
MODEL QUESTION PAPER  
MATERIAL TESTING PRACTICE**

**SCHEME: C-20  
MAX MARKS:60**

**SUB CODE: C-309  
TIME: 3 Hours**

**Instructions:**

- (1) Any one full question of the following shall be allotted to the students on lottery basis.
- (2) All the questions are competency based and are for assessing the candidate's psychomotor skills
- (3) Underpinning knowledge shall be assessed through viva voce- 4 M

1. a) Mount the M.S. rod specimen in the U.T.M. for conducting tension test. 12M  
b) Calculate Fineness modulus of the fine aggregate given the given values of cumulative percentage of weight retained. 16M  
c) Determine the standard consistency of the given sample of cement. 26M
  
2. a) Prepare the cement paste required for finding out the setting time of cement. 12M  
b) Compute the percentage reduction in cross sectional area for the given broken tension test specimen of 12 mm M.S. rod. 16M  
c) Determine the compressive strength of the given brick samples. 26M
  
3. (a) Prepare the cement paste required for finding out the normal consistency of cement. 12M  
(b) Compute the fineness of the given quantity of cement and write your inference. 16M  
(c) Conduct the Izod test for the given brass and steel specimens in the impact testing machine and compare the values. 26M
  
4. a) Setup the apparatus for finding the Young's modulus and bending stress for the given wooden beam. 10M  
(b) Given the values of loads and corresponding deflections, draw the graph between load (Y-axis) Vs deflection (X-axis). Calculate the slope of the curve and then calculate the value of N, C or G. 18M  
(c) Using the field method, determine the fine silt in the given aggregate. 26M
  
5. a) Select the apparatus required for finding out the fineness of cement and weigh the required quantity of cement. 10M  
b) Determine the specific gravity of aggregate using given values. 18M  
c) Conduct the Izod test for the given brass and steel specimen in the impact testing machine and compare the values. 26M