INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

ADVANCED MATERIAL TESTING LABORATORY								
V Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
ACEC22	**Core**	0	0	3	1.5	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Concrete Technology Laboratory								

I. COURSE OVERVIEW:
Advanced Materials Testing laboratory course emphasizes the practical aspects of the latest developments in the field of concrete construction. It focuses the latest Indian standard specifications and codes, which regulates the concrete construction. The laboratory course covers the properties of concrete and its constituent materials, the role of various admixtures in modifying these properties to suit specific requirements, such as ready mix concrete, reinforcement detailing, disaster-resistant construction, concrete machinery and it also enable the students to acquire knowledge on special and new generation concrete with their applications.

II. COURSES OBJECTIVES:
The students will try to learn

1. The fundamental properties of construction materials like cement, aggregates and admixtures based on laboratory and field tests for identifying material quality.
2. The factors influencing workability and methods involved in measuring workability of self compacting concrete.
3. The importance of water/cement ratio and its influence on compressive strengths of hardened concrete.
4. The concept of quality control and design of concrete mix with various admixtures for ensuring quality of concrete.

III. COURSE OUTCOMES:
At the end of the course students should be able to:

CO1	Recall the basic properties of cement and aggregates for determining their suitability through various laboratory tests.
CO2	Determine physical and chemical properties of cement in laboratory for deciding its suitability in construction practice.
CO3	Examine the gradation, strength of aggregates and bulking of sand for producing good quality concrete.
CO4	Measure the workability of self compacting concrete and compressive strength of concrete by non destructive testing methods for accepting in construction practice.
CO5	Determine the effect of air content and accelerated curing of concrete for producing durable concrete.
CO6	Determine influence of water cement ratio and admixtures on Compressive strength of cement concrete for accepting in construction practice.

IV. COURSE SYLLABUS:

EXCERCISES ON ADVANCED MATERIAL TESTING LABORATORY

Note: Students are encouraged to wear shoes for laboratory practice sessions.

1. Advanced Material Testing Laboratory

1.1 Introduction

Tests on cement-consistency, setting times, soundness, compressive strength

Consistency of cement refers to its ability to flow or maintain a certain level of plasticity when mixed with water. It is an important property of cement because it affects the workability and the strength of the concrete or mortar made from it. There are different methods to measure the consistency of cement, but the most commonly used method is the Vicat apparatus test in fig 1.1, which determines the setting time and consistency of cement paste.

Setting time of cement refers to the time it takes for cement paste to change from a liquid state to a solid state. It is an important property of cement because it affects the handling, placement, and curing of concrete and mortar. There are two main setting times associated with cement: initial setting time and final setting time.

Soundness of cement is a property that measures its ability to maintain its volume and not undergo significant expansion or contraction after it has hardened. It is an essential characteristic because cement that undergoes excessive expansion or contraction after setting can lead to cracking, disintegration, and structural problems in concrete structures. The primary test used to evaluate the soundness of cement is the "Le-Chate D2lier" test as shown in fig1.2, which is standardized and widely accepted.

Compressive strength is a critical property of concrete and mortar, as it measures their ability to withstand axial loads (forces pushing or pulling along the axis) without breaking or crushing.

Fig 1.1: Setting time of cement

Fig 1.2: Soundness of cement

Try: The following questions are to be answered about Tests on cement-consistency, setting times, soundness, compressive strength.

1. How does the water-cement ratio affect the consistency of cement paste?
2. Define compressive strength in the context of cement and concrete?
3. What is the purpose of the soundness test for cement?
4. Why is it important to control the setting time of cement in construction applications?

