SCHEME : K

Name : _____

Roll No. : _____ Year : 20___ 20___

Exam Seat No. : _____

LABORATORY MANUAL FOR

CONCRETE TECHNOLOGY

(313322)

CIVIL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous) (ISO 9001: 2015) (ISO/IEC 27001:2013)

VISION:

To ensure that the Diploma level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION:

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY:

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES:

MSBTE believes in the following:

- Skill development in line with industry requirements
- Industry readiness and improved employability of Diploma holders
- Synergistic relationship with industry
- Collective and Cooperative development of all stake holders
- Technological interventions in societal development
- Access to uniform quality technical education.

A Laboratory Manual

For

CONCRETE TECHNOLOGY

(313322)

SEMESER-III

“K-SCHEME”

(CE/CR/CS/LE)

Maharashtra State

Board of Technical Education, Mumbai.

(Autonomous) (ISO: 9001: 2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education, Mumbai
(Autonomous) (ISO: 9001: 2015) (ISO/IEC 27001:2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai – 400051,
(Printed On July 2024)

Maharashtra State
Board of Technical Education, Mumbai.

Certificate

This is to certify that Mr./Ms……

Roll No …… Of Third semester of Diploma in ……..

…… Of Institute……..

…… (Code……) has completed the term satisfactorily in course **Concrete Technology (313322)** for the academic year 20……. To 20…….. as prescribed in the curriculum.

Place: …… Enrollment No: ……..

Date: …… Exam. Seat No: ……

Subject teacher Head of the Department Principal

Seal of Institution

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

PREFACE

The development of the critically important industry-relevant abilities and skills is the main goal of any engineering laboratory or field work in the technical education system. In light of this, MSBTE developed the most recent "K" Scheme curricula for engineering diploma programs, emphasizing outcome-based learning. As a result, a sizable portion of the program is dedicated to practical work. This demonstrates how crucial laboratory work is in helping teachers, instructors, and students understand that every minute of lab time must be used efficiently to create these outcomes rather than wasting it on unnecessary activities. Every practical has thus been created to operate as a "vehicle" to help each student acquire this industry-identified capability in order to ensure the effective implementation of this outcome-based curriculum. The "chalk and duster" practice in the classroom is a challenging way to build practical skills. As a result, the development team of the "K" scheme laboratory manual focused on the intended results when creating the practical, as opposed to the customary approach of performing practical's to "verify the theory".

This lab manual is intended to support all parties involved, particularly the students, instructors, and teachers, in helping the students achieve the pre-established goals. It is required of every student to read through the relevant practical process in its entirety and comprehend the bare minimum of theoretical background related to the practical at least one day in advance of the practical. As a crucial starting point for carrying out the practical, each exercise in this handbook starts with establishing the competency, industry-relevant skills, course outcomes, and practical results. After that, the students will learn about the abilities they will acquire through the process outlined there and the safety measures that must be followed, which will enable them to use in addressing real-world situations in their professional life.

This manual also offers guidance to educators on how to manage resources so that students follow protocols and safety measures methodically and meet learning objectives. This allows teachers and instructors to effectively support student-centered lab activities through each practical exercise.

Today's globalized world has witnessed tremendous technological breakthroughs in surveying equipment and technology. Currently available accurate digital surveying tools are employed because of their speed, precision, and ease of use. The disciplines of civil engineering, mining engineering, environmental engineering, transportation engineering, and marine engineering heavily rely on these tools and applications. Given the importance of remote sensing and Geographic Information Systems (GIS) and their widespread usage in mapping and storing spatial data, it is expected that students will have a basic understanding of these subjects in order to use them in the field. Students who complete this course will have the necessary abilities and competences to perform tasks linked to surveys.

Although best possible care has been taken to check for errors (if any) in this laboratory manual, perfection may elude us as this is the first edition of this manual. Any errors and suggestions for improvement are solicited and highly welcome.

Program outcome (POs)

PO 1. Basic & Discipline specific knowledge: Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the engineering problems.

PO 2. Problem Analysis: Identify and analyze well defined engineering problems using codified standard methods.

PO 3. Design /Development Solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

PO 4. Engineering tools experimentation and testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO 5. Engineering practices for society sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO 6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO 7. Lifelong learning: Ability to analyze individual needs and engage in updating in context of technological changes.

List of Relevant Skills

On the successful completion of the course the students will acquire the required industry relevant skills and they will be able to:

1. Use relevant types of cement in different site conditions.
2. Use relevant type of aggregates for required concrete works
3. Select the required ingredients of concrete.
4. Prepare concrete of required specification.
5. Test the concrete for its compressive strength.
6. Interpret the result for conclusion
7. Maintain the quality of concrete.

Guidelines to teachers

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain prior concepts to the students before starting of each practical.
3. Involve students in performance of each practical.
4. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
5. Teachers should give opportunity to students for hands on experience after the demonstration.
6. Teacher is expected to share the skills and competencies to be developed in the students.
7. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
8. Finally give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.

Instructions to Students

1. Organize the work in the group and make record all programs.
2. Students shall develop maintenance skill as expected by industries.
3. Student shall attempt to develop related hand-on skills and gain confidence.
4. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
5. Student shall refer technical magazines.
6. Student should develop habit to submit the practical on date and time.
7. Student should well prepare while submitting write-up of exercise.
8. Attach /paste separate papers wherever necessary.

Practical Course outcome matrix:

- CO1 - Suggest relevant types of cement to be used in the given site conditions.
- CO2 - Classify the given aggregates based on its shape and size with the importance of their properties.
- CO3 - Prepare concrete of required specifications in the given situation.
- CO4 - Undertake the necessary procedures to maintain the quality of given type of concrete.
- CO5 - Suggest relevant type of admixtures to be used in the given situation.

Pr. No.	Title of the Practical	Mapped Course Outcome				
		CO 01	CO 02	CO 03	CO 04	CO 05
01	Determine fineness of cement by Blaine's air permeability apparatus or by sieving.	√	--	--	--	--
02	*Determine standard consistency, initial and final setting times of OPC.	√	--	--	--	--
03	*Determine compressive strength of ordinary Portland cement.	√	--	--	--	--
04	Determine the soundness of ordinary Portland cement (OPC)	√	--	--	--	--
05	Determine silt content of given sample of sand by volume.	--	√	--	--	--
06	Determine bulking of the given sample of sand.	--	√	--	--	--
07	Determine bulk density of fine and coarse aggregates.	--	√	--	--	--
08	Determine water absorption of fine and coarse aggregates	--	√	--	--	--
09	*Determine Fineness modulus of fine aggregate by sieve analysis.	--	√	--	--	--
10	*Determine Fineness modulus of coarse aggregate by sieve analysis.	--	√	--	--	--
11	*Determine aggregate impact value or Crushing Value or Abrasion value	--	√	--	--	--
12	*Determine aggregate elongation index and flakiness index.	--	√	--	--	--
13	*Determine workability of concrete by slump cone test or Compaction factor test.	--	--	√	--	--
14	*Determine compressive strength of concrete for 7 days	--	--	√	--	--
15	*Visit to RMC plant to understand the components and its functioning.	--	--	--	√	√

CONTENT PAGE

List of Practical's and Formative Assessment sheet.

Pr. No	Title of the Practical	Page No.	Date of performance	Date of Submission	Assessment marks	Dated sign of teacher	Remarks (if any)
01	Determine fineness of cement by Blaine's air permeability apparatus or by sieving.						
02	*Determine standard consistency, initial and final setting times of OPC.						
03	*Determine compressive strength of ordinary Portland cement.						
04	Determine the soundness of ordinary Portland cement (OPC)						
05	Determine silt content of given sample of sand by volume.						
06	Determine bulking of the given sample of sand.						
07	Determine bulk density of fine and coarse aggregates.						
08	Determine water absorption of fine and coarse aggregates.						
09	*Determine Fineness modulus of fine aggregate by sieve analysis.						
10	*Determine Fineness modulus of coarse aggregate by sieve analysis.						
11	*Determine aggregate impact value **or** Crushing Value **or** Abrasion value						
12	*Determine aggregate elongation index and flakiness index.						
13	*Determine workability of concrete by slump cone test or Compaction factor test.						
14	*Determine compressive strength of concrete for 7 days						
15	*Visit to RMC plant to understand the components and its functioning.						

Note : Out of above suggestive LLOs -

- '*' Marked Practical (LLOs) are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mixes of LLOs are to be performed to achieve desired outcomes.

Practical No: 01 **Determine fineness of cement by Blaine's air permeability apparatus or by sieving.**

I. Practical Significance:

Cement plays a vital role in construction industry. Fineness is the important property of cement in bearing on the rate of hydration and thereby on its strength. This practical will enable the students to select the relevant type of cement based on hydration, amount of water required for gaining strength in concrete.

II. Industry/Employer expected outcome(s):

- Propose the relevant type of cement to be used in the given situation.

III. Course Level Learning Outcome (COs):

- CO1 - Suggest relevant types of cement to be used in the given site conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 1.1 - Check suitability of cement based on its fineness.

V. Relevant Affective Domain related Outcome(s):

- Use relevant type of cement at different site conditions.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

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 faster the development of strength. The fineness of grinding has increased over the years but now it has got nearly stabilized. Different cements are ground to different fineness. The particle size fraction below 3 microns has been found to have the predominant effect on the strength at one day while 3-25 micron fraction has a major influence on the 28 days strength. Increase in fineness of cement is also found to increase the drying shrinkage of concrete.

Fineness of cement is tested in two ways.

a) By sieving.

b) By determination of specific surface (total surface area of all the particles in one gram of cement) by air-permeability apparatus, expressed as cm^2/gm or m^2/kg. Generally Blaine Air permeability apparatus is used.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	IS-90 micron sieve	Brass Sieve conforming to IS: 460 (Part 1-3)-1985	1 nos.
2.	Weighing balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm.	1 nos.
3.	Blaine's Air Permeability Apparatus	Refer to IS 4031 Part -1991	1 nos.
04	Timer	Accuracy-0.2 sec	1 nos.

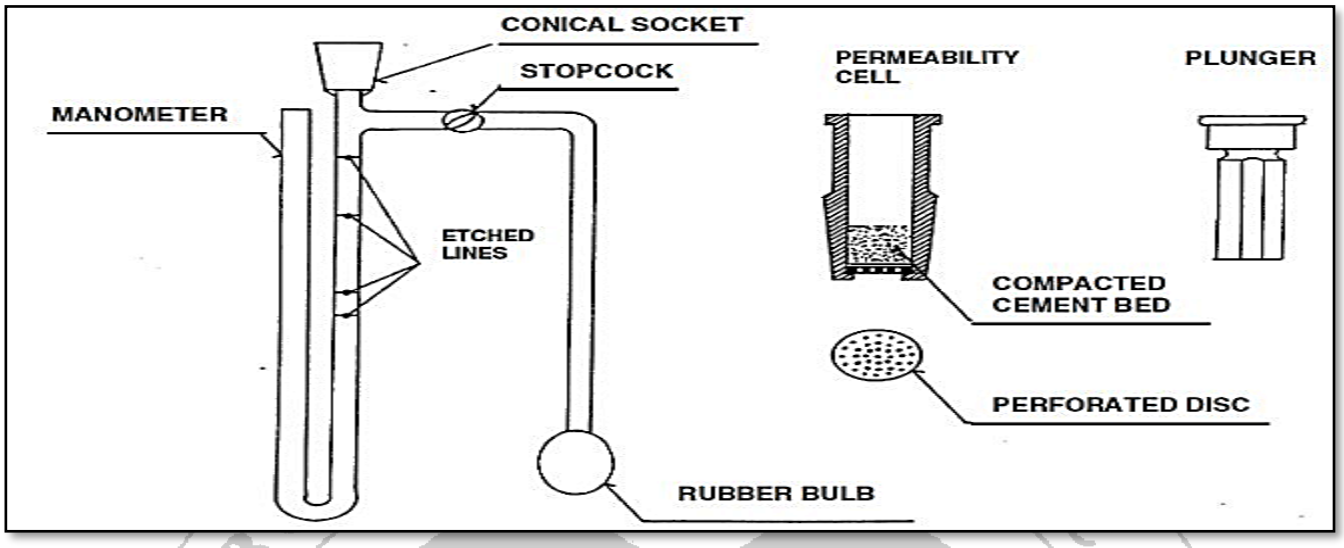

Fig 1. Blaine's Air Permeability Apparatus

VIII. Precautions to be followed:

1. No loss of cement while sieving.
2. No loss of mercury while filling in the permeability apparatus.
3. Break down any air set lumps in the sample without rubbing them on the sieve.

IX. Procedure:

A) Sieving Method

1. Weigh 100 gm of cement (W) and place it on a I.S. 90 micron sieve.
2. Sieve the sample continuously for 15 minutes.
3. Weigh the residue left on the sieve. (W1).
4. Calculate fineness of cement.

B) Blains Air Permeability Method

1. Calculate the bulk volume (V) of compacted bed of standard cement.
2. Determine the weight of standard sample (W) required to produce a bed.
3. Determine the time taken (Ts) by manometer liquid to fall from top to the third mark on the manometer.
4. Calculate the constant of the apparatus.
5. Using same quantity of cement (W) find the time (T) in seconds required to fall from top to the third mark on the manometer
6. Calculate specific surface area of cement in sq cm/gm.

X. Observations and Calculations

A) Sieving Method

Sr. No.	Particulars	I	II	III
1.	Weight of cement (W) gm.			
2.	Weight of cement retained (W) gm.			
3.	% of cement retained on sieve.			

B) Blains Air Permeability Method

1. Weight of empty crucible **……**
2. Weight of crucible and mercury filling permeability cell **…….**
3. Weight of mercury filled (W_A) **……..**
4. Weight of crucible and mercury filling portion above cement bed **……**
5. Weight of mercury filling cell above cement bed of 2.80 gm of standard cement (W_B) **……**
6. Time (Ts) for standard cement **……**
7. Constant of apparatus (K) **……**
8. Time (T) for sample cement **…….**
9. Specific surface of cement sample (S) **……..**

Sample Calculations:-

A) Sieving Method

% of Weight retained = $\frac{W1}{W}$ =

B) Blains Air Permeability Method

1. V = $\frac{WA-WB}{D}$ =
2. W =3.15 x V (1-e) =

   Where, e=0.500 ± 0.005
3. K = $\frac{Ss}{\sqrt{Ts}}$ =
4. S = $K\sqrt{T}$ =

XI. Result:

A) Sieving Method

Fineness of cement = **……**

B) Blains Air Permeability Method

Specific surface area of cement = **……**

XII. Interpretation of results (Give the meaning of above obtained results)**:**

……

……

XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

……

……

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the effect of fineness of cement on the rate of hydration.
2. State BIS requirements of specific area of cement for OPC and rapid hardening cement.
3. Justify selecting the 2.8 gm of standard cement sample.
4. Justify the suitability of cement from the following.
   i. Fineness of OPC sample A is 15%
   ii. Fineness of OPC sample B is 8%

Space for Answer

……

……

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……

XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	FINENESS TEST OF CEMENT BY BLAINE'S AIR PERMEABILITY METHOD (IS-4031-PART-2) – we civil engineers (wordpress.com)	BLAINE'S AIR PERMEABILITY Apparatus
2.	https://youtu.be/sl0smPfvVAo?list=PLkyVnO47pDX9YJglk1o2iYzWg_ABo5I_xA	Testing of Cement by NITTTR Chandigarh
3.	https://youtu.be/6iThtydES5c?si=OAOv5EW3lukFiFBD	Fineness of Cement as per IS 4031-Part1 by Sieving method

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the cement sample	15%
3.	Measuring the residue of cement sample	20%
4.	Calculation of fineness of cement	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 02 Determine standard consistency, initial and final setting times of OPC.

I. Practical Significance:

Cement is inevitable ingredient used as pasting material in construction activity and therefore its properties such as Standard Consistency, Initial and Final Setting Time bears a significant impact on the strength of structure.

After performing this practical, students will develop the competency of selecting the correct W/c ratio in concrete operations.

II. Industry/Employer expected outcome(s):

- Use the correct W/c ratio in concrete operations.

III. Course Level Learning Outcome (COs):

- CO1 - Suggest relevant types of cement to be used in the given site conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 2.1 - Propose the water cement ratio for the given type of cement.

