I

Name _____

Roll No. _____ Year 20____20____

Exam Seat No. _____

CIVIL GROUP | SEMESTER - III | DIPLOMA IN ENGINEERING AND TECHNOLOGY

A LABORATORY MANUAL

FOR

CONCRETE TECHNOLOGY

(22305)

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 changing technological and 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 followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual

for

Concrete Technology

(22305)

Semester-III

(CE/CR/CS/CV)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO : 9001 : 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on June, 2018)

MAHARASHTRA STATE

BOARD OF TECHNICAL EDUCATION

Certificate

This is to certify that Mr. / Ms. ……..…… Roll No. ……..…., of Third Semester of Diploma in ……..…… of Institute, ……..…….……..… (Code: ……...) has completed the term work satisfactorily in course **Concrete Technology (22305)** 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

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

Concrete is the most widely used construction material today for different kinds of infrastructural development works. The versatility and mouldability of the concrete and its high compressive strength have contributed largely to its wide spread use in development and construction works. The contents of course will focus on learning about quality of concrete

with regards to mix design, preparation, transporting and placing in position for various structures. It will also provide guidelines for effective supervision and quality control of concreting work. With good knowledge of concrete materials namely cement, aggregates, water and admixtures and concreting operation namely selection of materials, mixed design, mixing, placing, compacting and finishing, curing, one can obtain concrete of desired workability and required strength. The content of this course will also enable students to acquire knowledge and skills for carrying out various tests on different ingredients of concrete for quality construction works. Effective learning on above aspects will help the students to become a successful professional civil engineer contributing to the profession of construction and development works.

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.

Programme Outcomes (POs) to be achieved through Practical of this Course

Following POs and PSO are expected to be achieved through the practicals of the Concrete Technology Course.

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline **-** specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

PO 4. Engineering tools: Apply relevant Civil technologies and tools with an understanding of the limitations..

List of Industry Relevant Skills

The following industry relevant skills of the competency 'Evaluate suitability of concrete for different site conditions**.**' are expected to be developed in you by undertaking the practicals of this practical manual.

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.

Practical- Course Outcome matrix

Course Outcomes (COs)

- **a.** Use relevant types of cement in different site conditions.
- **b.** Use relevant aggregates for required concrete works.
- **c.** Prepare concrete of desired compressive strength.
- **d.** Prepare concrete of required specification.
- **e.** Maintain the quality of concrete.
- **f.** Apply relevant admixtures for concreting for different weather conditions.

S. No.	Practical Outcome	CO a.	CO b.	CO c.	CO d.	CO e.	CO f.
1.	Determine fineness of cement by Blaine's air permeability apparatus Or by sieving.	√	-	√	√	-	-
2.	Determine standard consistency, initial and final setting times of OPC.	√	-	√	√	-	-
3.	Determine compressive strength of ordinary Portland cement.	√	-	√	√	-	-
4.	Determine specific gravity of ordinary Portland cement.	√	-	√	√	-	-
5.	Determine silt content in sand by volume.	-	√	√	√	-	-
6.	Determine bulking of sand.	-	√	√	√	-	-
7.	Determine bulk density of fine and coarse aggregates.	-	√	√	√	-	-
8.	Determine water absorption of fine and coarse aggregates.	-	√	√	√	-	-
9.	Determine Fineness modulus of fine aggregate by sieve analysis.	-	√	√	√	-	-
10.	Determine Fineness modulus of coarse aggregate by sieve analysis.	-	√	√	√	-	-
11.	Determine aggregate impact value.	-	√	√	√	-	-
12.	Determine aggregate crushing value.	-	√	√	√	-	-
13.	Determine abrasion value of aggregate.	-	√	√	√	-	-
14.	Determine aggregate elongation index and flakiness index.	-	√	√	√	-	-

15.	Determine workability of concrete by slump cone test.	-	-	√	√	-	-
16.	Determine workability of concrete by compaction factor test.	-	-	√	√	-	-
17.	Determine compressive strength of concrete for 7 days.	-	-	√	√	-	-
18.	Determine compressive strength of concrete by any one method of NDT.	-	-	-	-	√	-

Guidelines to Teachers

1. Teacher need to ensure that a dated log book for the whole semester, apart from the laboratory manual is maintained by every student which s/he has to submit for assessment to the teacher in the next practical session.
2. There will be two sheets of blank pages after every practical for the student to report other matters (if any), which is not mentioned in the printed practicals.
3. For difficult practicals if required, teacher could provide the demonstration of the practical emphasizing of the skills which the student should achieve.
4. Teachers should give opportunity to students for hands-on after the demonstration.
5. Assess the skill achievement of the students and COs of each unit.
6. One or two questions ought to be added in each practical for different batches. For this teachers can maintain various practical related question bank for each course.
7. If some repetitive information like data sheet, use of software tools etc. has to be provided for effective attainment of practical outcomes, they can be incorporated in Appendix.
8. For effective implementation and attainment of practical outcomes, teacher ought to ensure that in the beginning itself of each practical, students must read through the complete write-up of that practical sheet.
9. During practical, ensure that each student gets chance and takes active part in taking observations/ readings and performing practical.
10. Teacher ought to assess the performance of students continuously according to the MSBTE guidelines

Instructions for Students

1. For incidental writing on the day of each practical session every student should maintain a dated log book for the whole semester, apart from this laboratory manual which s/he has to submit for assessment to the teacher in the next practical session.
2. For effective implementation and attainment of practical outcomes, in the beginning itself of each practical, students need to read through the complete write-up including the practical related questions and assessment scheme of that practical sheet.
3. Student ought to refer the data books, IS codes, Safety norms, Electricity act/rules, technical manuals, etc.
4. Student should not hesitate to ask any difficulties they face during the conduct of practicals.

Content Page

List of Practicals and Progressive Assessment Sheet

16.	Determine workability of concrete by compaction factor test.	107					
17.	Determine compressive strength of concrete for 7 days.	114					
18.	Determine compressive strength of concrete by any one method of NDT.	120					
Total							

- **To be transferred to Proforma of CIAAN-2017**

Practical No. 01: Determine Fineness of Cement by Blaine's Air Permeability Apparatus or by Sieving

I Practical Significance

In Civil Engineering construction, properties of Cement plays an important role. Fineness is an important property of cement. The fineness of cement has an important 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 slump and its strength in concrete.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant types of cement in different site conditions.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine fineness of cement by Blaine's air permeability apparatus or by sieving.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum 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.

VIII Practical Set-up

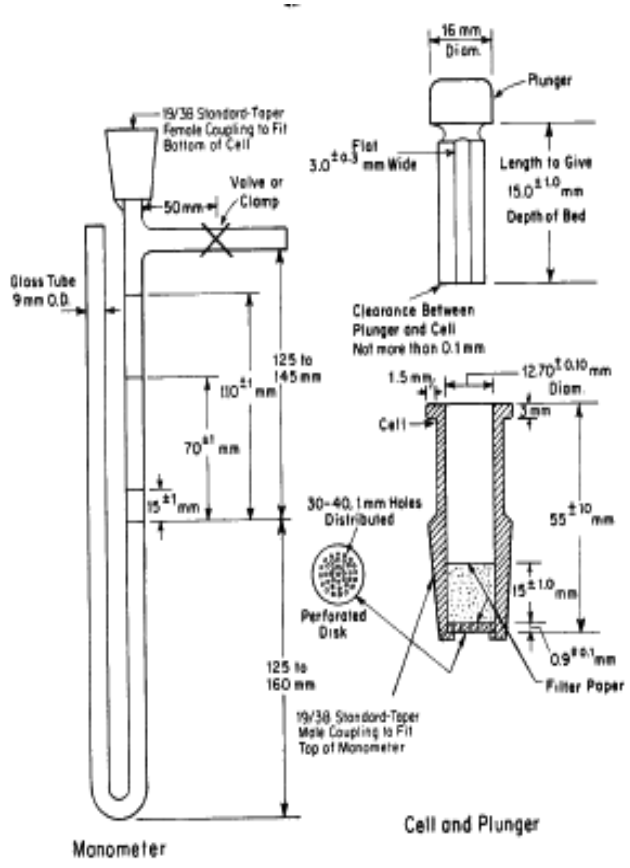

Figure: Blains Air Permeability Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Blaine's Air Permeability apparatus	Blaine's air permeability apparatus as per IS: 4031 (part 1)-1999,	01 No.	
2	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm	01 No.	
2	Sieve no. IS 90 micron	- IS Brass Sieve (200 mm dia), 90 Micron size.	01 No.	

X Procedure:-

A) 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.

B) 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.

