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

COURSE CONTENT

CONCRETE TECHNOLOGY LABORATORY								
IV Semester: CE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACEC11	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		0	0	2	1	30	70	100
Contact Classes:	**Total Tutorials:**	**Total Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Engineering Geology Laboratory								

I. COURSE OVERVIEW:

Concrete technology 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, and it also enable the students to acquire knowledge on special and new generation concrete with their applications.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The factors influencing workability and methods involved in measuring workability of fresh concrete.
II. Importance of water/cement ratio and its influence on compressive strength of hardened concrete.
III. Concepts of quality control and design of concrete mix for ensuring quality of concrete.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1 Explain the basic properties of cement and aggregates for determining their suitability through various laboratory tests.
CO 2 Examine the physical properties of cement in laboratory for the concrete mix design.
CO 3 Determine the mechanical properties of aggregate for good workability of concrete.
CO 4 Compare the compressive strength of concrete with different types fibers for the use of suitable fibers in concrete.
CO 5 Make use of recycled aggregate in place of coarse aggregate in concrete for the reduction of environmental concerns.
CO 6 Develop the concrete without cement for the reduction of carbon footprint in the atmosphere.

IV. COURSE CONTENT:

EXPERIMENTS ON CONCRETE TECHNOLOGY LABORATORY

Note: Students are encouraged to proper dress code field practice sessions.

Safety

Safety is a vital issue in all workplaces. Before using any equipment and machines or attempting practical work in a laboratory everyone must understand basic safety rules. These rules will help keep all safe in the laboratory.

Safety Rules

1. New students must receive an orientation on laboratory operating procedures before working in a laboratory.
2. Students shall publish a safety checklist for equipment for which they are responsible.
3. Students must read the safety checklist for each piece of equipment before operating it.
4. Ensure you know the location of the emergency stop button before starting equipment.

Getting Started Exercises

Introduction to Concrete Technology laboratory

In its simplest form, concrete is a mixture of cement paste and aggregates. The paste, composed essentially of Portland cement and water, coats the surface of the fine (small) and coarse (larger) aggregates. Through a series of chemical reactions called hydration, the paste hardens and gains strength to form the rock-like mass known as concrete. This laboratory mainly deals with the quality control of materials used in concrete.

1. FINENESS, NORMAL CONSISTENCY AND SETTING TIME OF CEMENT

1.1. Fineness by Sieving method:

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. Finer cement offers a greater surface area for hydration and hence the faster and greater the development of strength. Fineness of cement is to tested based on IS 4031(Part 1):1996.

Determine the fineness of cement sample.

Try: fineness of different grades of cement

1.2. Normal consistency of cement

A certain minimum quantity of water is required to be mixed with cement so as to complete chemical reaction between water and cement Fig.1 shows the Vicat apparatus used for this experiment.

Find the normal consistency of cement sample.

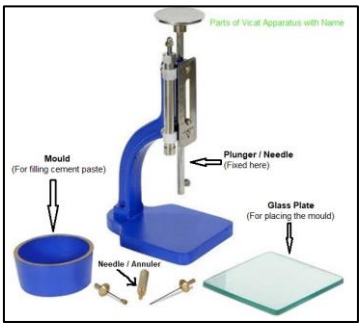

Fig. 1 Vicat Apparatus

Try: Normal consistency of different grades of cement

1.3. Initial and final setting times of cement

Initial setting is a stage where the cement paste stiffens to such an extent that the Vicat needle (Fig.1) is not permitted to move down through the paste within 5 ± 0.5 mm measured from the bottom of the mould. In other words, the cement paste starts losing its plasticity. The time elapsed between the moments that the water is added to the cement to the initial set is regarded as initial setting time.
Final setting time is the time when the paste becomes so hard that the annular attachment to the needle under standard weight only makes an impression on the hardened cement paste. These both tests are confirming to IS: 4031 (Part 5) – 1988.

Determine the initial and final setting time of cement sample.

Try: Setting times of 33, 43 and 53 grades of cement.

2. SPECIFIC GRAVITY, SOUNDNESS AND COMPRESSIVE STRENGTH OF CEMENT

2.1. Specific gravity of cement

Specific gravity is defined as the ratio between weight of a given volume of material and weight of an equal volume of water. To determine the specific gravity of cement, kerosene is used which does not react with cement.