2. Gradation Charts of Aggregates

2.1 Introduction

Gradation charts of aggregates are graphical representations of the particle size distribution of aggregate materials. These charts are essential tools in the field of civil engineering and construction, as they help assess the suitability of aggregates for various concrete and asphalt mix designs. They provide information about the distribution of different-sized particles within the aggregate, which can impact the workability, strength, and durability of the resulting construction materials

2.2 Study of Gradation charts:

A gradation chart typically consists of a horizontal axis representing particle size (usually logarithmic scale) and a vertical axis representing the percentage of aggregate passing through a sieve of a particular size. Gradation charts are used to classify aggregates into different categories based on their particle size distribution.

I. Fuller Curve (Fuller-Thompson Curve)
II. Sieve Analysis Chart
III. Aggregate Grading Chart (ASTM C33)
IV. Fuller-Segregation Curve

Try: The following questions are to be answered about the gradation charts of aggregate?

1 What is the fineness modulus of the aggregate?
2 Which sieve size corresponds to the maximum aggregate size?
3 Is the aggregate well-graded or poorly-graded? Explain your reasoning.

3. Bulking of sand

"Bulking of sand" refers to the increase in volume or expansion that occurs when dry sand absorbs moisture or water. This phenomenon is important to consider when using sand in construction, particularly in applications where accurate measurements of sand volume are crucial, such as in concrete mixtures.

3.1 Determination of Bulking of sand:

Bulking occurs because sand particles tend to separate and expand when water is added, leading to an increase in volume in fig 3.1. This increase in volume can affect the accuracy of measurements and calculations in various construction and geotechnical applications.

3.2 Materials and Equipment:

I. **Sand sample**: You'll need a sample of the sand you want to test.
II. **Container**: A container to hold the sand.
III. **Graduated cylinder**: To measure the volume of water.
IV. **Water**: Clean and preferably distilled water.
V. **Spatula or scoop**: To handle the sand.
VI. **Measuring tape or rule**r: To measure the height or volume of the sand.

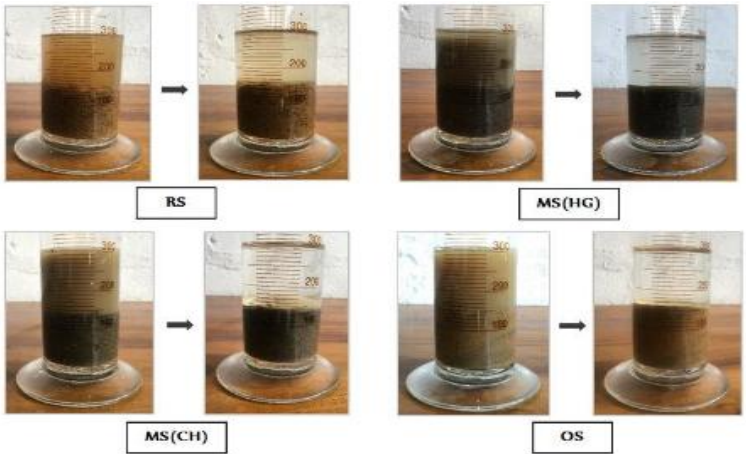

Fig 3.1: Bulking of sand

Try: Demonstrate the following

1. Define the term "bulking of sand" and explain the underlying reason for this phenomenon..
2. Discuss the practical implications of bulking of sand in construction projects, particularly in concrete mix design.

4. Aggregate Crushing and Impact value:

4.1 Determining of Aggregate Crushing Value (ACV):

This test is a standard test used to assess the quality of aggregates, specifically their resistance to crushing under a gradually applied compressive load in fig 4.1. This test is important because the strength of aggregates plays a significant role in the strength and durability of concrete and asphalt mixtures used in construction.