V. Relevant Affective Domain related Outcome(s):

- Use relevant type of cement at different site conditions.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

Consistency refers to the approximate density of the freshly mixed cement slurry, or mortar, and its ability to flow. It is important that the cement does not harden too quickly and not too slowly. In the first case, there may not be enough time to transport and place the concrete before it becomes too hard. In the second case, the hardening time is too long which delays the work and also delays the actual use of the structure because the strength of the structure is low for the required life. The setting time is the time it takes for the cement slurry to harden to a concrete size. Indirectly, cement reacts with water to form aluminum silicate compounds. The initial setting time is when the adhesive begins to lose its plasticity. The final drying time refers to the time when the adhesive loses all of its plasticity. This is the time required for the cement slurry or cement concrete to harden enough to form a mould. Determining the final curing time will help ensure the safe removal of scaffolding and formwork. During this time, the main chemical reaction between cement and water is complete.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	Measuring Cylinder	Measuring Cylinder of 100ml capacity	4 nos.
2.	Weighing balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm.	1 nos.
3.	Timer	Accuracy-0.2 sec	4 nos.
4.	Vicat's Apparatus	Consist of a metallic frame bearing a movable rod with cap at one end and a	1 set for a group of 4

		Vicat Mould 80 ± 5mm in Dia. at the base, 70 ± 5mm at the Top and 40 ± 0.2mm High & with a glass base plate consistency plunger, initial and final setting needles in a nice jewelry case. With dash pot to facilitate the gentle lowering of the needle.	to 5 students

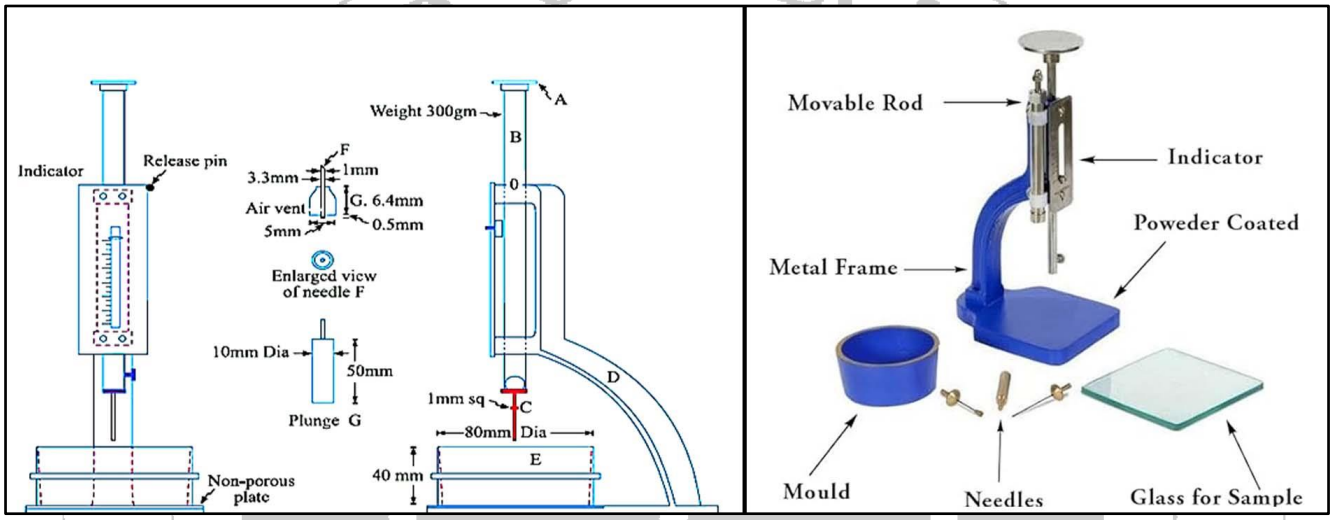

Fig 2.1. Vicat's Apparatus

VIII. Precautions to be followed:

1. Gauging time should be strictly observed.
2. Room temperature should be well maintained as per test requirement.
3. All apparatus used should be clean.
4. The experiment should be performed away from vibrations and other disturbances.
5. Release the initial and final setting time needles gently.
6. Needle should be cleaned every time it is used.
7. Position of the mould should be shifted slightly after each penetration to avoid penetration at the same place.

IX. Procedure:

Consistency of cement:-

1. Take 400 gm. of cement and place it in the enameled tray.
2. Mix about 25% water by weight of dry cement thoroughly to get a cement paste. Total time taken to obtain thoroughly mixed water cement paste i.e. "Gauging time" should not be more than 3 to 5 minutes.
3. Fill the Vicat's mould, resting upon a glass plate, with this cement paste.
4. After filling the mould completely, smoothen the surface of the paste, making it level with top of the mould.
5. Place the whole assembly (i.e. mould + cement paste + glass plate) under the rod bearing plunger.

6. Lower the plunger gently so as to touch the surface of the test block and quickly release the plunger allowing it to sink into the paste.
7. Measure the depth of penetration and record it.
8. Prepare trial pastes with varying percentages of water content and follow the steps (2 to 7) as described above, until the depth of penetration becomes 33 to 35 mm from the top of mould.

Initial and Final Setting time of Cement

Test block preparation:

1. Take 400 gm of cement and prepare a neat cement paste with 0.85P of water by weight of cement.
2. Gauge time is kept between 3 to 5 minutes. Start the stop watch at the instant when the water is added to the cement. Record this time (T_1).
3. Fill the Vicat's mould, resting on a glass plate, with the cement paste gauged as above.
4. Fill the mould completely and smooth off the surface of the paste making it level with the top of the mould. The cement block thus prepared is called test block.

Initial setting time

1. Place the test block confined in the mould and resting on the non-porous plate, under the rod bearing the needle.
2. Lower the needle gently until it comes in contact with the surface of test block and quick release, allowing it to penetrate into the test block.
3. In the beginning the needle completely pierces the test block. Repeat this procedure i.e. quickly releasing the needle after every 2 minutes till the needle fails to pierce the block for about 5 mm to 7mm measured from the bottom of the mould. Note this time (T_2).

Final setting time

1. For determining the final setting time, replace the needle of the Vicat's apparatus by the needle with an annular attachment.
2. The cement is considered finally set when upon applying the final setting needle gently to the surface of the test block; the needle makes an impression thereon, while the attachment fails to do so. Record this time (T_3).

X. Observations and Calculations

1. Type and brand of cement = **……**
2. Grade of cement = **……**

Consistency of cement

Sr. No.	Description	I	II	III	IV	V	VI
1.	Weight of water added.						
2.	% of water by weight.						
3.	Penetration of plunger from bottom in mm.						

Initial and Final setting time.

1. Water for standard consistency (P) is water required for attaining standard consistency = **…….**
2. Water to be added 0.85 P = **…….**
3. Time at which water is first added to cement (T_1) = **…….**
4. Time when initial setting time needle reaches for penetration up to 5 to 7 mm from bottom of mould (T_2) = **…….**
5. Time when final setting time needle makes an impression but the attachment fails to do so (T_3) = **…….**

Sample Calculations:-

A) Consistency of cement

% of water added = **…….**

B) Initial setting time

Initial setting time = $T_2 - T_1$ = **…….**

C) Final setting time

Final setting time = $T_3 - T_1$ = **…….**

XI. Result:

A) Consistency of cement = **…….**

B) Initial setting time of cement = **…….**

C) Final setting time of cement = **…….**

XII. Interpretation of results (Give the meaning of above obtained results)**:**

……

……

……

XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

……

……

……

……

……

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. What do you understand by initial and final setting times of a cement sample?
2. What precautions do you observe in performing the above tests?
3. What are is specifications for setting times of various types of cements recommended for use on a construction site?
4. What is the amount of water to be added for initial setting time?
5. What is difference between setting and hardening?

Space for Answer

XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	Vicat's Apparatus Hd image - Google Search	Vicat's Apparatus
2.	https://youtu.be/sl0smPfvVAo?list=PLkyVnO47pDX9YJglk1o2iYzWg_ABo5I_xA	Testing of Cement by NITTTR Chandigarh

XVI. Assessment Scheme

Sr.No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measurement of cement and water	15%
3.	Observations and recording	20%
4.	Calculations	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 03 Determine compressive strength of ordinary Portland cement.

I. Practical Significance:

The structure has to be safe, economical and need to withstand the various attacks in natural calamities or accidental circumstances. This ultimately depends on the quality of cement used in mortar and/or concrete in relevant proportion with sand (fine aggregates) to give the desired minimum compressive strength of cement. This practical will enable the students to justify the use of cement in the given situation.

II. Industry/Employer expected outcome(s):

- To determine the compressive strength of ordinary Portland cement.

III. Course Level Learning Outcome (COs):

- CO1 - Suggest relevant types of cement to be used in the given site conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 3.1 - Undertake the testing on the given type of cement to determine its compressive strength.

V. Relevant Affective Domain related Outcome(s):

- Use relevant type of cement at different site conditions.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

Strength of cement is the most important of all the cement properties. Strength test of cement is carried out on the cubes of hardened cement- sand mortar; not on a neat cement paste. Strength of cement mortar cube can be affected by no. of items such as W/C ratio, cement sand ratio, type and grading of sand, manner of mixing, size and shape of specimen, curing conditions and age of specimen. Cement mortar cube strength is generally used as a quality control measure of cement.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	Measuring Cylinder	Measuring Cylinder of 100ml capacity	4 nos.
2.	Weighing balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm.	1 nos.
3.	Cement mortar cube	Area of mould – 50cm^2 (Size – 7.07 x 7.07x 7.07 cm)	6 nos.
4.	Cement cube vibrator	As per IS 10080-1982	1 nos.
5.	Compression Testing Machine	Capacity – 2000KN	1 nos.

Fig 3.1 Compression Testing Machine

VIII. Precautions to be followed:

1. Gauging time should be strictly observed.
2. The mould should be oiled before use.
3. Increase the load of CTM gradually during testing.
4. The cubes should be tested immediately after taking out of water and not allowed to dry until they fail during testing.
5. The cubes should be tested on their sides and not on their faces.

IX. Procedure:

1. Take 200 gm of cement and 600 gm of standard sand and mix them dry thoroughly.
2. Add $(\frac{P}{4}+3)\%$ of water (where P is % of water required for preparing paste of standard consistency) to the dry mix of cement and sand and mix thoroughly for a minimum of 3 minutes and maximum of 4 minutes to obtain a mix of uniform colour. If even in 4 minutes uniform colour of the mix is not obtained reject the mix and mix fresh quantities of cement, sand and water to obtain a mix of uniform colour.
3. Place the thoroughly cleaned and oiled (on interior face) mould on the vibrating machine and hold it in position by clamps provided on the machine for the purpose.
4. Fill the mould with entire quantity of mortar using a suitable hopper attached to the top of the mould for facility of filling and vibrate it for 2 minutes at a specified speed of 12000±400 per minute to achieve full compaction.

5. Remove the mould from the machine and keep it in a place with temp of 27±2°C and relative humidity of 90% for 24 hours.
6. At the end of 24 hrs remove the cube from the mould and immediately submerge in fresh clean water. The cube be taken out of the water only at the time of testing.
7. Prepare at least 6 cubes in the manner explained above.
8. Place the test cube on the platform of a compressive testing machine without any packing between the cube and the plates of the testing machine.
9. Apply the load steadily and uniformly, starting from zero at a rate of 35 N/mm²/minute till the cube fails.
10. Record the crushing load of each cube and calculate compressive strength of each cube.

X. Observations and Calculations

1. Type and brand of cement = **……**
2. Grade of cement = **……**
3. Standard consistency of cement (P) =**……**
4. Surface area of test block = **……**
5. Quantities of ingredients required for each sample cube
   i Cement = **……**
   ii. Standard Sand =**……**
   iii. Water = **……**
6. Date of Casting of cubes = **……**
7. Date of Testing of cubes - After 3 days = **……**
   After 7 days = **……**
   After 28 days = **……**

Observation Table:-

Sr. No.	Description	I	II	III	I	II	III	I	II	III
1.	Curing periods in days	3	3	3	7	7	7	28	28	28
2.	Load at Failure (N)									
3.	Compressive strength in N/mm^2									
4.	Average Compressive strength in N/mm^2									

Sample Calculations:-

Compressive Strength = Load/Area

$\sigma = P/A =$

XI. Result:

A) Average Compressive strength of cement at 3 days = **…….**

B) Average Compressive strength of cement at 7 days = **…….**

C) Average Compressive strength of cement at 28 days = **…….**

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. What precautions do you observe in performing the above tests?
2. State the importance of this test?
3. What is the compressive strength for rapid hardening cement at 3, 7, 28 days?
4. What is the compressive strength for low heat Portland cement at 3, 7, 28 days?
5. If the compressive strength result are not as per IS requirement, justify according to following parameters:
   i. Storage period
   ii. Compaction
   iii. W/C ratio
6. State the necessity of standard sand used for preparing cement mortar cube?
7. State the significance of Compressive strength of cement test?

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://www.nitttrchd.ac.in/sitenew1/nctel/civil.php	Practical's on Cement /Concrete / Aggregate by NITTTR Chandigarh
2.	https://youtu.be/sl0smPfvVAo?list=PLkyVnO47pDX9YJglk1o2iYzWg_ABo5I_xA	Testing of Cement by NITTTR Chandigarh
3.	https://cs-iitd.vlabs.ac.in/List%20of%20experiments.html	Virtual laboratory practical on concrete technology

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus and machine	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculations	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 04 Determine the soundness of ordinary Portland cement (OPC).

I. Practical Significance:

Cement is a combination of lime, silica, alumina, magnesium oxide, alkali, sulfur trioxide, iron oxide and calcium sulfate. Lime is 60% to 70%. Therefore, cement without lime hardens quickly and affects the properties of cement. Too much lime will weaken the cement. Low concrete will affect the quality of cement work. This requires the cement to be tested before use.

This practical will enable the students that the cement does not suffer from expansion in any way due to the presence of lime.

II. Industry/Employer expected outcome(s):

- To determine the soundness test on ordinary Portland cement.

III. Course Level Learning Outcome (COs):

- CO1 - Suggest relevant types of cement to be used in the given site conditions.

IV. Laboratory Learning Outcome (LLO):

- LLO 4.1 - Measure the volumetric changes in the given sample of cement.

V. Relevant Affective Domain related Outcome(s):

- Use relevant type of cement at different site conditions.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

It is very important that the cement does not undergo large changes in volume after hardening. Some cements were found to stretch too much after hardening, causing the joint to crack and the body to harden. This makes the durability of the structure very problematic when using this type of cement. The instability of the cement is due to the excess of free lime in addition to the amount that can be combined with the acid in the kiln. Too much magnesium or calcium sulfate will weaken the cement. The stability of cement can be determined using two methods, namely the Le- Chatelier method and the autoclave method. In the solidification test, a hardened cement slurry sample is boiled for a period of time to accelerate and observe the growth rate. Durability is the ability to withstand volume expansion.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	Measuring Cylinder	Measuring Cylinder of 100ml capacity	4 nos.
2.	Weighing balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm.	1 nos.
3.	Le- Chatelier apparatus	Le- Chatelier apparatus conforming to IS: 5514-1969	1 set for a group of 4 to 5.
4.	Gauging trowel	As per the specification	1 nos.
5.	Water bath	As per the specification	1 nos.

