COURSE CONTENT

CONCRETE MATERIALS LABORATORY								
IV Semester: CE								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
ACED11	Core	0	0	2	1	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Nil								

I. COURSE OVERVIEW:

Concrete material 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. COURSE OBJECTIVES:

The students will try to learn:

I. Fundamental properties of construction materials like cement, aggregates and admixtures based on laboratory and field tests for identifying material quality.
II. The factors influencing workability and methods involved in measuring workability of fresh concrete.
III. Importance of water/cement ratio and its influence on compressive strengths of hardened concrete.
IV. Concept of quality control and design of concrete mix for ensuring quality of concrete.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1 Demonstrate the basic properties of cement and aggregates for determining their suitability through various laboratory tests.
CO 2 Determine physical and chemical properties of cement in laboratory for deciding its suitability in construction practice.
CO 3 Determine the specific gravity of cement for estimating quantity in mix design.
CO 4 Examine the fineness modulus of aggregates and bulking of sand for producing good quality concrete.
CO 5 Measure the workability of fresh concrete for identifying the condition of plastic concrete.
CO 6 Determine Compressive strength of cement concrete for accepting in construction practice.

IV. COURSE CONTENT:

EXCERCISES ON ENGINEERING SURVEYING LABORATORY

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

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

2. Introduction

The objective of concrete laboratory is to determine the physical properties of building construction materials like cement, fine and coarse aggregate, steel, wood, and strength characteristics of cement mortar, plain cement concrete and reinforced cement concrete. The tests include determination of specific gravity, fineness, normal consistency, setting times, workability and soundness of cement, fineness modulus of fine and coarse aggregate, strength of cement mortar, cement concrete and bricks, tensile test on steel rods, bending and flexural strength on concrete, bending test on wood, and non-destructive test on concrete. The students will be able to infer the suitability of these materials for construction. They can design the mix, make the specimens and test the same for the strength for comparison with design strength. This laboratory course will help the students to understand the theoretical concepts learned in the course building materials.

2. Fineness of cement and normal consistency of cement

2.1 Determine the percentage of residue of a given sample of cement on 90 micron I.S. sieve and assess the rate of hydration of cement when water is added to it using Fig.2.1.

Fig.2.1. Weighing machine and sieve set

2.2 Determine the quantity of water required to produce a cement paste of standard consistency. It is used as a parameter for other tests like setting time, soundness and compressive strength test of Cement. As shown in Fig.1.2.

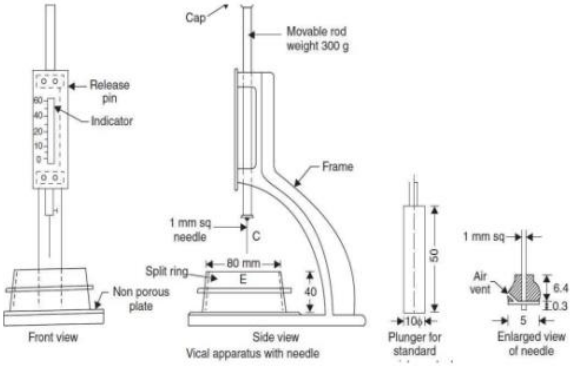

Fig.1.2 Normal consistency of cement

Try:

1. What is the field test to test the fineness of cement.
2. Enumerate the advantages and disadvantages of using finer cement.
3. What is meant by normal consistency? Why it is determined.
4. Discuss the effect of different cement grades on normal consistency

3. Initial and Final setting times of cement and Specific gravity of cement

3.1 Determine the initial and final setting times for the given sample of cement, to know the time of mixing and placing of cement mortar / concrete at site and also the undisturbed time to be allowed after placement. as shown in Fig.3.1.

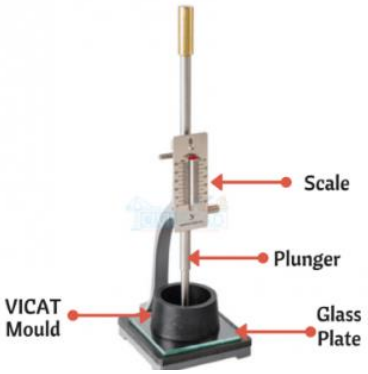

Fig.3.1 Vicat Apparatus

3.2 Determine the specific gravity of given sample of hydraulic cement. as shown in Fig.3.2.

Fig.2.2 Specific gravity of cement

Try:

1. List out the factors which affect setting times.
2. Does setting time vary with grade of cement? Explain your answer.
3. Describe significance of each setting time.
4. Why water cannot be used for determination of specific gravity of cement. If the air bubbles are not completely removed from the flask, how the results will be affected.