XI Precautions to be followed

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

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

A) 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)= ……

B) Sieving Method

Sr. No.	Particulars	I	II	III
1	Weight of cement (W)gm			
2	Weight of cement retained (W1) gm			
3	% weight of cement retained on the sieve			

Sample Calculations:

A) Blains Air Permeability Method

1. $V = \frac{W_A - W_B}{D} =$

2. $W = 3.15 \times V(1-e) =$

Where, $e = 0.500 \pm 0.005$

3. $K = \frac{S_s}{\sqrt{T_s}} =$

4. $S = K\sqrt{T} =$

B) Sieving Method

$$\% \text{ of Weight Retained} = \frac{W_1}{W} =$$

XVI Results

A) **Blains Air Permeability Method**

Specific Surface area of cement =……..

B) **Sieving Method**

Fineness of cement = ……

XVII Interpretation of results (Give meaning of the above obtained results)

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

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XIX 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 Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 4031 part I - 1996	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002
3	IS 4031 part II-1999	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
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	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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

Practical No. 02: Determine standard consistency, initial and final setting time 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.
PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant types of cement in different site conditions.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine standard consistency, initial and final setting times of OPC.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency:
a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum Theoretical Background

Consistency refers to the relative mobility of a freshly mixed cement paste or mortar or its ability to flow. It is essential that cement set neither too rapidly nor too slowly. In the first case there might be insufficient time to transport and place the concrete before it becomes too rigid. In the second case too long a setting period tends to slow up the work unduly, also it might postpone the actual use of the structure because of inadequate strength at the desired age. Setting time is the time required for stiffening of cement paste to a defined consistency. Indirectly it is related to the initial chemical

reaction of cement with water to form aluminum-silicate compound. Initial setting time is the time when the paste starts losing its plasticity. Final setting time is the time when the paste completely loses its plasticity. It is the time taken for the cement paste or cement concrete to harden sufficiently and attain the shape of the mould in which it is cast. Determination of final setting time period facilitates safe removal of scaffolding or form. During this period of time primary chemical reaction of cement with water is almost completed

VIII Practical Set-up

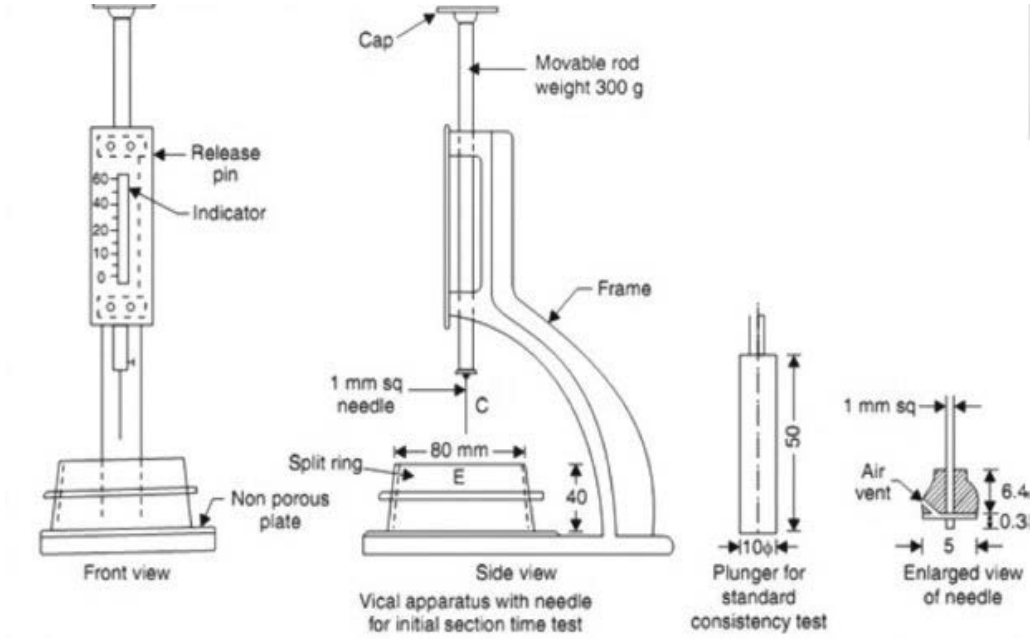

Figure: Vicat's Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Vicat's Apparatus	Vicat mould of dia. 80 mm and 40 mm high glass base plate, initial needle, final needle. Consistency plunger M.S. base plate (non porous) of weight 300 gm. Vicat mould split type with camping ring	1 set for Group of 4 to 5 students	
2	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm	01 No.	
3	Measuring Cylinder	Measuring Cylinder of 100 ml capacity	04 No.	

X Procedure:-

Consistency of cement

1. Take 400 g 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.
5. After filling the mould completely, smoothen the surface of the paste, making it level with top of the mould.
6. Place the whole assembly (i.e. mould + cement paste + glass plate) under the rod bearing plunger.
7. 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.
8. Measure the depth of penetration and record it.
9. 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 g 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).

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

1. Type and brand of cement =…….
2. Grade of cement =…….
3. Quantity of cement sample = …….

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 = $T_3 - T_1$ = ……..

XVI Results

A) Consistency of cement = ……..

B) Initial Setting time of cement = ……

C) Final Setting time of cement = ……..

XVII Interpretation of results (Give meaning of the above obtained results)

.....
.....
.....

XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Conclude with the following parameters if initial setting time of OPC is 20 minutes:
   i. rate of heat of hydration
   ii. concreting operations

2. Conclude with the following parameters if final setting time of OPC is 800 minutes:
   i. rate of heat of hydration
   ii. concreting operations
3. State BIS requirements of specific area of cement for OPC and rapid hardening cement. .
4. Justify selecting the 2.8 gm of standard cement sample.
5. 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 Answers]

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XX References / Suggestions for further Reading

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1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN,* : 978-8-121-90003-4
2	IS 4031 part IV - 1988	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002
3	IS 4031 part V- 1988	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus.	5%
2	Measurement of cement and water	20%
3	Observations and recording	25%
4	Calculations	5%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant types of cement in different site conditions.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine compressive strength of Ordinary Portland cement.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum 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.

VIII Practical Set-up

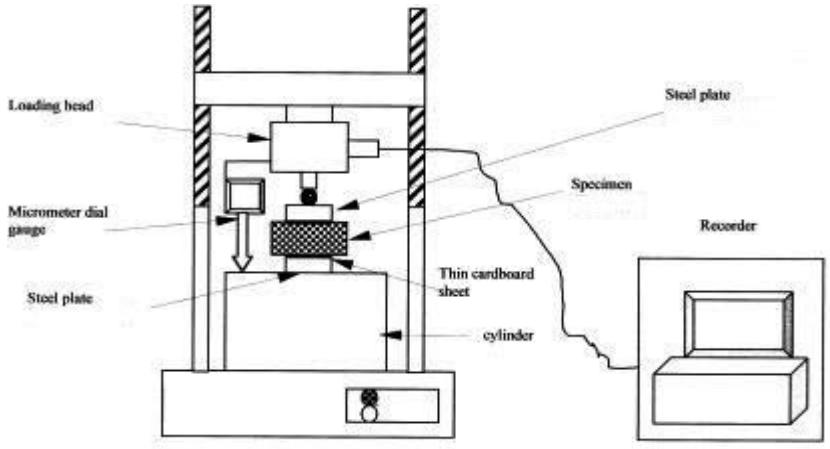

Figure: Compression Testing Machine

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Compression testing machine	Compression testing machine - 2000 kN capacity	1 No.	
2	Cement mortar cube	Moulds size of area 50 cm^2 (7.07cm x 7.07 cm x 7.07cm)	6 Nos.	
3	Cement cube Vibrator	As per IS 10080-1982	1 No.	

X Procedure:-

1. Take 200 g of cement and 600 g of standard sand and mix them dry thoroughly.
2. Add $\left(\frac{P}{4}+3\right)\%$ 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 ± 2^0C 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/mm^2/minute till the cube fails.
10. Record the crushing load of each cube and calculate compressive strength of each cube.

XI Precautions to be followed

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

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

a. Type and brand of cement - ……..
b. Grade of cement -…….
c. Standard consistency of cement (P) = ……....
d. Surface area of test block = …….
e. Quantities of ingredients required for each sample cube
i. Cement = ……
ii. Standard Sand = …….
iii. Water = …….
f. Date of Casting of cubes - ……....
g. Date of Testing of cubes – After 3 days - ……

After 7 days - ……..

After 28days - …….