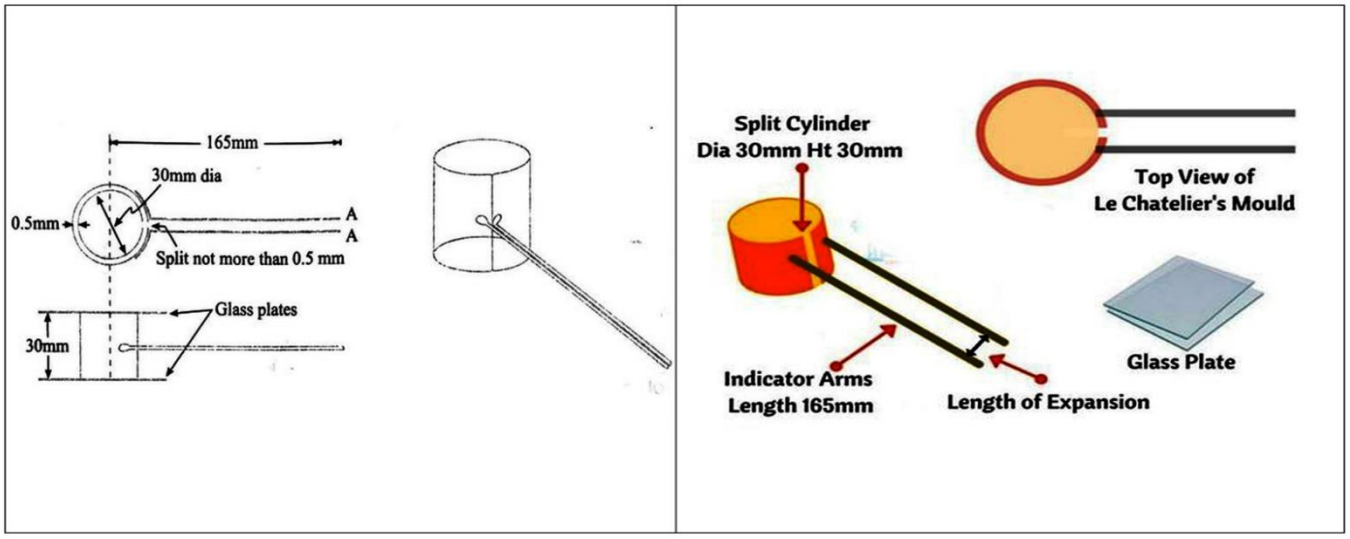

Fig 4.1. Le- Chatelier apparatus

VIII. Precautions to be followed:

1. Special care should be taken while performing this test.
2. The mould should be oiled before use.
3. No extra pressure should be applied while filling the mould.
4. During the process of boiling, the water level must not go below the height of the mould

IX. Procedure:

1. The Le-chatelier mould and the glass plates are lightly oiled before conducting the test.
2. Prepare a cement paste as in consistency test with 0. 78 times the water required to give a paste of standard consistency
3. Fill the cement paste in the Le-chatelier mould taking care to keep the edges of the mould gently together during the operation.
4. Cover the mould with another piece of a glass plate and place a small weight over the cover plate.
5. Submerge the whole assembly immediately in water at a temperature of 27°±2°C and keep it there for 24 hours.
6. Take out the assembly again in water at 27°±2°C. Then distance between the indicators points are to measure.
7. Submerge assembly again in water at 27°±2°C.
8. Bring the water to boiling in 25 to 30 minutes and keep at boiling for 3 hours. The assembly should be immersed in water during this process.

X. Observation Table:-

Sr. No.	Description	Observed Values
1.	Distance between pointers before boiling (D1) in mm	
2.	Distance between pointers after boiling (D2) in mm	
3.	Expansion of the cement = E1 = (D2- D1) in mm	
4.	Average expansion of the cement in mm	

XI. Result:

A) Average expansion of the cement is obtained is **……** mm.

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. What are the causes of unsoundness in cement? List out the methods to reduce unsoundness?
2. Why the cement paste is kept submerged under water during the test?
3. What is the purpose of boiling the setup?
4. What are the limiting values for maximum expansion of cement as per Le-Chatelier test for following cements: rapid hardening cement; Portland puzzolana cement; high alumina cement; low heat cement; and super sulphated cement?

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://www.nitttrchd.ac.in/sitenew1/nctel/civil.php	Practical's on Cement /Concrete / Aggregate by NITTTR Chandigarh
2.	https://youtu.be/sl0smPfvVAo?list=PLkyVnO47pDX9YJglk1o2iYzWg_ABo5I_xA	Testing of Cement by NITTTR Chandigarh
3.	https://cs-iitd.vlabs.ac.in/List%20of%20experiments.html	Virtual laboratory practical on concrete technology
4.	Le- Chatelier apparatus - Google Search	Le- Chatelier apparatus Figure

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculations	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 05 Determine silt content of given sample of sand by volume.

I. Practical Significance:

In Civil Engineering structures concrete plays an important role. To prepare concrete some percentage of fine aggregate is required. Fine aggregate is an important ingredient of concrete. It plays the vital role in every part of the construction (concrete, plastering, brickwork, flooring etc.). If silt content is more than standard value, it will reduce the strength of bond. So it is essential to ensure that silt content must be within standard limit.

This practical will enable the students to decide the suitability of sand for concreting work.

II. Industry/Employer expected outcome(s):

- To determine the silt content in sand by volume.

III. Course Level Learning Outcome (COs):

- CO2 - Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 5.1 - Verify the suitability of given sample of sand to prepare concrete.

V. Relevant Affective Domain related Outcome(s):

- Use relevant type of sand for preparing mortar and concrete.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

Silt content in the sand is the total quantity of fine particles of deleterious materials having particle from 0.06 mm to 0.002 mm present in the sand. The presence of silt in the sand may adversely affect the strength and durability of concrete. It also weakens the bond between the aggregate and the cement paste.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	Measuring Cylinder	Measuring Cylinder of 250ml capacity	4 nos.
2.	Steel Rule	30 cm long	4 nos.

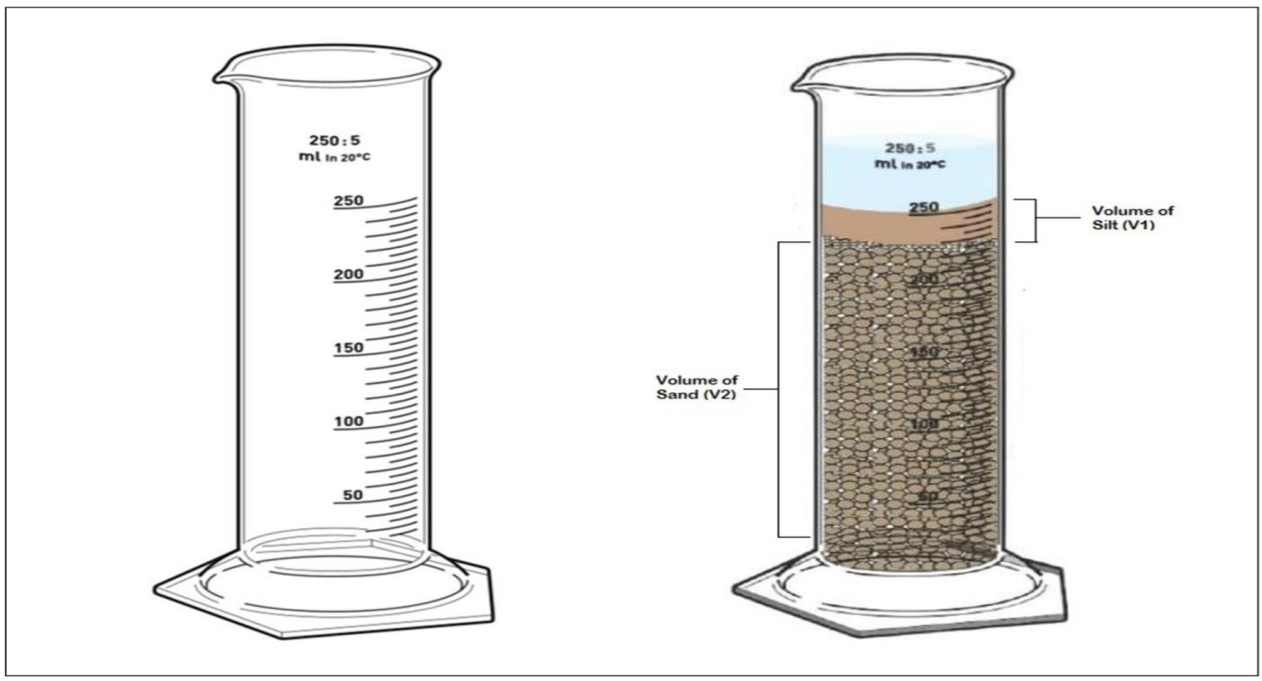

Fig 5.1. Measuring Cylinder

VIII. Precautions to be followed:

1. The jar should be dry.
2. All volumes must be taken accurately.
3. Shake the mixture vigorously.

IX. Procedure:

1. Prepare 1% solution of common salt by dissolving 10 gm of common salt in 1 litre water.
2. Fill the measuring jar with 1% solution of common salt up to 50 ml mark.
3. Add sand to be tested in the jar such that the level of common salt solution reaches 100 ml mark.
4. Add more solution of above concentration in the test jar till the level reaches 150 ml mark.
5. Cover the jar tightly with palm and shake vigorously the mixture and common salt solution by turning upside down repeatedly.
6. Allow the mixture to settle down in the jar for three hours.
7. Measure the thickness of silt layer, which is settled down on the layer of the sand.

X. Observation and Calculations:-

Sr. No.	Description	I	II	III
1.	Volume of sample V_1			
2.	Volume of silt after 3 hours V_2			
3.	Percentage of silt by volume			
4.	Average Percentage of silt			

Sample Calculations:-

Percentage of silt by volume = $(V_2 / V_1) \times 100$ = **……**

XI. Result:

A) Average Percentage of silt by volume **……** mm.

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the significance of knowing the silt content in the sand.
2. Explain the need to add common salt into the water.
3. Following are values of silt content of three different samples.
   i. Silt Content = 8%
   ii. Silt Content = 3%
   iii. Silt Content = 4%

   Write the Suitability of sand for various construction works.
4. If the percentage of silt content in the sand is 12%, is it recommended for the concrete? If not, suggest remedial measures.

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://www.nitttrchd.ac.in/sitenew1/nctel/civil.php	Practical's on Cement /Concrete / Aggregate by NITTTR Chandigarh
2.	https://youtu.be/FmNsa_yNy9M?t=74	Practical on silt content

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculations	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 06 Determine bulking of the given sample of sand.

I. Practical Significance:

While preparing concrete, quantity of aggregates must be known. Due to bulking, fine aggregate shows completely unrealistic volume. The consideration must be given to the effect of bulking in proportioning the concrete oy volume. If care is not taken to the effect of bulking, in the case of volume batching, the resulting concrete may have less sand than required and concrete becomes harsh. It will also affect the yield of concrete for a given cement content.

This practical will enable the students to estimate the required quantity of sand for preparing concrete.

II. Industry/Employer expected outcome(s):

- To determine the quantity of sand for preparing concrete.

III. Course Level Learning Outcome (COs):

- CO2 - Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 6.1 - Undertake the required test to estimate the quantity of sand for preparing concrete.

V. Relevant Affective Domain related Outcome(s):

- Use relevant type of sand for preparing mortar and concrete.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

Bulking of sand means increase in volume of a given sand due to presence of surface water. It is caused by a film of surface water covering each particle of sand and pushing them apart due to surface tension. There is no bulking when the sand is dry or when it is fully saturated with water. Fine: Coarse aggregate does not bulk. Bulking of sand is increases with the increase in moisture content up to a certain limit and beyond that the further increase in the moisture content results in the decrease in the volume and at a moisture content representing saturation point, there is no bulking of fine aggregate.

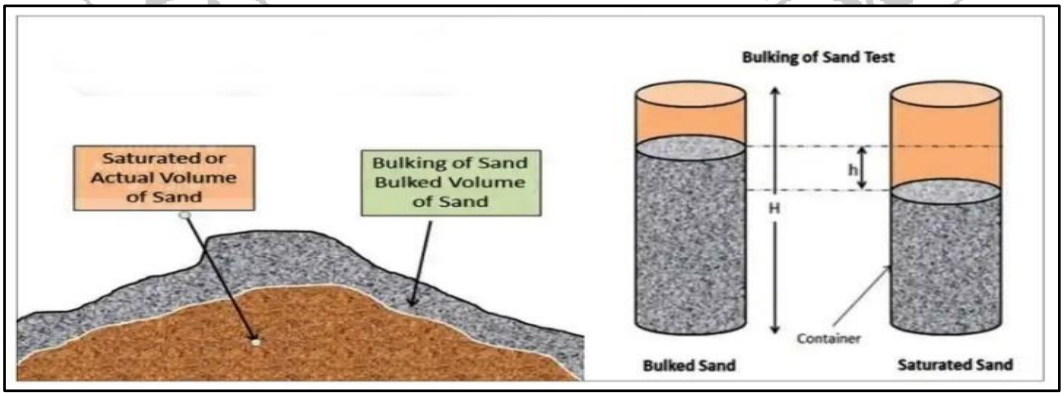

Fig 6.1. Bulking of sand

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	Measuring Cylinder	Measuring Cylinder of 250ml capacity	1 nos.
2.	Glass Rod	10mm diameter and 300mm long	1 nos.
3.	Enamel Tray	450 x 300 x 40 mm	1 nos.

VIII. Precautions to be followed:

1. The jar should be dry.
2. All volumes must be taken accurately.

IX. Procedure:

i) Bulking of Sand:

1. Put dry sand up to two third volume of the cylinder.
2. Note the volume of sand (V_1).
3. Mix thoroughly sand by adding water (2 to 4% volume of dry sand) in the enamel tray, pour gently the wet sand in the jar and level the top surface of sand.
4. Note the volume of wet mixture of sand in the cylinder (V_2).
5. Gradually increase the water in regular interval and repeat the above procedure (steps '3' and '4') up to saturation point at which sand shows no bulking and tabulate the same.
6. Plot the graph of % bulking of sand against percent of moisture. Note the maximum percent of bulking of sand and corresponding percent of moisture.

ii) Determination of bulking of moist sand:

1. Put sufficient quantity of moist sand loosely into a container until it is about two-third filled.
2. Level up the top by pushing a glass rod vertically down through sand at middle to bottom, measure height (h).
3. Transfer the sand into another container.
4. Fill the container with water to one fourth volume occupied by sand.
5. Put back about half the sand and rod it with glass rod (6 mm dia.) so that its volume reduces to minimum.
6. Add remainder of sand and rod in the same way.
7. Smooth and level the top surface of the compacted sand and measure its depth at middle say (h')
8. Repeat the above procedure thrice by taking samples of the same sand three times and find the average value as a result.

X. Observation and Calculations:-

i) Bulking of Sand:

Volume of dry sand (V_1) = **……**

Sr. No.	% Moisture Content	Volume of wet sand (V_2)	% Bulking of sand
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10			

ii) Determination of bulking of moist sand:

Sr. No.	Description	I	II	III
1.	Height of loose sand (h) mm			
2.	Height of saturated sand (h') mm			
3.	Percentage of bulking of sand			
4.	Average value of bulking (%)			

Sample Calculations:-

i) Bulking of Sand = $\frac{(V2-V1)}{V1}$ $x\ 100$ = **……**

ii) Bulking of moist sand = $\frac{(h-h')}{h'}$ $x\ 100$ = **……**

XI. Result:

i) Maximum Percentage of bulking of sand **……**

ii) Maximum Percentage volume of water at saturation point **……**

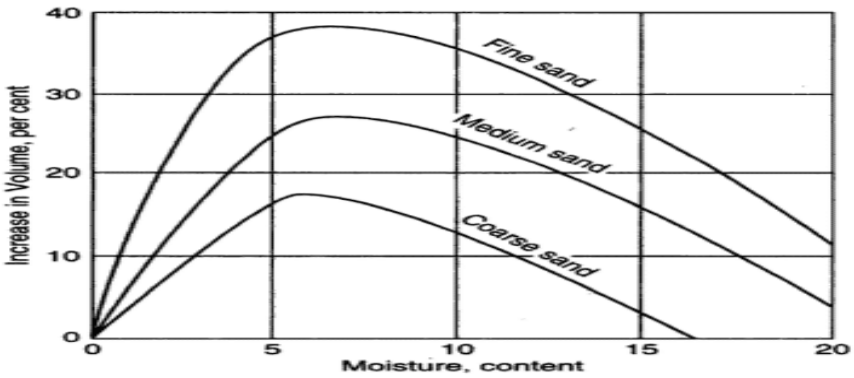

Fig No. 6.2 Variation of Bulking of sand with moisture content

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the purpose of finding bulking of sand.
2. Give the reason of bulking of sand.
3. Justify the statement why after certain percentage of moisture content bulking of sand decreases.
4. State the adverse effect of bulking of sand on the concrete mix.
5. What do you mean by bulking?

