KG REDDY
College of Engineering
& Technology
AN AUTONOMOUS INSTITUTION

CELEBRATING 15 YEARS OF BRILLIANCE

Material Testing Lab

LABORATORY MANUAL

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Department of Civil Engineering

Institute Vision

To become an institution which is internationally recognized for its holistic approach to engineering, innovative teaching and learning culture, research and entrepreneurial ecosystem, and sustainable social impact in the community.

Institute Mission

- To offer undergraduate and post-graduate programs which are supported through industry relevant curriculum and innovative teaching and learning processes that would help students succeed in their professional careers.
- To provide faculty and students with an ecosystem that fosters innovation, research, entrepreneurship, and international exposure through strategic partnerships with government organizations and collaboration with industries.
- To provide holistic learning environment to students which will contribute to their personal and professional growth and enable them to become leaders in their respective fields.
- To contribute to the development of the region by using our technological expertise to work with nearby communities and support them in their social and economic development

Department Vision

To be recognized for excellence in teaching, innovation, and research aimed towards betterment of society through sustainable infrastructural development.

Department Mission

- To integrate innovative teaching and learning practices that will enable students to build technical competence for working in civil engineering industries.
- To encourage innovation, research, and entrepreneurship among faculty and students that will lead to sustainable development.
- To become self-sustainable through strategic collaborations with industries and nearby communities focused on consultancy services.

Program Educational Objectives

- **PEO1:** Graduates will be able to work in multidisciplinary teams focused on development of infrastructure, design, sustainability, construction management and all the other related fields of Civil Engineering.
- **PEO2:** Graduates will be professionally competent through their ability to use modern civil engineering tools and manage projects in leadership positions.
- **PEO3:** Graduates will transform into change makers who will work towards societal development and advocate for equity, social justice, and sustainable development.

Program Outcomes

PO 1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO 2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1, WK2)

PO 3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO 4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis &interpretation of data to provide valid conclusions. (WK8).

PO 5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling, recognizing their limitations to solve complex engineering problems. (WK2 & WK6)

PO 6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for an appeal of sustainability, with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO 7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion, adhere to national & international laws (WK9)

PO 8: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO 10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO 11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcomes (PSO's)

PSO1: Graduates will be able to plan, analyze, design safe and sustainable green infrastructure.

PSO2: Graduates will be able to utilize the latest software tools for modeling and simulation in the field of civil engineering.

PSO3: Graduates will be able to work in multidisciplinary teams to design, develop and promote smart construction related.

Material Testing Lab

Course Objectives: The objectives of this course for the student are to:

1. Know the various procedures to determine the characteristics of cement

2. Determine the test procedures to evaluate the characteristics of aggregates

3. Know the test procedures to find the properties of fresh concrete

4. Elaborate the test procedures to find mechanical properties of hardened concrete

5. Determine Non-destructive testing of concrete

Course Outcomes: After completion of this course, the students will be able to

CO1: Perform various tests required to assess the characteristics of cement

CO2: Test and evaluate the properties of fine and coarse aggregates and determine its suitability for construction

CO3: Evaluate the fresh and hardened properties of concrete

CO4: Evaluate hardened properties of concrete

CO5: Design the concrete mix for required strength and test its performance characteristics

Department of Civil Engineering

Material Testing Lab

Course Code: KG25ACE228 **B. Tech. II Year I - Semester**

LIST OF EXPERIMENTS:

I. Test on Cement

1. Soundness of cement

2.Compressive strength of cement

II. Test on Aggregates Fine and Coarse

1. Specific gravity of fine aggregate

2. Specific gravity of coarse aggregate

3. Bulking of fine aggregate

4. Grading of Coarse aggregate 5

III. Concrete Mix Design

1. IS method of mix design of normal concrete as per IS: 10262

IV. Test on Fresh Concrete

1. Slump Cone test

2. Compact Factor Test

3. Vee-bee Test

V. Test on Hardened concrete

1.Compression Test & Split Tensile Strength Test

2.Modulus of Elasticity

3. NDT Methods (Rebound hammer & USPV Test)

MANDATORY INSTRUCTIONS

1. Students should report to the labs concerned as per the timetable.
2. Record should be updated from time to time and the previous experiment must be signed by the faculty in charge concerned before attending the lab.
3. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.
4. After completion of the experiment, certification of the staff in-charge concerned in the observation book is necessary.
5. Students should bring a notebook of about 100 pages and should enter the readings/observations/results into the notebook while performing the experiment.
6. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff member in-charge.
7. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.
8. The components required pertaining to the experiment should be collected from Lab- in-charge after duly filling in the requisition form.
9. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
10. **Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.**
11. Students should be present in the labs for the total scheduled duration.
12. Students are expected to prepare thoroughly to perform the experiment before coming to Laboratory.

13. Procedure sheets/data sheets provided to the student's groups should be maintained neatly and are to be returned after the experiment.

14. DRESS CODE:
    i. Boys - Formal dress with tuck in and shoes
    ii. Girls - Formal dress
    iii. **Apron for both boys and girls.**

I.TEST ON CEMENT

EXPERIMENT NO. I

1. SOUNDNESS OF CEMENT

AIM: To determine the soundness of a given sample of cement by Le-Chatelier method.

APPARATUS: Le- Chatelier test apparatus conforms to IS: 5514-1969, Balance, Gauging Trowel, Water Bath, measuring scale (0.1mm accuracy), etc.

PRECAUTIONS:

1.Oil the mould with a thin layer of mineral oil
2.Lengths L1 and L2 should be measured accurately
3.The temperature of autoclave should be raised and lowered gradually
4.The experiment should be performed away from vibrations and other disturbances

PROCEDURE:

1. Place the lightly oiled mould on a lightly oiled glass sheet and fill it with 100gm of cement and make a cement paste formed by gauging cement with 0.78 times the water required to give a paste of standard consistency.
2. The paste shall be gauged in the manner and under the conditions prescribed taking care to keep the edges of the mould gently together while this operation is being performed.
3. Cover the mould with another piece of lightly oiled glass sheet, place a small weight on this covering glass sheet and after few minutes submerge the whole assembly in water at a temperature of 27 ± 2°C and keep there for 24 hours.
4. Measure the distance separating the indicator points to the nearest 0.5 mm Submerge the mould again in water at the temperature prescribed above.
5. Bring the water to boiling, with the mould kept submerged, in 25 to 30 minutes, and keep it boiling for three hours. Remove the mould from the water, allow it to cool and measure the distance between the indicator points.
6. The difference between these two measurements indicates the expansion of the cement. This must not exceed 10 mm for ordinary, rapid hardening and low heat Portland cements. If in case the expansion is more than 10mm as tested above, thecement is said to be unsound.

