ADVANCED MATERIAL TESTING

LAB MANUAL

Year	:	2019 - 2020
Course Code	:	ACE109
Regulations	:	IARE - R16
Class	:	III B.Tech II Semester
Branch	:	CE

Prepared by

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CIVIL ENGINEERING

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

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(Autonomous)

Dundigal, Hyderabad - 500 043

Vision
To produce eminent, competitive and dedicated civil engineers by imparting latest technical skills and ethical values to empower the students to play a key role in the planning and execution of infrastructural & developmental activities of the nation.

Mission
To provide exceptional education in civil engineering through quality teaching, state-of-the-art facilities and dynamic guidance to produce civil engineering graduates, who are professionally excellent to face complex technical challenges with creativity, leadership, ethics and social consciousness.

Quality Policy
Our policy is to nurture and build diligent and dedicated community of engineers providing a professional and unprejudicedenvironment, thus justifying the purpose of teaching and satisfying the stake holders. A team of well qualified and experienced professionals ensure quality education with its practical application in all areas of the Institute.

Philosophy
The essence of learning lies in pursuing the truth that liberates one from the darkness of ignorance and Institute of Aeronautical Engineering firmly believes that education is for liberation. Contained therein is the notion that engineering education includes all fields of science that plays a pivotal role in the development of world-wide community contributing to the progress of civilization. This institute, adhering to the above understanding, is committed to the development of science and technology in congruence with the natural environs. It lays great emphasis on intensive research and education that blends professional skills and high moral standards with a sense of individuality and humanity. We thus promote ties with local communities and encourage transnational interactions in order to be socially accountable. This accelerates the process of transfiguring the students into complete human beings making the learning process relevant to life, instilling in them a sense of courtesy and responsibility.

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Program Outcomes	
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complexengineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems anddesign system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modernengineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutionsin societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader indiverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineeringcommunity and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of theengineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage inindependent and life-long learning in the broadest context of technological change.

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Program Specific Outcomes - Aeronautical Engineering	
PSO1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products
PSO2	**Problem solving skills**: imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles
PSO3	**Practical implementation and testing skills**: Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies.
PSO4	**Successful career and entrepreneurship**: To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats
Program Specific Outcomes - Mechanical Engineering	
PSO1	To produce engineering professional capable of analyzing and synthesizing mechanical systems including allied engineering streams.
PSO2	An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.
PSO3	To build the nation, by imparting technological inputs and managerial skills to become technocrats.
Program Specific Outcomes - Civil Engineering	
PSO1	**Engineering Knowledge:** Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.
PSO2	**Broadness and Diversity:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.
PSO3	**Self-Learning and Service:** Graduates will be motivated for continuous self-learning in engineering practice and/ or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.

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ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

EXPT.No.	AERO		ME		CE	
	Program Outcomes Attained	Program Specific Outcomes Attained	Program Outcomes Attained	Program Specific Outcomes Attained	Program Outcomes Attained	Program Specific Outcomes Attained
I	PO1, PO2, PO3	PSO2, PSO3	PO1, PO2, PO3	PSO1, PSO3	PO1, PO2, PO3	PSO2, PSO3
II	PO1, PO2, PO3	PSO2, PSO3	PO1, PO2, PO3	PSO1, PSO3	PO1, PO2, PO3	PSO2, PSO3
III	PO1, PO2, PO3	PSO2, PSO3	PO1, PO2, PO3	PSO1, PSO3	PO1, PO2, PO3	PSO2, PSO3
IV	PO1, PO2, PO3	PSO2, PSO3	PO1, PO2, PO3	PSO1, PSO3	PO1, PO2, PO3	PSO2, PSO3
V	PO1, PO2, PO3	PSO2, PSO3	PO1, PO2, PO3	PSO1, PSO3	PO1, PO2, PO3	PSO2, PSO3
VI	PO1, PO2, PO3	PSO2, PSO3	PO1, PO2, PO3	PSO1, PSO3	PO1, PO2, PO3	PSO2, PSO3
VII	PO1, PO2, PO3, PO5	PSO2, PSO3	PO1, PO2, PO3, PO5	PSO1, PSO3	PO1, PO2, PO3, PO5	PSO2, PSO3
VIII	PO1, PO2, PO3	PSO2, PSO3	PO1, PO2, PO3	PSO1, PSO3	PO1, PO2, PO3	PSO2, PSO3
IX	PO1, PO2, PO3, PO5	PSO2, PSO3	PO1, PO2, PO3, PO5	PSO1, PSO3	PO1, PO2, PO3, PO5	PSO2, PSO3
X	PO1, PO2, PO3, PO5	PSO2 ,PSO3	PO1, PO2, PO3, PO5	PSO1, PSO3	PO1, PO2, PO3, PO5	PSO2, PSO3
XI	PO1, PO2, PO3, PO5	PSO2, PSO3	PO1, PO2, PO3, PO5	PSO1, PSO3	PO1, PO2, PO3, PO5	PSO2, PSO3
XII	PO1, PO2, PO3, PO5	PSO2, PSO3	PO1, PO2, PO3, PO5	PSO1, PSO3	PO1, PO2, PO3, PO5	PSO2, PSO3

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Certificate

This is to certify that it is a bonafied record of Practical work done by Sri/Kum. ______________________________________ bearing the Roll No. ______________________ of ____________ class ____ branch in the ____________________________ laboratory during the academic year ___________________ under our supervision.

Head of the Department

Lecture In-Charge

External Examiner

Internal Examiner

Index

S. No.	List of Experiments	Page No.	Date	Remarks
I	Tests on cement			
II	Ggradation charts of aggregates			
B	Bulking of sand			
IV	Aggregate crushing and impact value			
V	Workability tests on fresh self-compacting concrete			
VI	Air entrainment test on fresh concrete			
VII	Marsh cone test			
VIII	permeability of concrete			
IX	non destructive testing of concrete			
X	accelerated curing of concrete			
XI	influence of w/c ratio on strength and aggregate / cement ratio on workability and strength			
XII	influence of different chemical admixtures on concrete			

MANDATORY INSTRUCTIONS

1. Students should report to the labs concerned as per the timetable.
2. Record should be updated from time to time and the previous experiment must be signed by the faculty in charge concerned before attending the lab.
3. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.
4. After completion of the experiment, certification of the staff in-charge concerned in the observation book is necessary.
5. Students should bring a notebook of about 100 pages and should enter the readings/observations/results into the notebook while performing the experiment.
6. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff member in-charge.
7. Not more than FIVE students in a group are permitted to perform the experiment on a set up.
8. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.
9. The components required pertaining to the experiment should be collected from Lab- in-charge after duly filling in the requisition form.
10. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
11. Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.
12. Students should be present in the labs for the total scheduled duration.
13. Students are expected to prepare thoroughly to perform the experiment before coming to Laboratory.
14. Procedure sheets/data sheets provided to the students groups should be maintained neatly and are to be returned after the experiment.
15. DRESS CODE:
    a. Boys - Formal dress with tuck in and shoes.
    b. Girls - Formal dress (salwarkameez).
    c. Apron in blue color for both boys and girls.
    d. Wearing of jeans is strictly prohibited

EXPERIMENT-I

NORMAL CONSISTENCY OF CEMENT

AIM:

To determine the percentage of water required for preparing cement paste of standard consistency, used for other tests.

APPARATUS:

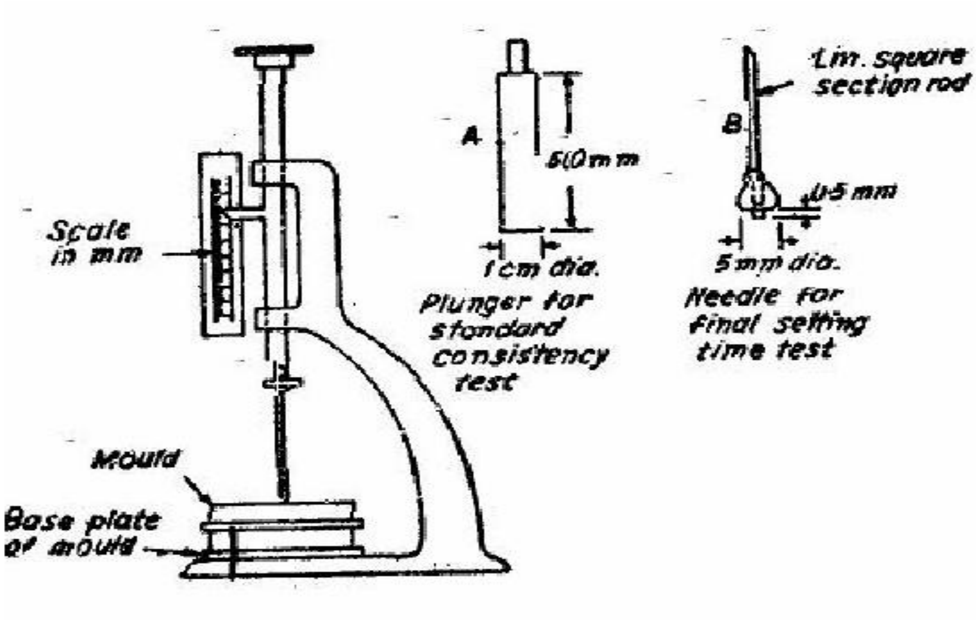
Vicat apparatus with plunger, I.S. Sieve No. 9, measuring jar, weighing balance

THEORY AND SCOPE:

A certain minimum quantity of water is required to be mixed with cement so as to complete chemical reaction between water and cement ,less water than this quantity required wood not complete chemical reaction thus resulting in reaction strength and more water increases water cement ratio and it reduces the strength. So correst proportion of w/c is required.