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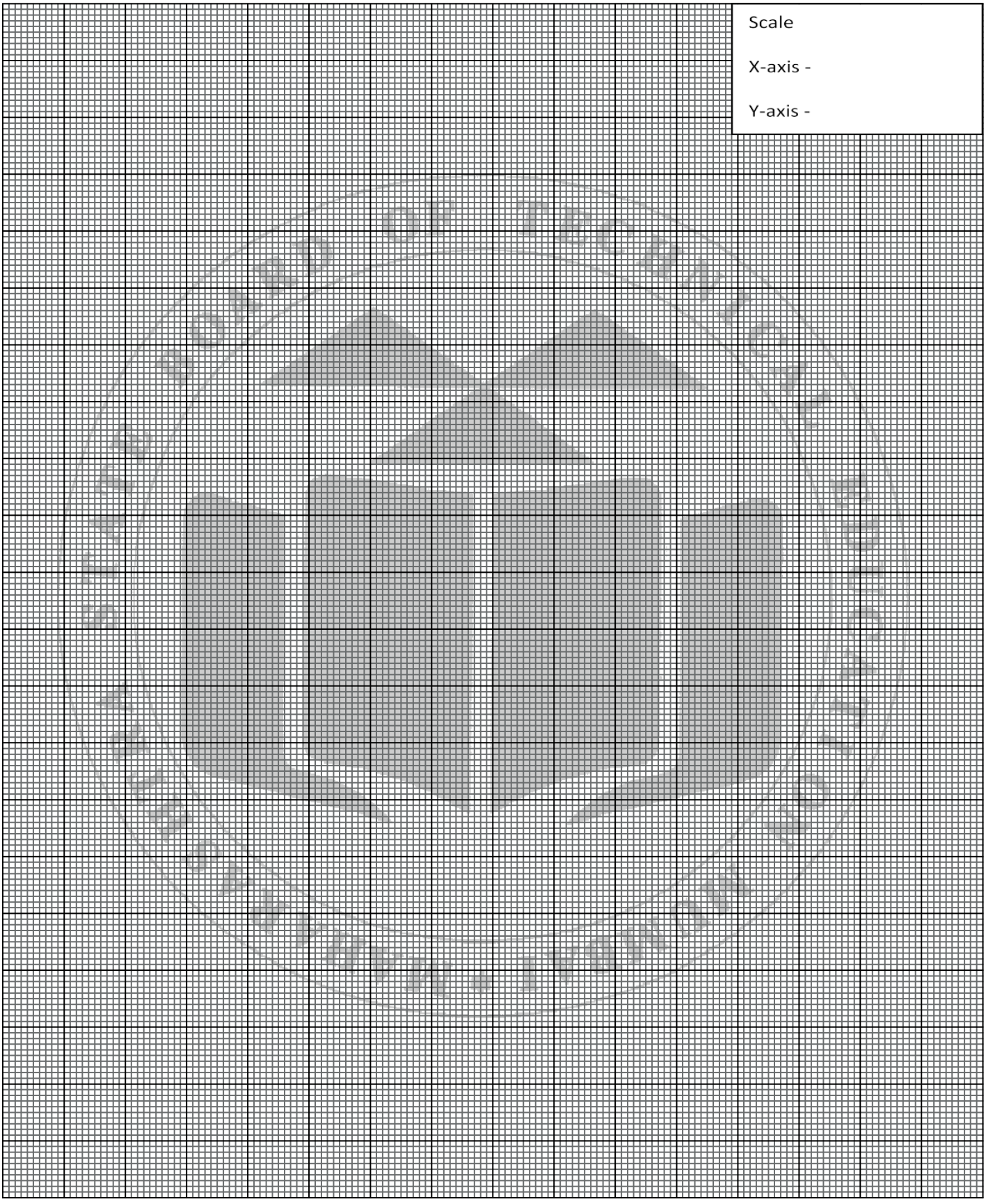
XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://www.nitttrchd.ac.in/sitenew1/nctel/civil.php	Practical's on Cement /Concrete / Aggregate by NITTTR Chandigarh
2.	https://youtu.be/VEpbjOrSs8Q?t=82	Videos on Bulking of sand by animeedu. for study purpose
3.	Bulking Of Sand: Test And Limit As Per IS Code - Civiconcepts	Bulking of sand image taken from the website for study purpose

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculations of bulking of sand and plotting the graph	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	


Scale
X-axis -
Y-axis -

Practical No: 07 Determine bulk density of fine and coarse aggregates.

I. Practical Significance:

Aggregate plays an important role in making of concrete. The bulk density or unit weight of an aggregate gives valuable information regarding the shape and grading of the aggregate. For a given specific gravity the angular aggregates show a lower bulk density. Bulk density shows how densely the aggregate is packed when filled in standard manner.

This practical will enable the students to decide suitability of aggregate for concrete mix design.

II. Industry/Employer expected outcome(s):

- To use relevant aggregates for preparing concrete work.

III. Course Level Learning Outcome (COs):

- CO2 - Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 7.1 - Use relevant aggregate for concrete mix design.

V. Relevant Affective Domain related Outcome(s):

- Use relevant aggregates for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

Bulk density of aggregate is the mass of a unit volume of bulk aggregate material, in which the volume includes the volume of individual particles and volume of voids among the particles. It is measured by filling a container of known volume in a standard manner and weighing it. The higher the bulk density, the lower is the void content to be filled by sand and cement. It is expressed in kg/litre.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	Weighing Balance	Capacity – 5kg, readable to 0.1gm	1 nos.
2.	Steel tamping rod	Round, straight 16mm diameter steel tamping rod of 600mm length, having one end round	1 nos.
3.	Hot Air Oven	Thermostatically controlled, to maintain temperature of 100°C to 110°C	1 nos.
4.	Cylindrical metal container	As given in the following table	1 nos.

Size of Cylindrical metal container: -

Sr. No.	Sizes of largest particles	Normal capacity in litre	Inside Diameter in cm	Inside Height in cm	Thickness of metal (min) in mm
1.	4.5 mm and under	03	15	17	3.15
2.	Over 4.75 to 40 mm	15	25	30	4.00
3.	Over 40 mm	30	35	31	5.00

Fig 7.1 Cylindrical Metal Container

VIII. Precautions to be followed:

1. Test sample should be oven dried
2. The aggregate should be weighed accurately.
3. The tamping of the aggregate should be done properly.
4. Use hand gloves while removing aggregate from oven.
5. Take care to tamp each layer by standard tamping rod by giving 25 evenly spaced strokes.

IX. Procedure:

1. The bulk density may be required for aggregate in loose state or compact state. Adopt shoveling procedure for loose bulk density when specifically stipulated. Otherwise, adopt rodding procedure for compact bulk density.

2. For loose bulk density fill the measure to overflowing by means of a shovel or scoop. Discharge the aggregate into measure from a height not exceeding 5 cm above the top of the measure. Level the surface of aggregate to top of measure with a straight edge. Obtain the net weight of the aggregate in measure.

3. For compact bulk density fill the measure about one-third full with thoroughly mixed aggregate and tamp it with 25 strokes of the rounded end of the tamping rod. Add further a similar quantity of aggregate and tamp it with another 25 strokes. Finally fill the measure over flowing, tamp with 25 strokes, struck off surplus aggregate using the tamping rod as a straight edge. Obtain the net weight of the aggregate in measure.

X. Observation and Calculations:-

Sr. No.	Particulars	Fine Aggregate			Coarse Aggregate		
		I	II	III	I	II	III
1.	Weight of aggregate and measure in G (gm)						
2.	Weight of empty measure W(gm)						
3.	Volume of measure V (cm^3)						
4.	Bulk density M (gm/ cm^3)						
5.	Average Bulk density (gm/ cm^3)						

Sample Calculations:-

i) Fine aggregate:-

Bulk density, M = $\frac{(G-T)}{V}$ = **…….**

ii) Coarse aggregate :-

Bulk density, M = $\frac{(G-T)}{V}$ = **…….**

XI. Result:

i) Average Bulk density of fine aggregate = **…….**

ii) Average Bulk density of coarse aggregate = **…….**

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the effect of bulk density of coarse aggregate on the compressive strength of concrete.
2. The proportions of sand shall be different while mixing sand in dry condition and set condition. Justify the statement.
3. Explain the bulkage adjustment at the site.
4. State the use of value of bulk density in the volume batching.

Space for Answer

XV. References/Suggestions for further Reading

Sr.No.	Link	Description
1.	https://www.nitttrchd.ac.in/sitenew1/nctel/civil.php	Practical's on Cement /Concrete / Aggregate by NITTTR Chandigarh
2.	https://youtu.be/rdtDV-bE0wo	The Overview of the Stages involved in Manufacture of Concrete

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculations of bulking density	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 08 Determine water absorption of fine and coarse aggregate

I. Practical Significance:

Fine and coarse aggregate plays an important role in making of good quality of concrete. Some of the aggregates are porous and absorptive. Porosity and absorption of aggregate will affect the water/cement ratio and hence the workability of concrete. The porosity of aggregate will also affect the durability of concrete when the concrete is subjected to freezing and thawing and also when the concrete is subjected to chemically aggressive liquids.

This practical will enable the students to calculate percentage of absorbed water and able to decide water cement ratio.

II. Industry/Employer expected outcome(s):

- To use relevant aggregates for preparing concrete work.

III. Course Level Learning Outcome (COs):

- CO 2- Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 8.1 - Decide percentage of absorbed water in aggregate and able to decide Water cement ratio.

V. Relevant Affective Domain related Outcome(s):

- Use relevant aggregates for required concrete work.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

The water absorption of aggregate is determined by measuring the increase in weight of an oven dry sample when immersed in water for 24 hours. The ratio of the increase in weight to the weight of the dry sample expressed as percentage known as water absorption of aggregate. The aggregate absorbs water in concrete and thus affects the workability and final volume of concrete. Porosity and absorption of aggregate will affect the water/cement ratio and hence the workability of concrete.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Weighing Balance	Capacity – 5kg, readable to 0.1gm	1 nos.
02	Steel tamping rod	Round, straight 16mm diameter steel tamping rod of 600mm length, having one end round	1 nos.
03	Hot Air Oven	Thermostatically controlled, to maintain temperature of 100°C to 110°C	1 nos.
04	Cylindrical metal container	5 kg Capacity	1 nos.

Fig 8.1 Container and Dry cloth

VIII. Precautions to be followed:

1. Test sample should be oven dried.
2. After test electric supply of oven should be switched off.
3. Use hand gloves while removing aggregate from oven.
4. The aggregate should be weighed accurately.
5. The aggregate sample should be washed thoroughly.

IX. Procedure:

1. Take sample of aggregate not less than 2000 gm.
2. Wash the sample thoroughly to remove finer particles and dust.
3. Drain out the sample and immerse it in distilled water at a temperature between 22°C and 32°C with a cover of at least 5 cm of water above the top of the container.
4. Immediately after immersion remove the entrapped air from the sample by stirring a rod into the container and keep the sample immersed for a period of 24 + 1/2 hours afterwards.
5. Remove the water from container and allow to drain for a few minutes. Gently empty the aggregate from container on to one of the dry clothes.
6. Allow aggregate to surface dry on the cloth and then transfer it to second dry cloth for about 10 minutes or until it appears it to be completely surface dry.
7. Take weight of this surface dry and saturated aggregate. (A)
8. Place the aggregate in the shallow tray, at a temperature of 100 to 110°C in an oven and maintain temperature for 24 ± 1/2 hours.
9. Remove the sample from oven, allow it to cool in air tight container and record its weight. (B)

X. Observation and calculations:

Sr. No.	Particulars	Fine Aggregate			Coarse Aggregate		
		I	II	III	I	II	III
1	Weight of surface saturated dry sample A(gm.)						
2	Weight of oven dry sample B(gm.)						
3	% Water absorption						
4	Average % water absorption						

Sample Calculations: -

Fine aggregate: -

Water absorption, $= \frac{(A-B)}{B} X\ 100 =$ **……**

Coarse aggregate: -

Water absorption, $= \frac{(A-B)}{B} X\ 100 =$ **……**

XI. Result:

Average water Absorption of fine aggregate = **……**

Average water Absorption of coarse aggregate = **……**

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Explain State the effect of water absorption of coarse aggregate on the workability of concrete.
2. Give reason for using dry cloth in this experiment.
3. Aggregate is placed in the shallow tray, at a temperature of 100 to l l0°C in an oven. Justify.

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/hqXFPq676iM?si=zZF4-cyyb7U8gYKU	Specific Gravity & Water Absorption of Coarse Aggregate by NCTEL
2.	https://youtu.be/rdtDV-bE0wo?si=lHGSBTB58XkiScPV	The Overview of the Stages involved in Manufacture of Concrete

XVI. Assessment Scheme

Sr.No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 09 Determine fineness modulus of fine aggregate by sieve analysis.

I. Practical Significance:

Fineness modulus is a physical property of aggregate. It is an index number which gives an idea about coarseness or fineness of aggregate. The larger the fineness modulus, the coarser is the aggregate. Fine aggregate affects many concrete properties, including workability and finish ability. A lower Fineness modulus results in more paste, making concrete easier to finish. For the high cement contents used in the production of high-strength concrete, coarse sand with a Fineness modulus around 3.0 produces concrete with the best workability and highest compressive strength. This practical will enable the students to know the coarseness or fineness of aggregate and can decide the quality of concrete mix.

II. Industry/Employer expected outcome(s):

- To use relevant aggregates for preparing concrete work.

III. Course Level Learning Outcome (COs):

- CO 2- Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 9.1 Decide Grading of fine aggregates for quality of concrete Mix.

V. Relevant Affective Domain related Outcome(s):

- Use relevant aggregates for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

The aggregate most of which passes through a 4.75mm IS sieve and contains only that much coarser material as is permitted by the specifications is termed as fine aggregate. The fineness modulus is an empirical index of fineness, giving some idea of the mean size of particles present in entire aggregate. The determination of the fineness modulus consists of dividing a sample of aggregate into fractions of different sizes by sieving through a set of standard test sieves taken in order. Each fraction contains particles between definite limits. The limits being the opening sizes of standard test sieves. The material retained on each sieve after sieving represents the fraction of aggregate coarser than sieve in question and finer than the sieve above.

Sieving can be done either manually or mechanically. In the manual operation the sieve is shaken giving movements in all possible directions to give chance to all particles for passing through the sieve. Operation should be continued till such time that almost no particle is passing through. Mechanical devices are actually designed to give motion in all possible directions and it is more systematic and efficient than hand sieving.

Fineness modulus is an empirical index obtained by adding the cumulative percentage of aggregate retained on each of the standard sieves ranging from 80mm to 150-micron and dividing the sum by an arbitrary number 100. The larger the figure, coarser the material. Many a time, fine

aggregates are designated as coarse sand, medium sand and fine sand. These classifications do not give any precise meaning.

Following limits may be taken as guidance. For fine aggregate the value of fineness modulus varies as follows.

Fine sand 2.2 to 2.6
Medium sand 2.6 to 2.9
Coarse sand 2.9 to 3.2

Sand having a fineness modulus more than 3.2 will be unsuitable for making satisfactory concrete.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Motorized sieve shaker	Mechanical sieve shaker digital timer adjustable from 0-99 minutes. It should carry 8 sieves.	1 nos.
02	IS Sieve	IS sieve having 200mm diameter of brass metal. Sizes: 4.75mm, 2.36mm, 1.18mm, 600 micron, 300 micron, 150micron, pan and lid.	1 Set
03	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm	1 nos.
04	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5°C	1 nos.

Fig 9.1 Sieves and Mechanical Sieve Shaker

VIII. Precautions to be followed:

1. Test sample should be oven dried.
2. Break lumps of fine aggregate if present by gentle pressure with finger against side of the wall.
3. Spilling of aggregate should be avoided during the sieving operation.
4. Excessive sieving should be avoided.
5. While taking aggregate from the sieve there should not be any waste of aggregate.

6. Material cleaned from brush should consider for weighing.
7. The weight of aggregate should be taken accurately nearest to 0.lgm.
8. While hand sieving care should be taken to sieve separately over a clean tray until not more than trace passes but in any case for a period not less than two minutes.

IX. Procedure:

1. Make the sample air dry and cool it at the room temperature.
2. Weigh the dried sample.
3. Arrange the sieve with largest size at the top.
4. Place the sample on set of sieve.
5. Use sieve shaker to shake the sieve set minimum 20 minutes.
6. Weigh the material retained on each sieve and record it.

X. Observation and Calculations:

Total weight of fine aggregate sample taken for sieving in gm.

Sr. No.	IS Sieve Size	Weight Retained (gm)	% Retained	Cumulative % Retained	Cumulative % Passing
1	4.75mm				
2	2.36mm				
3	1.18mm				
4	600µ				
5	300µ				
6	150µ				
	Total (W)			Sum=	
7	75µ				
8	Pan				
	Sum				

Sample Calculations: -

FM of fine aggregate = W / 100 =

XI. Results:

The fineness modulus of fine aggregate = ...