DIAGRAM

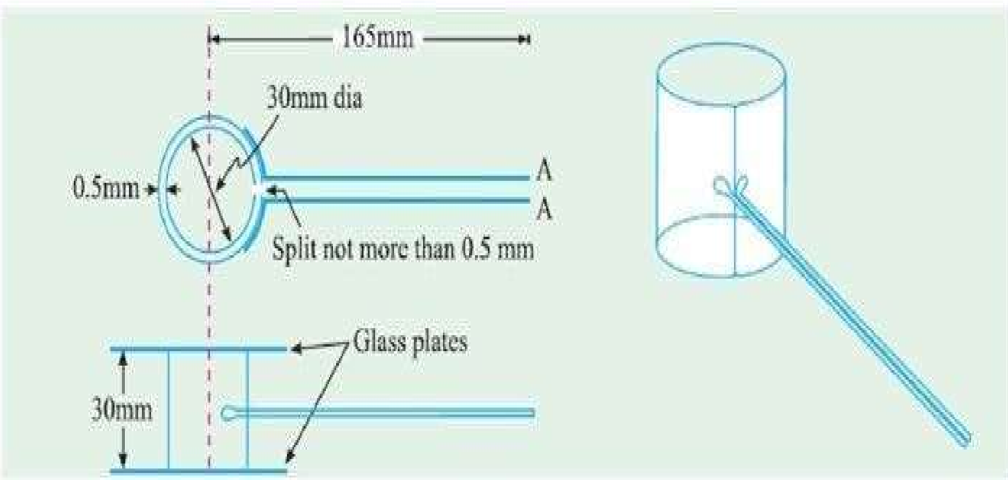


Fig: Le-chatelier Apparatus

OBSERVATION TABLE & CALCULATIONS:

Express the amount of water as a percentage by mass of the dry cement to the first place of decimal.

S No	Distance separating the indicator submerge in normal temp water for 24 hours (L1)	Distances separating the indicator submerge in boiling for three Hours (L2)	The difference between these two measurements(L) L= (L1 – L2)
.1			
2			
3			

RESULT:

The given cement is said to be sound / unsound the expansion is --- mm

COCLUSION:

The expansion of ordinary Portland, rapid, low heat cement should not exceed 10 mm

2. COMPRESSIVE STRENGTH OF CEMENT

AIM: To determine the compressive strength of a given sample of cement.

APPARATUS:

The standard sand to be used in the test shall conform to IS: 650-1966, Vibration Machine, Poking Rod, Cube Mould of 70.6 mm size conforming to IS: 10080-1982, Balance, Gauging Trowel, Stop Watch, Graduated Glass Cylinders, etc.

PRECAUTIONS:

1. The moulds should be oiled before the experiment.

2.The weighing should be done accurately.

3.The temperature and humidity must be accurately controlled.

4.Increase the load gradually during testing.

PROCEDURE

1. Preparation of test specimens - clean appliances shall be used for mixing and the temperature of water and that of the test room at the time when the above operations are being performed shall be 27 ± 2°C. Potable/distilled water shall be used in preparing the cubes.
2. The material for each cube shall be mixed separately and the quantity of cement, standard sand and water shall be as follows: Cement 200g and standard Sand 600g are required to produce a paste of standard consistency determined as described in IS: 4031 (Part 4)-1988
3. Then the calculation of water required to make a standard consistency is calculated using the formula:

$$\left(\frac{P}{4}+3\right)*\frac{1}{100}*800$$

Where P is the percentage of water required for producing a paste of standard consistency.
4. Place on a nonporous plate, a mixture of cement and standard sand.
5. Mix it dry with a trowel for one minute and then with water until the mixture is of uniform colour. The quantity of water to be used shall be as specified in step 2. The time of mixing shall in any event be not less than 3 min and should the time taken to obtain a uniform colour exceed 4 min, the mixture shall be rejected and the operation repeated with a fresh quantity of cement, sand and water.
6. Moulding Specimens - In assembling the moulds ready for use, treat the interiorfaces of the mould with a thin coating of mould oil.

7. Then the mould oil is applied in the mould and the mortar is poured in the mould. The mould is then prodded with a rod.

8. Then vibration is applied in the rate of 12000 ± 400 per minute. After 2 minutes, the mould together with the base plate is removed from the machine and the top surface is finished levelling up with the help of a trowel.

9. Now, the above process is repeated for the next 8 cubes.Then the cubes are placed at a place and covered by moist gunny bags for 24 hours.

10. After 24 hours, all the filled cube mould should be demoulded and marked with date and number.

11. After that, the cubes are submerged in the freshwater tank for curing. The water in which the cubes are submerged shall be renewed every 7 days and shall be maintained at a temperature of 27 ± 2°C. After they have been taken out and until they are broken, the cubes shall not be allowed to become dry.

12.Test three cubes for compressive strength for each period of curing mentioned under the relevant specifications (i.e. 3 days, 7 days, 28 days)

13. The cubes shall be tested on their sides without any packing between the cube and the steel plattens of the testing machine. One of the plattens shall be carried on a base and shall be self-adjusting, and the load shall be steadily and uniformly applied, starting from zero at a rate of 35 $N/mm^2/min$.

Fig: Compression Testing Machine (CTM)

OBSERVATION TABLE & CALCULATIONS:

S. No	**Age of cube**	**Weight of Cement Cube (gm)**	**Cross Sectional Area (mm^2)**	**Load(N)**	**Compressive Strength (N/mm^2)**	***Average Compressive Strength (N/mm^2)***
1	**7 Days**					
2	**14 Days**					
3	**21 Days**					
4	**28 Days**					

RESULT

i) The average 7 Days Compressive Strength of given cement sample is found to be …..…..

ii) The average 14 Days Compressive Strength of given cement sample is found to be …..…..

iii) The average 21 Days Compressive Strength of given cement sample is found to be …..…..

iv) The average 28 Days Compressive Strength of given cement sample is found to be …..…..

II.TEST ON AGGREGATES

(FINE & COARSE)

EXPERIMENT NO -II

1. SPECIFIC GRAVITY OF FINE AGGREGATE

AIM: To determine Specific gravity and water absorption of a given sample of fine aggregate.

APPARATUS: A balance of capacity not less than 3kg, Pycnometer of about 1 litre capacity having a metal conical screw top with a 6mm hole at its apex. Filter papers and funnel.

PROCEDURE:

1.Take about 500g of sample and place it in the pycnometer and Pour distilled water into it until it is full.

2.Eliminate the entrapped air by rotating the pycnometer on its side, the hole in the apex of the cone being covered with a finger.

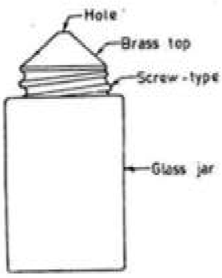
3Wipe out the outer surface of pycnometer and weigh it **(A)**

4.Transfer the contents of the pycnometer into a tray, care being taken to ensure that all the aggregate is transferred.

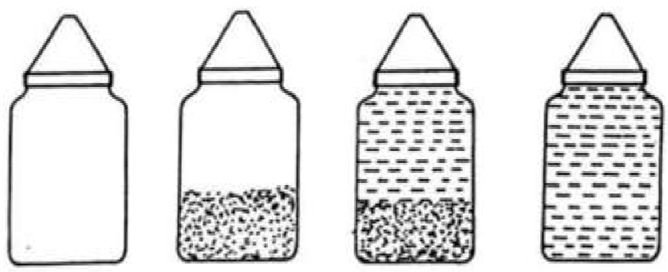
4.Refill the pycnometer with distilled water to the same level and find out the weight **(B).**

5.Drain water from the sample through a filter paper and take the separated surface dry sample weight **(C)**.