Determine the specific gravity of given cement sample.

Try: Specific gravity of cement and fly-ash

2.2. Soundness of cement

One of the most important properties of cement is its soundness (IS 4031(Part 3):1988) (Fig.2).

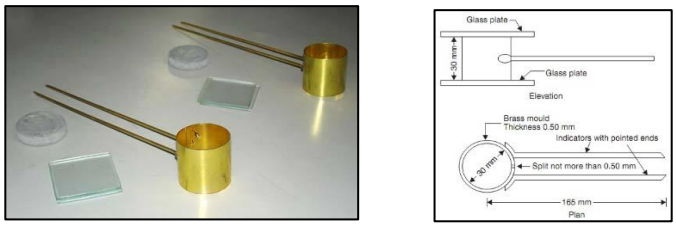

Fig. 2 Le-Chatelier Apparatus

The apparatus for conducting the test consists of small split cylinder of spring brass or other suitable metal of 0.5mm thickness forming a mould 30 mm internal diameter and 30mm high.

Find the soundness of given cement sample.

Try: Soundness of 33,43 and 53 grades of cement

2.3. Compressive strength of cement

The compressive strength of cement mortars is determined in order to verify whether the cement conforms to IS specifications (IS 4031 (Part 6) – 1988) and whether it will be able to develop the required compressive strength of concrete. The average compressive strength of at least three mortar cubes (area of the face 50 cm2) composed of one part of cement and three parts of standard stand should satisfy IS code specifications. Determine the compressive strength of cement.

Try: Compressive strength of 33,43 and 53 grades of cement

3. BULKING OF SAND, FINENESS MODULUS OF FINE AND COARSE AGGREGATES

3.1. Bulking of sand:

Increase in volume of sand due to presence of moisture is known as Bulking of sand.

Find the bulking of given sand.

Try: Bulking of different grades of sand

3.2. Fineness modulus of fine and coarse aggregate:

Fineness modulus is a numerical index used to know the mean size of particle in the total quantity of aggregate.

Determine the fineness modulus of fine and coarse aggregate.

Try: Fineness modulus of sand, manufactured sand and coarse aggregate.

4. WORKABILITY TESTS ON FRESH CONCRETE

4.1. Slump Cone Test

Workability is a property of raw or fresh concrete mixture. In simple words, workability means the ease of placement and workable concrete means the concrete which can be placed and can be compacted easily without any segregation. Consistency is a general term to indicate the degree of fluidity or the degree of mobility (Fig. 3). Determine the slump of given concrete.

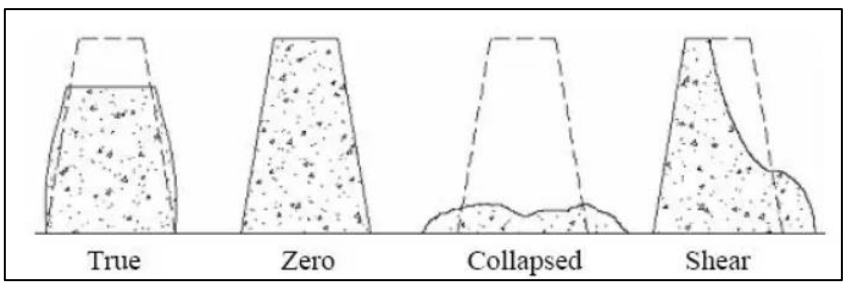

Fig. 3 Slump of concrete

Try: Slump of concrete with different water/cement ratios.

4.2. Compaction Factor Test

The compaction factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. The compacting factor test (Fig. 4) is designed primarily for use in the laboratory but it can also be used in the field.

Determine the compaction factor of fresh or raw concrete.

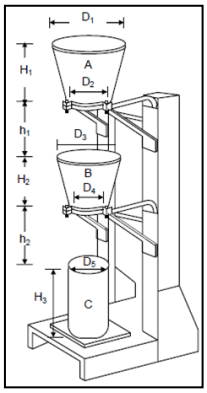

Fig. 4 Compaction Factor test

Try: Compaction factor of concrete with different water/cement ratios.

5. COMPRESSIVE STRENGTH OF CEMENT CONCRETE

Concrete is very strong in compression. It is assumed that whole of the compression will be taken up by the concrete while designing any RCC structure. The most important strength test for concrete is the compression test.