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions

1. The aggregate should be oven dried before sieving. Justify.
2. Differentiate between well graded, poorly graded and gap graded.
3. List the effect of grading of aggregate on concrete properties.
4. Explain the grading of aggregate affect the water requirement of the mix.
5. Explain gradation plays an important role on requirement of cement paste.

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://www.nitttrchd.ac.in/sitenew1/nctel/civil.php	Sieve Analysis of Fine Aggregate by NCTEL
2.	https://youtu.be/rq5XTRRBU8g?si=I9V1fO2IeooEbNPr	Sieve Analysis of Fine Aggregate

XVI. Assessment Scheme

Sr.No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 10 Determine fineness modulus of coarse aggregate by sieve analysis.

I. Practical Significance:

Fineness modulus is a physical property of aggregate. It is an index number which gives an idea about coarseness or fineness of aggregate. The larger the fineness modulus, the coarser is the aggregate. Fine aggregate affects many concrete properties, including workability and finish ability. A lower Fineness modulus results in more paste, making concrete easier to finish. For the high cement contents used in the production of high-strength concrete, coarse sand with a Fineness modulus around 3.0 produces concrete with the best workability and highest compressive strength. This practical will enable the students to know the coarseness or fineness of aggregate and can decide the quality of concrete mix.

II. Industry/Employer expected outcome(s):

- To use relevant aggregates for preparing concrete work.

III. Course Level Learning Outcome (COs):

- CO 2 - Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 10.1 Decide Grading of coarse aggregates for quality of concrete Mix.

V. Relevant Affective Domain related Outcome(s):

- Use relevant aggregates for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

The aggregate most of which are retained on the 4.75mm IS sieve and contains only that much of fine material as is permitted by the specifications are termed as coarse aggregate. The fineness modulus is an empirical index of fineness, giving some idea of the mean size of particles present in entire aggregate. The determination of the fineness modulus consists of dividing a sample of aggregate into fractions of different sizes by sieving through a set of standard test sieves taken in order. Each fraction contains particles between definite limits. The limits being the opening sizes of standard test sieves. The material retained on each sieve after sieving represents the fraction of aggregate coarser than sieve in question and finer than the sieve above.

Sieving can be done either manually or mechanically. In the manual operation the sieve is shaken giving movements in all possible directions to give chance to all particles for passing through the sieve. Operation should be continued till such time that almost no particle is passing through. Mechanical devices are actually designed to give motion in all possible directions and it is more systematic and efficient than hand sieving.

Fineness modulus is an empirical index obtained by adding the cumulative percentage of aggregate retained on each of the standard sieves ranging from 80mm to 150 microns and dividing the sum by an arbitrary number 100. The larger the figure, coarser the material. Many a time, the number does not give any precise meaning. Aggregate having a fineness modulus between 5.5 to 8.0 is coarse aggregate.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
1.	Motorized sieve shaker	Mechanical sieve shaker digital timer adjustable from 0-99 minutes. It should carry 8 sieves.	1 nos.
2.	IS Sieve	IS sieve having 300 mm diameter having sizes: 80mm, 40mm, 20mm, 10mm, 4.75mm, 2.36 mm, 1.18 mm, 600µ, 300µ, 150µ, 75µ, pan and lid.	1 Set
3.	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm	1 nos.
4.	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5°C	1 nos.

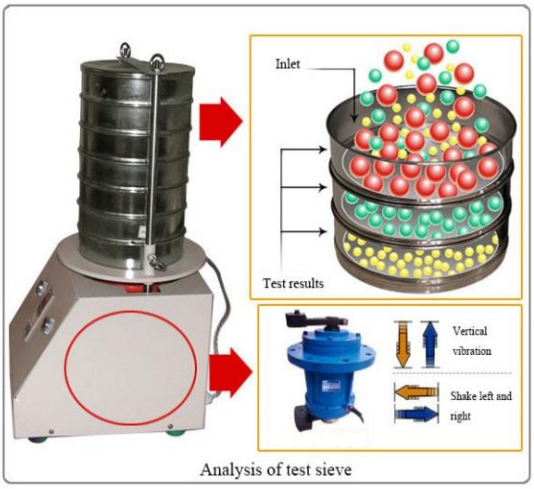

Fig 10.1 Sieves and Mechanical Sieve Shaker

VIII. Precautions to be followed:

1. Test sample should be oven dried.
2. Break lumps of fine aggregate if present by gentle pressure with finger against side of the wall.
3. Spilling of aggregate should be avoided during the sieving operation.
4. Excessive sieving should be avoided.
5. While taking aggregate from the sieve there should not be any waste of aggregate.
6. Material cleaned from brush should consider for weighing.
7. The weight of aggregate should be taken accurately nearest to 0.lgm.
8. While hand sieving care should be taken to sieve separately over a clean tray until not more than trace passes but in any case for a period not less than two minutes.

IX. Procedure:

1. Make the sample air dry and cool it at the room temperature.
2. Weigh the dried sample.

3. Arrange the sieve with largest size at the top.
4. Place the sample on set of sieve.
5. Use sieve shaker to shake the sieve set minimum 20 minutes.
6. Weigh the material retained on each sieve and record it

X Observation and Calculations:

Total weight of fine aggregate sample taken for sieving= ……gm.

Sr. No.	IS Sieve Size	Weight Retained (gm)	% Retained	Cumulative % Retained	Cumulative % Passing
1	80mm				
2	40mm				
3	20mm				
4	10mm				
5	4.75mm				
6	2.36mm				
7	1.18mm				
8	600µ				
9	300µ				
10	150µ				
		Total (W)		Sum=	
11	75µ				
12	Pan				
	Sum				

Sample Calculations: -

FM of Coarse aggregate = W/l 00 =

XI Results:

The fineness modulus of Coarse aggregate = ...

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Write the effect of maximum size of aggregate on concrete strength.
2. Write the use of gap graded aggregate in civil work.
3. Following are three different values of Fineness modulus of three different samples.
4. Write the relevance.
    1. FM= 3.0
    2. FM= 3.5
    3. FM= 6.5
5. Following are two grading of aggregate. Differentiate related to voids and cement paste requirement.
    i. Uniform grading
    ii. Continuous grading

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/MuhpE0Sk4EI?si=gtMUBJxZbEIYbcFZ	Sieve Analysis of Coarse Aggregate By NCTEL
2.	https://youtu.be/BLmViFfpawY?si=64aQHZJXiZA0WZZG	Fineness modulus of coarse aggregate

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No:11A Determine Aggregate Impact Value.

I. Practical Significance:

Aggregate impact value is a mechanical property of coarse aggregate and it gives relative measure of an aggregate to sudden shock or impact. It is a measure of toughness. Lower the aggregate impact value stronger the aggregate against impact. Lower value of aggregate is preferred. This practical will enable the students to decide the suitability of coarse aggregate for wearing or non-wearing surfaces.

II. Industry/Employer expected outcome(s):

- To use relevant aggregates for preparing concrete work.

III. Course Level Learning Outcome (COs):

- CO 2- Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 11.1 Decide the suitability of coarse aggregate for wearing or non-wearing surfaces.

V. Relevant Affective Domain related Outcome(s):

- Use relevant aggregates for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

The aggregate impact value is defined as the ratio of the weights of fines passing through 2.36mm IS sieve to the total weight of the sample expressed as a percentage. Aggregate impact value is a mechanical property of coarse aggregate and it gives relative measure of an aggregate to sudden shock or impact. Which in some aggregates differs from its resistance to a slow compressive load. Ultimately it is a measure of toughness. Lower the aggregate impact value stronger the aggregate against impact. Lower value of aggregate is preferred. Aggregate impact value is expressed in percentage. The aggregate impact value should not be more than 45% by weight for aggregate used for concrete other than wearing surfaces and 30% by weight for concrete to be used as wearing surfaces, such as runways, roads and pavements.

VII. Required resources/equipment.

Sr. No.	Resource required	Particulars	Quantity
01	Aggregate Impact Value Apparatus	Cylindrical cup of ID 102mm and height 50mm. Metal measure 75 mm ID x 50 mm deep. Tamping rod and automatic blow counter, height of fall 380 mm (Hammer). IS brass sieve having 200mm diameter having sizes: 12.5mm, 10mm, 2.36 mm, pan and lid.	01 No.
02	Weighing Balance	Electronic weighing balance of capacity10kg with accuracy of 0.1gm. Pan Size 240x210mm.	01 No.
03	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5°C	01 No.

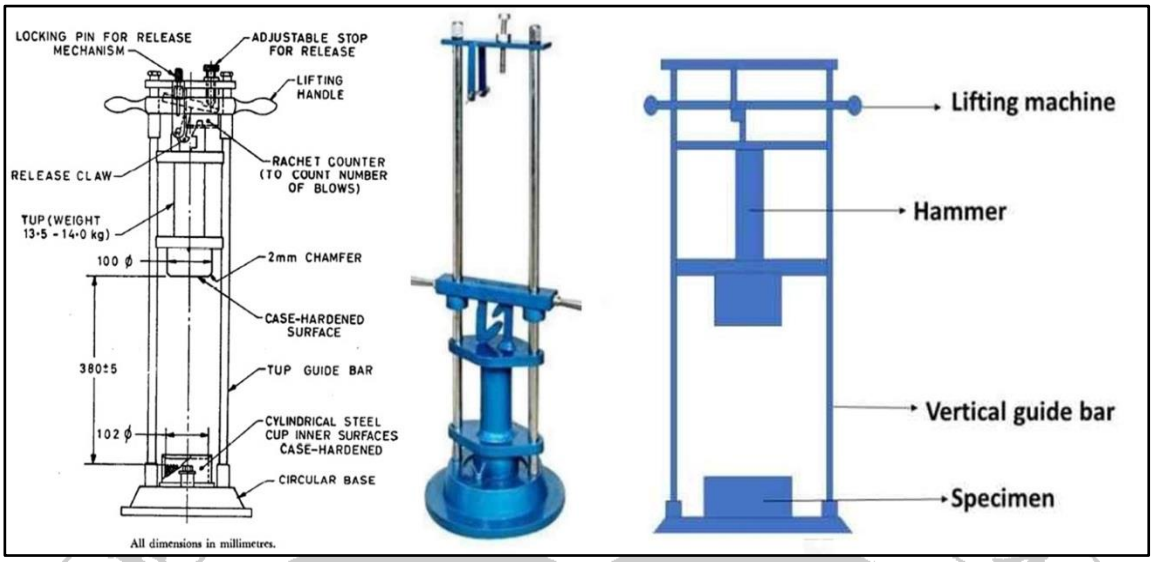

Figure 11 A.1 Aggregate Impact Value Test Apparatus

VIII. Precautions to be followed:

1. Test sample should be oven dried.
2. Use hand gloves while removing aggregate from oven.
3. Wear safety shoes and goggles at the time of testing.
4. Before testing check the machine properly.
5. After testing clean the sieve with smooth brush.
6. Take care to tamp each layer by standard tamping rod by giving 25evenly spaced strokes.
7. Cylindrical cup should not be filled up to the top level of cup so that aggregate should not slip out from the cup.
8. Interval between two blows should not less than 1second.
9. IS sieve 2.36mm sieved until no further significant amount passes in one minute.
10. The fraction passing IS 2.36mm sieve weighted to accuracy 0.lgm of total weight.
11. If the total weight is less than initial weight by more than 1gm the result shall be discarded and fresh test is made.

IX. Procedure:

1. Prepare the test sample: Aggregate passing through 12.5mm IS sieve and retained on 10mm IS sieve.
2. Dry the sample in an oven at temperature 100°C to 110 °C for four hours and allow it to cool at room temperature.
3. Fill the aggregate in cylindrical metal measure in three layers approximately in equal depth and tamp 25 times with tamping rod. The top of cylinder measure leveled off.
4. Take weight of sample (W1).
5. Remove the sample from the measure and fill it in the metal cup. Use tamping rod.
6. Fix the metal cup to the base plate and raise the hammer till the lower face is 380±5mm above upper surface of sample and give 15 similar blows.
7. Remove the crushed aggregate from the metal cup and sieve it through 2.36mm IS sieve.

8. Weigh the fraction passing through 2.36mm IS sieve (W2).
9. Weigh the fraction retained on 2.36mm IS sieve (W3).

X. Observation and Calculations:

Sr. No.	Particulars	I	II	III
1	Weight of oven dried sample (W1) gm			
2	Weight of fraction passing through IS 2.36mm sieve (W2) gm.			
3	Weight of fraction retained on IS 2.36mm sieve (W3) gm.			

Sample Calculations: -

Aggregate Impact Value = $\frac{W2}{W1} X\ 100$ = **……%**

XI. Results:

The aggregate impact value of coarse aggregate = **……**

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. If the height of free fall of the hammer is less than the prescribed value, write the effect on test result.
2. The test shows the following results. Justify the suitability of aggregate sample.
   i. AIV of sample A = 25%,
   ii. AIV of sample B = 35%
3. Angular shape aggregate provides higher resistance to impact than flaky and elongated shape aggregate. Give reason.

Space for Answer

XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/Mn7aeorMpTs?si=5aigmOfIOOjvF-bk	Determination of Aggregate Impact Value By NCTEL
2.	https://youtu.be/x4ekpMEERxI?si=jMn6eFMkC29jZcW5	Determination of Aggregate Impact Value

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No:11B Determine Aggregate Crushing Value.

I. Practical Significance:

Relative measure of an aggregate to the resistance to crushing under gradually applied compressive load. It is a measure of strangeness (i.e. compressive strength). Lower the aggregate crushing value stronger the aggregate against crushing. Lower crushing value of aggregate is preferred. This practical will enable the students to decide the suitability of coarse aggregate for wearing or non-wearing surfaces and correlate the aggregate crushing value with crushing strength, ultimately strength of concrete.

II. Industry/Employer expected outcome(s):

- To use relevant aggregates for preparing concrete work

III. Course Level Learning Outcome (COs):

- CO 2- Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 11B.1 Decide the suitability of coarse aggregate for wearing or non-wearing surfaces.

V. Relevant Affective Domain related Outcome(s):

- Use relevant aggregates for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

The aggregate crushing value is defined as the ratio of the weights of fines passing through 2.36mm IS sieve to the total weight of the sample expressed as a percentage. The aggregate crushing value is a mechanical property of coarse aggregate and it gives relative measure of an aggregate to resistance to crushing under gradually applied compressive load. It is an indirect measure of crushing strength of the aggregate. Low crushing value indicates strong aggregate against crushing as the crushed fraction is less. Therefore, to achieve good quality of concrete, low crushing value of aggregate is preferred. The test can be used to assess the suitability of aggregates with reference to strength for various types of pavement components. The test also measures the quality of rock and nature of source rather than the quality of aggregate.