Observation Table-

Sr. No.	Particulars	I	II	III	I	II	III	I	II	III
1	Curing period in days	3	3	3	7	7	7	28	28	28
2	Load at failure (N)									
3	Compressive strength (N/mm^2)									
4	Average Compressive Strength (N/mm^2)									

Sample Calculations:

$$\text{Compressive strength} = \frac{\text{Load}}{\text{Area}}$$

$$\sigma = \frac{P}{A} =$$

XVI Results

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 = …….

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 result are not as per IS requirement, justify according to following parameters:
   i. Storage period
   ii. Compaction
   iii. W/C ratio
2. Give the reason for taking the quantity of water as $\left(\frac{P}{4}+3\right)\%$.
3. State the necessity of standard sand used for preparing cement mortar cube.
4. State the significance of Compressive strength of cement test.
5. Suggest remedy, if standard sand is not available.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 10080 -1982	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002
3	IS 4031 part 6 - 1988	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Measuring the ingredients and preparing sample	20%
3	Observation and recording	15%
4	Calculation of compressive strength	15%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1 ……..

2 ……..

3 ……..

4 ……..

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

Practical No. 04: Determine specific gravity of ordinary portland cement

I Practical Significance

In Civil Engineering construction properties of Cement plays an important role. Excessive presence of moisture content in cement effects workability and strength of cement. Specific gravity is also required for mix design of concrete. For Nominal mix design, the specific gravity of cement should be 3.15g/cc.

This practical will enable the students to know the moisture content in cement and its use in mix design of concrete.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant types of cement in different site conditions.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine specific gravity of ordinary Portland cement.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum Theoretical Background

Nominal mix design is based on the value of specific gravity of cement. The value will change over time if the cement is exposed to various weather conditions. So it is essential to determine the specific gravity of cement before using it. If the specific gravity of cement is greater than 3.19 then, the cement is either not minced finely as per the industry standard or it has more moisture content which will affect the mix and bonding.

VIII Practical Set-up

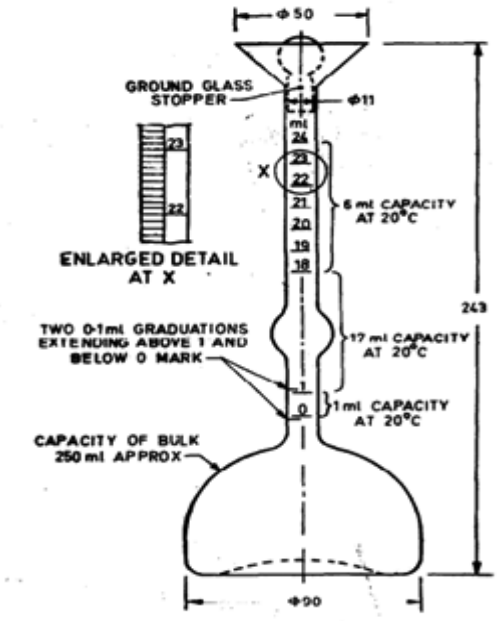

Figure: Le-Chatelier Flask

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Le-Chatelier Flask	Glass flask 250 ml capacity, with graduated neck from 0 to 1 ml and from 18 to 24 ml in 0.1 ml graduation with accuracy of 0.05 ml	1 No.	
2	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm	1 No.	

X Procedure:-

1. The Flask should be free from the liquid that means it should be fully dry. Weigh the empty flask (W1)
2. Fill the cement on the bottle up to half of the (about 50gm) and weigh with its stopper. (W2)
3. Add Kerosene to the cement up to the top of the bottle. Mix well to remove the air bubbles in it. Weigh the flask with cement and kerosene (W3)
4. Empty the flask. Fill the bottle with kerosene up to the top and weigh the flask (W4)

XI Precautions to be followed

1. The flask should be dry.
2. All weights must be taken accurately.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Sr. No.	Particulars	I	II	III
1	Weight the empty flask (W1) in gm			
2	Weight of bottle and cement (W2) in gm			
3	Weight of the flask with cement and kerosene (W3) in gm			
4	Weight of the flask with kerosene (W4) in gm			

Sample Calculations:

$$S_o = \left(\frac{W2 - W1}{(W2 - W1) - (W3 - W4) \times 0.79} \right)$$

= ……..

= ……..

XVI Results

Average specific gravity of cement = …….

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 specific gravity of cement.
2. If the specific gravity of cement is greater than 3.15, write the effect on hydration of cement.
3. Write the effect of specific gravity of cement on its strength.
4. Is there any change in the specific gravity of cement, if it is exposed to the atmosphere?

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 4030- part 11 - 1988	BIS Panel	Bureau of Indian Standards,Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus.	5%
2	Measuring the ingredients and preparing sample	15%
3	Observation and recording	25%
4	Calculation of specific gravity	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1 ……..

2 ……..

3 ……..

4 ……..

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

Practical No. 05: Determine Silt Content in 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant aggregates for required concrete works.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine silt content in sand by volume.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum 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.

VIII Practical Set-up

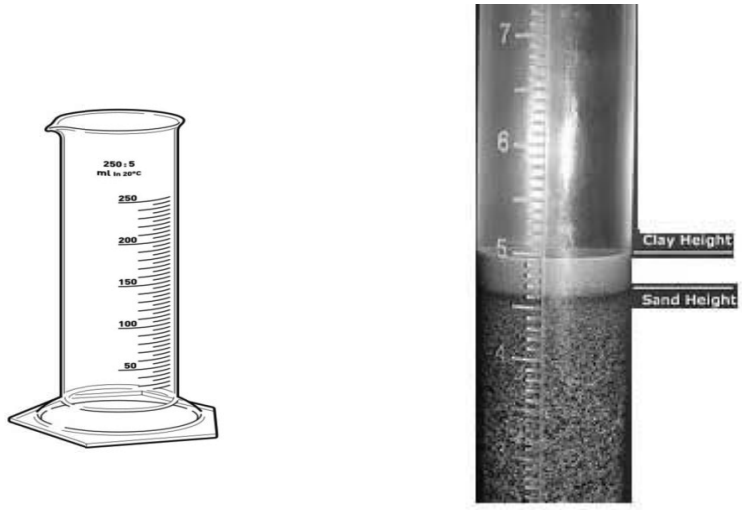

Figure: Measuring Cylinder

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Measuring Cylinder	Capacity - 250 ml	1 No.	
2	Steel rule	30 cm length	1 No.	

X 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.

XI Precautions to be followed

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

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Sr. No.	Particulars	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 = $(V_2/V_1) \times 100$ =…….

XVI Results

Average Percentage of silt by volume = …….

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 2386- part 2 - 1963	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus.	5%
2	Measuring the ingredients and preparing sample	20%
3	Observation and recording	15%
4	Calculation of silt content	15%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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

Practical No. 06: Determine Bulking 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 by 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant aggregates for required concrete works.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine bulking of sand.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum 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 sand bulks more than coarse sand. 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.

VIII Practical Set-up

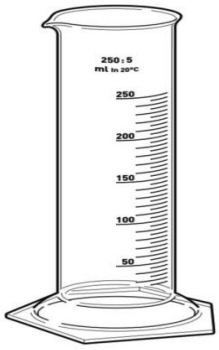

Figure: Measuring Cylinder

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Measuring cylinder	Capacity - 250 ml	1 No.	
2	Glass rod	10 mm diameter and 300 mm long	1 No.	
3	Enamel tray	450x300x40 mm	1 No.	

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, say this height is '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.

XI Precautions to be followed

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

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

(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) For determination of bulking of moist sand:

Sr. No.	Particulars	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 $= \frac{(V2-V1)}{V1} \times 100$

=……

=…….

(ii) Bulking of sand $= \frac{h-h'}{h'} \times 100$

=……...

=……..

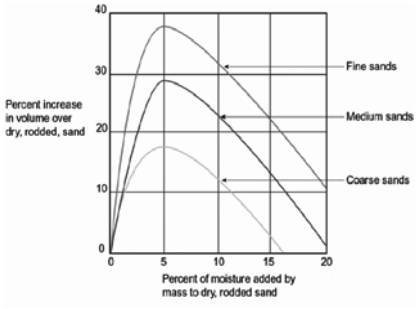
XVI Results

(i) Maximum percentage of bulking of sand = …….

Maximum percentage Volume of Water at saturation point = …….

(ii) Maximum percentage of bulking of sand = …….

Maximum percentage Volume of Water at saturation point = …….



Bulking of Aggregate

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. State the reason of bulking of sand.
3. After certain percentage of moisture content bulking of sand decreases. Justify.
4. State the adverse effect of bulking of sand on the concrete mix.