PROCEDURE:

1. The vicat apparatus consists of a D- frame with movable rod. An indicator is attached to the movable rod, which gives the penetration on a vertical scale.
2. A plunger of 10 mm diameter, 50 mm long is attached to the movable rod to find out normal consistency of cement.
3. Take 300 gm of cement sieved through I.S. Sieve No. 9 and add 30% by weight (90 ml) water to it. Mix water and cement on a non-porous surface thoroughly with in 3 to 4 minutes.
4. The cement paste is filled in the vicatmould and top surface is leveled with a trowel. The filled up mould shall be placed along with its bottom non-porous plate on the base plate of the vicat apparatus centrally below the movable rod. The plunger is quickly released into the paste. The settlement of plunger is noted. If the penetration is between 33 mm to 35 mm from top (or) 5 mm to 7 mm from the bottom, the water added is correct. If the penetration is less than required, the process is repeated with different percentages of water till the desired penetration **is obtained.**



S.No.	Amuont of water mixed	Penetration of Plunger from top	Remark

RESULT: The normal consistency of cement =

VIVA QUATIONS:

1. List out the various tests on cement..
2. Which needle is used for normal consistency of cement.
3. Whyyour finding normal consistency of cement.
4. What is theimportance of finding normal consistency of cement.

INITIAL AND FINAL SETTING TIMES OF CEMENT

AIM:

To find initial and final setting times of cement.

APPARATUS:

Vicat apparatus with mould, I.S. sieve No. 9, Initial and final setting time needles, measuring jar, weighing balance, etc.

THEORY AND SCOPE:

Setting means becoming finer and harder, changing from seme liquid state to plastic state and form plastic state to solid state. Morter or concrete when mixed is in semi liquid state.

The chemical action between cement and water starts, and the mixture goes into plastic state.

PROCEDURE:

Initial setting time:

1.Initial setting time is defined as the time elapsed between the moment that the water is added to the cement, to the time that the paste starts losing its plasticity i.e. the initial setting time needle fails to penetrate the cement paste kept in the mould by about 33-35 mm from the top or 5-7 mm from bottom of the indicator is called initial setting time.

2. Take a cement sample weighing 300 gm, sieved through I.S. sieve No. 9 and mixed with percentage of water as determined in normal consistency test. Stopwatch should be started at the instant when water is added to the cement.

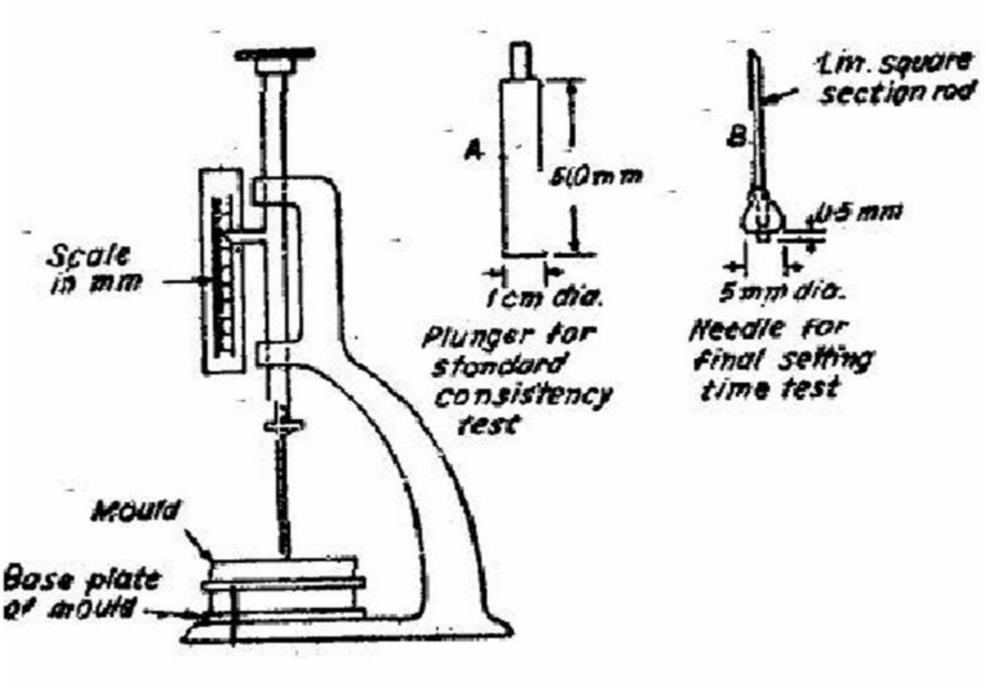
3. Prepared cement paste is filled in vicatsmould and leveled with trowel. This mould filled with cement paste kept on the non porous plate is now placed under the movable rod with initial setting time needle of cross section 1mm x 1mm

4. The needle is quickly released and it is allowed to penetrate the cement paste. In the beginning the needle penetrates completely. It is then taken out and dropped at a fresh place.

5. This procedure is repeated at regular intervals till the needle does not penetrate the block for about 5 mm measured from the bottom of indicator. Note the time for initial setting of cement. The initial setting time of an ordinary Portland cement shall not be less than 30 minutes.

Final setting time:

1. After noting the time for initial setting of cement, the needle shall be replaced by the final setting time needle.
2. The movablerod is slowly released on to the cement paste.
3. In the initial stages he needle and collar may pierce through the paste. But after some time the same procedure is followed.
4. Such trials shall be carried out until the needle only makes as impression on the top surface of the cement paste and the collar of the needle fails to do so. Note the time for final setting time of cement.
5. The final setting time of an ordinary Portland cement shall not be more than 10 hours.



Vicat Apparatus

Result:

1. Initial setting time of cement=
2. Final setting time of cement=

VIVA QUATIONS:

1. What is Initial and Final setting time of cement.
2. Which needle is used for initial setting time of cement.
3. What is the use of Initial and Final setting time of cement.
4. What is the difference between initial and final setting time of cement.

SOUNDNESS OF CEMENT

THEORY AND SCOPE:

Unsoundness of cementmeans, that the cement having excess lime, magnesiumsulphates, etc. due to excess of these items there will be volume changes and large expansions, there by reduces the durability of the structures.

AIM:

To find out the soundness of cement.

APPARATUS:

Le-chatelier Apparatus Cement, Water , Glass plate.

PROCEDURE:

1. The cement is gauged with 0.78 times the water required for standard consistency (0.78P) in a standard manner and filled in to the Le-Chateliermould kept on the glass plate.

The mould is covered on the top with another glass plate.

2. The whole assembly is immersed in water at temperature of 27oC to 32oC and kept there for 24 hrs.

3. Measure the distance between the indicator points.

4. Submerge the mould again in water, heat the water up to boiling point in 30 minutes and keep it boiling for 3 hrs.

5. Remove the mould from hot water and allow it to cool and measure the distance between the indicator points.

6. The distance between these two measurements gives the expansion of cement.

7. This must not exceed 10mm for OPC, RHC, LHC, etc.

8. If the expansion is more than 10mm, the cement is unsound

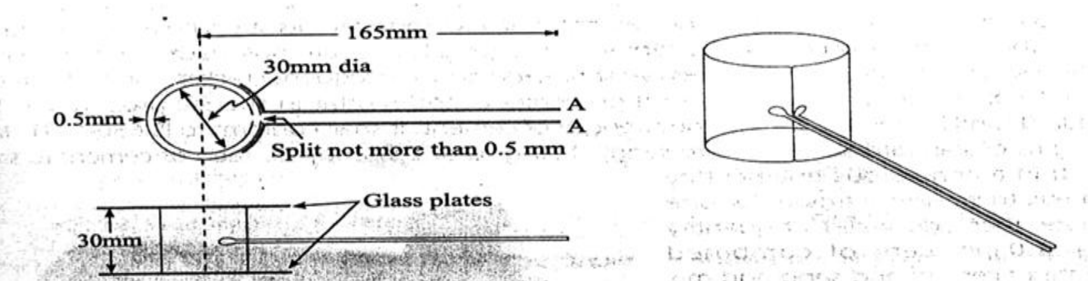


Fig. 2.9. Le-Chatelier apparatus for finding soundness of cement.

RESULT:

Soundness of given cement =

VIVA QUATIONS:

1. What is meant by unsound cement.
2. Which apparatus is used for soundness of cement.
3. Of what importance is the soundness of cement.
4. What is thecause of free lime in cement.

COMPRESSIVE STRENGTH OF CEMENT

AIM:

To determine the compressive strength of 1:3 Cement sand mortar cubes after 3 days and 7 days curing.

APPARATUS:

Universal Testing Machine or Compression Testing Machine, cube moulds, vibrating machine, crucible for mixing cement and sand measuring cylinder, trowels, non-porous plate and balance with weight box.

THEORY AND SCOPE:

The compressive strength of cement mortar is determined strength of cement mortar is determined in order to verify whether the cement conforms to IS specification **(IS: 269-1976)** and whether it will be able to develop the required compressive strength of concrete. According **to IS: 269-1976**, the ultimate compressive strength of cubes of cement sand mortar of the ratio 1:3, containing (P/4+3.0) percent of water should be as.

PROCEDURE:

1. Calculate the material required. The material for each cube shall be mixed separately and the quantities of cement and standard sand shall be as follows:

Cement = 200 gm.

Standard Sand = 600 gm.