6.Place the sample in oven in a tray at a temperature of 100ºC to 110º C for 24±0.5 hours, during which period, it is stirred occasionally to facilitate drying. Cool the sample and weigh it **(D)**



Pycnometer



Empty bottle   Bottle filled with sand   Bottle filled with sand+water   bottle filled with water

OBSERVATION TABLE & CALUCULATIONS:

<table>
<tr><th rowspan="2" colspan="2">Description</th><th colspan="2">Observed values</th></tr>
<tr><th>I</th><th>II</th></tr>
<tr><td colspan="2">Weight of Pycnometer+sand+water(A)</td><td></td><td></td></tr>
<tr><td colspan="2">Weight of Pycnometer + water(B)</td><td></td><td></td></tr>
<tr><td colspan="2">Weight of saturated surface dry sample(C)</td><td></td><td></td></tr>
<tr><td colspan="2">Weight of Oven dried sample(D)</td><td></td><td></td></tr>
<tr><td colspan="2">Specific Gravity (G)</td><td></td><td></td></tr>
<tr><td colspan="2">Apparent Specific Gravity</td><td></td><td></td></tr>
<tr><td colspan="2">Water absorption</td><td></td><td></td></tr>
<tr><td rowspan="3">Average values</td><td>Specific Gravity</td><td colspan="2"></td></tr>
<tr><td>Apparent Specific Gravity</td><td colspan="2"></td></tr>
<tr><td>Water Absorption</td><td colspan="2"></td></tr>
</table>

CALCULATIONS:

Weight of Pycnometer+sand+water**(A)**

Weight of Pycnometer + water**(B**

Weight of saturated surface dry sample**(C)**

Weight of Oven dried sample**(D)**

Specific Gravity $G = \frac{D}{C-(A-B)}$

Apparent Specific Gravity $= \frac{D}{D-(A-B)}$

Water Absorption $\frac{C-D}{D} X100$

RESULT

Specific Gravity of a given sample of fine aggregate is found to be--------------------

The apparent specific gravity of a given sample of fine aggregate found to be----------------

The Water Absorption of a given sample of fine aggregate is found to be--------------------

2. SPECIFIC GRAVITY OF COARSE AGGREGATE

AIM: To determine specific gravity and water absorption of a given sample of coarse aggregate.

APPARATUS: A wire basket of not more than 6-3 mm mesh, A stout watertight container in which the basket may be freely suspended, Thermostatically Controlled Oven, Glass vessel, Air tight container, 10 mm IS Sieve, tamping rod, Weighing Balance.

PRECAUTIONS:

1. Keep in mind that the saturated surface dry sample is the condition when all the visible films of water are removed from the sample
2. All the weighing should be done carefully and accurately

PROCEDURE:

1. Take about 2 kg of an aggregate sample (Aggregate which has been artificially heated shall not be used).
2. The aggregates are thoroughly washed so, the finer particles of the dust are removed from their surface.
3. Then the washed aggregates are placed in the wire basket and immersed in the distilled water at a temperature between 22° C to 32° C with a cover from the water surface of at least 5 cm on top of the basket.
4. The basket immersed in the water requires immediate removal of entrapped air. This entrapped air was removed by lifting the basket 25 mm above the base of the tank and allowing 25 drops at the rate of about 1 drop/sec. Then basket filled with aggregate is allowed to be immersed in water for a period of 24 hrs.
5. After 24 hours the basket and the aggregates are weighed in the water at a temperature of 22° C to 32° C. **(W1)**
6. Then the basket and the aggregates are taken out from the water and allowed to drain for a couple of minutes after these aggregates are removed from the basket and placed on the dry cloths.
7. After this the empty basket is again immersed in the water, apply 25 drops, and weighed in water. **(W2)**
8. The aggregates are placed on the dry cloth and are gently surface dried with a cloth if 1st cloth is not taken moisture, then aggregates are transferred to the second one.
9. After these aggregates are spread on the cloth and less exposed to the atmosphere away from direct sunlight or also away from another source of heat until it appears to be completely surface dried.
10. For accelerating the unheated air may be used after the first 10 minutes for those aggregates which are difficult to dry and weigh it. **(W3)**
11. Then the aggregates are placed in the shallow tray and put in the oven at a temperature of 100° C to

110° C for 24 hours.

12. After 24 hours the aggregates are removed from the oven and filled in the airtight container for the cooling of it and weighed. **(W4)**

Fig: Wired basket (Mesh)

Fig: Weighing Balance

OBSERVATION TABLE & CALCULATIONS:

Description		Sample No	
		I	II
A	Weight of sample, g		
B	Weight of basket + sample + water (W1), g		
C	Weight of basket + Water (W2), g		
D	Weight of saturated & Surface dry sample (W3), g		
E	Weight of oven dry sample (W4), g		
F	Specific Gravity = [W4 /W3 - (W1 – W2)]		
G	Apparent specific gravity = [W4 /W4 - (W1 – W2)]		
H	Water Absorption, Percentage Dry Weight = [W3– W4 /W4]*100, %		
Average Values	Specific Gravity		
	Apparent Specific Gravity		
	Water Absorption		

Result:

1. The Specific Gravity of a given sample of coarse aggregate is found to be_________________
2. The Water Absorption of a given sample of coarse aggregate is found to be__________________

3. BULKING OF FINE AGGREGATE

AIM: To determine bulking of a given sample of fine aggregate.

APPARATUS: Measuring jar, tamping rod etc.

PRECAUTIONS:

1. All the weighing should be done accurately
2. No sand should be lost while filling or emptying the pot
3. Mix the water in the sand uniformly.

PROCEDURE:

1. Fill sufficient quantity of the sand loosely into a container with the sample up to the 200 ml mark.
2. Use a steel scale for accurate measurement without compacting the sand.
3. Transfer the sand to a container.
4. Refill the measuring cylinder with 100 ml of water.
5. Reintroduce the sample sand into the measuring cylinder and stir with a steel rod.
6. Allow time for the sand to settle, observing the new level, denoted as "a."
7. Calculate the bulking of sand using the equation:
8. Bulking of Sand = $(200-a)/a \times 100$.
9. Repeat the procedure twice, and the average of the three observations provides the percentage of bulking for the given sample.

OBSERVATION TABLE & CALCULATIONS:

SNO	Height of sand(mm)	Height of sand and water(mm)	Percentage of bulking sand (%)
1			
2			
3			
Average percentage of bulking of the sand			

CALCULATIONS:

Height with sand only (h1) ....mm

Height of the sand and water (h2)... mm

The percentage of bulking of the sand = $(h_1 – h_2/ h_2)$ x 100=................ %

RESULT:

Bulking of a given sample of fine aggregate is found to be ....%

4. GRADING OF COARSE AGGREGATE

AIM:

To determination of particle size distribution of coarse aggregates by sieving or screening.

APPARATUS:

Test Sieves conforming to IS: 460-1962 Specification of 80 mm, 40 mm, 20 mm, 10 mm, 4.75 mm, Balance, Gauging Trowel, Stop Watch, etc.

THEORY:

Grading refers to the determination of the particle-size distribution for aggregate. Grading limits and maximum aggregate size are specified because grading and size affect the amount of aggregate used as well as cement and water requirements, workability, pumpability, and durability of concrete. In general, if the water-cement ratio is chosen correctly, a wide range in grading can be used without a major effect on strength. When gap-graded aggregate is specified, certain particle sizes of aggregate are omitted from the size continuum. Gap-graded aggregate is used to obtain uniform textures in exposed aggregate concrete. Close control of mix proportions is necessary to avoid segregation.

PROCEDURE:

1.The sample shall be brought to an air-dry condition before weighing and sieving.