[Space for Answers]

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XX References / Suggestions for further Reading

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1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 2386- part 3 - 1997	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus .	5%
2	Measuring the ingredients and preparing sample	15%
3	Observation and recording	15%
4	Calculation of Bulking of sand and plotting the graph	20%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

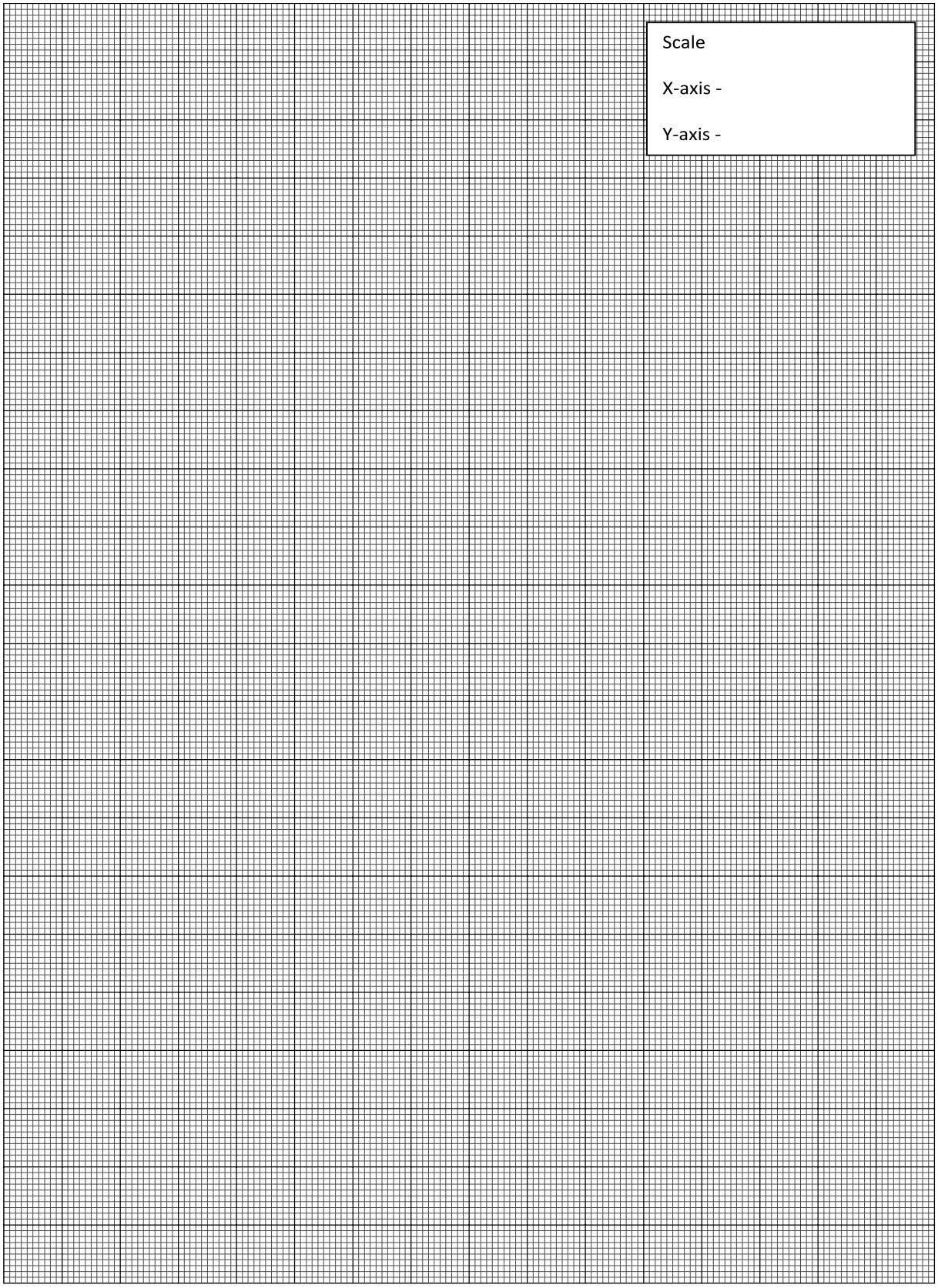
1……..

2……..

3……..

4……..

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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant aggregates for required concrete works.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine bulk density of fine and coarse aggregates.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

d. Follow safety practices.
a. Demonstrate working as a leader/ a team member.
b. Maintain tools and equipments

VII Minimum 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.

VIII Practical Set-up

Figure: Metal Measure

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Weighing balance	Capacity - 5 kg, readable to 0.1 g	1 No.	
2	Steel tamping rod	Round, straight, 16 mm diameter steel tamping rod of 600 mm length, having one end round	1 No.	
3	Oven	Thermostatically controlled, to maintain temperature of 100^0C to 110^0C	1 No.	
4	Cylindrical metal container	As given in the following table	1 No.	

Size of metal container:

Sizes of largest particles	Nominal capacity	Inside Diameter	Inside Height	Thickness of metal (min)
	Litre	cm	cm	mm
4.5 mm and under	3	15	17	3.15
Over 4.75 mm to 40 mm	15	25	30	4.00
Over 40 mm	30	35	31	5.00

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.

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

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

Sample Calculations:

For fine aggregate:

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

=……...

For coarse aggregate:

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

=……....

XVI Results

1. Average bulk density of fine aggregate = ……
2. Average bulk density of coarse aggregate = …….

VII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 2386- part 3 - 1963	BIS Panel	Bureau of Indian Standards,Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus	5%
2	Measuring the ingredients and preparing sample	20%
3	Observation and recording	15%
4	Calculation of bulk density	15%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.
PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant aggregates for required concrete works.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine water absorption of fine and coarse aggregates.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum 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.

VIII Practical Set-up

Figure: Container and Dry cloth

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Aggregate Container	Capacity - 5 kg	1 No.	
2	Steel steering rod	Round, straight, 12 mm diameter steel of 300 mm length, having one end round	1 No.	
3	Weighing balance	Capacity - 5 kg, readable to 0.1 g	1 No.	
4	Oven	Thermostatically controlled, to maintain temperature of 100^0C to 110^0C	1 No.	

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)

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

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:

For fine aggregate:

$$\text{Water Absorption} = \frac{(A-B)}{B} \times 100\% = \ldots\ldots\ldots \times 100$$

$$= \ldots\ldots\ldots\%$$

For coarse aggregate:

$$\text{Water Absorption} = \frac{(A-B)}{B} \times 100\% = \ldots\ldots\ldots \times 100$$

$$= \ldots\ldots\ldots\%$$

XVI Results

1. Average Water Absorption of fine aggregate = ……
2. Average Water Absorption of coarse aggregate = …….

VII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 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 110°C in an oven. Justify.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 2386- part 3 - 1963	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus.	5%
2	Measuring the ingredients and preparing sample	20%
3	Observation and recording	15%
4	Calculation of water absorption	15%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1 ……..

2 ……..

3 ……..

4 ……..

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 finishability. 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 an 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.
PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant aggregates for required concrete works.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

Determine fineness modulus of fine aggregate.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency:
a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments.

VII Minimum 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 consist 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.

i. Fine sand 2.2 to 2.6
ii. Medium sand 2.6 to 2.9
iii. Coarse sand 2.9 to 3.2

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

VIII Practical Set-up

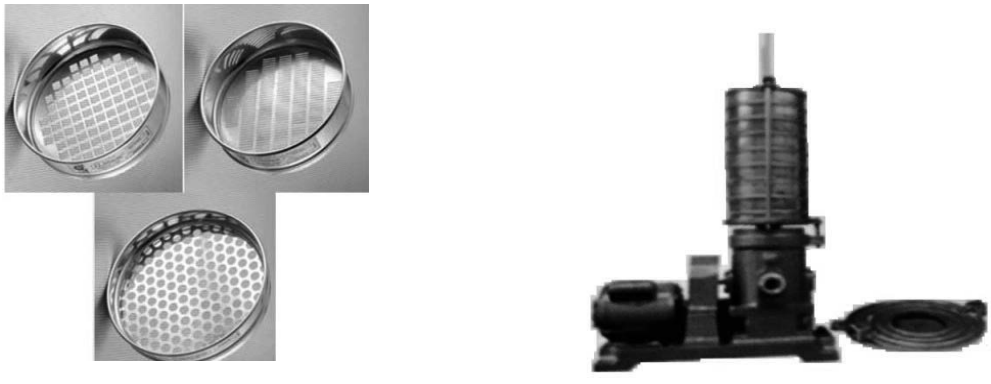

Figure: Sieves and Mechanical Sieve Shaker

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Motorized Sieve Shaker	Mechanical sieve shaker digital timer adjustable from 0-99 minutes. It should carry 8 sieves. It is driven by 1/4 H. P. geared motor, operating on 220V, single phase A.C.	1No.	
2	IS Sieve	IS sieve having 200mm diameter of brass metal. Sizes: 4.75mm, 2.36mm, 1.18mm, 600micron, 300micron, 150micron, pan and lid.	01set	
3	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm	01 No.	
4	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5^{o}C	01 No.	