Water = (P/4+3.0) percent = 84 gm.

2. The time of mixing (gauging) in any event shall not be less than 3 minutes and if the time taken to obtain a uniform colour exceeds 4 minutes the mixture shall be rejected and the operation is repeated with a fresh quantity of cement, sand and water.

3. Place the assembled mould on the table of the vibrating machine and firmly hold it in the vibrating machine and firmly hold it in position by means of suitable clamps. Securely attach the hopper at the top of the mould to facilitate filling and this hopper shall not be removed until completion of the vibration perio

4. Immediately after mixing the mortar as explained above, fill the entire quantity of mortar

5. In the hopper of the cube mould and compact by vibration. The period of vibration shall be 2 minutes at the specified speed of 12000+400 cycles per minute.

6. Remove the mould from the machine and keep it at a temperature of 27+ 2^0C in an atmosphere of at least 90 percent relative humidity for 24 hours after completion of vibrations.

7. The cubes are removed from the mould and immediately submerge it in clean and fresh water and keep there until taken out just prior to breaking. The water is which the cubes are submerged shall be renewed after every 7 days and be maintained at a temperature of 27+ 2^0C, keep the cubes wet till they are placed in machine for testing.

8. Test the specimens at the required periods, test three cubes at the periods mentioned below, the periods being reckoned from the completion of vibration. The compressive strength shall be the average of the strengths of the three cubes for each period.

a) Ordinary Portland Cement: 3 and 7days.

b) Rapid Hardening Portland Cement: 1 and 3 days. c) Low Heat Portland Cement: 3, 7 and 28 days.

The cubes shall be tested on their sides, the load being applied at the rate of 35 N/mm^2/ minute.

OBSERVATION AND cALCULATIONS:

Ordinary Portland cement

S.No.	3-day strength		7-day strength	
	Load in KN	Strength in N/mm2	Load in KN	Strength in N/mm^2
1				
2				
3				
Average				

RESULT:

Compressive strength of cement=

VIVA QUATIONS:

1. What are the strengths of cement-sand mortar cubes after 3 days and 7 days.
2. Whaprecautions should be taken during the deterimination of compressive strength.
3. What are the requirments for moulds including base and cover plates.
4. What is the rate of loading.

EXPERIMENT-II

GRADATION CHARTS OF AGGREGATES

FINENESS MODULUS OF COARSE AND FINE AGGREGATES

AIM:

To determine fineness modulus and grade of fine and coarse aggregate (IS: 383-1970)

APPARATUS:

Set of sieves, Balance, Gauging Trowel, Watch.

a) For fine aggregates: 4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300 micron & 150 micron, pan.

b) For coarse aggregates: 80mm, 40mm, 20mm, 10mm, 4.75mm, pan.

Material:

a) Fine aggregates (1 Kg)

b) Coarse aggregates (5 Kg)

Theory:

Aggregate is the inert, inexpensive materials dispersed throughout the cement paste so as the produce a large volume of concrete. They constitute more than three quarters of volume of concrete. They provide body to the concrete, reduce shrinkage and make it durable.

The aggregates are classified in two categories; fine aggregate and coarse aggregate. The size of fine aggregates is limited to a maximum of 4.75 mm, beyond which it is known as coarse aggregates. Many a time, fine aggregates are designated as coarse sand, medium sand and fine sand. These classifications do not give any precise meaning. What the supplier terms as fine sand may be really medium or even coarse sand. To avoid this ambiguity fineness modulus could be used as a yard stick to indicate the fineness of sand and in general aggregates.

Fineness modulus for a given aggregate is obtained by sieving known weight of it in a set of standard sieves and by adding the percent weight of material retained on all the sieves and dividing the total percentage by 100. It serves the purpose of comparing one aggregate with another in respect of fineness or coarseness. For classification of fine aggregates, the following limits may be taken as guidance:

Fine sand: Fineness modulus should lie in between 2.2 to 2.6

Medium sand: Fineness modulus should lie in between 2.6 to 2.9

Coarse sand: Fineness modulus should lie in between 2.9 to 3.2

Sand having a fineness modulus more than 3.2 is unsuitable for making satisfactory concrete. The coarse aggregates have fineness modulus usually more than 5.

A heap of aggregate is classified as a single sized aggregate when the bulk of aggregate passes one sieve in normal concrete series and retained on next smaller size. Such aggregates are normally expressed by the maximum size of the aggregates present in considerable amount in it. For example, a heap of 20 mm size aggregate means that the heap contains maximum 20 mm size aggregate in a substantial amount.

A graded aggregate comprises of a proportion of all sizes in a normal concrete series. When these sizes are so proportionated to provide a definite grading, it is known as well graded aggregate. Well graded aggregates are desirable for making concrete, as the space betweenlarger particles is effectively filled by smaller particles to produce a well-packed structure. This minimizes the cement requirement.

All-in aggregates comprise a mixture of coarse aggregate and fine aggregates. Such aggregates may directly be used for low quality concreting. But in case of good quality concreting work; necessary adjustments may be made in the grading by the addition of single-sized aggregates.

IS 383:1970 specifies four grading zones for fine aggregates. These four grading zones become progressively finer from Grading Zone I to Grading Zone IV (see Table). The fine aggregates within each of these grading zones are suitable for making concrete. But, the ratio of ratio of fine to coarse aggregate reduces as the fine aggregate becomes finer from Grading Zones I to IV.

Table 1: Grading of fine aggregates

I.S. Sieve Designation	**Percentage of passing by weight for grading**			
	Zone-I	**Zone-II**	**Zone-III**	**Zone-IV**
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 μ	15-34	35-59	60-79	80-100
300 μ	5-20	8-30	12-40	15-50
150 μ	0-10	0-10	0-10	0-15

The grading of coarse aggregate may vary through wider limits than that of fine aggregates. However, this variation does not much affect the workability, uniformity and finishing qualities of concrete mix. As per IS-383:1970 the grading limit of coarse aggregate, both for single size as well as graded should be as per the table given below.

Table 2: Grading of single-graded coarse aggregates

SievE Size (mm)	For Single-Sized Aggregate of Nominal Size						For Graded Aggregate of Nominal Size			
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
	Percentage of Passing by weight for grading									
80	100	–	–	–	–	–	100	–	–	–
63	85 to 100	100	–	–	–	–	–	–	–	–
40	0 to 30	85 to 100	100	–	–	–	95 to 100	100	–	–
20	0 to 5	0 to 20	85 to 100	100	–	–	30 to 70	95 to 100	100	100
16	–	–	–	85 to 100	100	–	–	–	90 to 100	–
12.5	–	–	–	–	85 to 100	100	–	–	–	90 to 100
10	0 to 5	0 to 5	0 to 20	0 to 30	0 to 45	85 to 100	10 to 35	25 to 55	30 to 70	40 to 85
4.75	–	–	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10
2.36	–	–	–	–	–	0 to 5	–	–	–	–

Procedure:

1. Take the aggregate from the sample byquartering.
2. Sieve the aggregate using the appropriatesieves.
3. Record the weight of aggregate retained on each sieve.
4. Calculate the cumulative weight of aggregate retained on eachsieve.
5. Calculate the cumulative percentage of aggregateretained.
6. Add the cumulative weight of aggregate and calculate the fineness modulus usingformula:
   a. Fineness modulus forfineaggregates $=\sum CC/ 100$
   b. Fineness modulus forcoarseaggregates $=(\sum CC/ 100)+5$

   Where, C denotes the cumulative percentage of mass retained in a sieve.
7. Determine the grade of aggregates from the Table 1 and the Table2.
8. Plot the gradation curves, in a semi-log graph, between percentage of aggregates passed and size of sieve both for a) Fine aggregate and b) For coarse aggregate.

(*Note: A typical grading curve for fine aggregates looks like Figure 4. A similar grading curve will be observed for coarse aggregates.*)

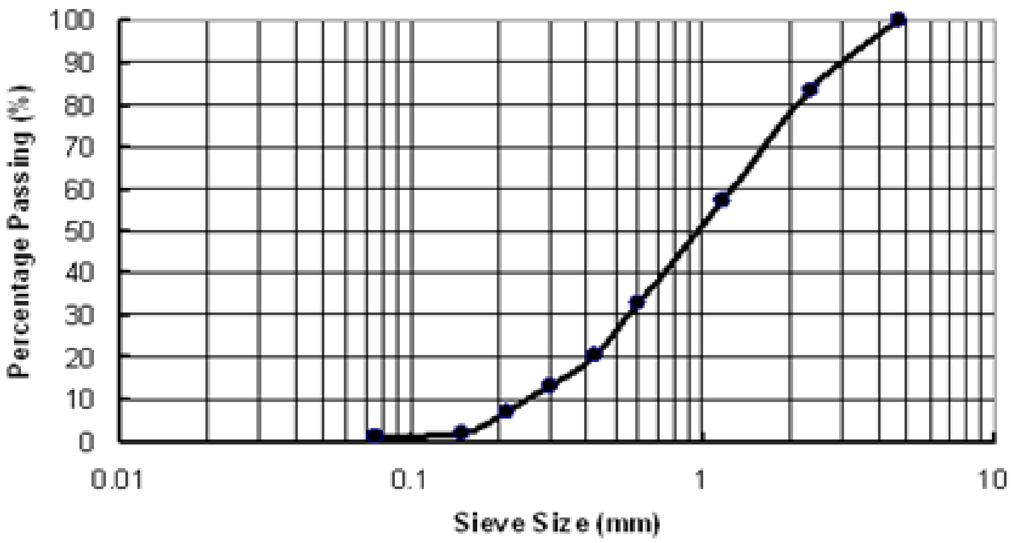


Figure 4: A typical gradation curve for fine aggregates

Observations:

(a) For fineaggregates:

Weight of fine aggregatetaken (W_f):__________Kgs					
Sl. No.	Sieve size	Weight retained (in kg)	%age retained	Cumulative %age retained	Percentage passed (100 –C_5)
C_1	C_2	C_3	C4	C_5	C_6
1	4.75 mm				
2	2.36 mm				
3	1.18 mm				
4	600 micron				
5	300 micron				
6	150 micron				
7	Pan			-	-
Sumofcumulativepercentageretained(excludingpan)$\sum CC_5$=					-
FinenessModulus$\frac{\sum CC_5}{100}$=					-
Zone to which the fine aggregate belongs:					

(b) For coarseaggregates:

Weight of coarse aggregatetaken(W_c):___________Kgs					
Sl. No.	Sieve size	Weight retained (in kg)	%ageretained	Cumulative %age retained	Percentage passed (100 –C_5)
C_1	C_2	C_3	C4	C_5	C_6
1	80 mm				
2	40 mm				
3	20 mm				
4	10 mm				
5	4.75 mm				
6	Pan			-	-
Sumofcumulativepercentageretained(excludingpan)$\sum CC_5$=					-
FinenessModulus$\frac{\sum CC5}{100}$+5=					-
Grade to which the coarse aggregate belongs:					

Results and discussions:

The fineness modulus of given samples are:

a) Forfineaggregates :____________.

b) For coarseaggregates:_______________.

The grading to which the given samples belong are:

a) Forfineaggregates :____________.

b) For coarseaggregates:_______________.

VIVA QUATIONS:

1. What are the strengths of cement-sand mortar cubes after 3 days and 7 days.
2. Whaprecautions should be taken during the deterimination of compressive strength.
3. What are the requirments for moulds including base and cover plates.
4. What is the rate of loading.

EXPERIMENT-III

BULKING OF SAND

AIM:

To ascertain the bulking phenomena of given sample of sand.(IS: 2386(Part-3)-1963).

APPARATUS:

Beaker, 1000ml measuring jar, brush, scale, mixing tray.

THEORY AND SCOPE:

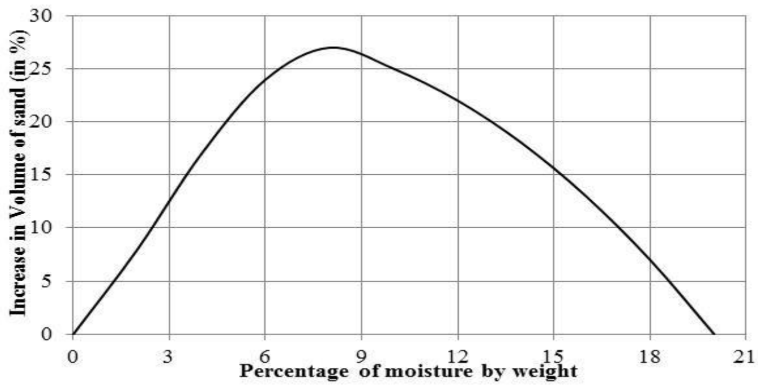
Increase in volume of sand due to presence of moisture is known as bulking of sand. Bulking is due to the formation of thin film of water around the sand grains and the interlocking of air in between the sand grains and the film of water. When more water is added sand particles get submerged and volume again becomes equal to dry volume of sand.

Due to the bulking, fine aggregate shows completely unrealistic volume. Therefore, it is absolutely necessary that consideration must be given to the effect of bulking in proportioning the concrete by volume. If cognisance is not given to the effect of bulking, in case of volume batching, the resulting concrete is likely to be under-sanded and harsh. It will also affect the yield of concrete for given cement content.

To compensate the bulking effect extra sand is added in the concrete so that the ratio of coarse to fine aggregates will not change from the specified value. Maximum increase in volume may be 20 % to 40 % when moisture content is 5 % to 10 % by weight. Fine sands show greater percentage of bulking than coarse sands with equal percentage of moisture.

PROCEDURE:

1. Put sufficient quantity of dry sand into the beaker until it is about one-thirds full.
2. Level off the top of the sand and measure the height (H1) by pushing a steel rule vertically down through the sand at the middle to the bottom. Measure weight of the sand.
3. Add 2% of water; mix it thoroughly in the container. Smooth and level the top surface measure the height (H2) of soil. Find the height percentage increment.
4. Repeat the same procedure with increasing amount of water by 2% until percentage increment of sand height is reduced and attends original level.
5. Plot a graph of percentage increment of sand height against percentage of water. (Note: A typical bulking of sand graph looks like Figure)



Typical curve showing bulking of sand

CALCULATIONS:

Initial Height of sand in the Jar(H_1):____mm

Weight offine aggregate :_________g

Sl. No.	% of Water	Volume of water (in ml)	Height of sand (H_2)	page bulking $= \frac{HH_{22}-HH_{11}}{HH_{11}} \times 111111$

RESULT:

From the tabulated results and the plotted graph is is observed that, the given sand specimen under goes maximum bulking at % of moisture contain. Maximum percentage of bulking is .

VIVA QUATIONS:

1. How do you calculate bulking of sand.
2. Wha is the limit of bulking of sand.
3. What is the limit of bulking of sand.
4. What is the bulking of sand and its effect on batchingrate of loading.

EXPERIMENT- IV

AGGREGATE CRUSHING AND IMPACT VALUE

AGGREGATE IMPACT TEST

AIM:

To determine the aggregate impact value of given aggregate as per I.S-2386 Part IV.

APPARATUS:

The apparatus consists of an

1. Impact testing machine: The machine consists of a metal base. A detachable cylindrical steel cup of internal diameter 10.2cm and depth 5cm. A metal hammer of weight between 13.5 to 14Kg, 10cm in diameter and 5cm long. An arrangement for raising the hammer and allow it to fall freely between vertical guides from a height of 38cm on the test sample in the cup.
2. A cylindrical metal measure having 7.5cm and depth of 5cm for measuring aggregates.
3. A tamping rod of circular cross section, 1cm in diameter and 23cm long, rounded at one end.
4. I.S. sieve of sizes 12.5mm, 10mm and 2.36mm.
5. Balance of capacity not less than 500gm to weigh accurate up to 0.01gm.

THEORY AND SCOPE:

Toughness is the property of a material to easiest impact. Due to moving loads the aggregates are subjected to pounding action or impact and there is possibility of stones breaking into smaller pieces. Therefore a test designed to evaluate the toughness of stones i.e., the resistance of the stones to fracture under repeated impacts may be called Impact test on aggregates. The test can also be carried on cylindrical stone specimen known as Page Impact test. The aggregate Impact test has been standardized by Indian Standard Institution. The aggregate impact test is conducted as per IS-2386 Part IV.

The aggregate Impact value indicates a relative measure of the resistance of aggregate to a sudden shock or an Impact, which in some aggregates differs from its resistance to a slope compressive load in crushing test. A modified Impact test is also often carried out in the case of soft aggregates to find the wet Impact value after soaking the test sample.

Various agencies have specified the maximum permissible aggregate Impact values for the different types of pavements. IRC has specified the following values.

The maximum allowable aggregate Impact value for water bound Macadam; Sub-Base coarse 50% where as cement concrete used in base course is 45%. WBM base course with Bitumen surface in should be 40%. Bituminous Macadam base course should have A.I.V of 35%. All the surface courses should possess an A.I.V below 30%.

PROCEDURE:

1. The test sample consists of aggregates passing 12.5mm sieve and retained on 10mm sieve and dried in an oven for 4 hours at a temperature of 100 C to 110 C.

2. The aggregates are filled upto about 1/3 full in the cylindrical measure and tamped 25 times with rounded end of the tamping rod.

3. The rest of the cylindrical measure is filled by two layers and each layer being tamped 25 times.

4. The overflow of aggregates in cylindrically measure is cut off by tamping rod using it has a straight edge.

5. Then the entire aggregate sample in a measuring cylinder is weighted nearing to 0.01gm.

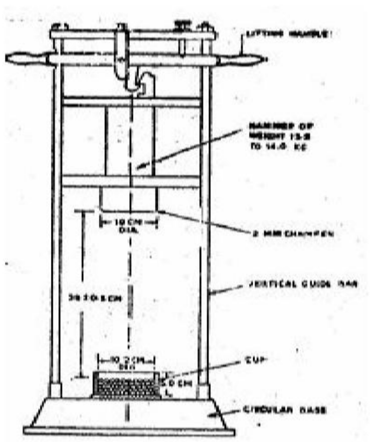
6. The aggregates from the cylindrical measure are carefully transferred into the cup which is firmly fixed in position on the base plate of machine. Then it is tamped 25 times.

7. The hammer is raised until its lower face is 38cm above the upper surface of aggregates in the cup and allowed to fall freely on the aggregates. The test sample is subjected to a total of 15 such blows

each being delivered at an interval of not less than one second. The crushed aggregate is than removed from the cup and the whole of it is sieved on 2.366mm sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to 0.1gm. Repeat the above steps with other fresh sample

8. Let the original weight of the oven dry sample be w1gm and the weight of fraction passing 2.36mm I.S sieve be w2gm. Then aggregate Impact value is expressed as the % of fines formed in terms of the total weight of the sample.