Find the compressive strength of hardened concrete.
Age at Test: - Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days.

Try: Compressive strength of M30 and M40 concrete.

6. NON-DESTRUCTIVE TESTING OF CONCRETE:

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

I. Rebound Hammer Test (Schmidt Hammer)
II. Ultrasonic Pulse Velocity (UPV)

6.1. Rebound hammer test:

Rebound hammer (or) Schmidt's Rebound Hammer (Fig. 3) is an instrument that consists of a spring control hammer that slides on a plunger within a tubular housing. It is commonly used for measuring the surface hardness of concrete (IS13311 – Part 2).

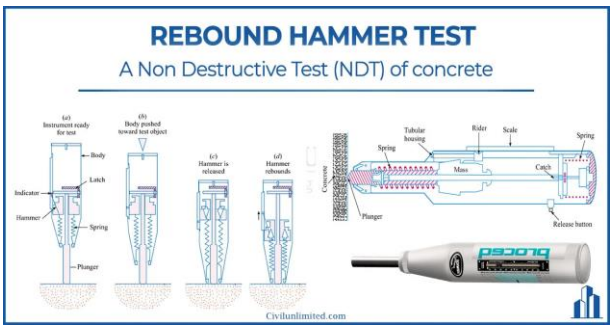

Fig. 3 Rebound hammer test

Rebound hammer test is based on the principle that the rebound of an elastic mass depends on the hardness of the concrete surface against which the mass strikes. The compressive strength can be read directly from the graph provided on the body of the hammer.

Verify the compressive strength of concrete using rebound hammer.

Try: Compressive strength of concrete in different parts of existing structure.

6.2. Ultrasonic pulse velocity test:

This is one of the most commonly used method, in which the ultrasonic pulses (fig. 4) are transmitted through the concrete (IS13311 – Part 1).

Verify the quality of concrete using ultrasonic pulse velocity test.

Fig. 4 Non-destructive tests

Try: Quality of concrete in different parts of existing structure.

7. INFLUENCE OF FIBERS IN CONCRETE:

Fiber-reinforced concrete (FRC) is concrete containing fibrous material (Fig. 5.) which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented.

1. Determine the compressive strength of concrete using steel fibers.
2. Find the strength of M20 concrete using glass fibers.

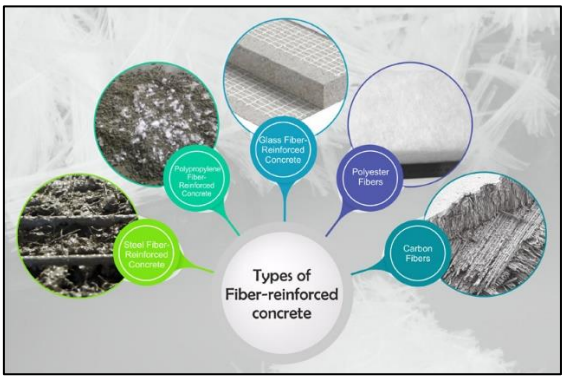

Fig. 5 Different fiber reinforced concrete

Try: Compressive strength of M20 concrete with different percentages of fibers in concrete

8. CONCRETE WITH AGRICULTURE WASTE:

Agricultural wastes used as fine aggregate in concrete are sugarcane bagasse ash, groundnut shell, oyster shell, sawdust, giant reed ash, rice husk ash, cork and tobacco waste (Fig. 6). These are used as partial replacement of fine aggregate which provide additional pozzolanic property in concrete.

1. Find the properties of agriculture waste materials.
2. Determine the compressive strength of concrete with agriculture waste.

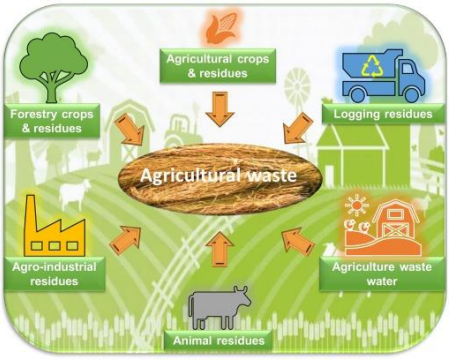

Fig. 6 Different sources of agriculture waste

Try: Compressive strength of M25 concrete with different percentages of agriculture waste in concrete.