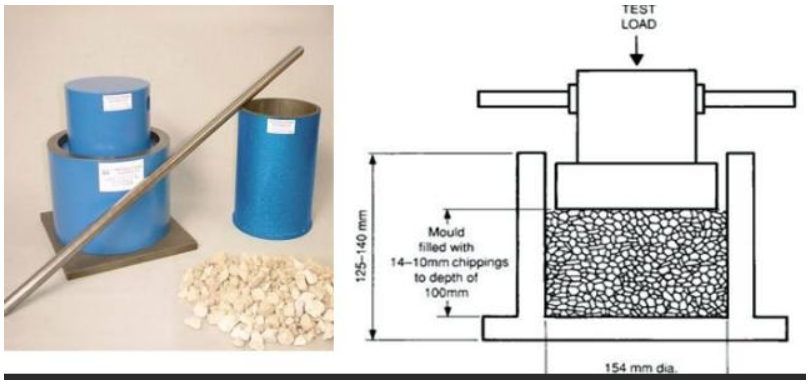

Fig 4.1: Aggregate Crushing test

4.2 Determining of Aggregate Impact Value (ACV):

This test is a standard test used to determine the resistance of aggregates to sudden impacts or shock in fig 4.2. This test is important in assessing the suitability of aggregates for road construction and other applications where they may be subjected to impact loads.

Fig 4.2: Aggregate Impact Test

Try: Demonstrate the following

1. Define the aggregate crushing value (ACV) test.
2. Describe the equipment and procedure used to conduct the ACV test on a given sample of coarse aggregate.
3. Define the aggregate impact value (AIV) test and its relevance in evaluating the impact resistance of aggregates.

5. Workability tests on Fresh Self-compacting concrete:

5.1 Self compacting concrete:

Self-compacting concrete (SCC), also known as self-consolidating concrete, is a specialized type of high-performance concrete that has the ability to flow and fill formwork under its own weight without the need for mechanical vibration or compaction in fig 5.1. It is designed to be highly workable and easily flow into even the most intricate and congested reinforcement without segregation.

I. Slump flow test
II. V-Funnel test
III. L-Box test
IV. J-Ring test
V. T50 Test

Fig 5.1: Workability tests

Try: Demonstrate the following

1. Explain the purpose of the slump flow test in assessing self-compacting concrete

(SCC) workability.

2. What is the T50 test, and how does it help in characterizing the workability of self-compacting concrete (SCC)?

6. Air Entrainment test on fresh concrete:

6.1 Introduction:

This test on fresh concrete is essential for determining the amount of air trapped within the concrete mixture. Air entrainment is the intentional addition of tiny air bubbles to concrete to improve its durability and resistance to freeze-thaw cycles in fig 6.1. The test ensures that the desired amount of air entrainment is achieved and meets project specifications.

Fig 6.1: Air Entrainment test

Try: Demonstrate the following

1. Why is the air entrainment test conducted on fresh concrete, and what is its primary purpose in construction projects?
2. What is the role of the pressure meter (air meter) in the test procedure, and how does it measure air content?

7. MARSH CONE TEST

7.1 Introduction

Marsh Cone Test, also known as the Modified Marsh Funnel Test, is a standard test used to determine the viscosity or flow properties of drilling fluids or slurries, particularly in the field of drilling and wellbore construction in fig 7.1. This test is crucial in the oil and gas industry and geotechnical engineering to assess the flow characteristics of drilling muds and slurries used during drilling operations.

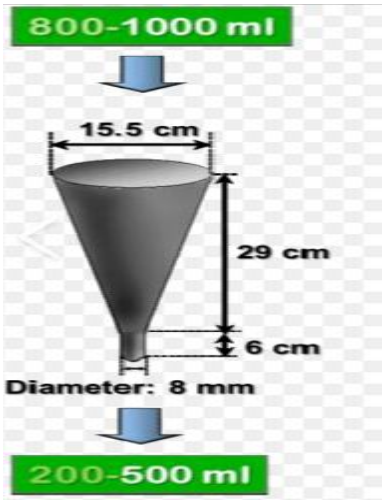

Fig. 7.1. Marsh Cone test

7.2 Functions of Marsh cone test

Its primary purpose is to evaluate the viscosity and flow properties of drilling fluids or slurries, and it provides valuable information for optimizing drilling performance and borehole stability. Here are the key functions of the Marsh Cone Test:

- Viscosity Assessment
- Flowability Evaluation
- Quality control

7.3 Precautions

- Wear appropriate PPE, including gloves and safety goggles.
- Ensure proper ventilation and emergency preparedness.
- Calibrate equipment regularly and keep it clean.
- Collect representative and well-mixed samples.