2.This may be achieved either by drying at room temperature or by heating at a temperature of 100‖ to 110°C. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be takento ensure that the sieves are clean before use.

3.Each sieve shall be shaken separately over a clean tray until not more than a trace passes, but in any case, for a period of not less than two minutes. The shaking shallbe done with a varied motion, backward sand forwards, left to right, circular clockwise and anti-clockwise, and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions.

4.Material shall not be forced through the sieve by hand pressure. Lumps of fine material, if present, may be broken by gentle pressure with fingers against the sideof the sieve.

5.On completion of sieving, the material retained on each sieve, together with anymaterial cleaned from the mesh, shall be weighed.

OBSERVATION TABLE & CALCULATIONS:

I S Sieve	Weight Retained onSieve (gms)	Percentage of Weight Retained (%)	Percentage of Weight Passing (%)	Cumulative Percentage ofPassing (%)	Remark
80 mm					
40mm					
20 mm					
10 mm					
4.75 mm					
Total					

Table 3.14. Grading Limits for Coarse Aggregate IS: 383-1970

IS Sieve Designation	Percentage passing for single-sized aggregate nominal size (by weight)						Percentage passing for Graded aggregate of nominal size (by weight)			
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
80 mm	100	–	–	–	–	–	100	–	–	–
63 mm	85–100	100	–	–	–	–	–	–	–	–
40 mm	0–30	85–100	100	–	–	–	95–100	100	–	–
20 mm	0–5	0–20	85–100	100	–	–	30–70	95–100	100	100
16 mm	–	–	–	85–100	100	–	–	–	90–100	–
12.5 mm	–	–	–	–	85–100	100	–	–	–	90–100
10 mm	–	0–5	0–20	0–30	0–45	85–100	10–35	25–55	30–70	40–85
4.75 mm	–	–	0–5	0–5	0–10	0–20	0–5	0–10	0–10	0–10
2.36 mm	–	–	–	–	–	0–5	–	–	–	–

RESULT: The particle size distribution of coarse aggregate is **---------------**

III. IS METHOD OF MIX DESIGN OF NORMAL CONCRETE AS PER IS: 10262

EXPERIMENT NO -III

IS METHOD OF MIX DESIGN OF NORMALCONCRETE AS PER IS:10262

A-0 An example illustrating the mix proportioning for a concrete of M 40 grade is given in **A-1** to **A-11**.

A-1 STIPULATIONS FOR PROPORTIONING

a)	Grade designation	:	M 40
b)	Type of cement	:	OPC 43 grade conforming to IS 8112
c)	Maximum nominal size of aggregate	:	20 mm
d)	Minimum cement content	:	320 kg/m^3
e)	Maximum water-cement ratio	:	0.45
f)	Workability	:	100 mm (slump)
g)	Exposure condition	:	Severe (for reinforced concrete)
h)	Method of concrete placing	:	Pumping
j)	Degree of supervision	:	Good
k)	Type of aggregate	:	Crushed angular aggregate
m)	Maximum cement content	:	450 kg/m^3
n)	Chemical admixture type	:	Superplasticizer

A-2 TEST DATA FOR MATERIALS

a)	Cement used	:	OPC 43 grade conforming to IS 8112
b)	Specific gravity of cement	:	3.15
c)	Chemical admixture	:	Superplasticizer conforming to IS 9103
d)	Specific gravity of:		
	1) Coarse aggregate	:	2.74
	2) Fine aggregate	:	2.74
e)	Water absorption:		
	1) Coarse aggregate	:	0.5 percent
	2) Fine aggregate	:	1.0 percent

A-3 TARGET STRENGTH FOR MIX PROPORTIONING

$$f'_{ck} = f_{ck} + 1.65\,s$$

where

f'_{ck} = target average compressive strength at 28 days,

f_{ck} = characteristic compressive strength at 28 days, and

s = standard deviation.

From Table 1, standard deviation, $s = 5$ N/mm².

Therefore, target strength = $40 + 1.65 \times 5 = 48.25$ N/mm².

A-4 SELECTION OF WATER-CEMENT RATIO

From Table 5 of IS 456, maximum water-cement ratio = 0.45.

Based on experience, adopt water-cement ratio as 0.40.

$0.40 < 0.45$, hence O.K.

A-5 SELECTION OF WATER CONTENT

From Table 2, maximum water content for 20 mm aggregate = 186 litre (for 25 to 50 mm slump range)

Estimated water content for 100 mm slump = $186 + \frac{6}{100} \times 186$

= 197 litre

As superplasticizer is used, the water content can be reduced up 20 percent and above.

Based on trials with superplasticizer water content reduction of 29 percent has been achieved. Hence, the arrived water content = $197 \times 0.71 = 140$ litre

A-6 CALCULATION OF CEMENT CONTENT

Water-cement ratio = 0.40

Cement content $= \frac{140}{0.40} = 350$ kg/m³

From Table 5 of IS 456, minimum cement content for 'severe' exposure condition = 320 kg/m³

A-7 PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGATE CONTENT

From Table 3, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone I) for water-cement ratio of 0.50 = 0.60.

In the present case water-cement ratio is 0.40. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.10, the proportion of volume of coarse aggregate is increased by 0.02 (at the rate of –/+ 0.01 for every ± 0.05 change in water-cement ratio). Therefore, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.40 = 0.62.

NOTE — In case the coarse aggregate is not angular one, then also volume of coarse aggregate may be required to be increased suitably, based on experience.

For pumpable concrete these values should be reduced by 10 percent.

Therefore, volume of coarse aggregate = 0.62 × 0.9 = 0.56.

Volume of fine aggregate content = 1 – 0.56 = 0.44.

A-8 MIX CALCULATIONS

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = $\mathbf{1\ m^3}$

b) Volume of cement

$$= \frac{\text{Mass of cement}}{\text{Specific gravity of cement}} \times \frac{1}{1\,000}$$

$$= \frac{350}{3.15} \times \frac{1}{1\,000}$$

$$= \mathbf{0.111\ m^3}$$

c) Volume of water

$$= \frac{\text{Mass of water}}{\text{Specific gravity of water}} \times \frac{1}{1\,000}$$

$$= \frac{140}{1} \times \frac{1}{1\,000}$$

$$= \mathbf{0.140\ m^3}$$

d) Volume of chemical admixture (superplasticizer) (@ 2.0 percent by mass of cementitious material)

$$= \frac{\text{Mass of chemical admixture}}{\text{Specific gravity of admixture}} \times \frac{1}{1\,000}$$

$$= \frac{7}{1.145} \times \frac{1}{1\,000}$$

$$= \mathbf{0.006\ m^3}$$

e) Volume of all in aggregate

= [a – (b + c + d)]

= 1–(0.111 + 0.140 + 0.006)

= $\mathbf{0.743\ m^3}$

f) Mass of coarse aggregate

= *e* × Volume of coarse aggregate × Specific gravity of coarse aggregate × 1 000

= 0.743 × 0.56 × 2.74 × 1 000

= **1 140 kg**

g) Mass of fine aggregate

= *e* × volume of fine aggregate × Specific gravity of fine aggregate × 1 000

= 0.743 × 0.44 × 2.74 × 1 000

= **896 kg**

A-9 MIX PROPORTIONS FOR TRIAL NUMBER 1

Cement	=	350 kg/m^3
Water	=	140 kg/m^3
Fine aggregate	=	896 kg/m^3
Coarse aggregate	=	1 140 kg/m^3
Chemical admixture	=	7 kg/m^3
Water-cement ratio	=	0.4

NOTE — Aggregates should be used in saturated surface dry condition. If otherwise, when computing the requirement of mixing water, allowance shall be made for the free (surface) moisture contributed by the fine and coarse aggregates. On the other hand, if the aggregates are dry, the amount of mixing water should be increased by an amount equal to the moisture likely to be absorbed by the aggregates. Necessary adjustments are also required to be made in mass of aggregates. The surface water and percent water absorption of aggregates shall be determined according to IS 2386.