4. Compressive Strength of Cement and Soundness of Cement

4.1 Determine the compressive strength of standard cement mortar cubes compacted by means of standard vibration machine. This test is not made on neat cement paste because of difficulties of excessive shrinkage and subsequent cracking of neat cement as shown in Fig.4.1.

Fig.4.1 Compression testing machine

4.2 Determine the soundness of cement refers to the stability of the volume change in the process of setting and hardening and is ensured by limiting the quantities of free lime, magnesia and sulphates as these compounds undergo a large change in volume as shown in Fig.4.2.

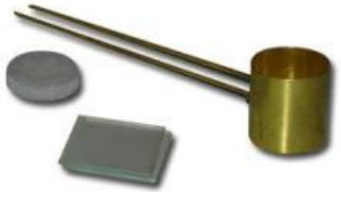

Fig.4.2 Soundness of cement

Try

1. Why strength test is not made on cubes of only cement paste.
2. What will happen if the rate of application of load is more than the specified value.
3. What is the compressive strength for ordinary Portland cement at 3 days.

4. What is the purpose of boiling the setup.

5. Fineness Modulus of Fine and Coarse aggregate and bulking of sand

5.1 Determine the fineness modulus of Fine and Coarse aggregate by performing sieve analysis with standard sieves, need to perform sieve analysis and for sieve sizes, mechanical shaker and digital weigh scale are required as shown in Fig.4.1.

Fig.4.1 Fineness Modulus of Fine and Coarse aggregate

5.2 Determine the bulking phenomena of given sample of sand, to make necessary adjustment for the bulking of fine aggregate test to be used in volume batching of nominal mix concrete as shown in Fig.4.2.

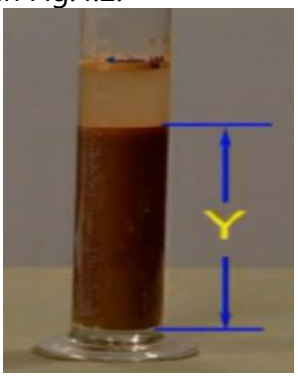

Fig.4.2 Bulking of Sand

Try:

1. What is the significance of bulking of sand experiment.
2. What is the effect of moisture on bulking.
3. What is the difference between the density and bulk density.
4. What is meant by bulking of sand? Why it happens

6. Workability tests on fresh concrete

6.1 Concrete slump test is to determine the workability or consistency of concrete mix prepared at the laboratory or the construction site during the progress of the work as shown in Fig.6.1.

Fig.6.1 Slump Cone Test

6.2 Determine the workability of concrete by compaction factor test, consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction as shown in Fig.6.2.

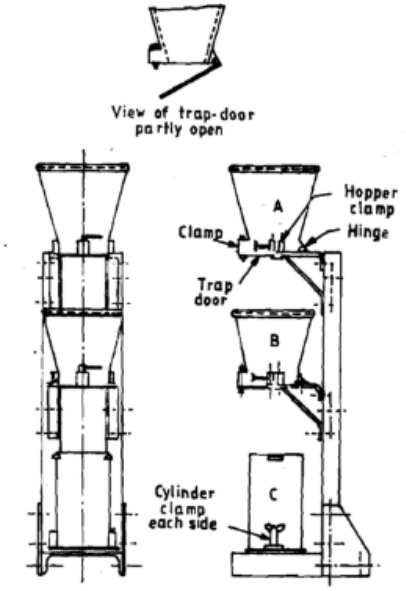

Fig.6.2 Compaction Factor Test

Try:

1. What is segregation of concrete.
2. What is the standard w/c value for nominal mix of concrete.
3. How many types of tests are there to find workability.
4. What is the slump value for medium workability.

7. Beam Column Joint

7.1 Determine the compressive strength of concrete cubes by compression testing machine in terms of the characteristic compressive strength of 150 mm size cubes tested at 28 days (f_{ck})- as per Indian Standards (ACI standards use cylinder of diameter 150 mm and height 300 mm) as shown in Fig.7.1.