X 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.

XI 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 0.1gm.
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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Observation Table

Total weight of fine aggregate sample taken for sieving = ……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)				Σ=	
7	75µ				
8	Pan				
	Sum				

Sample Calculations:

FM of fine aggregate = W / 100

= ……
=……..

VI Results

The fineness modulus of fine aggregate = …….

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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.
6. Following are three different values of Fineness modulus of three different samples.
   Write the relevance.
   i. FM = 2.0
   ii. FM = 2.6
   iii. FM =3.2
7. Following are the nature of grading curves. Write the indications about type of aggregate.
   i. Curve is uniform and liner.
   ii. Curve having steep slope.
   iii. Curve having flat slope.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN,* : 978-8-121-90003-4
2	IS:383-1970	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002
3	IS:2386(part I)-1963	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Measurement of weight of aggregate retained on each sieve.	25%
3	Observations and recording.	15%
4	Calculations and finding result.	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation.	5%
7	Interpretation of result.	15%
8	Conclusion and recommendation.	10%
9	Answer to the practical related questions.	5%
10	Submission of report in time.	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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. For the high cement contents used in the production of high-strength concrete, coarse sand with an 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Use relevant aggregates for required concrete works.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

IV Practical Outcome

1. Determine fineness modulus of coarse aggregate.
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency:

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments.

VII Minimum 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 consist 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, the number does not give any precise meaning. Aggregate having a fineness modulus between 5.5 to 8.0 is coarse aggregate.

VIII Practical Set-up

Figure: Sieves and Motorized Sieve Shaker

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Motorized Sieve Shaker	Mechanical sieve shaker digital timer adjustable from 0-99 minutes. It should carry 8 sieves. It is driven by 1/4 H. P. geared motor, operating on 220V, single phase AC.	1No.	
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.	01set	
3	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm. Pan Size 240x210mm.	01 No.	
4	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5^{o}C	01 No.	

X 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.

XI 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. 1gm.
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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Observation Table

Total weight of coarse 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)			Σ=	
11	75µ				
12	Pan				
	Sum				

Sample Calculations:

FM of Coarse aggregate = W / 100

= ……..

= …….

VI Results

The fineness modulus of coarse aggregate is = ----------

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write the significance of grading of aggregate.
4. Determine the fineness modulus and interpret the result.
   Total weight of sample is 400gm.

IS sieve	10mm	4.45mm	2.36mm	1.18mm	600µ	300µ	150µ	75µ
% passing(gm)	100	92	74	55	23	12	9	7

5. Following are three different values of Fineness modulus of three different samples.

Write the relevance.

i. FM = 3.0
ii. FM = 3.5
iii. FM = 6.5

6. Following are two grading of aggregate. Differentiate related to voids and cement paste requirement.
   i. Uniform grading
   ii. Continuous grading.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN,* : 978-8-121-90003-4
2	IS:383-1970	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002
3	IS:2386(part I)-1963	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Measurement of weight of aggregate retained on each sieve.	25%
3	Observations and recording.	15%
4	Calculations and finding result.	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
1	Error Estimation.	5%
2	Interpretation of result.	15%
3	Conclusion and recommendation.	10%
4	Answer to the practical related questions.	5%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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

Practical No. 11: 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.
PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

a. Use relevant aggregates for required concrete works.
b. Prepare concrete of desired compressive strength.
c. Prepare concrete of required specification.

IV Practical Outcome

Determine aggregate impact value.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency:
a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments.

VII Minimum 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.

VIII Practical Set-up

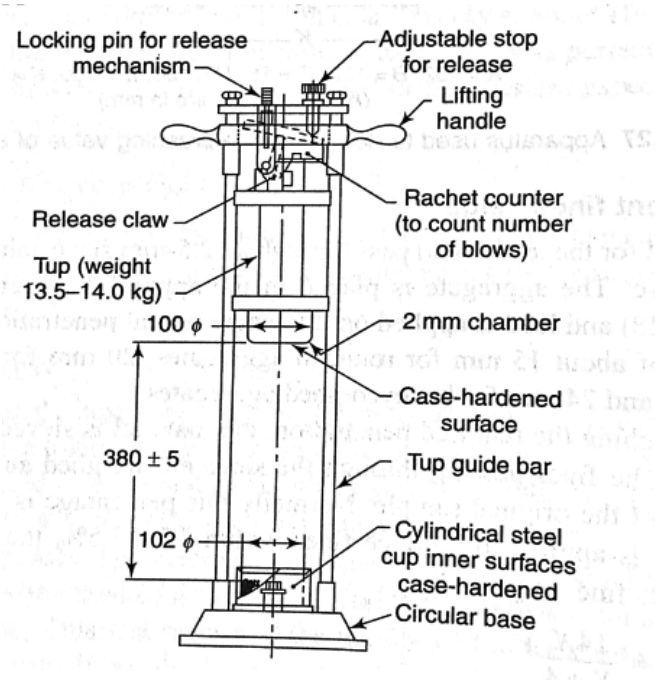

Figure: Aggregate Impact Value Test Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	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.	
2	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm. Pan Size 240x210mm.	01 No.	
3	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5^{o}C	01 No.	

X 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 (W_1).
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 (W_2).
9. Weigh the fraction retained on 2.36mm IS sieve (W_3).

XI 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 0.1gm 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)
Observation Table

Sr. No.	Particulars	I	II	III
1	Weight of oven dried sample (W_1) gm.			
2	Weight of fraction passing through IS 2.36mm sieve (W_2) gm.			
3	Weight of fraction retained on IS 2.36mm sieve (W_3) gm.			

Sample Calculations:

$$\text{Aggregate Impact Value} = \frac{W2}{W1} \times 100$$

= ……

VI Results

The aggregate impact value of coarse aggregate = ----------

XVII Interpretation of results (Give meaning of the above obtained results)
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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 provide higher resistance to impact than flaky and elongated shape aggregate. Give reason.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN,* : 978-8-121-90003-4
2	IS:9376-1976	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002
3	IS:2386(part IV)-1963	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Preparation of test sample.	20%
3	Observations and recording.	20%
4	Calculations and finding result.	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
1	Error Estimation.	5%
2	Interpretation of result.	15%
3	Conclusion and recommendation.	10%
4	Answer to the practical related questions.	5%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1 ……..

2 ……..

3 ……..

4 ……..

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

Practical No. 12: Determine aggregate crushing value

I Practical Significance

Aggregate crushing value is a mechanical property of coarse aggregate and it gives relative measure of an aggregate to the resistance to crushing under gradually applied compressive load. It is a measure of strongness (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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

a. Use relevant aggregates for required concrete works.
b. Prepare concrete of desired compressive strength.
c. Prepare concrete of required specification.

IV Practical Outcome

Determine aggregate crushing value.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency:
a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments.

VII Minimum 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.

VIII Practical Set-up

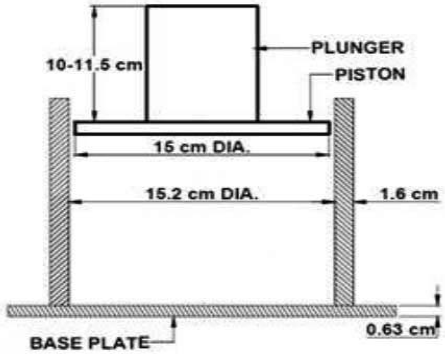

Figure: Aggregate Crushing Value Test Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	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	
2	IS Sieve	IS brass sieve 200mm diameter of sizes: 12.5mm, 10mm, 2.36 mm with pan and lid.	01 Set	

3	Compression Testing Machine	As per IS 516, Capacity 300 ton (mechanical type) manually and electrically operated with three dial gauges, suitable for testing cubes of various sizes and cylinders up to 15 cm diameter and 30 cm height, a hydraulic jack is fixed to the base.	01 No.	
4	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm. Pan Size 240mm x 210mm.	01 No.	
5	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5^{o}C	01 No.	

X 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 (W_1).
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 (W_2).
10. Take weigh of the fraction retained on 2.36mm IS sieve (W_3).