A-10 The slump shall be measured and the water content and dosage of admixture shall be adjusted for achieving the required slump based on trial, if required. The mix proportions shall be reworked for the actual water content and checked for durability requirements.

A-11 Two more trials having variation of ±10 percent of water-cement ratio in **A-10** shall be carried out and a graph between three water-cement ratios and their corresponding strengths shall be plotted to work out the mix proportions for the given target strength for field trials. However, durability requirement shall be met.

IV.TEST ON FRESH CONCRETE

EXPERIMENT NO -IV

1. SLUMP CONE TEST

AIM: To determine the relative consistency of freshly mixed concrete by the use of Slump Test.

APPARATUS:
The Slump Cone apparatus for conducting the slump test essentially consists of a metallic mould in the form of a frustum of a cone having the internal dimensions as under: Bottom diameter: 20 cm, Top diameter: 10 cm, Height: 30 cm and the thickness of the metallic sheet for the mould should not be thinner than 1.6 mm
Weights and weighing device, Tamper (1 6 mm in diameter and 600 mm length), Ruler,Tools and containers for mixing, or concrete mixer etc.

PRECAUTIONS:

1. Apply the strokes with the tamping rod uniformly through the full depth.
2. Remove the mould very slowly by lifting it upwards so that concrete does not getdisturbed
3. Test should be completed in a minimum of 2 to 3 minutes.
4. The experiment should be performed away from vibrations and other disturbances.

PROCEDURE:

1. Dampen the mould and place it on a flat, moist, nonabsorbent (rigid) surface. It shall be held firmly in place during filling by the operator standing on the two-foot pieces. Immediately fill the mold in three layers, each approximately one third the volume of the mold.

2. Rod each layer with 25 strokes of the tamping rod. Uniformly distribute the strokes over the cross section of each layer.

3. In filling and rodding the top layer, heap the concrete above the mold before rodding start. If the rodding operation results in subsidence of the concrete below the top edge of the mold, add additional concrete to keep an excess of concrete above the top of the mold at all time.

4. After the top layer has been rodded, strike off the surface of the concrete by means of trowel and rolling motion of the tamping rod.

5. Remove the mold immediately from the concrete by raising it carefully in the verticaldirection. Raise the mold a distance of 300 mm in 5 ± 2 sec by a steady upward lift with no lateral or torsional motion.

6. Immediately measure the slump by determining the vertical difference between top ofthe mould and displaces original center of the top surface of the specimen. Complete the entire test from the start of the filling through removal of the mold withoutinterruption and complete it within 2½ min.

7. If a decided falling away or shearing off of concrete from one side or portion of the mass occurs, disregard the test and make a new test on another portion of the sample. If two consecutive tests on a sample of concrete show a falling away or shearing off of a portion of concrete from the mass of

specimen, the concrete lacks necessary plasticity and cohesiveness for the slump test to be applicable.

8. After completion of the test, the sample may be used for casting of the specimens for the future testing.

DIAGRAM

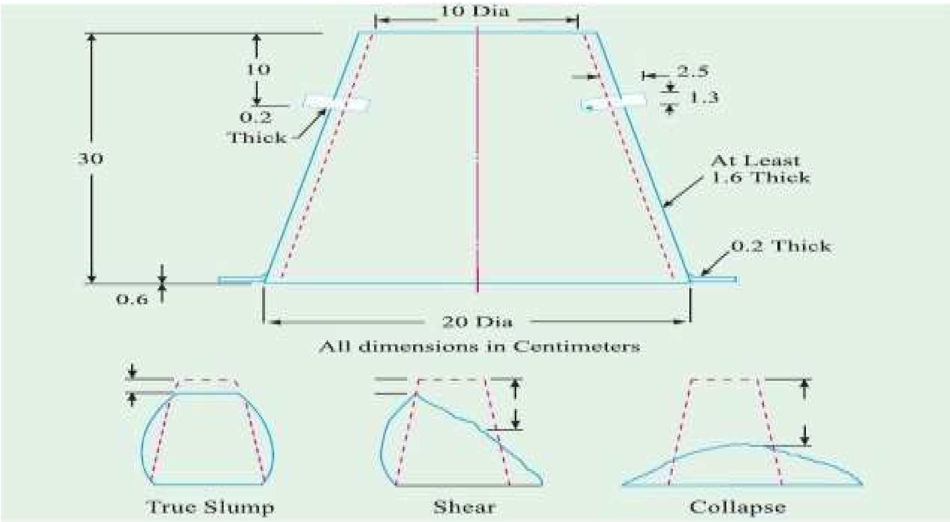


Fig: Slump cone Apparatus

OBSERVATION TABLE & CALCULATIONS:

S.NO	W/C ratio	Slump (mm)
1		
2		
3		
4		

RESULT:

1. The slump of concrete------ ------ mm
indicates **Low/ Medium/ High** Degree of workability (W/C)

2. COMPACTION FACTOR TEST

AIM:

To determine the relative consistency of freshly mixed concrete by the use of Compacting Factor Test

APPARATUS:

Compacting Factor Apparatus, Trowel, Scoop about 150 mm long. Balance capable of weighing up to 25 kg with the sensibility of 10 g. Weights and weighing device, Tamper (16 mm in diameter and 600 mm length), Ruler, Tools and containers for mixing, or concrete mixer etc.

PRECAUTIONS:

1. Oil the inner surface of apparatus before starting of the experiment
2. Fill the top hopper gently and to the same extent each time
3. The hoppers and cylinder must be washed, cleaned and wiped before use.
4. The experiment should be performed away from vibrations and on level ground.

PROCEDURE:

1. The internal surface of the hoppers and cylinder shall be thoroughly clean and free from superfluous moisture and any set of concrete commencing the test.

2. The sample of concrete to be tested shall be placed gently in the upper hopper using the scoop. The trap door shall be opened immediately after filling or approximately 6 min after water is added so that the concrete fails into the lower hopper. During this process the cylinder shall be covered.

3. The lower hopper opened and the concrete allowed falling to into the cylinder.

4. For some mixes have a tendency to stick in one or both of the hoppers. If this occurs the concrete shall be helped through by pushing the tamping rod gently into the concrete from the top.

5. The excess of concrete remaining above the level of the top of the cylinder shall then be cut off by holding a trowel in each hand, with the plane of the blades horizontal, and moving them simultaneously one from each side across the top of the cylinder, at the same time keeping them pressed on the top edge of the cylinder. The outside of the cylinder shall then be wiped clean. This entire process shall be carried out at a place free from vibration or shock.