9. RECYCLED AGGREGATE CONCRETE:

Recycled Aggregate Concrete (RAC) is basically concrete mix that is prepared from crushed aggregates and concrete which has already been used in construction works. Use of good quality materials all the time is not a sign of good engineering as it can be costly and energy and natural resources consuming. From this point of view, the idea of recycling of concrete to produce recycled aggregate (RA) is developed.

1. Examine the properties of recycled aggregate.
2. Determine the strength of concrete using recycled aggregate.

Try: Compressive strength of M30 concrete with different percentages of recycled aggregate in concrete

10. GEO-POLYMER CONCRETE:

Geopolymer concrete (GPC) is a new material in the construction industry, with different chemical compositions and reactions involved in a binding material. The pozzolanic materials (industrial waste like fly ash, ground granulated blast furnace slag (GGBFS), and rice husk ash), which contain high silica and alumina, work as binding materials in the mix. Geopolymer concrete is economical, low energy consumption, thermally stable, easily workable, eco-friendly, cementless, and durable.

1. Design the mix constituents of the concrete without cement.
2. Find the compressive strength of geo-polymer concrete.

Try: Compressive strength of M35 geopolymer concrete with different percentages of supplementary materials

11. CONCRETE WITH WASTE PLASTICS:

Plastic waste management is of global concern while construction industry keeps searching for innovations to become more sustainable. In this scenario, recycling plastic waste as fibers for reinforcement of concrete stands out as a promising alternative to address both problems.

1. Find the tensile properties of plastic fibers used in concrete.
2. Determine the compressive strength of concrete with plastic aggregates.

Try: Compressive strength of M40 concrete with different percentages of fibers in concrete.

12. BRICKS:

Bricks are the most common and useful building materials used for masonry construction works. To build a long-lasting structure we should always use good quality bricks and other building materials. In our previous article, we have already discussed the types of bricks used in construction. Today we will discuss some important brick tests to determine the quality of bricks.

12.1. Compressive Strength of brick:

Crushing strength of bricks is determined by placing brick in compression testing machine. After placing the brick in compression testing machine, apply load on it until brick breaks (Fig.10).

1. Find the compressive strength of red brick.
2. Determine the size properties of red bricks.

Fig.10. Compressive Strength test on brick

Try: Compressive strength of hollow brick, plastic mixed brick and fly-ash brick

12.2. Water absorption in brick

Absorption test is conducted on brick to find out the amount of moisture content absorbed by brick under extreme conditions (Fig.11). For a good quality brick, the amount of water absorption should not exceed 20% of weight of dry brick.

1. Determine the percentage of water absorption of bricks.
2. Find the sorpitivity of the concrete bricks.

Fig.11. Absorption test of bricks

Try: Percentage of water absorption of hollow brick, plastic mixed brick and fly-ash brick

13. PERVIOUS CONCRETE:

Pervious concrete (Fig.13) is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge.

1. Determine the aggregate properties of pervious concrete.
2. Find the strength and permeability of pervious concrete.

Fig. 13. Pervious concrete

Try: M35 concrete with different sizes of aggregate in concrete

14. ULTRA HIGH-PERFORMANCE CONCRETE:

Ultra-High-Performance Concrete (UHPC), is also known as reactive powder concrete (RPC). The material is typically formulated by combining portland cement, supplementary cementitious materials, reactive powders, limestone and or quartz flour, fine sand, high-range water reducers, and water. The material can be formulated to provide compressive strengths in excess of 200 MPa.

1. Design the mix proportions of UPHC.
2. Determine the compressive strength of UPHC.

Try: M250 Ultra-high-performance concrete with fibers

V. TEXT BOOKS:

1. M. S. Shetty, “Concrete Technology”, S. Chand and Co, 4th edition, 2005.
2. Gambhir, M.L., Concrete Technology, Tata McGraw Hill, 5th edition, 2013.

VI. REFERENCE BOOKS:

1. V.N.Vazirani & S.P.Chandola, Concrete Technology, 6th edition, 2015.
2. Santakumar A.R., Concrete Technology, Oxford University Press, 4th edition, 2007.

VII. ELECTRONICS RESOURCES:

1. http://nptel.ac.in/courses/105102012/
2. http://nptel.ac.in/courses/105104030/

VIII. MATERIALS ONLINE:

1. Course Description
2. Laboratory manual