XI 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 0.1gm of total weight.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Observation Table

Sr. No.	Particulars	I	II	III
1	Weight of oven dried sample (W_1) gm.			
2	Weight of fraction passing through IS 2.36mm sieve (W_2) gm.			
3	Weight of fraction retained on IS 2.36mm sieve (W_3) gm.			

Sample Calculations:

$$\text{Aggregate Crushing Value} = \frac{W2}{W1} \times 100$$

= ----------

VI Results

The aggregate crushing value of coarse aggregate = …….

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Write the limits of ACV for flexible pavements.
   i. Soling ii.WBM iii. Bituminous iv. Thin premix carpet v. Dense mix carpet.
3. If test shows the following results. Justify the suitability of aggregate sample.
   i. ACV of sample A = 27%, ii. ACV of sample B = 38%
4. 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.
5. Write the effect of shape of aggregate on test result. Give reason.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN,* : 978-8-121-90003-4
2	IS:383-1963	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002
3	IS:2386(part IV)-1963	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi -110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Preparation of test sample.	20%
3	Observations and recording.	20%
4	Calculations and finding result.	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
1	Error Estimation.	5%
2	Interpretation of result.	15%
3	Conclusion and recommendation.	10%
4	Answer to the practical related questions.	5%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1 ……..

2 ……..

3 ……..

4 ……..

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

Practical No. 13: 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.
PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

a. Use relevant aggregates for required concrete works.
b. Prepare concrete of desired compressive strength.
c. Prepare concrete of required specification.

IV Practical Outcome

Determine aggregate abrasion value.

V Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency:
a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments.

VII Minimum 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, wear 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.

VIII Practical Set-up

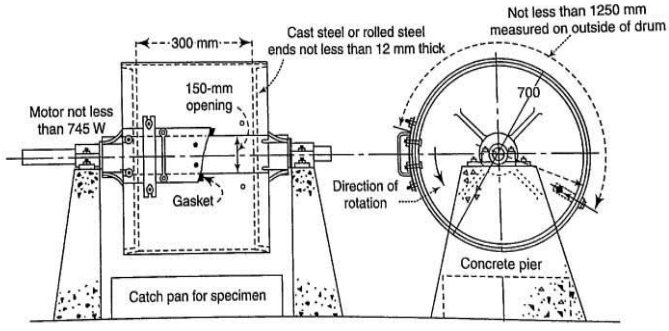

Figure: Los Angeles Abrasion Testing Machine

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Los Angeles 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 25mm x 300mm projecting 90mm from inside. Rotation of drum 30 to 33 rpm. Operation on 415V, 3 Phase, 50Hz, AC Supply.	01 No.	
2	Abrasive Charge	Set of 12 Steel or CI balls of 48mm diameter and each having weight between 390gm to 445gm.	01 Set	

3	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	
4	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm. Pan Size 240mm x 210mm.	01 No.	
5	Oven	Thermostatically controlled, with interior of non-corroding material to maintain the temperature of 110+5^{o}C	01 No.	

Table- I Number of Revolutions and Abrasive Charge

Sr. No.	Grading	No. of Revolutions	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

Table- II Grading of Test Samples

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			

X 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 than1.70mm 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.

XI 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 0.1gm of total weight.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Observation Table:

Sr. No.	Particulars	I	II	III
1	Weight of oven dried sample (W_1) gm.			
2	Weight of fraction coarser than 1.70mm IS sieve (W_2) gm.			

Sample Calculations:

$$\text{Aggregate Abrasion Value} = \frac{(W1-W2)}{W1} \times 100$$

=……

=……

XVI Results

The aggregate abrasion value of coarse aggregate = ……..

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN,* : 978-8-121-90003-4
2	IS:383-1970	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi - 110002
3	IS:2386(part IV)-1963	BIS Panel	Bureau of Indian Standards, Manak Bhavan , 9, Bahadur Shah Zafar Marg, New Delhi - 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Preparation of test sample.	20%
3	Observations and recording.	20%
4	Calculations and finding result.	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
1	Error Estimation.	5%
2	Interpretation of result.	15%
3	Conclusion and recommendation.	10%
4	Answer to the practical related questions.	5%
5	Submission of report in time.	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1 ……..

2 ……..

3 ……..

4 ……..

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

Practical No. 14: 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.
PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

a. Use relevant aggregates for required concrete works.
b. Prepare concrete of desired compressive strength.
c. Prepare concrete of required specification.

IV Practical Outcome

Determine aggregate elongation index and flakiness index**.**

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency
a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments.

VII Minimum 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.

VIII Practical Set-up

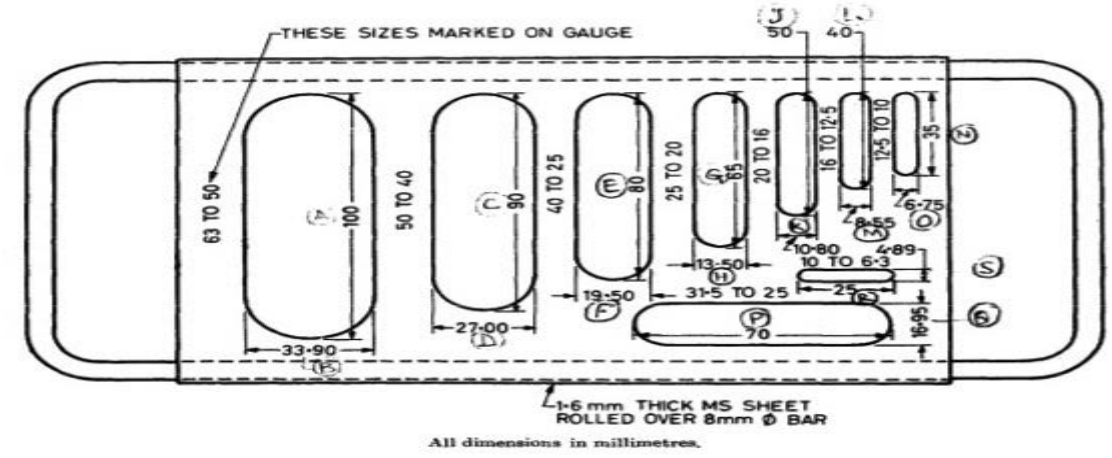
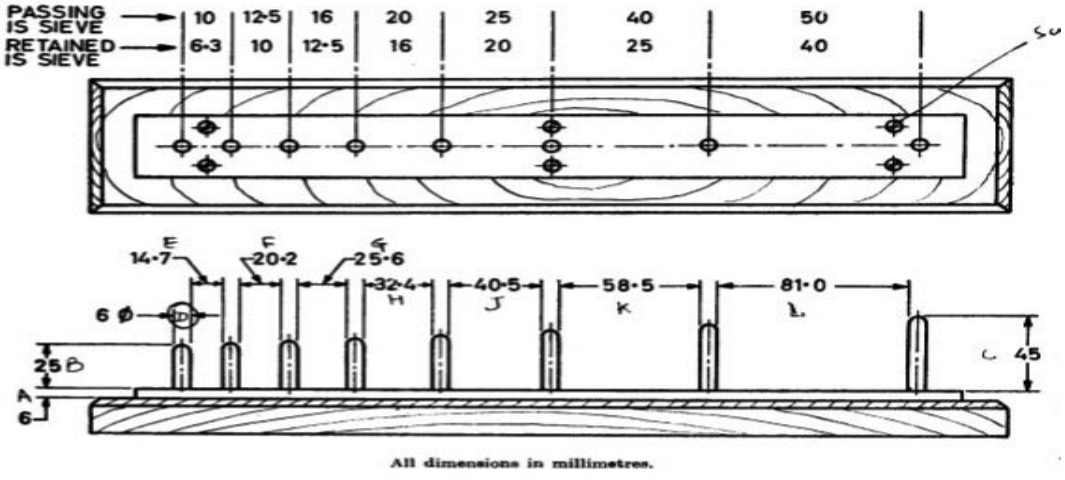


Figure No.1: Thickness Gauge



FigureNo.2:Length Gauge

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Thickness Gauge	As per IS : 2386 (Part I) – 1963	1 No.	
2	Length Gauge	As per IS : 2386 (Part I) – 1963	1 No.	

3	Weighing Balance	Electronic weighing balance of capacity 10 kg with accuracy of 0.1 gm	1 No.	
3	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.	

X 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.

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

(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 W_1 (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 =**	**W_1 =**

(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 W_1 (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=**	**$W_{1=}$**

Sample Calculations:

(i) Elongation Index = $\frac{W1}{W} \times 100$

=……

= …….

(ii) Flakiness Index = $\frac{W1}{W} \times 100$

=……

=…….