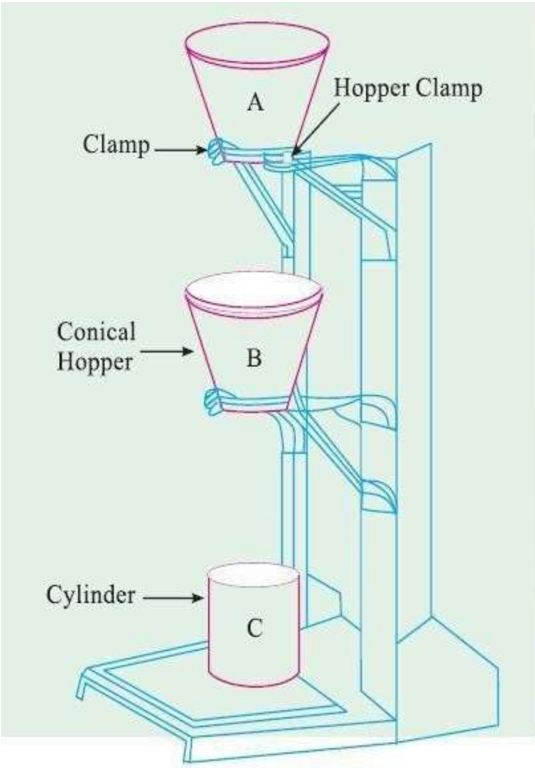
6. Determine the weight of concrete to the nearest 10 g. This is known as "weight of partially compacted concrete", W_p.

7. Refill the cylinder with concrete from the same sample in layers approximately 50 mm depth. The layers being heavily rammed with the compacting rod or vibrated to obtain full compaction. The top surface of the fully compacted concrete shall be carefully struck off and finished level with the top of the cylinder. Clean up the outside of the cylinder

8. Determine the weight of concrete to the nearest 10 g. This is known as "weight of fully compacted concrete", Wf.
The compacting factor, CF can be calculated as follows:

9. The compaction factor = weight of partially compacted concrete/weight of fully compacted concrete.

DIAGRAM:



Compacting Factor Apparatus

OBSERVATION TABLE & CALCULATIONS:

The compacting factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. It shall normally be stated to the nearest second decimal place.

S.No	Description	Sample 1	Sample 2
1	Weight of Empty Cylinder (W1)		
2	Weight of Cylinder + Free Fall Concrete (W2)		
3	Weight of Cylinder + Hand CompactedConcrete (W2)		
4	Weight of Partially Compacted Concrete(W_p=W2-W1)		
5	Weight of Fully Compacted Concrete(W_f=W2-W1)		
6	The Compacting Factor =W_p/W_f		

RESULT:

The Compaction factor of the concrete is_________________________________

3.VEE-BEE TEST

AIM:

The determination of consistency of concrete using a Vee-Bee Consistometer, which determines the time required for transforming, by vibration, a concrete specimen in the shape of a conical frustum into a cylinder.

APPARATUS:

Vee Bee Consistometer: a) A vibrator table resting upon elastic supports, b) A metal pot, c) A sheet metal cone, open at both ends, and d) A standard iron rod. Weights and weighing device, Tamper (16 mm in diameter and 600 mm length), Ruler, Tools and containers for mixing, or concrete mixer etc.

PRECAUTIONS:

1.The slump test to be performed before giving vibrations as per the standardspecifications
2.The experiment should be performed away from vibrations and other disturbances.
3.The moulds should be oiled before the starting of the experiment.

DIAGRAM:

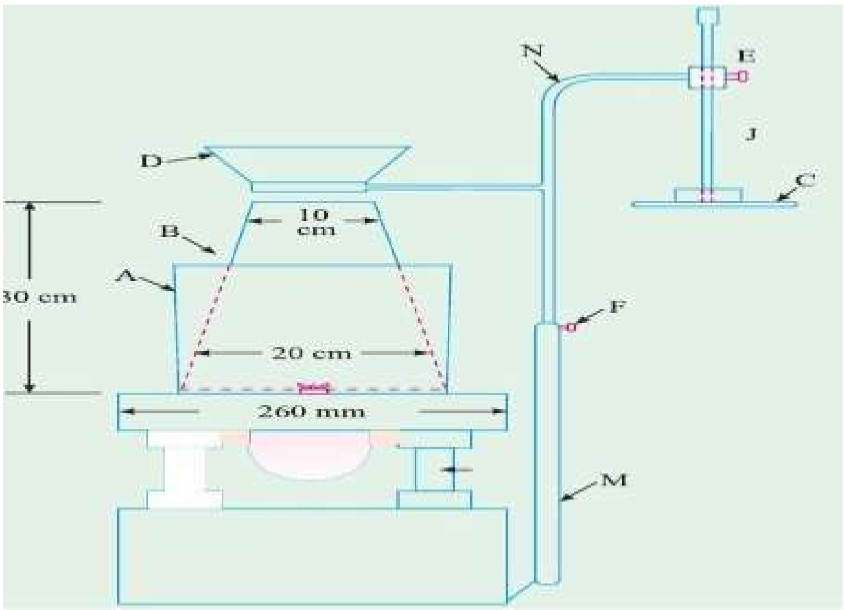


Fig: **Vee Bee Consistometer Equipment**

PROCEDURE:

1. Slump test as described earlier is performed, placing the slump cone inside the sheet metal cylindrical pot of the Consistometer.

2. The glass disc attached to the swivel arm is turned and placed on the top of the concrete in the pot. The electrical vibrator is then switched on and simultaneously a stop watch started

3. The vibration is continued till such a time as the conical shape of the concrete disappears and the concrete assumes a cylindrical shape. This can be judged by observing the glass disc from the top for disappearance of transparency.

4. Immediately when the concrete fully assumes a cylindrical shape, the stop watchis switched off. The time required for the shape of concrete to change from slump cone shape to cylindrical shape in seconds is known as Vee Bee Degree.

5. This method is very suitable for very dry concrete whose slump value cannot be measured by Slump Test, but the vibration is too vigorous for concrete with a slump greater than about 50 mm.

OBSERVATION TABLE AND CALCULATION:

Sr. No.	W/C ratio	Vee Bee degree (Sec)
1		
2		
3		

RESULT:

The Vee-Bee Degree of concrete ………. Sec Indicate **Low/ Medium/ High** Degree ofworkability

V. TEST ON HARDENED CONCRETE

EXPERIMENT NO -V

1a. COMPRESSION TEST ON CUBES & CYLINDERS

AIM: The test method covers determination of compressive strength of cubic concrete specimens. It consists of applying a compressive axial load to molded cubes at a rate which is within a prescribed range until failure occurs.

APPARATUS:

Testing Machine - The testing machine may be of any reliable type, of sufficient capacity for ther tests and capable of applying the load at the rate specified in 5.5. The permissible error shall be not greater than ± 2 percent of the maximum load.

Cube Moulds - The mould shall be of 150 mm size conforming to IS: 10086-1982.

Cylinders -The cylindrical mould shall be of 150 mm diameter and 300 mm height conforming to IS: 10086-1982.

Weights and weighing device, Tools and containers for mixing, Tamper (square in cross section) etc.

PRECAUTIONS:

1. All the materials should be weighed to an accuracy of 1 in 1000.

2. The mould and base plate should be oiled lightly

3.Cubes should be placed in the testing machine centrally on platens

4.The cubes should not be allowed to dry and they must be tested wet.

PROCEDURE:

1.Sampling of Materials - Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material.

2.Proportioning - The proportions of the materials, including water, in concrete mixes used for determining the suitability of the materials available, shall be similar in all respects to those to be employed in the work.