.

Try: The following questions are to be answered about the Marsh cone test

1. What is the primary purpose of the Marsh Cone Test in drilling operations?
2. Why is it important to ensure that the Marsh Cone is set up on a level and stable surface during the test?

8. Permeability of Concrete

This test is essential to assess its ability to resist the penetration of water or other fluids. The permeability of concrete can be evaluated through various laboratory and field tests in fig 8.1.

8.1 Steps involved in determining Permeability of Concrete

Here are the steps to determine the Permeability of Concrete:

I. Sample Preparation
II. Conditioning
III. Selecting the Permeability Test Method
IV. Testing Apparatus Setup
V. Specimen Installation
VI. Testing and Data Collection
VII. Data Analysis

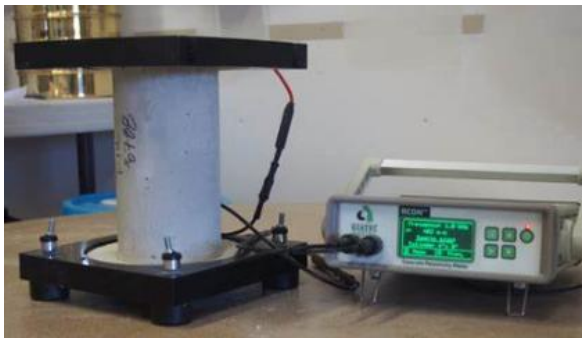

Fig 8.1: Permeability of concrete

Try: The following questions are to be answered about the permeability of concrete.

1. What is permeability in the context of concrete, and why is it an important property to assess in construction?
2. What are some specific examples of durability issues that can arise due to high permeability in concrete?

9. Non Destructive Testing of Concrete:

9.1: Introduction

Non-destructive testing (NDT) of concrete is a group of methods and techniques used to assess the condition, quality, and properties of concrete structures without causing any damage to the material. NDT methods are valuable for inspecting existing structures, ensuring the quality of new construction, and evaluating concrete in a variety of applications.

9.2: Non-destructive tests:

Here are some common non-destructive testing methods in fig 9.1 for concrete: Setup and Instrument Calibration

I. Ultrasonic Pulse Velocity (UPV)
II. Rebound Hammer Test (Schmidt Hammer)
III. Ground-Penetrating Radar (GPR)
IV. Electromagnetic Induction (EMI)
V. Acoustic Emission Testing

Fig.9.1. Non destructive tests

Try: The following questions are to be answered about the Non-destructive tests of concrete.

1. How does the Ultrasonic Pulse Velocity (UPV) method work in assessing the condition of concrete?
2. Describe the principle behind the rebound hammer test and its application in evaluating concrete strength?

10. Accelerated Curing of Concrete

10.1: Introduction

Accelerated curing of concrete is a process that is used to speed up the normal curing time of concrete, allowing it to gain strength and achieve its desired properties more quickly. This is particularly useful in construction projects where fast-setting or early strength development is required.

Fig. 10.1 Accelerated curing tank

10.2: Functioning of Accelerated Curing of Concrete

The purpose of an accelerated curing tank, also known as a curing chamber or curing tank, is to provide controlled conditions for the accelerated curing of concrete specimens. This equipment is commonly used in laboratories, quality control, and research settings in the construction industry. The primary purposes of an accelerated curing tank are:

1. Speeding Up Curing Time
2. Quality Control
3. Research and Development
4. Meeting Project Deadlines
5. Simulating Real-World Conditions
6. Comparative Testing
7. Certification and Compliance

Try: The following questions are to be answered about accelerating curing tank.