Aggregate Impact Value = 100 *w2% .
W1



Aggregate Impact Testing Machine

OBSERVATION AND CALCULATION:

Sl. No.	Details of Sample	Trail 1	Trail 2	Average
1	**Total Weight of aggregate sample filling the cylinder measure = W_1 g**			
2	**Weight of aggregate passing 2.36 mm sieve after the test = W_2 g**			
3	**Weight of aggregate retained 2.36 mm sieve after the test =W_2 g**			
4	**(W_1-W_2 + W_2)**			
5	**Aggregate Impact Value =(W_2/W_1)*100 Percent**			

RESULT:

The mean is _____________________%.

VIVA QUATIONS:

1. How do you calculate aggregate impact value.
2. Wha is the ggregate ipact value test
3. What is the difference between impact and crushing value test.
4. What are the uses of impac test.

AGGREGATE CRUSHING STRENGTH

THEORY AND SCOPE:

This is one of the major Mechanical properties required in a road stone. The test evaluates the ability of the Aggregates used in road construction to withstand the stresses induced by moving vehicles in the form of crushing. With this the aggregates should also provide sufficient resistance to crushing under the roller during construction and under rigid tyre rims of heavily loaded animal drawn vehicles.

The crushing strength or aggregate crushing value of a given road aggregate is found out as per ***IS-2386 Part- 4***.

The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavement aggregate possessing low aggregate crushing value should be preferred.

AIM:

To determine crushing strength of a given aggregate as per **IS: 2386 part - IV**

APPARATUS:

1. A steel cylinder of internal diameter 15.2 cm (Steel cylinder with open ends)
2. A square base plate, plunger having a piston diameter of 15 cm.
3. A cylindrical measure of internal diameter of 11.5 and height 18 cms.
4. Steel tamping rod having diameter of 1.6 cms length 45 to 60 cms.
5. Balance of capacity 3 kg with accuracy up to 1 gm.
6. Compression testing machine capable of applying load of 40 tonnes at a loading rate tonnes per minute

The aggregate crushing value of the coarse aggregates used for cement concrete pavement at surface should not exceed 30% and aggregates used for concrete other than for wearing surfaces, shall not exceed 45% as specified by Indian Standard (IS) and Indian Road Congress (IRC).

PROCEDURE:

1. The aggregate in surface-dry condition before testing and passing 12.5 mm sieve and retained on 10 mm sieve is selected.
2. The cylindrical measure is filled by the test sample of the aggregate in three layers of approximately equal depth, each layer being tamped 25 times by the rounded end of the tamping rod.
3. After the third layer is tamped, the aggregates at the top of the cylindrical measure are leveled off by using the tamping rod as a straight edge. Then the test sample is weighed. Let that be w_1 gm.
4. Then the cylinder of test apparatus is kept on the base plate and one third of the sample from cylindrical measure is transferred into cylinder and tamped 25 times by rounded end of the tamping rod.
5. Similarly aggregate in three layers of approximately equal depth, each layer being tamped 25 times by rounded end of the tamping rod.
6. Then the cylinder with test sample and plunger in position is placed on compression testing machine.
7. Load is then applied through the plunger at a uniform rate of 4 tonnes per minute until the total load is 40 tonnes and the load is released.

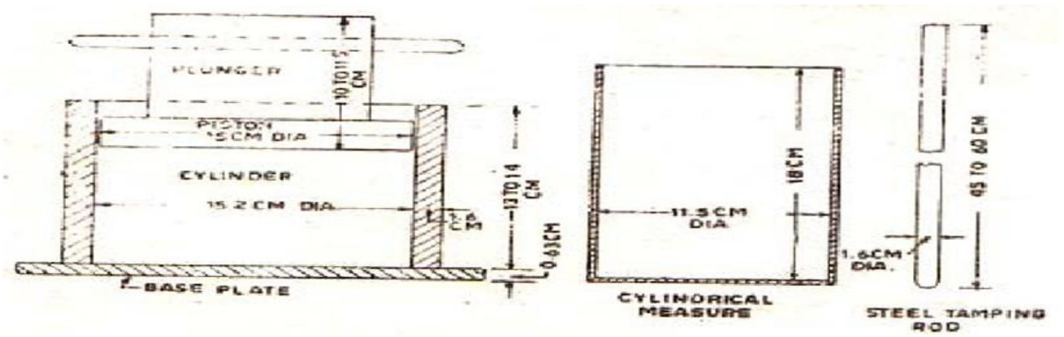
8. Aggregates including the crushed position are removed from the cylinder and sieved on a 2.36mm IS Sieve and material which passes this sieve is collected and weighed. Let this be w_2 gm.

9. The above step is repeated with second sample of the same aggregate. The two tests are made for the same specimen for taking an average value.

10. Total weight of dry sample taken is $w_1$gm. weight of the portion of crushed material passing 2.36mm IS sieve be w_2 gm.

Then the aggregate crushing value is defined as the ratio of weight of fines passing the specified IS sieve to the total weight of the sample (w_1).

Aggregate crushing value = $100*w_2/w_1$%



OBSERVATION AND CALCULATION:

Trials	Total Weight of dry aggregate sample 10 gm	Weight of fines passing 2.36mm IS sieve, w2gm	Aggregate crushing value %	Average aggregate crushing strength value
1				
2				

Aggregate crushing value = $100*w_2/w_1$.

RESULT:

The mean (average) of the crushing value aggregate is __________________%

VIVA QUATIONS:

1. How do you calculate aggregate crushing value.
2. Wha is the ggregate crushing value test.
3. What is the difference between impact and crushing value test.
4. Which type of aggregate gives maximum strength.

EXPERIMENT- IV

WORKABITY TEST ON SCC-SLUMP FLOW+ T500

AIM:

To measure the filling ability of Self compacting concrete.

APPARATUS:

1. Base plate of size at least 900 × 900 mm, made of impermeable and rigid material(steel or plywood) with smooth and plane test surface (deviation of the flatness not exceed 3 mm), and clearly marked with circles of Ø200mm and Ø500mm at the centre, as shown in Fig- 2.
2. Abrams cone with the internal upper/lower diameter equal to 100/200 mm and theheight of 300 mm, as shown in Figure 1.
3. Weight ring (>9 kg) for keeping Abrams cone in place during sample filling. Anexample of its dimensions is given in Figure 2. Alternatively, a cast iron cone may be used as long as the weight of the cone exceeds 10 kg. As a second alternative the cone may be kept in position by human force.
4. Stopwatch with the accuracy of 0.1 second for recording the flow time T50.
5. Ruler (graduated in mm) for measuring the diameters of the flow spread.
6. Bucket with a capacity of larger than 6 litres for sampling fresh concrete.
7. Moist sponge or towel for wetting the inner surface of the cone and the test surface ofthe base plate.
8. Rag for cleaning spilled concrete if any.

THEORY AND SCOPE:

The slump flow test aims at investigating the filling ability of SCC. It measures two parameters: flow spread and flow time T500 (optional). The former indicates the free, unrestricted deformability and the latter indicates the rate of deformation within a defined flow distance.

PROCEDURE:

1. Place the cleaned base plate in a stable and level position.
2. Fill the bucket with 6~7 litres of representative fresh SCC and let the sample stand stillfor about 1 minute (± 10 seconds).
3. During the 1 minute waiting period pre-wet the inner surface of the cone and the testsurface of the base plate using the moist sponge or towel, and place the cone in the centre on the 200 mm circle of the base plate and put the weight ring on the top of the cone to keep it in place. (If a heavy cone is used, or the cone is kept in position by hand no weight ring is needed).
4. Fill the cone with the sample from the bucket without any external compacting actionsuch as rodding or vibrating. The surplus concrete above the top of the cone should be struck off, and any concrete remaining on the base plate should be removed.
5. Check and make sure that the test surface is neither too wet nor too dry. No dry areaon the base plate is allowed and any surplus of the water should be removed – the moisture state of the plate has to be 'just wet'.
6. After a short rest (no more than 30 seconds for cleaning and checking the moist stateof the test surface), lift the cone perpendicular to the base plate in a single movement, in such a manner that the concrete is allowed to flow out freely without obstruction from the cone, and start the

stopwatch the moment the cone looses contact with the base plate.

7. Stop the stopwatch when the front of the concrete first touches the circle of diameter500 mm. The stopwatch reading is recorded as the T50 value. The test is completed when the concrete flow has ceased.

8. Measure the largest diameter of the flow spread,d_{max}, and the one perpendicular to it,d_{perp}, using the ruler (reading to nearest 5 mm). Care should be taken to prevent the ruler frombending.

9. Clean the base plate and the cone after testing.

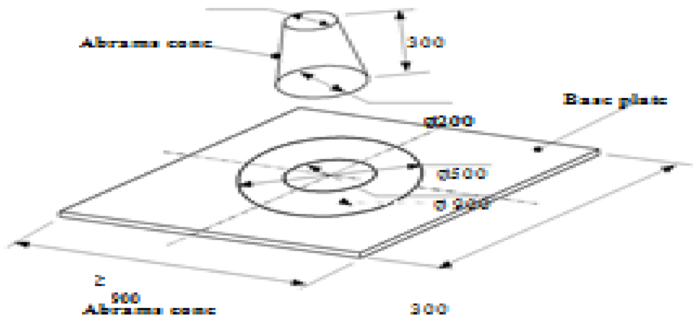


Figure 1 — Base plate and Abrams cone

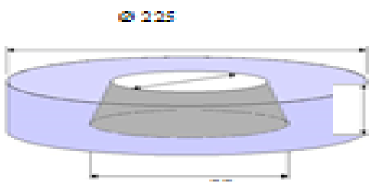


Table 1 — Precisions of the slump flow spread and flow time T50

Slump flow spread *S* [mm]	**< 600**	**600 ~ 750**	**> 750**
Repeatability *r* [mm]	N.A.	42	22
Reproducibility *R* [mm]	N.A.	43	28
Slump flow time T50 [sec]	**≤ 3.5**	**3.5 ~ 6**	**> 6**
Repeatability *r* [sec]	0.66	1.18	N.A.
Reproducibility *R* [sec]	0.88	1.18	N.A.