3.Weighing - The quantities of cement, each size of aggregate, and water foreach batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.

4.Mixing Concrete - The concrete shall be mixed by hand, or preferably, in alaboratory batch mixer, in such a manner as to avoid loss of water or other materials.Each batch of concrete shall be of such a size as to leave about 10 percent excess aftermoulding the desired number of test specimens.

5.Mould - Test specimens cubical in shape shall be 15 × 15 × 15 cm. If thelargest nominal size of the aggregate does not exceed 2 cm, 10 cm cubes may be used as an alternative. Cylindrical test specimens shall have a length equal to twice the diameter.

6.Compacting - The test specimens shall be made as soon as practicable aftermixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance.

7.Curing - The test specimens shall be stored in a place, free from vibration, inmoist air of at least 90 percent relative humidity and at a temperature of 27°± 2°C for 24 hours ± ½ hour from the time of addition of water to the dry ingredients.

8.Placing the Specimen in the Testing Machine - The bearing surfaces ofthe testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen which are to be in contact with the compression plates.

9.In the case of cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast, that is, not to the top and bottom

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

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

12.The maximum load applied to the specimen shall then be recorded and theappearance of the concrete and any unusual features in the type of failure shall be noted.

OBSERVATION TABLE AND CALCULATIONS

S. No	Age of cube	Weight of Cement Cube (gm)	Cross Sectional Area (mm^2)	Load(N)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
1	7 Days					
2	14 Days					
3	21 Days					
4	28 Days					

RESULT

1. The average 7 Days Compressive Strength of given cement sample is found to be

…..…..

2. The average 14 Days Compressive Strength of given cement sample is found to be

…..…..

3. The average 21 Days Compressive Strength of given cement sample is found to be

…..…..

4. The average 28 Days Compressive Strength of given cement sample is found to be

….

1b. SPLIT TENSILE TEST ON CYLINDERS

AIM: This method covers the determination of the splitting tensile strength of cylindrical concrete specimens.

APPARATUS:

Testing Machine - The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified in 5.5. The permissible error shall be not greater than ± 2 percent of the maximum load.

Cylinders -The cylindrical mould shall be of 150 mm diameter and 300 mm height conforming to IS: 10086-1982.

THEORY:

Age at Test - Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours ±½ hour and 72 hours ± 2 hours. The ages shall be calculated from the time of the addition of water to the dry ingredients.

Number of Specimens - At least three specimens, preferably from different batches, shall be made for testing at each selected age.

PROCEDURE:

1.Sampling of Materials - Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material.

2.Proportioning - The proportions of the materials, including water, in concrete mixes used for determining the suitability of the materials available, shall be similar in all respects to those to be employed in the work.

3.Weighing - The quantities of cement, each size of aggregate, and water for each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.

4.Mixing Concrete - The concrete shall be mixed by hand, or preferably, in a laboratory batch mixer, in such a manner as to avoid loss of water or other materials. Each batch of concrete shall be of such a size as to leave about 10 percentexcess after moulding the desired number of test specimens.

5.Mould - The cylindrical mould shall be of 150 mm diameter and 300 mm height conforming to IS: 10086-1982.

6.Compacting - The test specimens shall be made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance.

7.Curing - The test specimens shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27° ± 2°C for 24 hours ± ½ hour from the time of addition of water to the drying redients.

8. Placing the Specimen in the Testing Machine - The bearing surfaces of the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contactwith the rollers.

9. Two bearings strips of nominal (1/8 in i.e 3.175mm) thick plywood, free of imperfections, approximately (25mm) wide, and of length equal to or slightlylonger than that of the specimen should be provided for each specimen.

10. The bearing strips are placed between the specimen and both upper and lower bearing blocks of the testing machine or between the specimen and thesupplemental bars or plates.

11. Draw diametric lines each end of the specimen using a suitable device that will ensure that they are in the same axial plane. Center one of the plywood strips alongthe center of the lower bearing block.

Place the specimen on the plywood strip and align so that the lines marked on the ends of the specimen are vertical and centered over the ply wood strip.

12. Place a second plywood strip lengthwise on the cylinder, centered on the lines marked on the ends of the cylinder. Apply the load continuously and without shock, at a constant rate within, the range of 689 to 1380 kPa/min splitting tensile stress until failure of the specimen

13. Record the maximum applied load indicated by the testing machine at failure. Note the type of failure and appearance of fracture.

OBSERVATION TABLE & CALCULATIONS:

Mix proportion of concrete	For 1 cubic meter of concrete	For one batch of mixing
Coarse aggregate (kg)		
Fine aggregate (kg)		
Cement (kg)		
Water (kg)		
S/A		
w/c		
Admixture		

S.No	Age of Specimen	Identification Mark	Dia of Specimen (mm)	Depth (mm)	Maximum Load (N)	Tensile Strength (MPa)	Average Tensile Strength (MPa)
1	7 Days						
2							
3							
4	21 Days						
5			`				
6							
7	28 Days						
8			`				
9							

RESULT:

i) The average 7 Days Modulus of Rupture of concrete sample is found to be…..…..

ii)The average 21 Days Modulus of Rupture of concrete sample is found to be…..…..

iii) The average 28 Days Modulus of Rupture of concrete sample is found to be…..….

1c. FLEXURAL TEST ON PRISMS

AIM:

To determine the Flexural Strength of Concrete, which comes into play when a road slab with inadequate sub-grade support is subjected to wheel loads and there are volume changes due to temperature / shrinking.

THEORY:

Age at Test - Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours ±½ hour and 72 hours ± 2 hours. The ages shall be calculated from the time of the addition of water to the dry ingredients.

Number of Specimens - At least three specimens, preferably from different batches, shall be made for testing at each selected age.

APPARATUS:

Testing Machine - The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified in 5.5. The permissible error shall be not greater than ± 2 percent of the maximum load.

Beam Moulds - The beam moulds shall conform to IS: 10086-1982. The standard size shall be 15 × 15 × 70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 19 mm, specimens 10 × 10 × 50 cm may be used.

Weights and weighing device, Tools and containers for mixing, Tamper (square in cross section) etc.

PROCEDURE:

1.Sampling of Materials - Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material.

2.Proportioning - The proportions of the materials, including water, in concrete mixes used for determining the suitability of the materials available, shall be similar in all respects to those to be employed in the work.

3.Weighing - The quantities of cement, each size of aggregate, and water for each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.

4.Mixing Concrete - The concrete shall be mixed by hand, or preferably, in a Laboratory batch mixer,in such a manner as to avoid loss of water or other materials. Each batch of concrete shall be of such a size as to leave about 10 percent excess after molding the desired number of test specimens.

5.Mould-
Thestandardsizeshallbe15×15×70cm. Alternatively, if the largest nominal size of the aggregate does not exceed 19 mm, specimens 10 × 10 × 50 cm may be used.

6.Compacting - The test specimens shall be made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance.

7.Curing - The test specimens shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27° ± 2°C for 24 hours ± ½ hour from the time of addition of water to the drying redients.

8.Placing the Specimen in the Testing Machine - The bearing surfaces of the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers.

9.The specimen shall then be placed in the machine in such a manner that the load shall be applied to the uppermost surface as cast in the mould, along two lines spaced 20.0or 13.3 cm a part.