Fig.7.1 Compression testing machine

7.2 Determine the e Flexural Strength of Concrete, which comes into play when a road slab with inadequate sub-grade support is subjected to wheel loads and / or there are volume changes due to temperature / shrinking as shown in Fig.7.2.

Fig.7.2 Split tensile strength

Try:

1. How compressive strength of concrete is is measured.
2. What should be the compressive strength of concrete at 7 days.
3. What happens if we test a wet cube in a compressive strength test machine.
4. How long does it take to concrete to reach its full strength.
5. What is the effect of W/C ratio on compressive strength of concrete.

8. Air entrainment test on fresh concrete

8.1 Determine the air content in fresh concrete of normal density is typically performed using the pressure method by Air entrainment test equipment, this test method is intended for use with concrete made with relatively dense aggregates as shown in Fig.7.1.

Fig.8.1 Air-entrainment test

8.2 Determine the workability of freshly mixed concrete by using of Vee – Bee consistometer apparatus, measures the relative effort required to change a mass of concrete from one definite shape to another (i.e., from conical to cylindrical) by means of vibration. as shown in Fig.8.2

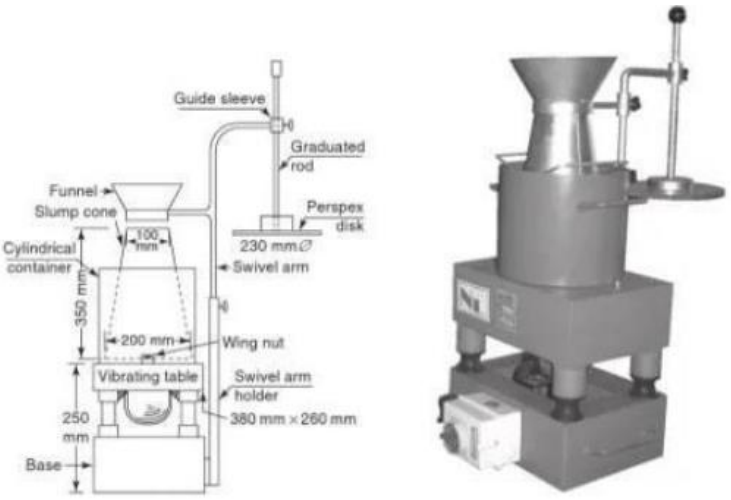

Fig.8.2 Vee-Bee apparatus

Try:

1. What is Concrete Maturity.
2. What is the standard value of vee – bee time for stiff plastic workability.
3. What is Segregation of concrete.
4. What is bleeding of concrete.

9. Permeability of Concrete

9.1 Determine the durability tests of concrete are to determine permeability of water through specimen. Permeability apparatus is used for determining the permeability of cement concrete specimens of 15cm cubes cast in the laboratory as shown in Fig.8.1.

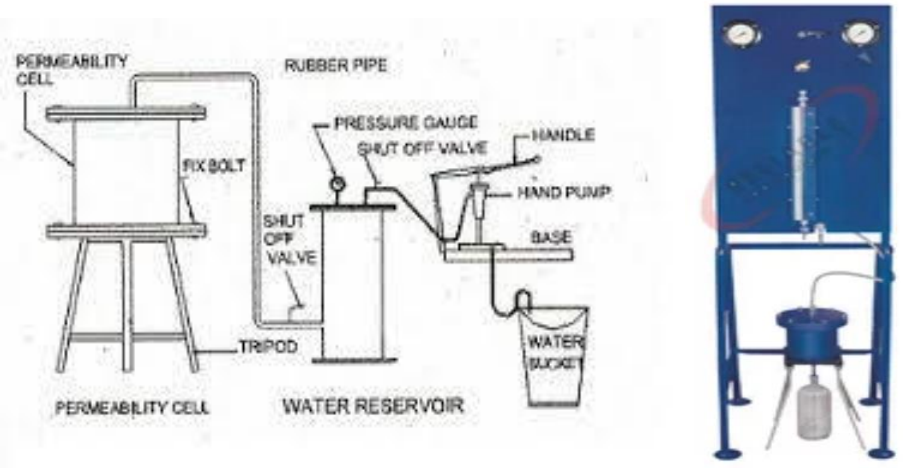

Fig.9.1 Permeability apparatus

9.2 Determine the fresh cement paste permeability is a key parameter to understand the hydro-mechanical behavior of cement-based materials, i.e., rhelogical properties and static stability. However, its permeability measurement is not easy to assess. The porous medium is not rigid and tends to change due to hydration kinetics as shown in Fig.9.2.