1. What are the common methods used for accelerating the curing of concrete?
2. What are the primary benefits of accelerated curing in concrete construction, and in what types of construction projects is it most commonly used?

11: Influence of W/C Ratio on Strength And Aggregate / Cement Ratio

11.1: Introduction

The water-to-cement (W/C) ratio and the aggregate-to-cement ratio (A/C) are critical factors in concrete mix design, and they have a significant influence on both the

workability and strength of the concrete.

In concrete mix design, achieving the right balance between the W/C ratio and the A/C ratio is essential in fig 11.1. Engineers and concrete professionals carefully consider these ratios, along with other factors like admixtures, curing conditions, and environmental exposure, to design concrete mixes that meet the specific requirements of a project while optimizing strength, workability, and durability.

Hint:

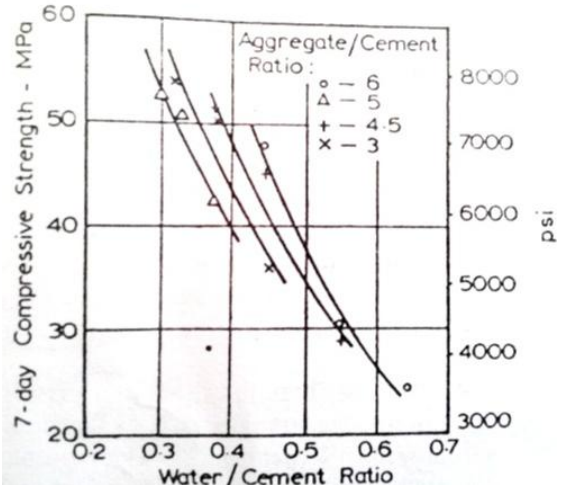

Fig 11.1: Water cement ratio

Try: The following questions are to be answered about Influence of W/C Ratio on Strength and Aggregate / Cement Ratio.

1. How does the W/C ratio affect the compressive strength of concrete, and what is the general trend when increasing the W/C ratio?.
2. How does the A/C ratio influence both the workability and the compressive strength of concrete mixes?

12. Influence of Different Chemical Admixtures on Concrete

12.1: Introduction

Chemical admixtures are additives used in concrete to enhance or modify its properties and performance in fig 12.1. Different types of chemical admixtures can have various influences on concrete.

Here's a broad overview of the influence of different chemical admixtures on concrete:

I. Water Reducers (Plasticizers)
II. Super plasticizers
III. Air-Entraining Admixtures
IV. Retarding Admixtures
V. Shrinkage -Reducing Admixtures

Fig 12.1: Chemical admixture

Try: The following questions are to be answered about Influence of different chemical admixtures on concrete.

1. What is the primary purpose of water-reducing admixtures (plasticizers) in concrete, and how do they affect the workability of the mix?
2. What is the purpose of air-entraining admixtures in concrete, and how do they enhance durability in freeze-thaw conditions?

V. TEXTBOOKS

1. Shetty, M.S., "Concrete Technology, Theory & Practice", 8th Edition, S. Chand and Co, 2018.
2. Gambhir, M.L., "Concrete Technology", 5th Edition ,Tata McGraw Hill,2013.

VI. REFERENCE BOOKS:

1. Hemanth sood and LN Mittal, —Laboratory Manual on Concrete Technology, CBS Publishers Pvt. Ltd., New Delhi, 2016.
2. Khanna S.K & Justo C.E.G. —Pavement materials and testing, Tata McGraw Hill Education10th Edition, 2018.

VII. WEB REFERENCE BOOKS

1. https://www.iare.ac.in/sites/default/files/lab1/IARE Advanced Material Testing laboratory.pdf
2. https://www.nitw.ac.in/ce/syllabus/material testing-lab.pdf