XVI Results

i) Elongation Index = …….

ii) Flakiness Index = ……

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS : 2386 (Part I) – 1963	BIS Panel	Bureau of Indian Standards,Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus .	5%
2	Measuring the ingredients and preparing sample	20%
3	Observation and recording	20%
4	Calculation of Flakiness and elongation Index	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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

Practical No. 15: Determine workability of concrete by slump cone 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Prepare concrete of desired compressive strength.
2. Prepare concrete of required specification.

IV Practical Outcome

Determine workability of concrete by slump cone test.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum 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.

VIII Practical Set-up

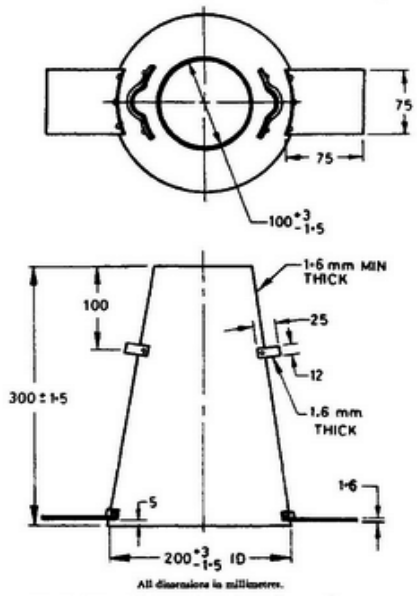

Figure: Slump Cone Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	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.	
2	Tamping rod	16 mm dia, 600 mm length and having one bullet end .	1 No.	
2	Enamel tray	Enamel tray size 650 x 500 x 50 mm	1No.	

X 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 is 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.

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

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

XVI Results

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

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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. Tremie concrete, iii. Mass concreting, iv. Slip formwork.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 7320 -1974	BIS Panel	Bureau of Indian Standards,Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Measuring the ingredients and preparing sample	20%
3	Observation and recording	20%
4	Calculation of Slump Value	10%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1 ……..
2 ……..
3 ……..
4 ……..

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

Practical No. 16: Determine workability of concrete by 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.
PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.
PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Prepare concrete of desired compressive strength.
2. Prepare concrete of required specification.

IV Practical Outcome

Determine workability of concrete by compaction factor test..

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency
a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum 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.

VIII Practical Set-up

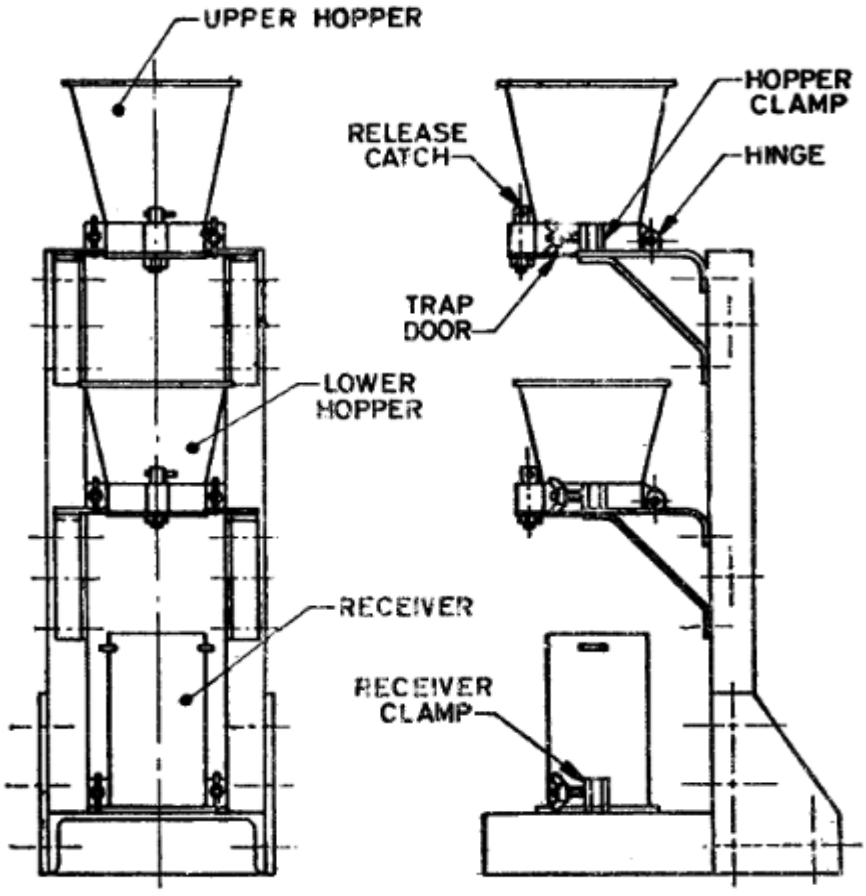

Figure: Compacting Factor Apparatus

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Compaction Factor apparatus	As per IS 5515-1983	1 No.	
2	Enamel Tray	650 x 500 x 50 mm	1 No.	
3	Weighing Balance	10 kg with accuracy of 1 gram	1 No.	

X 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 of 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 (W_1).
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 (W_2).

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Sr. No	Particulars	I	II	III
1	Proportion of sample			
2	W/C ratio			
3	Weight of empty cylinder ($W_{a)}$			
4	Weight of empty cylinder and concrete falling through standard height ($W_{b)}$			
5	The weight of partially compacted concrete (W_1)			
6	The weight of Fully compacted concrete and Cylinder (W_c)			
7	The weight of Fully compacted concrete (W_2)			
8	Compaction Factor			

Sample Calculations:

1. The weight of partially compacted concrete (W_1)= W_b - W_a

   = ……

   =……

2. The weight of fully compacted concrete (W_2)= W_c - W_a

   = ……

   =……

3. Compaction Factor = W_1/W_2 = ……..

XVI Results

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 = ……

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	As per IS 5515-1983	BIS Panel	Bureau of Indian Standards,Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Measuring the ingredients and preparing sample	20%
3	Observation and recording	15%
4	Calculation of compaction factor	15%
5	Working in team.	5%
Product related:10 Marks		**40%**
1	Error Estimation	5%
2	Interpretation of result	10%
3	Conclusion and recommendation	10%
4	Answer to the practical related questions	10%
5	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1 ……..

2 ……..

3 ……..

4 ……..

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

Practical No. 17: 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 Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

1. Prepare concrete of desired compressive strength.
2. Prepare concrete of required specification.

IV Practical Outcome

Determine compressive strength of Concrete for 7 days.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum Theoretical Background

Concrete mix can be designed to provide a wide range of mechanical and durability properties to meet the design requirements of a structure. The compressive strength of concrete is the most common performance measure used by the engineer in designing buildings and other structures.

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete.

VIII Practical Set-up

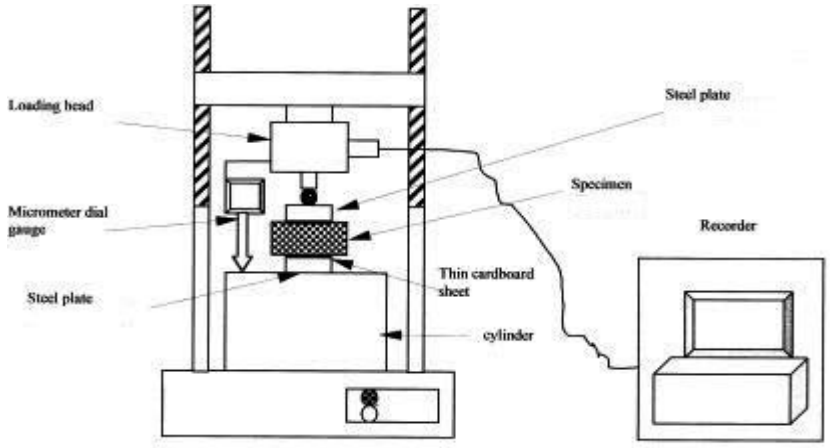

Figure: Compression Testing Machine

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Compression testing machine	Compression testing machine - 2000 kN capacity	1 No.	
2	Moulds	Cast iron : for 150 mm cube with ISI certification mark IS:10086	1 Set (3 Nos)	
3	Vibrating table	Vibrating table top 500mm x 500 mm with edges .Max. load capacity 140 kg.	1 No.	

X 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 $27+2^0C$; 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.

XI 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.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

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XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Observations-

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
   i. Cement = …….
   ii. Fine aggregate =……..
   iii. Coarse aggregate = …….
   iv. Water = …….
   e. Date of Casting of cubes = ……....
   f. Date of Testing of cubes after 7 days = ……..