Aggregate crushing value is expressed in percentage. The aggregate crushing value should not be more than 45% by weight for aggregate used for concrete other than wearing surfaces and 30% by weight for concrete to be used as wearing surfaces, such as runways, roads and pavements.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Compression Testing Machine	As per IS 516, Capacity 300 Ton (mechanical type) manually and electrically operated	01 No.
02	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm. Pan Size 240x210mm.	01 No.
03	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5°C	01 No.
04	Aggregate Crushing Value Apparatus	Cylindrical metal measure of ID 115mm and height 180mm. Tamping rod 16mm diameter and 600mm length with one end rounded. Open ended steel cylinder of ID 152mm with plunger150mm diameter and base plate.	01 Set
05	IS Sieve	IS brass sieve 200mm diameter of sizes: 12.5mm, 10mm, 2.36 mm with pan and lid.	01 Set

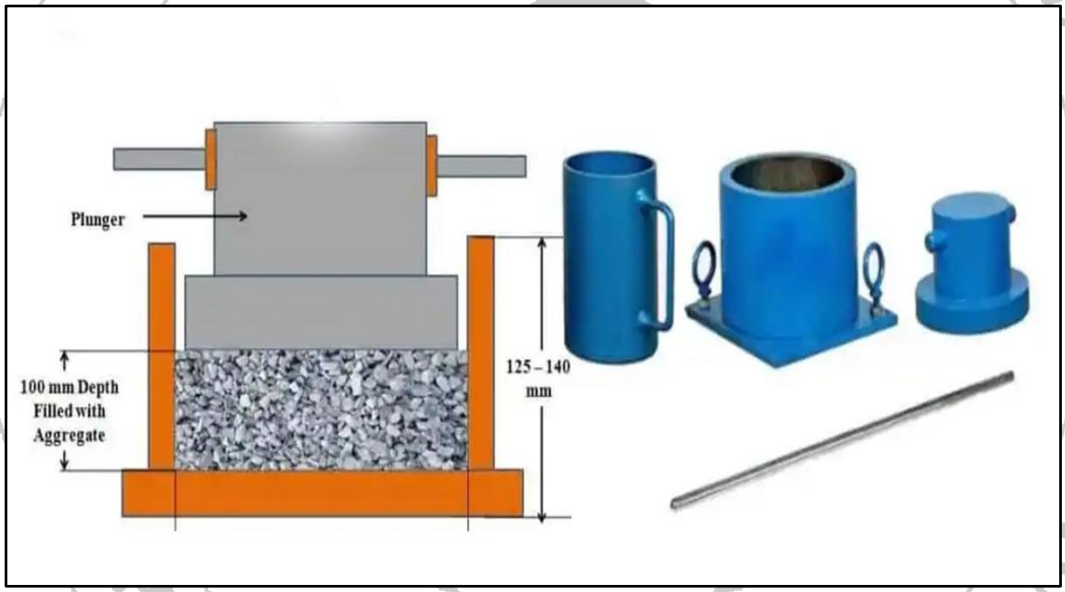

Fig 11 B.1 Aggregate Crushing Value Test Apparatus

VIII. Precautions to be followed:

1. Test sample should be oven dried.
2. Use hand gloves while removing aggregate from oven.
3. Wear safety shoes and goggles at the time of testing.
4. Before testing check the machine properly.
5. After testing clean the sieve with smooth brush.
6. Take care to tamp each layer by standard tamping rod by giving 25evenly spaced strokes.
7. In case of weak materials do not break the particles while tamping with tamping rod.
8. The surface of aggregate should be leveled before loading.
9. The plunger should rest horizontally on test sample.
10. Rate of loading should be uniform.

11. The Plunger should not jam in the cylinder.
12. Material should be collected on 2.36mm IS sieve carefully and avoid loss of fraction while sieving.
13. IS sieve 2.36mm sieved until no further significant fraction passes in one minute.
14. The fraction passing IS 2.36mm sieve weighted to accuracy 0.lgm of total weight.

IX. Procedure:

1. Prepare test sample: Aggregate passing through 12.5mm IS sieve and retained on 10mm IS sieve.
2. Dry the sample in an oven at temperature 100°C to 110 °C for four hours and allow it to cool at room temperature.
3. Fill the aggregate in cylindrical metal measure in three layers approximately in equal depth and tamp 25 times with tamping rod. The top of cylinder measure leveled off.
4. Take weight of sample (W1).
5. The cylinder of the test apparatus is placed in position on the base plate and one third test sample is added. Each layer is tamped for 25 times and aggregate is carefully leveled.
6. Insert the plunger and rest it horizontally on the surface of aggregate sample.
7. Place the apparatus on compression testing machine and apply load with uniform rate 400kN in 10minutes (i.e. 40kN/minute) and then release the load.
8. Remove all crushed aggregate from the cylinder and sieve it through 2.36mm IS sieve and collect the fraction passing through it.
9. Take weigh of the fraction passing through 2.36mm IS sieve (W2).
10. Take weigh of the fraction retained on 2.36mm IS sieve (W3).

X. Observation and Calculations:

Sr. No.	Particulars	I	II	III
1	Weight of oven dried sample (W1) gm.			
2	Weight of fraction passing through IS sieve 2.36mm (W2) gm.			
3	Weight of fraction retained on IS 2.36mm sieve (W3) gm.			

Sample Calculations: -

Aggregate Crushing Value = $\frac{W2}{W1} X\ 100$ = **……%**

XI. Results:

The aggregate Crushing value of coarse aggregate =……

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. If sample contains more percentage of flaky and elongated aggregates. Write the effect on test result.
2. If test shows the following results. Justify the suitability of aggregate sample.
   i. ACV of sample A= 27%,
   ii. ACY of sample B = 38%
3. If rate of loading is fast than the standard rate of loading. Write its effect on fraction passing through 2.36mm Is sieve and test result
4. Write the effect of shape of aggregate on test result. Give reason.

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/lE7LFOuGKyI?si=EX7stOR3c-WJHd8f	Aggregate Crushing Value Test by NCTEL
2.	https://youtu.be/0FzIk9gMReo?si=ikoR-AnJ1mV1UCI2	The Aggregate Crushing Value Test

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 11C Determine aggregate Abrasion value

I. Practical Significance:

Aggregate abrasion value is a mechanical property of coarse aggregate and it gives relative measure of an aggregate to resistance to wear. It is a measure of hardness against wear. Lower the aggregate abrasion value stronger the aggregate against wear. Lower value of aggregate is preferred.

This practical will enable the students to decide the suitability of coarse aggregate for wearing surfaces such as roads, floors and pavements.

II. Industry/Employer Expected Outcome(s):

- To use relevant aggregates for preparing concrete work.

III. Course Level Learning Outcome (COs):

- CO2 - Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 11C.1: - Decide the suitability of coarse aggregate for wearing or non-wearing surfaces.

V. Relevant Affective Domain related Outcome(s):

- Use relevant aggregates for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

The aggregate abrasion value is defined as the ratio of the weights of fines passing through 1.70mm IS sieve to the total weight of the sample expressed as a percentage. Aggregate abrasion value is a mechanical property of coarse aggregate and it gives relative measure of an aggregate of resistance to wear. Ultimately it is a measure of hardness. Resistance to wear is an important test for aggregate to be used for road construction, ware house floors and pavement construction. The percentage of wear depends upon the grading, the number of revolution of drum and weight of the sample. These all variables are according to grading.

Steel balls are used as abrasive charge. Wear action takes place rubbing action between the aggregate and steel balls. The number of steel balls used is adjusted for each grading, so as to make the result independent of grading of test samples. The percentage of wear is increased if aggregate is flaky, elongated and soft. If aggregate is of uniform quality the percentage of wear loss is proportional to number of revolutions.

Lower the aggregate abrasion value stronger the aggregate against wear. Lower value of aggregate abrasion is preferred and is expressed in percentage. The aggregate abrasion value should not be more than 50% by weight for aggregate used for concrete other than wearing surfaces and 30% by weight for concrete to be used as wearing surfaces, such as runways, roads and pavements. For cement concrete construction, it should be less than 16% by weight.

VII. Required Resources/equipment's:

Sr. No.	Resource required	Particulars	Quantity
01	LosAngeles Abrasion Testing Machine	Ref. Std. IS: 10070. Hollow steel cylinder closed with at both ends ID=700mm, length=500mm rotates on a Horizontal axis. An opening provided with steel shelf 48mm x 25mmx300mm projecting 90mm from inside. Rotation of drum 30 to 33 rpm. Operation on 415V, 3 Phase, 50Hz, AC Supply.	01 No.
02	Abrasive Charge	Set of 12 Steel or CI balls of 48mm diameter and each having weight between 390gm to 445gm.	01 Set
03	IS Sieve	IS brass sieve 200mm diameter of sizes: 80mm, 63mm, 50mm, 40mm, 25mm, 20mm, 12.5mm, 10mm, 6.3mm, 4.75mm, 2.36mm, 1.7mm,with pan and lid.	01 Set
04	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm. Pan Size 240mm x 210mm.	01 No.
05	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5°C	01 No.

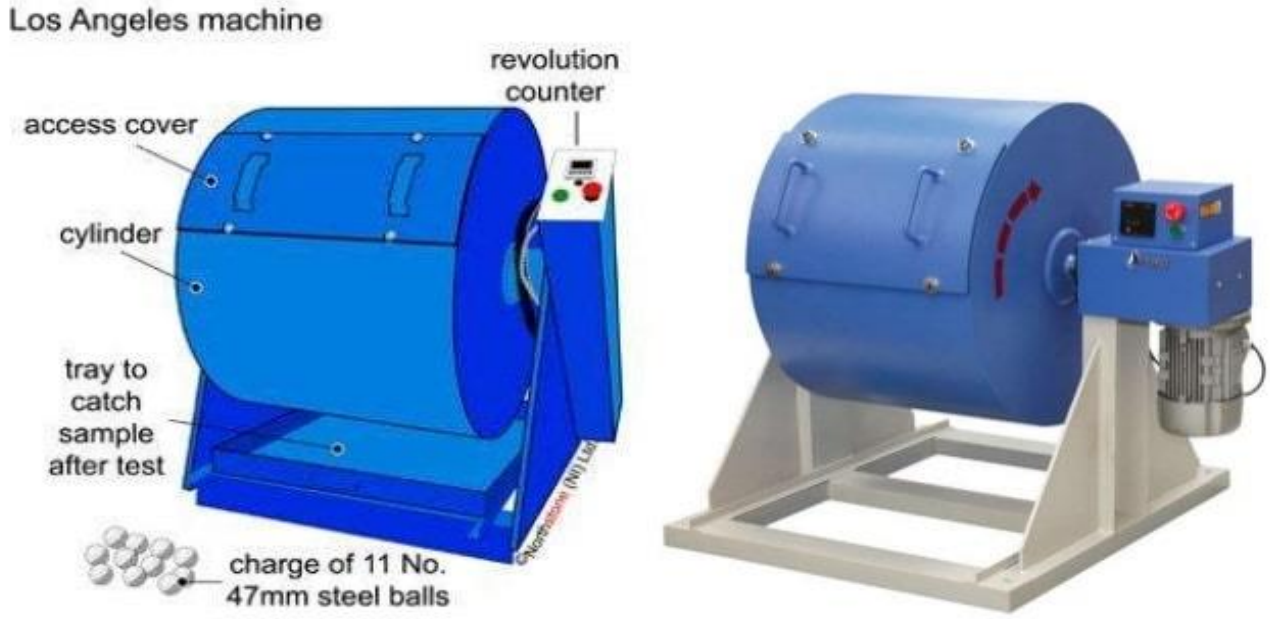

Fig 11 C.1 Los Angeles Abrasion Testing Machine

Sr.No	Grading	No of Revolution	No.of Steel Balls	Weight of Charge(gm)
1	A	500	12	5000±25
2	B	500	11	4584±25
3	C	500	8	3330±20
4	D	500	6	2500±15
5	E	1000	12	5000±25
6	F	1000	12	5000±25
7	G	1000	12	5000±25

Table11C.1- Number of Revolutions and Abrasive Charge

Sr.No	Sieve size (mm)		Weight of test sample for grade (gm)						
	Passing	Retained	A	B	C	D	E	F	G
1	80	63					2500		
2	63	50					2500		
3	50	40					2500	5000	
4	40	25	1250					5000	5000
5	25	20	1250						5000
6	20	12.5	1250	2500					
7	12.5	10	1250	2500					
8	10	6.3			2500				
9	6.3	4.75			2500				
10	4.75	2.36				5000			

Table 11C.2- Grading of Test Sample

VIII. Precautions to be followed:

1. Test sample should be oven dried.
2. Use hand gloves while removing aggregate from oven after switching off the oven.
3. Wear safety shoes, goggles, mask and apron at the time of testing.
4. Before testing check the machine properly.
5. The cover of opening should be dust tight.
6. Speed of revolution should be uniform.
7. The drum, cover of the opening and container should be clean and dry before and after each test.
8. Take care that entire stone dust should be discharged into the tray.
9. After test electric supply should be off.
10. After testing clean the sieve with smooth brush.
11. IS sieve 1.70mm sieved until no further significant amount passes in one minute.
12. The fraction retained on IS 1.70mm sieve weighted to accuracy 0.lgm of total weight.

IX. Procedure:

1. Take test sample confirming to one of the grading shown in Table No. II
2. Dry the sample in an oven at temperature 100°C to 110 °C for four hours and allow it to cool.
3. Place the sample and abrasive charge in Los Angele's Abrasion Testing Machine. Abrasive charge depends on grading of aggregate as shown in Table No. I
4. Rotate the machine at a speed of 20 to 30 rpm. Number of revolutions depends on grading of aggregate. (For grading A, B, C, D, 500 revolution and E, F, G, 1000 revolutions).
5. Discharge the material from the machine after completion of the test.
6. Make a preliminary separation of the sample on a sieve coarser than 1.70mm IS sieve.
7. Sieve the finer particles on **1**.70mm IS sieve.
8. Wash the material coarser thanl.70mm IS sieve and dry it in an oven at 105°C to 110 °C to a substantially constant weight and weight it accurately to the nearest gm.

X. Observation and Calculations:

Sr. No.	Particulars	I	II	III
1	Weight of oven dried sample (W1)gm			
2	Weight of fraction coarser than 1.70mm IS sieve (W2) gm.			

Sample Calculations: -

Aggregate Abrasion Value = $\frac{W1-W2}{W1} X\ 100$ = **…… %**

XI. Result:

The aggregate Abrasion value of coarse aggregate = ----------

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. If the aggregate abrasion values are 16% and 20%. Comment on hardness of aggregate.
2. Write the factors affecting percentage of wear.

3. Abrasive charge for aggregate of grade A is 12 Nos. of steel balls and for grade D is 6 Nos. of steel balls. Give reason.
4. Write the effect on test result of following:
   i. If speed of revolution is more than 33rpm.
   ii. If aggregate having more percentage of flaky and elongated shape.
   iii. If aggregate is not oven dried?

Space for Answer

XV. References/Suggestions for further Reading:

Sr. No.	Link	Description
1.	https://youtu.be/k6wXH50Kwkw?si=iX90-5PIY-h4ZG5C	Los Angeles Abrasion Value Test by NCTEL
2.	https://youtu.be/1acXr2T7JUw?si=lbF_Ji7h0qCq2-FO	The Los Angeles Abrasion Value Test

XVI. Assessment Scheme:

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 12 Determine aggregate elongation index and flakiness index.

I. Practical Significance:

The flaky and elongated particles lower the workability of concrete mixes, due to high surface area to volume ratio. Flaky and elongated particles are considered undesirable for base coarse construction as they may cause weakness with possibilities of braking down under heavy loads. This practical will enable the students to decide the suitability of aggregate for concreting work.

II. Industry/Employer Expected Outcome(s):

- To use relevant aggregates for preparing concrete work.

III. Course Level Learning Outcome (COs):

- CO2: - Classify the given aggregates based on its shape and size with the importance of their properties.

IV. Laboratory Learning Outcome (LLO):

- LLO 12.1: - Decide the suitability of coarse aggregate for concrete work based on its size and shape.

V. Relevant Affective Domain related Outcome(s):

- Use relevant aggregates for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

A flaky particle is the one whose least dimension (thickness) is than 0.6 times the mean size. These are the materials of which the thickness is small as compared to the other two dimensions. Elongated particle is the particles having length considerably larger than the other two dimensions and it is the particle whose greater dimension is 1.8 times its mean size. Elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than one and four-fifth times their mean dimension. It is measured on particles passing through mesh size of 63mm and retained on mesh size of 6.3mm.

VII. Required Resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Thickness Gauge	As per IS : 2386 (Part I) - 1963	**1** No.
02	Length Gauge	As per IS: 2386 (Part 1)- 1963	**1** No.
03	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm	**1** No.
04	IS sieve	IS sieve having 200mm diameter of brass metal. Sizes:63 mm,50mm, 40mm, 25mm,20mm,16mm,12.5mm,10mm 6.3mm.	**1** set.