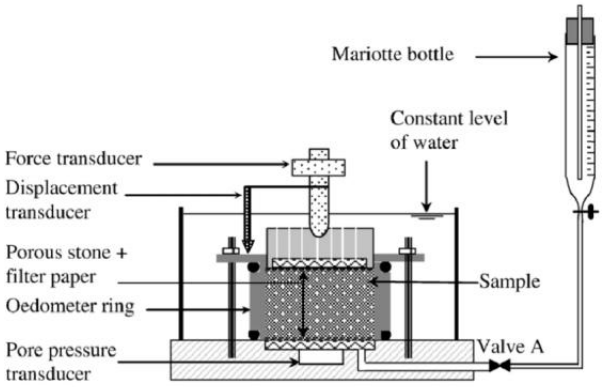

Fig.9.2 Cement paste permeability apparatus

Try:

1. Influence of concrete permeability on W/C ratio and curing period.
2. Role of permeability in the long-term durability of concrete.
3. What are the rapid-test procedures are ava i lab le for estimating permeability.
4. What is the correction factor of a sieve? Explain its necessity.

10. Non-Destructive testing of concrete

10.1 Determine the comprehensive strength compressive strength and other properties of concrete from the existing structures of harden concrete by Rebound Hammer as shown in Fig.10.1.

Fig.10.1 Rebound hammer

10.2 Determine the time of travel of an ultrasonic pulse passing through the concrete to obtain quality of concrete by ultrasonic pulse velocity method as per IS: 13311 (Part 1) – 1992 as shown in Fig.10.2.

Fig.10.2 Ultrasonic Pulse Velocity Tester

Try:

1.Which among the following is not a type of Non-destructive testing.
a) Compression test
b) Visual testing
c) Ultrasonic testing
d) Eddy current testing
2. List out various equipment used in NDT.
3. . During radiography test, which region absorbs less radiation and transmits more.

11. Accelerated curing of concrete

11.1 Determine the compressive strength of cubes by accelerated curing of concrete an Accelerated Cured concrete test is a process of checking the specimen cube within 28 hours and determining the quality of the concrete as shown in Fig.11.1

Fig.11.1 Accelerated curing of concrete

11.2 Determine the flexural Strength of Concrete, which comes into play when a road slab with inadequate sub-grade support is subjected to wheel loads and / or there are volume changes due to temperature / shrinking as shown in Fig.10.2

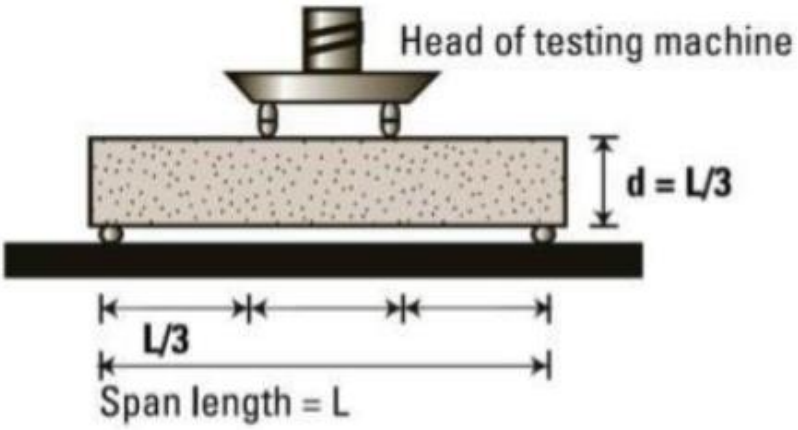

Fig.10.2 Flexural Strength Test

Try:

1. What are the standard dimensions of the beam mould.
2. What are the precautions to be taken while place the specimen.
3. What should be the compressive strength of concrete at 7 days.
4. What is the compressive strength of M30 grade concrete.