RESULT:

1. The slump flow spread*S*is the average of diametersd_{max}andd_{perp}, as shown inEquation (1). *S* is expressed in mm to the nearest 5 mm.

$$S = \frac{(d_{max} + d_{perp})}{2}$$

2. The slump flow time T50 is the period between the moment the cone leaves the baseplate and SCC first touches the circle of diameter 500 mm. T50 is expressed in seconds to the nearest 1/10 seconds.

VIVA QUATIONS:

1. Wha is significance of slump flow test.
2. Wha is Self compacting concrete.
3. What is T500 time.
4. What isvisual index (VSI) ratig.

WORKABITY TEST ON SCC-V FUNNEL TEST

AIM:

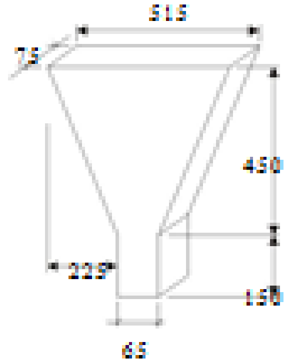
To determine the viscosity and filling ability or passing ability of the self-compacting concrete.

APPARATUS:

1. V-funnel, as shown in Figure 7, made of steel, with a flat, horizontal top and placed onvertical supports, and with a momentary releasable, watertight opening gate.
2. Stopwatch with the accuracy of 0.1 second for recording the flow time.
3. Straightedge for levelling the concrete.
4. Buckets with a capacity of 12∼14 litres for taking concrete sample.
5. Moist sponge or towel for wetting the inner surface of the V-funnel.

THEORY AND SCOPE:

The V-funnel flow time is the period a defined volume of 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.



Dimensions of the V-funnel

PROCEDURE

1. Place the cleaned V-funnel vertically on a stable and flat ground, with the top openinghorizontally positioned.

2. Wet the interior of the funnel with the moist sponge or towel and remove the surplusof water, e.g. through the opening. The inner side of the funnel should be 'just wet'.

3. Close the gate and place a bucket under it in order to retain the concrete to be passed.

4. Fill the funnel completely with a representative sample of SCC without applying compaction or rodding.

5. Remove any surplus of concrete from the top of the funnel using the straightedge.

6. Open the gate after a waiting period of (10 2) seconds. Start the stopwatch at thesame moment the gate opens.

7. Look inside the funnel and stop the time at the moment when clear space is visiblethrough the opening of the funnel. The stopwatch reading is recorded as the V-funnel flow time, noted as tV.

8. Clean the V-funnel after testing.

Precisions of the V-funnel flow time

V-funnel flow time t_V [sec]	**3**	**5**	**8**	**12**	**≥ 15**
Repeatability *r* [sec]	0.4	1.1	2.1	3.4	4.4
Reproducibility *R* [sec]	0. 6	1.6	3.1	5.1	6.6

RESULTS:

The V-funnel flow time tV is the period from releasing the gate until first light enters the pening,expressed to the nearest 0.1 second

VIVA QUATIONS:

1. Wha is the significance of V-funnel flow test for Self compacting concrete.
2. Why is the inside surfaces of the apparatus moisture.
3. What are the advantages ans disadvantages of V-funnel flow test.
4. How you can determine the ability of Self compacting concrete.

EXPERIMENT-VII

MARSH CONE TEST

THEORY AND SCOPE:

The term compatibility refers to the desired effect on performance when a specific combination of cement and chemical admixtures is used. In concrete mix design the superplasticizer dosage are fixed based on the composition of the paste (cement,water and chemical admixtures) with the maximum fluidity for a given water/cement ratio and a given chemical admixture/cement ratio. The characteristics of the fresh paste mostly govern the properties of the fresh concrete and this procedure will yield a concrete, With the desired workability for a given aggregate content. The only variable in this process is the superplasticizer/cement ratio. The optimum dosage of chemical admixture is decided for each batch of cement and each admixture. To formulate this objective, a test known as "Marsh Cone Test" is performed.

AIM:

To determine the optimum dosage of super plasticizer each batch of cement Self compacting concrete.

APPARATUS:

Marsh cone test ,stop watch

PROCEDUREPROCEDURE:

1. Mix the measured quantity of Cement, water and admixture thoroughly in a mechanical mixer for two minutes. While mixing, first put the water in mixing bowl and then add 2 Kg of cement to this water. Stirre for 1 minute and then add admixture dose and stirring operation is continued for next one minutes. Thus slurry is formed.

2. Pour one liter slurry into marsh cone duly closing the aperture with a finger.

3. Start the stop watch and simultaneously remove the finger. Note the time taken for emptying the Marsh Cone. This time is called the "Marsh Cone Time".

4. Repeat the test for 15 minutes and 60 minutes retention period for same mix and duly noting Marsh Cone time. The mixture of cement and admixture should be kept stirred throughout the test.

Sr. No.	Cement (Kg)	w/c ratio	Water (Kg)	Admix/ cement Dosage (%)	Admixture (mg)	Marsh Cone Time (0 min Retention) (Sec)	Marsh Cone Time (15min Retention) (Sec)	Marsh Cone Time (60 mill Retention) (Sec)
1	2.00	0.55	1.10	0.00	0.00			
2	2.00			0.20	4.20			
3	2.00			0.40	8.40			
4	2.00			0.60	12.60			
5	2.00			0.80	16.80			
6	2.00			1.00	21.00			
7	2.00			1.20	25.20			
8	2.00			1.40	29.40			
9	2.00			1.60	33.60			
10	2.00			1.80	37.80			
11	2.00			2.00	42.00			

OBSERVATION AND CALCULATIONS:

RESULT:

Dosage of super plasticizer =

VIVA QUATIONS:

1. How to determine the optimum dosage of super plasticizer .
2. Durability of Self compacting concrete.
3. What is the effect of high dosage of superplasticisers.
4. What is freeflow concrete.

EXPERIMENT-VIII

PERMEABILITY OF CONCRETE

AIM:

To determine the permeability of the concrete.

APPARATUS

1. Diamond cut saw.
2. Balance of suitable capacity readable to 0.1g with a limit of performance of not more than 0.6g at the 99% confidence level.
3. Supply of de-aired water.
4. Vacuum pump.
5. Vernier callipers.
6. Diamond corer drill.
7. 100mm diameter concrete mould complying with AS 1012.8.

THEORY AND SCOPE

This test covers the laboratory determination of the D'Arcy coefficient of water permeability of hardened concrete specimens using a Concrete Permeameter. The samples are either cored from existing concrete structures or taken from moulded cylindrical specimens.D'Arcy demonstrated in the late nineteenth century that for laminar flow conditions in saturated granular materials, the rate of flow is proportional to the pressure gradient ($q = ki$). The D'Arcy coefficient of permeability is the constant of proportionality between volume flow (q) and pressure gradient (i) and can be interpreted as the average velocity of flow through the sample cross section.

PROCEDURE

1. Obtain samples of hardened concrete of appropriate diameter from existing structures by diamond core drilling or from moulded specimens. The specimens shall be prepared in accordance with AS 1012. Using a diamond saw, cut a section of the sample to allow approximately 2mm clearance at each end of the Room Temperature Vulcanising (RTV) silicone rubber seal. The test sample should have a minimum length of 2.5 times the maximum aggregate size. The cut section will be the test sample.
2. Condition the test sample in accordance with AASHTO T277 to a Saturated Surface Dry state, deleting the section referring to the use of epoxy resins.
3. Fill the voids that are 2mm or greater in diameter that occur on the sides of the test sample with plasticine or a similar material.
4. Measure and record the mass of the test sample to the nearest 0.1g and the diameter (D) and length (L) of the sample to the nearest 1mm.
5. Seal the test sample within the permeameter cell. (See Appendix A).

6. Ensure that the permeameter apparatus is completely filled with de-aired water and contains no air pockets or bubbles.

7. Apply a constant pressure head of water to the inflow side of the permeameter cell and continuously monitor the pressure throughout the duration of the test.

8. Continuously monitor and record the volumetric inflow and outflow of water.

9. Continuously monitor and record the ambient temperature, to the nearest 0.1°C. Ensure that the temperature is maintained within a range of 21 to 25°C.

10. After steady state flow through the sample has been achieved, monitor and plot volume flow (Q) against time (t) until the slope of the inflow and outflow lines can be achieved. Calculate the permeability by taking the mean of the inflow and outflow plots within the steady state flow range.

11. Remove the test sample from the apparatus and measure and record the mass of the test sample to the nearest 0.1g.

CALCULATIONS:

COEFFICIENT OF PERMEABILITY

1. Determine the cross sectional area (A) in square metres of the test sample using the following formula:A= $\pi/4$ D2

where D = Diameter of test sample, to the nearest 0.001m.