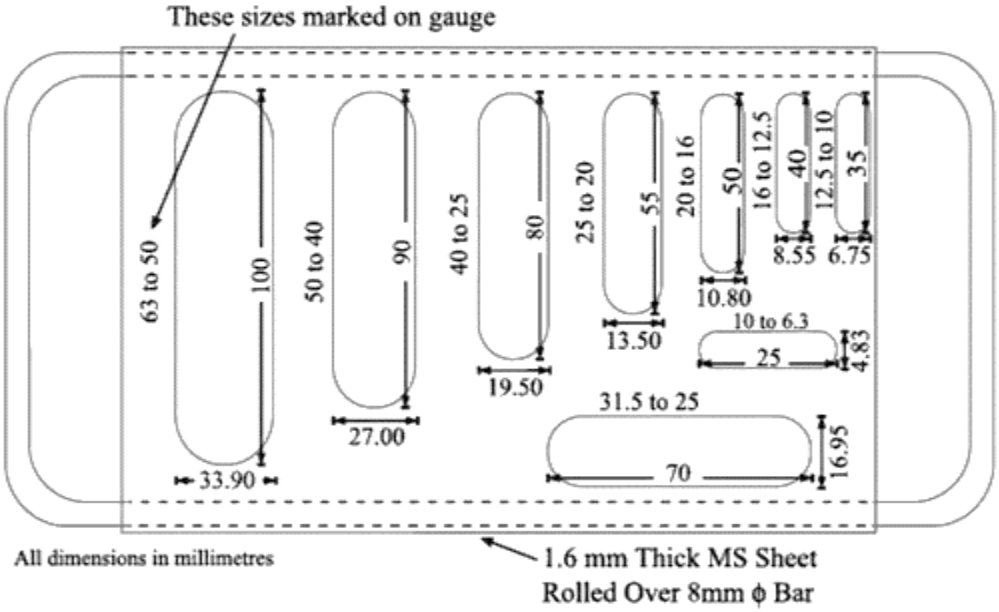

Fig 12 .1 Thickness Gauge
(Source https://www.civilalliedgyan.com/2020/07/flakiness-and-elongation-index-test.html)

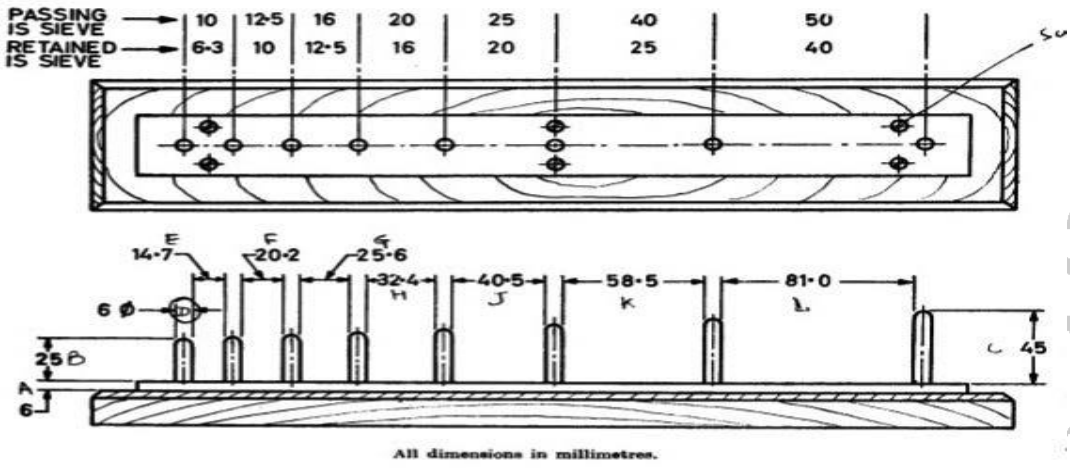

Fig 12 .2 Length Gauge

VIII. Precautions to be followed:

1. While sieving, care must be taken that the particles that are chocked in the sieve must not be forced down into the next sieve. Such particles should be pushed back into the same sieve.
2. While placing different fractions on the table, place them some distance apart so that no two fractions may get mixed.
3. All parts of the equipment should always be kept clean.
4. After the end of the test sieve should be clean by smooth brush.
5. Be careful while selecting the opening of the flakiness and elongation gauges for any particular fraction.

IX. Procedure:

Elongation index:

1. Take enough quantity of dry blended sample so that at least 200 pieces of any fraction is present. This is not applicable for the biggest and smallest size.
2. Sieve the blended sample through all the sieves mentioned above starting from the largest sieve i.e. 63mm.
3. Separate all the individual fractions - 63mm to 50mm, 50mm to 40mm, 40mm to 25mm, 25mm to 20mm, 20mm to 16mm. 16mm to 12.5mm. 12.5 mm to 10mm and 10mm to 6.3mm.
4. Take all the fraction separately, gauge them one by one through the corresponding slot provided in the length gauge. Keep the particles retained by the length separately. The aim should be to retain as much as possible to avoid testing bias.
5. Weigh the particles retained on length gauge.
6. Elongation index is the total weight of the material retained on the various length gauges, expressed as a percentage of the total weight of the sample gauged.

Flakiness Index:

1. Take enough quantity of dry blended sample so that at least 200 pieces of any fraction is present. This is not applicable for the biggest and smallest size.
2. Sieve the blended sample through all the sieves mentioned above starting from the largest sieve i.e. 63mm.
3. Separate all the individual fractions - 63mm to 50mm, 50mm to 40mm, 40mm to 25mm, 25mm to 20mm, 20mm to 16mm. 16mm to 12.5mm. 12.5mm to 10mm and 10mm to 6.3mm.
4. Take all the fraction separately, gauge them one by one through the corresponding slot provided in the thickness gauge. Keep the particles retained by the thickness separately. The aim should be to retain as much as possible to avoid testing bias.
5. Weigh the particles passed on thickness gauge.
6. Flakiness index is the total weight of the material retained on the various thickness gauges, expressed as a percentage of the total weight of the sample gauged.

X. Observation and Calculations:

(i) **Elongation Index**

Sr. No.	Aggregate sample passing through IS sieve (mm)	Aggregate sample retained through IS sieve (mm)	Length gauge size (mm)	Weight of aggregate sample taken w (gm)	Weight of aggregates in each fraction retained on length gauge W1 (gm)
1	50	40	81.0		
2	40	25	58.5		
3	25	20	40.5		
4	20	16	32.4		
5	16	12.5	25.6		

6	12.5	10	20.2		
7	10	6.3	14.7		
	Total Weight			**W=**	**W1=**

(ii) **Flakiness Index-**

Sr. No.	**Aggregate sample passing through IS sieve (mm)**	**Aggregate sample retained through IS sieve (mm)**	**Thickness gauge size (mm)**	**Weight of aggregate sample taken W (gm)**	**Weight of aggregates in each fraction passing thickness gauge W1(gm)**
1	63	50	33.90		
2	50	40	27.00		
3	40	25	19.50		
4	25	20	13.50		
5	20	16	10.80		
6	16	12.5	8.55		
7	12.5	10	6.75		
8	10	6.3	4.89		
			Total Weight	**W=**	**W1=**

Sample Calculations: -

Elongation Index = $\frac{W1}{W} X\ 100$ = **…….%**

Flakiness Index = $\frac{W1}{W} X\ 100$ = **…….%**

XI. Result:

The aggregate Elongation Index of coarse aggregate = ----------

The aggregate Flakiness Index of coarse aggregate = ----------

XII. Interpretation of results (Give the meaning of above obtained results):

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions

1. State the suitability of aggregate if elongation index is 35 %.
2. State the suitability of aggregate if flakiness index is 22 %.
3. Explain the effect of flaky and elongated particles on concrete.
4. State the significance of elongation index and flakiness index.

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/acfJIG9o8iw?si=8HMnq0KBThCWJoYV	Flakiness and Elongation Index of Aggregate by NCTEL
2.	https://youtu.be/Rx9Fvvxepmw?si=y_Qb6WV4O5J9Lr2-	The Flakiness and Elongation Index of Aggregate

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 13A Determine workability of concrete by slump cone test or Compaction factor test.

I. Practical Significance:

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete. It can also be used as an indicator of an improperly mixed batch. The slump test is used to ensure uniformity for different loads of concrete under field conditions.

This practical will enable the students to know the degree of workability of concrete and decide suitability of concrete for various situations in construction works.

II. Industry/Employer Expected Outcome(s):

- To find workability of concrete by slump cone test.

III. Course Level Learning Outcome (COs):

- CO3 - Prepare concrete of required specifications in the given situation.

IV. Laboratory Learning Outcome (LLO):

- LLO 13.1: - Decide suitability of concrete according its workability in different situations.

V. Relevant Affective Domain related Outcome(s):

- Use proper WC ratio for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

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. Concrete slump test is carried out from batch to batch to check the uniform quality of concrete during construction. Generally concrete slump value is used to find the workability, which indicates water- cement ratio, but there are various factors including properties of materials, mixing methods, admixtures etc. also affect the concrete slump value.

VII. Required Resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm. Pan Size 240x210mm.	**1** No.
02	Slump cone apparatus	As per IS 7320-1974, Top diameter 100mm, bottom diameter 200mm and height 300mm having metal thickness of 1.6mm	**1** No.
03	Tamping rod	16 mm dia, 600 mm length and having one bullet end.	**1** No.
04	Enamel tray	Enamel tray size 650 x 500 x 50 mm	**1** No.

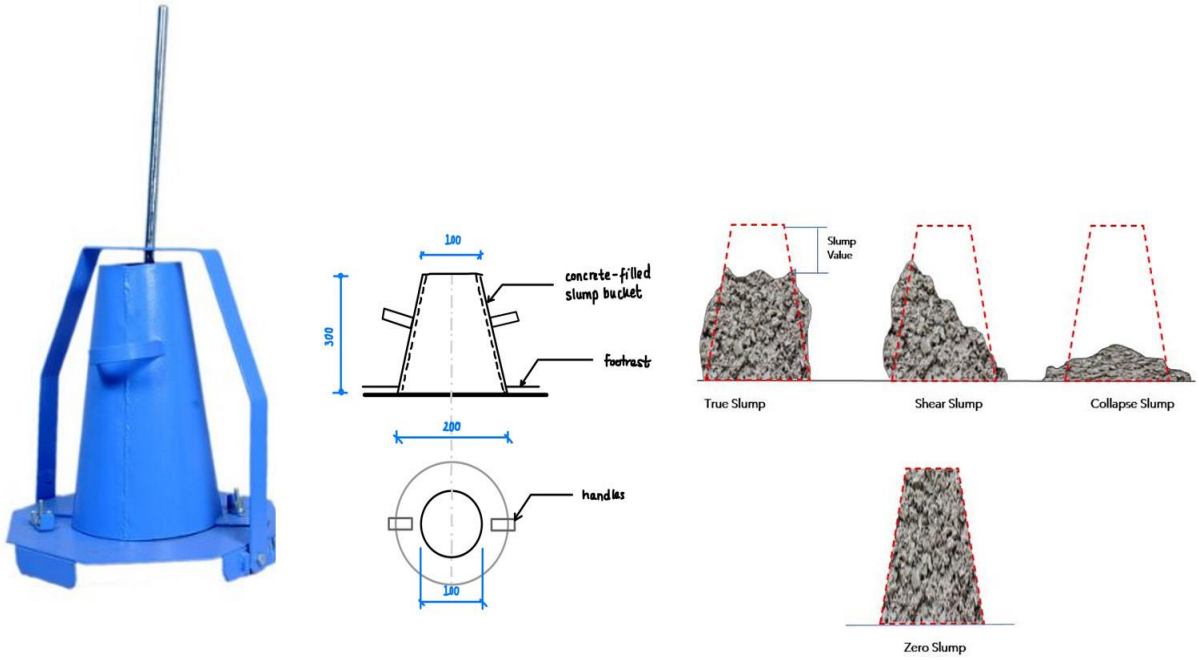

Fig 13 A: Slump Cone Test Apparatus

VIII. Precautions to be followed:

1. Hand gloves and shoes should be used while testing.
2. Equipment should be cleaned thoroughly before and after testing.
3. The apparatus should remain free from vibrations during the test.
4. Petroleum jelly or oil should be applied to the mould.

IX. Procedure:

1. Place the slump mould on a smooth flat and non-absorbent surface.
2. Mix the dry ingredients of the concrete thoroughly till a uniform colour 1s obtained and then add the required quantity of water in it.
3. Place the mixed concrete in the mould to about one-fourth of its height.
4. Compact the concrete 25 times with the help of a tamping rod uniformly all over the area.
5. Place the mixed concrete in the mould to about half of its height and compact it again.
6. Similarly, place the concrete up to its three-fourth height and then up to its top. Compact each layer 25 times with the help of tamping rod uniformly. For the second and subsequent layers, the tamping rod should penetrate into underlying layer.
7. Strike off the top surface of mould with a trowel or tamping rod so that the mould is filled to its top.
8. Remove the mould immediately, ensuring its movement in vertical direction.
9. When the settlement of concrete stops, measure the subsidence of the concrete in millimeters which is the required slump of the concrete.

X. Observation and Calculations:

Sr. No.	Cement	Total Aggregate	FA:CA	FA	CA	Water added	W/C ratio	Slump	Degree of workability
1									
2									
3									

XI. Result:

The Slump Values are obtained as follows

A) At W/C ratio=…… Slump= .....mm

B) At W/C ratio=…… Slump= .....mm

C) At W/C ratio=…… Slump= .....mm

XII. Interpretation of Results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the slump values for different types of construction works.
2. Explain the effect slump values on properties on concrete.
3. State the situations where slump cone test is used.
4. Suggest the suitable degree of workability for following concreting work:
   i. Road pavement,
   ii. Trimix concrete,
   iii. Mass concreting,
   iv. Slip formwork

Space for Answer

XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/HuxfQ0lwXOI?si=AILxTA9tr3cbrmyM	Workability of Concrete Compacting Factor Test By NCTEL
2.	https://youtu.be/Vy4VNOdCwbs?si=dRE_uOBmQGBPLMml	The Workability Test of concrete

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 13B **Determine workability of concrete by slump cone test or Compaction factor test.**

I. Practical Significance:

The Compaction factor test is performed by applying a standard amount of work to Standard quantity of concrete and measuring the resulting compaction. Workability gives an idea of the capability of being worked which controls the quantity of water in cement concrete mix to get uniform strength.

This practical will enable the students to determine the amount of work done required for full compaction.

II. Industry/Employer expected outcome(s):

- To find workability of concrete by Compaction factor test.

III. Course Level Learning Outcome (COs):

- CO 3- Prepare concrete of required specifications in the given situation.

IV. Laboratory Learning Outcome (LLO):

- LLO 13.1 Decide suitability of concrete according its workability in different situations.

V. Relevant Affective Domain related Outcome(s):

- Use proper WC ratio for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

Compaction factor test is adopted to determine the workability of concrete, where nominal size of aggregate does not exceed 40mm and is primarily used in laboratory. It is based upon the property of concrete which determines the amount of work required to produce full compaction. This test works on the principle of determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height. The degree of compaction, called the compacting factor, is measured by the density ratio i.e. the ratio of the density actually achieved in the test to density of same concrete fully compacted.

VII. Required resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Compaction Factor apparatus	As per IS 5515-1983	**1** No.
02	Enamel Tray	650 x 500 x 50 mm	**1** No.
03	Weighing Balance	10 kg with accuracy of 1 gram	**1** No.

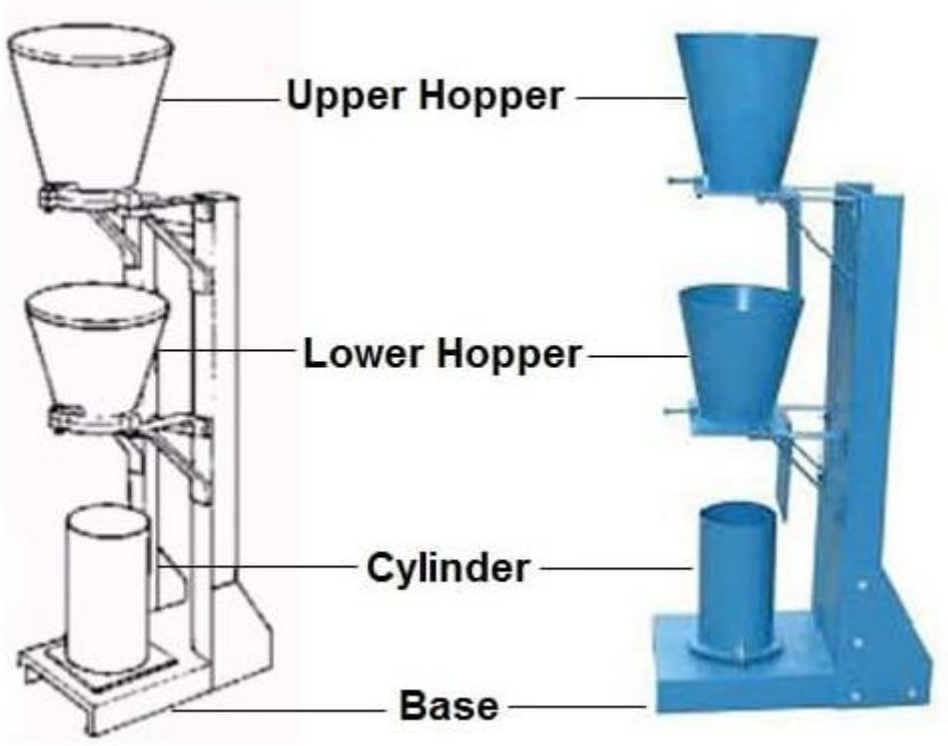

Fig 13 B: Compaction factor Test Apparatus

VIII. Precautions to be followed:

1. Use hand gloves and shoes while testing.
2. Equipment should be cleaned thoroughly before and after testing.
3. The apparatus should remain free from vibrations during the test.