12. Influence of W/C ratio on strength and aggregate / cement ratio on workability and strength

12.1 Determine the ratio of the amount of water to the amount of cement used (both by weight) is called the water to cement ratio (w/c), is required for hydration i.e to complete all chemical reactions and 15% water is entrapped in between the voids of cement as shown in Fig.12.1

Fig.12.1 Compression testing machine

12.2 Determine the flow of concrete by calculating the flow diameter as the percent increase in the average diameter of the spreading concrete relative to the mold's base diameter as shown in Fig.12.2

Fig.12.2 Flow table test apparatus

Try:

1. What is the effect of W/C ratio on compressive strength of concrete.
2. Mention the factors those affect the compressive strength of concrete.
3. What is butting of concrete mixture? Why is it done.
4. How does strength correlate with other properties of hardened concrete.
5. What is the height of raising and dropping of the table.

13. Marsh cone test

13.1 Determine the percentage of water required to prepare cement past to determine workability of self –compacting concrete with small variations in the amount of superplasticizer additive. For this reason, large number of tests is required to monitor its workability as shown in Fig.12.1

Fig.12.1 Marsh Cone Test

13.2 Determine the workability of self-compacting concrete by slump flow test is used assess the horizontal free flow of in the absence of obstructions as shown in Fig.12.2

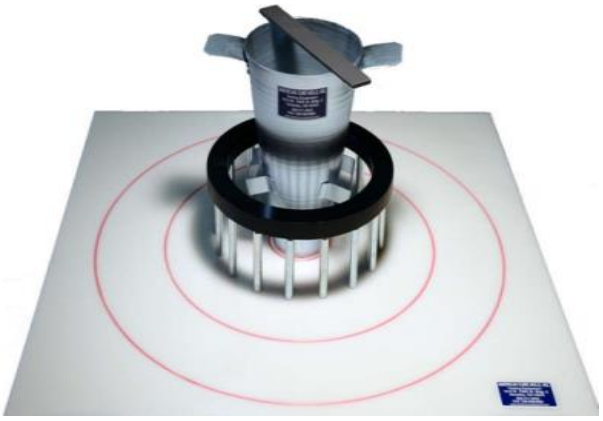

Fig.12.1 Slump Flow Test

Try:

What is the slump value for medium workability.

1. How many strokes for each layer for this experiment.
2. How to improve the workability of concrete.
3. How much amount of concrete is required for this test.

14. Workability tests on fresh self-compacting concrete

14.1 Determine the properties such as filling ability, passing ability and segregation resistance. Various workability tests methods are available for self-compacting concrete such as slump flow tests, V-funnel test, L-box test, U-Box test, Fill box test as shown in Fig.14.1

Fig.14.1 L-box test

14. Determine the workability of V-funnel flow time for SCC needs to pass a narrow opening and gives an indication of the filling ability of SCC provided that blocking and/or segregation do not take place; the flow time of the V-funnel test is to some degree related to the plastic viscosity as shown in Fig.14.2

Fig.14.2 V-funnel test

Try:

1. What is the significance of conducting the experiment.
2. What are the dimensions of the L – Box
3. What is the Vee-Bee time for medium degree of workability.
4. Explain any two tests for determining the workability of concrete.

V. TEXT BOOKS:

1. Hemanth Sood and LN Mittal, "*Laboratory Manual on Concrete Technology*", CBS Publishers Pvt. Ltd., New Delhi, 2nd Edition, 2013.
2. Khanna S.K and Justo C.E.G., "*Pavement Materials and Testing*" Tata McGraw Hill Education, 2012.

VI. REFERENCE BOOKS:

1. Malik R.S., Meo, G.S., "*Laboratory Manual on Concrete Technology*", Computech Publication Ltd New Asian, 2009.
2. Sikka, V.B., "*Laboratory Manual on Concrete Technology*", S. K. Kataria & Sons, 2013.

VII. ELECTRONICS RESOURCES:

1. https://www.globalgilson.com/concrete-testing-equipment
2. https://iitram.ac.in/labdetail/4
3. https://www.ce.washington.edu/research/facilities/construction-materials
4. https://www.ncbindia.com/testing-services.php
5. https://nptel.ac.in/courses/105102012/

VIII. MATERIAL ONLINE:

1. Course template
2. Lab manual