Observation Table-

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:

$$\text{Compressive strength} = \frac{\text{Load}}{\text{Area}}$$

$$\sigma = \frac{P}{A} =$$

XVI Results

Average Compressive Strength of Concrete at 7 days = …….

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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.
5. While testing, the specimen shall be placed in the machine on sides of cube and not to the top and bottom. Justify.

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	IS 516-1959	BIS Panel	Bureau of Indian Standards,Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002
3	IS14858-2000	BIS Panel	Bureau of Indian Standards,Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Measuring the ingredients and preparing sample	20%
3	Observation and recording	15%
4	Calculation of compressive strength	15%
5	Working in team.	5%
Product related:10 Marks		**40%**
6	Error Estimation	5%
7	Interpretation of result	10%
8	Conclusion and recommendation	10%
9	Answer to the practical related questions	10%
10	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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

Practical No. 18: Determine compressive strength of concrete by rebound hammer

I Practical Significance

The non-destructive tests are the group of useful methods to evaluate the strength of construction materials without causing damage. The test available for testing concrete range from the completely non-destructive, where there is no damage to the existing structure. Non destructive testing can be applied both old and new structures. Non-destructive testing includes determination of fundamental parameters like density, elastic modulus, strength, surface hardness, surface moisture and reinforcement location, size and distance from the surface.

This practical will enable the students to know the compressive strength of structure without destroying the existing structure.

II Relevant Program Outcomes (POs)

PO 1. Basic knowledge: An ability to apply knowledge of basic mathematics, science and engineering to solve the engineering problems.

PO 2. Discipline knowledge: An ability to apply discipline - specific knowledge to solve core and/or applied engineering problems.

PO 3. Experiments and practice: An ability to plan and perform experiments and practices and to use the results to solve engineering problems.

III Relevant Course Outcomes

Maintain the quality of concrete.

IV Practical Outcome

Determine compressive strength of concrete by Rebound hammer.

V Competency and Practical Skills

This practical is expected to develop the following skill for the industry identified competency

a. Measurement skill
b. Error estimation skill
c. Observation skill

VI Relevant Affective domain related

a. Follow safety practices.
b. Demonstrate working as a leader/ a team member.
c. Maintain tools and equipments

VII Minimum Theoretical Background

Non destructive testing is a powerful method for evaluating existing concrete structures with regard to their strength and durability. In certain cases investigation of crack depth, micro cracks and progressive deterioration are also studied by this method. Though non destructive testing method relatively simple to perform, the analysis and interpretation of test results are not so easy, therefore special knowledge is required.

Rebound hammer test procedure is used to examine the hardness of concrete particularly when want to carry out repairs of RCC structure. Rebound hammer is an instrument or a device, which is used to assess the relative compressive strength of concrete based on the hardness at or near its exposed surface. The rebound of an elastic mass depends on the hardness of the surface against which its mass strikes. When the plunger of the rebound hammer is pressed against the surface of the concrete, the spring-controlled mass rebounds and the extent of such a rebound depends upon the surface hardness of the concrete. The surface hardness and therefore the rebound is taken to be related to the compressive strength of the concrete. The rebound value is read from a graduated scale and is designated as the rebound number or rebound index. The compressive strength can be read directly from the graph provided on the body of the hammer.

VIII Practical Set-up

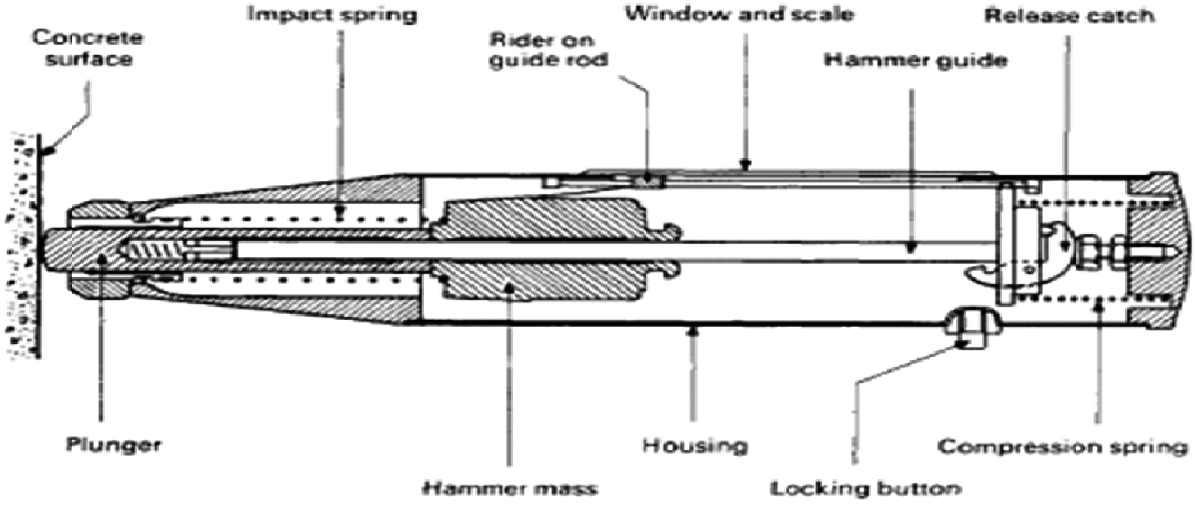

Figure: Rebound Hammer

IX Resources required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Rebound hammer	As per IS 13311(part 2)-1992	1 No.	

X Procedure:

1. Test the rebound hammer before commencement of a test to get reliable results, for which the manufacturer of the rebound hammer indicates the range of readings on the anvil suitable for different types of rebound hammer.
2. Apply light pressure on the plunger. It will release it from the locked position and allow it to extend to the ready position for the test.
3. Press the plunger against the surface of the concrete, keeping the instrument perpendicular to the test surface. Apply a gradual increase in pressure until the hammer impacts.
4. Record the rebound hammer number.
5. Take the average of about six readings.

XI Precautions to be followed

1. The concrete surface should be smooth, clean and dry.
2. The point of impact of rebound hammer on concrete surface should be at least 20 mm away from the edge or shape discontinuity.
3. The gauging time should be strictly observed.
4. Increase the load gradually during testing.

XII Actual procedure followed (Use blank sheet provided if space not sufficient)

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XIII Resources used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remark
		Make	Details		
1					
2					
3					

XIV Precautions followed

.....
.....
.....

XV Observations and Calculations (Use blank sheet provided if space not sufficient)

Sr. No	Location	Rebound number	Average Rebound no.	Remark
1	Slab			
2				
3				
4				
5				
6				
1	Beam			
2				
3				
4				
5				
6				

XVI Results

A) Compressive strength of concrete for Slab = …….

B) Compressive strength of concrete for Beam = …….

XVII Interpretation of results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendations (if any) (Actions/decisions to be taken based on the interpretation of results).

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XIX 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 the need of NDT.
2. Write limitations of the rebound hammer test.
3. List various types of NDT with their suitability.
4. State the applications of following approximate impact values for rebound hammer test.
   i. 2.25, ii. 0.75, iii. 30, iv. 0.90

[Space for Answers]

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XX References / Suggestions for further Reading

Sr. No.	Title of Book	Author	Publication
1	Concrete Technology	Shetty, M.S.	S. Chand and Co. Pvt. Ltd., Ram Nagar, New Delhi-110055 *ISBN*, : 978-8-121-90003-4
2	As per IS 13311 (part 2)-1992	BIS Panel	Bureau of Indian Standards,Manak Bhavan , 9, Bahadur Shah Zafar marg, New Delhi 110002

XXI Suggested Assessment Scheme

Performance Indicators		Weightage (%)
Process related:15 Marks		**60%**
1	Identifying the apparatus and machine.	5%
2	Observation and recording	35%
3	Calculation of compressive strength by rebound hammer	15%
4	Working in team.	5%
Product related:10 Marks		**40%**
5	Error Estimation	5%
6	Interpretation of result	10%
7	Conclusion and recommendation	10%
8	Answer to the practical related questions	10%
9	Submission of report in time	5%
Total: 25 Marks		**100%**

Names of Student Team Members

1……..

2……..

3……..

4……..

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

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	'C' programming Language	22218
15	Basic Electronics	22225
16	Programming in "C"	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
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26	Principles Of Electronics Communication	22334
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Fourth Semester:

1	Hydraulics	22401
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5	Technology Of Organic Chemicals	22410
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13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
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12	Switchgear and Protection	22524
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15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
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5	Industrial Fluid Power	17608
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27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

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1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
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4	Hospital and Clinical Pharmacy	0816

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