IX. Procedure:

1. Prepare a concrete mix in the ratio of 1:2:4
2. Fill the freshly prepared concrete with the help of a trowel in the top upper of the apparatus. The concrete should be filled to the brim of the hopper and level it off with trowel.
3. Open the trap of the upper hopper, so that the concrete falls in the lower hopper.
4. After all concrete falls from the upper hopper to lower one, then open the trap of the lower hopper. Let the concrete falls on the cylinder.
5. Take the weight of the cylinder in which concrete had filled. Let this weight be the weight of partially compacted concrete (W1).
6. Empty the cylinder and clean it.
7. Fill concrete in the cylinder in three layers with 25 blows for each layer using tamping rod up to the top of cylinder and scrape excess concrete above the brim.
8. Take the weight of the cylinder in which concrete is filled. Let this weight be the weight of fully compacted concrete (W2).

X. Observation and Calculations:

Sr. No	Particulars	I	II	III
1	Proportion of sample			
2	W/C ratio			
3	Weight of empty cylinder (Wa)			
4	Weight of empty cylinder and concrete falling through standard height (Wb)			
5	The weight of partially compacted concrete (W1)			
6	The weight of Fully compacted concrete and Cylinder (We)			
7	The weight of Fully compacted concrete (W2)			
8	Compaction Factor			

XI. Result:

The Compaction Factor (CF) Values are obtained as follows

A) At W/C ratio = …… CF = ...

B) At W/C ratio= ..... CF=.....

C) At W/C ratio = …… CF = ...

XII. Interpretation of results (Give the meaning of above obtained results)**:**

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XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

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XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. State the situations where compaction factor test is used.
2. The compaction factor test is used for low workability. Justify.
3. State compaction factor value for road vibrated by power operated machine.
4. Suggest the suitability of concrete for following compaction factor:

   i.0.78, ii. 0.85, iii. 0.92, iv. 0.95

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/Lnm6AxWJ4As?si=wjgQ4e7UFYTf83zg	workability of concrete by Compaction factor test by NPTEL
2.	https://youtu.be/L5M4B0plH90?si=btqfmYXzwzPoNooP	The workability of concrete by Compaction factor test

XV. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 14 Determine compressive strength of concrete for 7 days.

I. Practical Significance:

The structure has to be safe, economical and need to withstand the various attacks in natural calamities or accidental circumstances. This ultimately depends on the quality of concrete in relevant proportion with cement, fine aggregate and coarse aggregate to give the desired minimum compressive strength of concrete. The compressive strength of concrete cube test provides an idea about all the characteristics of concrete. The Compressive strength of concrete is a measure of the ability of concrete to resist loads which tends to compress it.

This practical will enable the students to justify the use of concrete in the given situation.

II. Industry/Employer Expected Outcome(s):

- To find Compressive strength of concrete.

III. Course Level Learning Outcome (COs):

- CO4 - Prepare concrete of required specifications in the given situation.

IV. Laboratory Learning Outcome (LLO):

- LLO 14.1 Measure the ability of concrete to resist the compressive loads.

V. Relevant Affective Domain related Outcome(s):

- Use proper WC ratio for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

The structure has to be safe, economical and need to withstand the various attacks in natural calamities or accidental circumstances. This ultimately depends on the quality of concrete in relevant proportion with cement, fine aggregate and coarse aggregate to give the desired minimum compressive strength of concrete. The compressive strength of concrete cube test provides an idea about all the characteristics of concrete. The Compressive strength of concrete is a measure of the ability of concrete to resist loads which tends to compress it.

This practical will enable the students to justify the use of concrete in the given situation.

VII. Required Resources/equipment:

Sr. No.	Resource required	Particulars	Quantity
01	Compression testing machine	Compression testing machine -2000 kN capacity	**1** No.
02	Moulds	Cast iron: for 150 mm cube with ISI certification mark IS:10086	**1** Set (3 Nos)
03	Vibrating table	Vibrating table top 500mm x500 mm with edges .Max. load capacity 140 kg.	**1** No.

Fig 14.1: Compression testing machine

VIII. Precautions to be followed:

1. Use hand gloves, safety shoes & apron at the time of test.
2. After test switch off the machine.
3. Keep all the exposed metal parts greased.
4. Keep the guide rods firmly fixed to the base & top plate.
5. Equipment should be cleaned thoroughly before & after testing.

IX. Procedure:

1. Prepare a sample of concrete mix and cast cubes of 15 cm x 15 cm x 15 cm.
2. The concrete shall be filled into the moulds in layers approximately 5 cm deep. It would be distributed evenly and compacted either by vibration or by hand tamping. After the top layer has been compacted, the surface of concrete shall be finished level with the top of the mould using a trowel; and covered with a glass plate to prevent evaporation.
3. The specimen shall be stored for 24 hrs under damp matting or sack. After that, the samples shall be stored in clean water at 27+2°C; until the time of test.
4. Specimen shall be tested immediately on removal from water and while they are still in wet condition.
5. The bearing surface of the testing specimen shall be wiped clean and any loose material removed from the surface. In the case of cubes, the specimen shall be placed in the machine on sides of cube and not to the top and bottom.
6. Align the axis of the specimen with the steel plate, do not use any packing.
7. The load shall be applied slowly without shock and increased continuously at a rate of approximately 140 kg/sq.cm/min until the resistance of the specimen to the increased load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and any unusual features noted at the time of failure brought out in the report.

X. Observation and Calculations:

a. Type and brand of cement =…….
b. Grade of cement =…….
c. Surface area of test block =……...
d. Quantities of ingredients required for each sample cube cement =
   Fine aggregate =……
   Coarse aggregate =……
   Water =…….
e. Date of casting of cubes = ……
f. Date of Testing of cubes after 7 days =…….

Sr.No.	Particulars	I	II	III
1	Load at failure (N)			
2	Compressive strength (N/mm^2)			
3	Average Compressive Strength (N/mm^2)			

Sample Calculations:

Compressive Strength = $\frac{P}{A} X\ 100$ = **……**N/mm^2

XI. Result:

Average Compressive Strength of Concrete at 7 days = ...N/mm^2(Mpa)

XII. Interpretation of Results (Give the meaning of above obtained results)**:**

……

……

XIII. Conclusions and Recommendations (Actions/decisions to be taken based on the interpretation of results)**:**

……

……

XIV. Practical Related Questions:

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. If the compressive strength results are not as per IS requirement, justify according to following parameters: i. Batching, ii. Compaction, iii. Placing and transportation
2. Explain the factor affecting compressive strength of concrete.

3. If 7 days test result of concrete is less than standard value, then concrete is unsuitable for the proposed work. Justify.
4. State the significance of rate of loading during test. While testing, the specimen shall be placed in the machine on sides of cube and not to the top and bottom. Justify

Space for Answer

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XV. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/e8bH26-3PCw?si=wkyA5Q92tr91Ltdl	Compressive Strength of Cement Concrete Cubes by NCTEL
2.	https://youtu.be/7lGYS21bHOs?si=63qB0U9OdDcinp3K	The Compressive Strength of Cement Concrete Cubes

XVI. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the apparatus	5%
2.	Measuring the ingredients and preparing sample	15%
3.	Observations and recording	20%
4.	Calculation	15%
5.	Team work	5%
B.	**Product Related (10 marks)**	**40%**
6.	Interpretation of result	10%
7.	Conclusion and recommendation	10%
8.	Practical Question Answer	10%
9.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No: 15 Visit to RMC plant to understand the components and its functioning.

I. Practical Significance:

The concept of RMC came to India in 1950's but remained confined to Mega-Projects as captive mechanized batch mixing plants. Growth of commercial RMC is a recent phenomenon in India. During the past decade, the construction industry in India has witnessed remarkable growth, in which the ready-mixed concrete (RMC) industry is a major player. During the past few years, housing and infrastructure have remained the major expansion areas. Faster speed and improved quality of concrete have been the two major demands of these sectors. Ready-mixed Concrete was the right solution for this and it was the RMC industry which responded positively to these demands. The result was the rapid growth of the RMC industry. Hence visit to RMC plant is helpful for our students to understand the components and functioning of RMC plant.

II. Industry/Employer Expected Outcome(s):

- To understand the work and functioning of various component part of RMC plant.

III. Course Level Learning Outcome (COs):

- CO4 - Undertake the necessary procedures to maintain the quality of given type of concrete.
- CO5 - Suggest relevant type of admixtures to be used in the given situation

IV. Laboratory Learning Outcome (LLO):

- LLO 15.1 To know the components parts of RMC and its functioning.

V. Relevant Affective Domain related Outcome(s):

- Use proper WC ratio for required concrete works.
- Prepare concrete of desired compressive strength.
- Prepare concrete of required specification.

VI. Relevant Theoretical Background:

Industrial visits of students to RMC are an essential part of the academic curriculum. Being a part of interactive learning; such educational visits give students major exposure to real working environments along with a practical perspective of a theoretical concept relevant about RMC. The objective of industrial visits is to bridge the widening gap between theoretical learning and practical exposure by giving students first-hand exposure to identify the inputs and outputs of different operations and processes performed at the RMC plant.

Intending to go beyond classroom learning, Industrial visits to RMC plant contribute a lot in holistic student development by letting students learn about the current trends in the market, the future scenario of the industry, and the new technologies that are being applied in the industry.

VII. Required Resources/equipment:

Sr.No.	Resource required	Particulars	Quantity
01	RMC Plant	RMC plant near your vicinity or video of RMC plant which shows details about the process and machinery	01 No.

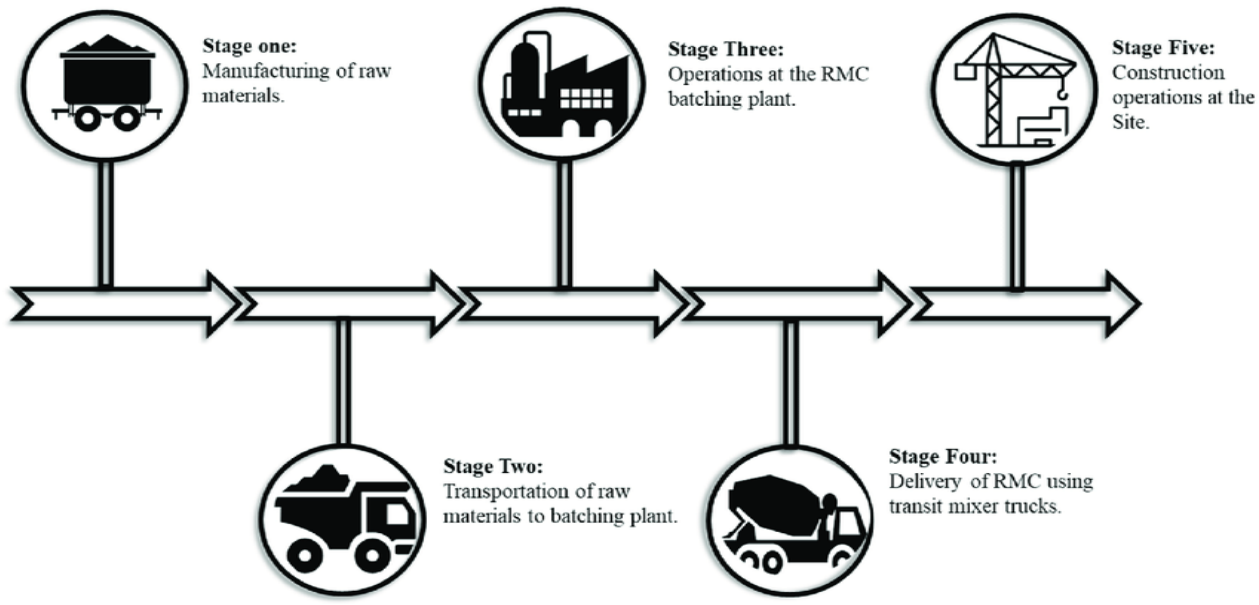

Fig 15.1: Stages of RMC manufacturing

VIII. Precautions to be followed:

1. Ensure all students wear appropriate safety gear such as hard hats, safety goggles, and closed-toe shoes. Provide any additional safety equipment required by the plant.
2. Have a knowledgeable guide or instructor accompany the students at all times. They should be familiar with the plant's operations and safety procedures.
3. students should stay within designated areas and not to wander into restricted zones without permission.
4. Emphasize the importance of listening to and following the instructions given by plant staff. This includes staying clear of operating machinery and vehicles.
5. Students maintain a safe distance from operating machinery and equipment to avoid accidents.
6. Students not to touch any machinery or equipment unless permitted by plant staff.
7. Familiarize students with emergency procedures, including evacuation routes and assembly points, in case of an emergency.

IX. Procedure:

1. Contact the RMC plant well in advance to schedule the visit and discuss logistics.
2. Obtain necessary permissions from the plant management and ensure they are aware of the purpose and scope of the visit.
3. Coordinate with plant staff to determine a suitable date and time for the visit.
4. Prior to the visit, provide students with a safety briefing covering essential safety precautions, emergency procedures, and appropriate behaviour within the plant premises.
5. Emphasize the importance of wearing appropriate safety gear, such as hard hats, safety goggles, and closed-toe shoes.
6. Upon arrival at the RMC plant, students should be greeted by a knowledgeable guide or plant staff member who will lead the tour.

7. The guide should provide an overview of the plant's operations, including the process of producing ready-mix concrete, the machinery and equipment used, and safety protocol.
8. Students should be given the opportunity to observe various stages of the concrete production process, from raw material storage to mixing and batching.
9. The guide should explain each step of the process in a clear and understandable manner, addressing any questions or concerns raised by the students.

X. Observation Table:

Students can use the given observation table as a guide to record their findings and insights during the visit. Write the description on the given observation category in detail.

Sr.No	Observation Category	Description
1	Plant Layout	Describe the layout of the RMC plant, including the location of batching plants, aggregate storage bins, cement silos, mixing units, etc.
2	Raw Materials	List and describe the types of raw materials used in the production of ready-mix concrete, such as aggregates (sand, gravel), cement, water, and admixtures.
3	Production Process	Record the different stages of the concrete production process observed during the visit, including material handling, batching, mixing, transportation, and delivery.
4	Machinery and Equipment	Identify and describe the various machinery and equipment used in the plant, such as conveyor belts, batch plants, mixers, trucks, pumps, etc.
5	Quality Control	Note any quality control measures observed, such as testing procedures for raw materials, monitoring of concrete consistency and strength, and compliance with industry standards.
6	Safety Practices	Document safety practices observed at the plant, including the use of personal protective equipment (PPE), safety signage, emergency procedures, and adherence to safety regulations.
7	Environmental Impact	Assess the plant's environmental impact by observing measures taken to minimize pollution, conserve resources, and manage waste, such as recycling of water and aggregates, dust control measures, etc.
8	Innovation and Technology	Identify any innovative technologies or practices employed in the RMC plant to improve efficiency, productivity, or sustainability, such as automated batching systems, digital monitoring and control systems, etc.

Space for Answer

XI. References/Suggestions for further Reading

Sr. No.	Link	Description
1.	https://youtu.be/2XTHmMHk35E?si=qwqNeAt26tpLm0rT	Basic Introduction of Ready Mix Concrete Plant
2.	https://youtu.be/Kwzg79Jsexk?si=aMQBu1_wj_njWpMY	The Overview of Ready Mix Concrete Plant

XII. Assessment Scheme

Sr. No.	Performance Indicators	Weightage
A.	**Process Related (15 marks)**	**60%**
1.	Identifying the components of RMC	10%
2.	Understanding the functions of components	15%
3.	Record the different stages of the concrete production process observed during the visit	20%
4.	Team work	15%
B.	**Product Related (10 marks)**	**40%**
5.	Note any quality control measures observed	20%
6.	Practical Question Answer	10%
7.	Submission of practical on time.	10%
C.	**Total marks (25 marks)**	**100%**

Marks Obtained			Dated sign of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	