2. Determine the applied pressure head (h) in metres of water.

3. The D'Arcy Coefficient of Permeability is calculated using the following formula:

$$k = Q / tAh$$

where k = D'Arcy Coefficient of Permeability (m/s)

Q = Volume of water in m^3

L = Length of the test sample in metres, to the nearest 0.001m

t = Elapsed time in seconds

h = Applied pressure head in metres of water

A = Area of the test sample in m^2

REPORTING

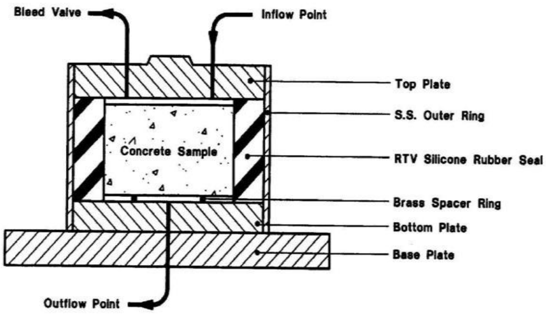
1. The D'Arcy Coefficient of Permeability, to the nearest significant figure for the inflow and outflow and the mean.

2. The source of the sample.

3. Any obvious features evident in the test sample such as surface defects, cracks etc.

4. The age of the sample if known.

5. A graphical presentation of the test data (Q versus t).



DETAILS OF PERMEABILITY CELL

RESULTS:

The D'Arcy Coefficient of Permeability is calculated using the following formula k=___________.

VIVA QUATIONS:

1. Wha is The permeability of concrete.
2. Wha is the relation between concrete permeability and durability.
3. How is permeability measured.
4. How can you reduce the permeability of concrete.

EXPERIMENT-IX

NON-DESTRUCTIVE TEST USING REBOUND HAMMER AND ULTRASONIC PULSE VELOCITY

AIM:

To determine the rebound number of hardened concrete which has close relation with compressive strength of concrete by using spring -driven steel hammer.

APPARATUS:

Rebound hammer (Schmidth hammer), abrasive stone.

THEORY AND SCOPE:

1. The rebound number determined by this method may be used to access the uniformity of concrete in situ, to delineate zones or regions (areas) of poor quality or deteriorated concrete in structures, and to indicate changes with time in characteristics of concrete such as those caused by the hydration of cement so that it provides useful information in determining when forms and shoring may be removed.

2. This test method is not intended as an alternative for strength determination of concrete.

3. Optimally, rebound number should be correlated with core testing information. Due to the difficulty of acquiring the appropriate correlation data in a given instance, the rebound number is most useful for rapidly surveying large areas of similar concretes in the construction under consideration.

PROCEDURE:

1. Calibration of Hammer: Carefully calibrate hammer every time before use. Follow the instruction manual of each hammer.

2. Selection of the Test Surface: Concrete member to be tested shall be at least 100 mm (4 in) thick and fixed within a structure. Smaller specimens must be rigidly supported. Area exhibiting honeycombing, scaling, rough texture or high porosity should be avoided.

For convenience, you may use concrete cylinders casted in Test C-7 as test specimens.

3. Preparation of Test Surface: A test area shall be at least 150 mm (6 in) in diameter. Heavily textured, soft or surfaces with loose mortar shall be ground smooth with the abrasive stone. Smooth-formed or troweled surfaces shall be tested without grinding.

4. Testing:

a) Firmly hold the instrument in a position that allows the plunger to strike perpendicularly to the tested surface. Gradually increase the pressure on the plunger until the hammer impacts.

b) After impact, record the rebound number. Take ten reading from each test area. No two impact test shall be closer together than 25 mm (1 in). Examine the impression made on the surface after impacted, and disregard the reading if the impact impact crushes or breaks through a near surface air void.

c) Discard readings differing from the average of 10 readings by more than 7 units and determine the average of the remaining readings. If more than 2 readings differ from the average by 7 units, discard the entire set of readings.

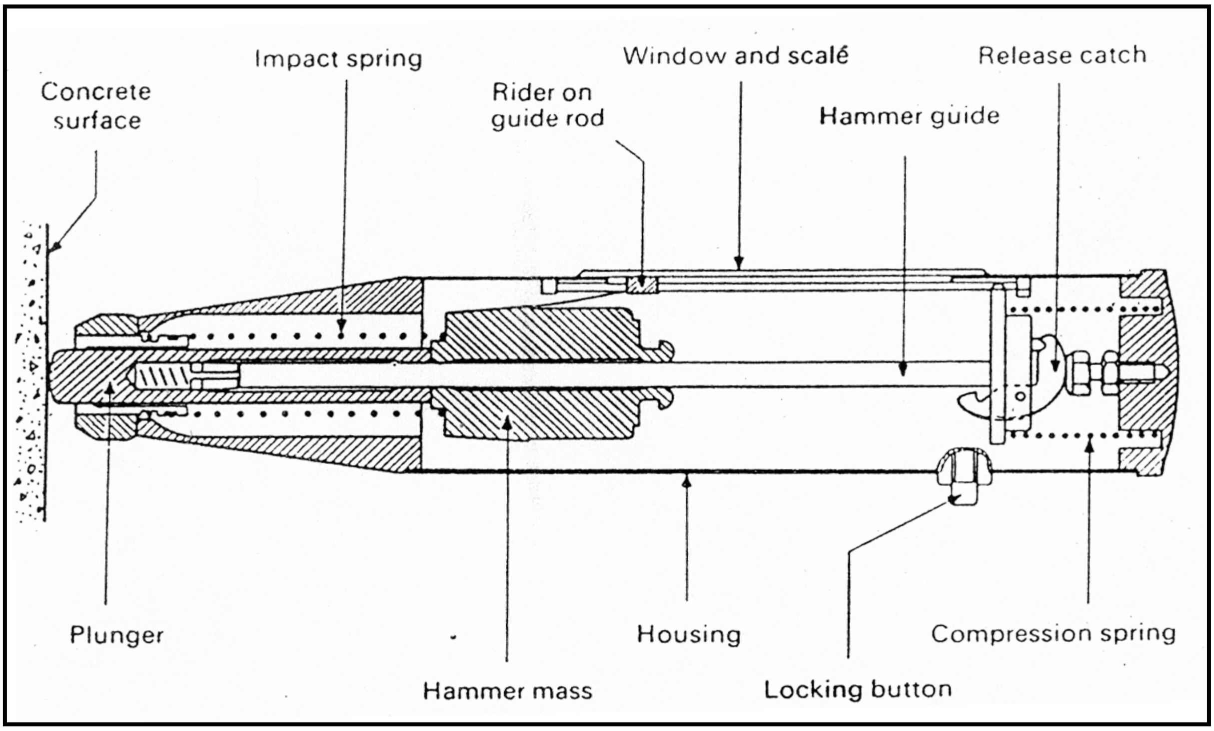
d) The rebound number used for estimation of concrete strength should be calculated from

$$R = (C * Rdg) + Q$$

where R is rebound number (to the nearest 0.5), C is coefficient of the hammer (Nominal value/Calibration value), Rdg is nominal impact reading and Q is correction for the inclination of impact as shown in table:

Rdg	Upward		Downward	
	+90 degree	+45 degree	-45 degree	-90 degree
10	NA.	NA.	+2.4	+3.2
20	-5.4	-3.5	+2.5	+3.4
30	-4.7	-3.1	+2.3	+3.1
40	-3.9	-2.6	+2.0	+2.7
50	-3.1	-2.1	+1.6	+2.2
60	-2.3	-1.6	+1.3	+1.7

Basic Features of Rebound hammer



CALCULATIONS:

Rebound Hammer Test				
No.	Calibration Test (Standard steel)	Concrete cylinders test		
		No.1	No.2	No.3
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Average				

VIVA QUATIONS:

1. What are the limitations of Rebound Hammer Test.
2. What does aSchmidt hammer measures.
3. Objective of Rebound Hammer Test.
4. What is Non-destructive testing of concrete**.**

ULTRASONIC PULSE VELOCITY METHOD

AIM:

To determine non-destructive testing of plain, reinforced and prestressed concrete whether it is precast or cast in-situ using ultrasonic pulse velocity method.The ultrasonic pulse velocity method could be used to establish, the homogeneity of the concrete, the presence of cracks, voids and other imperfections, changes in the structure of the concrete which may occur with time.

APPARATUS:

Electrical pulse generator, Transducer - one pair, Amplifier and Electronic timing device.

THEORY AND SCOPE:

The main objects of the ultrasonic pulse velocity method are to establish

1. The Homogeneity of the Concrete
2. The Presence of Cracks, Voids and other Imperfections
3. Changes in the Structure of the Concrete Caused by the Exposure Condition, Corrosion, Wear etc. which may occur with time,
4. The Quality of the Concrete in Relation to the Specified Standard Requirements.
5. The Quality of One Element of Concrete in Relation to the Another.
6. The Values of the Dynamic Elastic Modulus of the Concrete.

Principle: This is one of the most commonly used method in which the ultrasonic pulses generated by electro-acoustical transducer are transmitted through the concrete. In solids, the particles can oscillate along the direction of sound propagation as longitudinal waves or the oscillations can be perpendicular to the direction of sound waves as transverse waves. When the pulse is induced into the concrete from a transducer, it undergoes multiple reflections at the boundaries of the different material phases within the concrete. A complex system of stress waves is developed which includes longitudinal (Compressional), shear (Transverse) and surface (Rayleigh) waves. This transducers convert electrical signals into mechanical vibrations (transmit mode) and mechanical vibration into electrical signals (receive mode). The travel time is measured with an accuracy of +/- 0.1 microseconds. Transducers with natural frequencies between 20 kHz and 200 kHz are available, but 50 kHz to 100 kHz transducers are common.

The receiving transducer detects the onset of the longitudinal waves which is the fastest wave. Because the velocity of the pulses is almost independent of the geometry of the material through which they pass and depends only on its elastic property. Under certain specified conditions, the velocity and strength of concrete are directly related. The common factor is the density of concrete; a change in the density results in a change in a pulse velocity, likewise for a same mix with change in density, the strength of concrete changes. Thus lowering of the density caused by increase in water-cement ratio decreases both the compressive strength of concrete as well as the velocity of a pulse transmitted through it.

Pulse Velocity method is a convenient technique for investigating structural concrete. The underlying principle of assessing the quality of concrete is that comparative higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformity is good. In case poorer quality of concrete, lower velocities are obtained. If there is a crack, void or flaw inside the concrete which comes in the way of transmission of the pulses, the pulse strength is attenuated and it passes around the discontinuity, thereby making path length longer. Consequently, lower velocities are obtained. The actual pulse velocity obtained depends primarily upon the material and the mix proportion of the concrete. Density and modulus of elasticity of aggregate also significantly affect the pulse velocity.

Transducers: Piezoelectric and magnetostrictive types of transducers are available in the range of 20 kHz to 150 kHz of natural frequency. Generally, high frequency transducers are preferable for short path length and low frequency transducers for long path lengths. Transducers with a frequency of 50 to 60 kHz are useful for most all-round applications.

There are three possible ways of measuring pulse velocity through concrete :

a. Direct Transmission (Cross Probing) through Concrete : In this method transducers are held on opposite face of the concrete specimen under test as shown in fig. The method is most commonly used and is to be preferred to the other two methods because this results in maximum sensitivity and provides a well defined path length.

b. Semi-direct Transmission through Concrete : Sometimes one of the face of the concrete specimen under test is not accessible, in that case we have to apply semi-direct method as shown in fig. In this method, the sensitivity will be smaller than cross probing and the path length is not clearly defined.

c. Indirect Transmission (Surface Probing) through Concrete : This method of pulse transmission is used when only one face of concrete is accessible. Surface probing is the least satisfactory of the three methods because the pulse velocity measurements indicate the quality of concrete only near the surface and do not give information about deeper layers of concrete. The weaker concrete that may be below a strong surface can not be detected. Also in this method path length is less well defined. Surface probing in general gives lower pulse velocity than in the case of cross probing and depending on number of parameters.

Different Methods of Propagating Ultrasonic Pulses through Concrete

Velocity Criteria For Concrete Quality Grading

As per IS 13311 (Part 1) : 1992

Sr. No.	Pulse Velocity by Cross Probing (km/sec)	Concrete Quality Grading
1.	Above 4.5	Excellent
2.	3.5 to 4.5	Good
3.	3.0 to 3.5	Medium

4.	Below 3.0	Doubtful

Note : In case of doubtful quality of concrete, it may be necessary to carry out further tests.

Combined methods: There are different non-destructive testing methods which can be broadly classified as those which measure the overall quality of the concrete, dynamic or vibration methods like resonance frequency and ultrasonic pulse velocity tests and those which involve measurement of parameters like surface hardness, rebound, penetration, pull-out strength etc. are believed to be indirectly related to the compressive strength of concrete. In addition, radiographic, radiometric, nuclear, magnetic and electrical methods are also available. Since such non-destructive tests are at best indirect methods of monitoring the particulars, characteristics of concrete. The measurements are influenced by materials, concrete mix proportions and environmental factors. When the data of the materials and mix proportions used in the construction are not available, as is often the case. In view of the limitation of the methods for the predicting the strength of concrete in the structure, IS 13311 (Part 1) : 1992 Code has suggested to use combined method of ultrasonic pulse velocity and rebound hammer methods to alleviate the errors arising out of influence of materials, concrete mix proportions and environmental parameters on the respective measurement.The use of more than one methods are capable of providing useful information and statically improved accuracy for estimation of in situ strength of concrete. Combination of ultrasonic pulse velocity method and Schmidt rebound hammer may result much better estimation of strength of concrete because the influence of certain factors in the composition of the concrete and its curing are minimized.

FACTORS AFFECTING THE MEASUREMENTS OF PULSE VELOCITY

- Smoothness of Concrete Surface under Test
- Moisture Condition of Concrete
- Influence of Path Length on Pulse Velocity
- Lateral Dimensions.
- Temperature of Concrete

Effect of Reinforcing BarsInfluence of stress

VIVA QUATIONS:

1. How is ultrasonic pulse velocity calculated.
2. Wha is Self compacting concrete.
3. Objective of Rebound Hammer Test.
4. What is Non-destructive testing of concrete.

EXPERIMENT-X

ACCELERATED CURING OF CONCRETE

AIM

To find the strength of concrete after 24 hours using accelerated curing tank.

APPARATUS

Accelerated curing tank, Compression Testing Machine

THEORY AND SCOPE:

To find the compression strength of cube after 24 hours, with these values we can final compressive strength of concrete IS: 9013-1978-Method of making, curing and determining compressive strength of accelerated cured concrete test specimen. Normally, the strength of concrete is found out after 7 days and 28 days. For some construction activities, it may be too late and need to know the strength earlier.

Accelerated Curing Tank

PROCEDURE

1. Prepare the specimen and store it in moist air of at least 90% relative humidity and at a temperature of $27+2^{o}$C for 23 hrs + 15 minutes.
2. Lower the specimen, into a curing tank with water at 100 ^{0}C and keep it totally immersed for 3 ½ hours + 5 minutes.

3. The temperature of water shall not drop more than 3oC after the specimens are placed and should return to boiling within 15 minutes.
4. After curing for 3 ½ hours + 5 minutes in the curing tank, the specimen shall be removed from the moulds and cooled by immersing in cooling water 27+2^{o}C for a period of at least one hour.
5. Read compressive strength test of concrete for further steps.

CALCULATION:

The corresponding strength at 28 days can be found out from the following correlation. (It is however suggested that a new specific correlation should be developed for the specific concrete used at site.)

R_{28} (Strength at 28 days) = 8.09 + 1.64 Ra

Where,

Ra = Accelerated Curing Strength in MPa.

RESULT:

Accelerated curing strength=

VIVA QUATIONS:

1. Wha is accelerated curing test.
2. IS code for for accelerated curing of concrete.
3. What is compressive strength of concrete.
4. Which method is the most common and cheaper for water curing.

EXPERIMENT-XI

INFLUENCE OF W/C RATIO ON STRENGTH AND AGGREGATE / CEMENT RATIO ON WORKABILITY AND STRENGT

CUBE COMPRESSIVE STRENGTH OF CONCRETE

AIM:

To determine the compressive strength of concrete using 15 x 15 x 15 cm concrete cubes.

APPARATUS:

Compressive testing machine, Balance, Trays, Weights, Moulds and Trowels.

PROCEDURE:

1. Place the cube at the centre of the lower platen of the compression testing machine in such a manner that the load shall be applied to opposite sides of the cube as cast, that is, not to the top and bottom.

2. The axis of the specimen shall be carefully aligned with the centre of the thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine.

3. The load shall be applied without shock and increased continuously at a rate of approximately 140kg/cm2/min. until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.

4. The maximum load applied to the specimen shall then be recorded.

OBSERVATIONS:

Measured side of cube = cm

Weight of the cube = kg.

Load at first crack = kg.

Load at ultimate failure = kg.

CALCULATIONS:

Initial crack strength of concrete = <u>Load at first crack</u>
c/s area of the specimen

Ultimate cube compressive strength of the concrete = <u>Maximum Load</u>
c/s area of the specimen

Safe compressive strength of concrete = <u>Ultimate strength</u>
Factor of safety

= <u>Ultimate strength</u>
3

RESULT:

VIVA QUATIONS:

1. How is the water-cement ratio effects the strength of concrete.
2. Wha is aggregate cement ratio.
3. How do you make concrete more strength..
4. How long will it take for the concrete to achive 100 % of its strength.

EXPERIMENT-XII

INFLUENCE OF DIFFERENT CHEMICAL ADMIXTURES ON CONCRETE CUBE COMPRESSIVE STRENGTH OF CONCRETE

AIM:

To determine the compressive strength of concrete using 15 x 15 x 15 cm concrete cubes.

APPARATUS:

Compressive testing machine, Balance, Trays, Weights, Moulds and Trowels.

PROCEDURE:

1. Place the cube at the centre of the lower platen of the compression testing machine in such a manner that the load shall be applied to opposite sides of the cube as cast, that is, not to the top and bottom.

2. The axis of the specimen shall be carefully aligned with the centre of the thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine.

3. The load shall be applied without shock and increased continuously at a rate of approximately 140kg/cm2/min. until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.

4. The maximum load applied to the specimen shall then be recorded.

OBSERVATIONS:

Measured side of cube = cm

Weight of the cube = kg.

Load at first crack = kg.

Load at ultimate failure = kg.

CALCULATIONS:

Initial crack strength of concrete = Load at first crack
c/s area of the specimen

Ultimate cube compressive strength of the concrete = Maximum Load
c/s area of the specimen

Safe compressive strength of concrete = Ultimate strength
Factor of safety

= Ultimate strength
3

RESULT:

VIVA QUATIONS:

1. Which admixturesincrease the strength of the concrete.
2. How the strength of concrete can be increased, what are the various methods.
3. What factors affect concrete strength..
4. What is the most important determinant f concrete strength.