10.The axis of the specimen shall be carefully aligned with the axis of the loading device.

11.No packing shall be used between the bearing surfaces of the specimen andthe rollers.

The load shall be applied without shock and increasing continuously at a rate suchthat the extreme fibre stress increases at approximately 7 kg/sq cm/min, that is, at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/minfor the 10.0 cm specimens.

12. The load shall be increased until the specimen fails, and the maximum load applied To the specimen during the test shall be recorded. The appearance of the fractured faces of concrete and any un usual features in the type of failure shall be noted.

OBSERVATION TABLE AND CALCULATIONS:

S No.	Age of Specimenn	Identification on Mark	Size of Specimen (mm)	Span Length (mm)	Maximum Load(N)	Position of Fracture _a' (mm)	Modulus of Rupture (MPa)
1	7 Days						
2							
3							
4	28 Days						
5			`				
6							

CALCULATION:

The flexural strength of the specimen shall be expressed as the modulus of rupture f_b, which, if_ a'equals the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen, in cm, shall be calculated to the nearest 0.5 kg/sq cm as follows:

f_b= pl/bd^2 (when **a**> 20.0cm for 15.0cm specimen or > 13.0cm for 10cm specimen) or

f_b= 3pa/bd^2 (when **a**< 20.0cm but > 17.0 for 15.0cm specimen or < 13.3 cm but > 11.0cm for 10.0cm specimen.)

Where,

a = the distance between the line of fracture and the nearer support, measured on the center line of the tensile side of the specimen

b = width of specimen (cm)d = failure point depth (cm)

l = supported length (cm)p = max. Load (kg)

RESULT:

i) The average 7 Days Modulus of Rupture of concrete sample is found to be……..

ii) The average 14 Days Modulus of Rupture of concrete sample is found to be…..…

iii) The average 28 Days Modulus of Rupture of concrete sample is found to be…..….

2. MODULUS OF ELASTICITY

AIM:

To determine the modulus of elasticity of concrete.

APPARATUS:

Concrete cylinder 15 cm diameter and 30cm long, compressometer

Fig: Setting up of Compressometer

PROCDURE:

1. Assemble the top and bottom frame by keeping the spacers in position.
2. Keep the pivot rod on the screws and lock them in position.
3. Keep the tightening screws of the bottom and top frame unscrewed (but notcompletely).
4. Place the specimen on a level surface.
5. Keep the compressometer centrally on the specimen so that the tighteningscrew of the bottom and top frame are at equal distance from the two ends.
6. Tighten the screws so that the compressometer is held on the specimen.
7. Remove the spacers by unscrewing the spacer screws.

Testing

(I) Place the specimen with compressometer in the compression testing machine and center it.

(II) Apply load continuously without stock at a rate of 140 kg /cm²/minute until a stress of(c+5) kg/cm² is reached where c is the one third of average compressive strength of cubes calculated to the nearest 5kg /cm² (a load of 12.4T)

(III) Maintain the load at this stress for at least one minute and reduce gradually to an average stress of 1.5 kg/ cm² (a load of 0.3 T)

(IV) Apply the load again at the same rate until an average stress of (c+ 1.5) kg/cm² is reached (a load of 11.8T)

(V) Note the compress meter reading at this load.

(VI) Reduce the load gradually and take readings at an interval of 1T up to 0.3T(11.8T,10.8T,9.8T,8.8T,7.8T,............... ,1.8T,0.3T)

(VII) Apply load third time and note the compressometer readings at an interval of 1T (0.3T,1.8T,2.8T,................ 11.8T).

NOTE

1. Readings should be taken without delay

2. If the overall strain observed on the second and third readings differ by more than 5%,the loading shall be repeated until the difference in strain between consecutive readings of (c+1.5) kg/sq.cm. (11.8T) does not exceed 5%.

3. To get the actual deformation, divide the observed readings of the dial gauge by 2.

GRAPH

A load – deflection graph is plotted for loading and nu loading conditions. Draw tangents at the initial portion of the loading curve and at the load corresponding to the working stress of the mix. Join the initial point and the point on the loading curve corresponding to working stress.

CALCULATION

Initial tangent modulus = stress/ strain

(Take load and deflection from the initial tangent)

Tangent modulus at working stress= stress/ strain

(Take load and deflection from the tangent drawn at working stress)

Secant modulus = stress/strain

(Take load and deflection from the line joining initial point and the point at working stresses)

REPORT

The following information shall be included in the report.

(i) Identification mark

(ii) Date of test

(iii) Age of specimen

(iv) Shape and nominal dimensions of the specimen

RESULT.

Initial tangent modulus of given concrete =........................ N / mm^2

Tangent modulus at working stress =.........................N / mm^2

Secant modulus (Modulus of elasticity of given concrete) =.................. N / mm^2

3a. REBOUND HAMMER

AIM: To test the concrete specimens by the nondestructive test method of rebound hammer

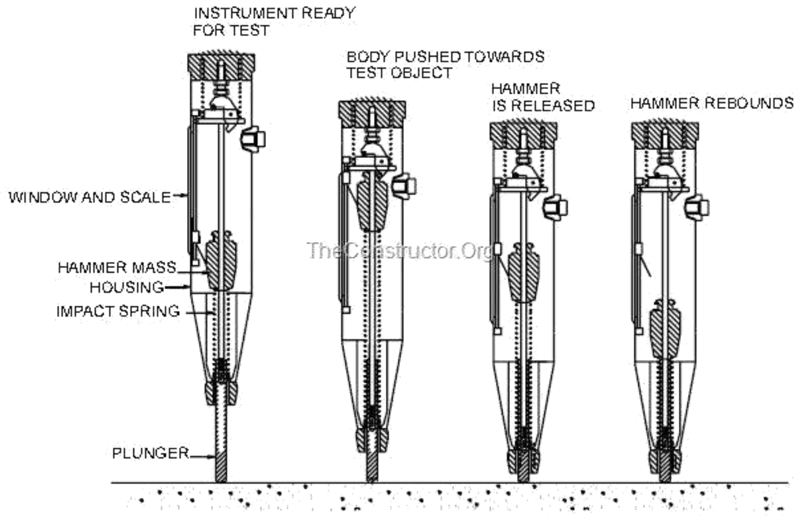
APPARATUS:

Universal Testing Machine, Balance, scale, Schmidt hammer etc.

PRECAUTIONS:

1. All the materials should be weighed to an accuracy of 1 in 1000.
2. The mould and base plate should be oiled lightly
3. Cubes should be placed in the universal testing machine centrally on platens
4. Hold the hammer very carefully as it directly affects the rebound number thus affecting the compressive strength

DIAGRAM:



PROCEDURE:

1. The specimen to be tested shall be kept and cured in such a way that the softening and hardening of the surface due to leaching of calcium hydroxide corrosion is avoided.
2. The specimen surface shall be cleaned of dust or any loose material
3. The specimen shall be held or fixed in such a way that is does not yield under the impact of hammer
4. The plunger of the hammer shall always be kept perpendicular to the surface
5. About ten to twelve readings shall be taken and their average value is calculated to get a

representative index of hardness

6. All the readings which are to be compared shall be taken while keeping the hammer in a specified inclination with the vertical, while the hammer pointing the same direction always. For the same surface the readings taken vertically are likely to be different from those taken by keeping the hammer in the horizontal position

OBSERVATION TABLE& CALCULATIONS:

1. Concrete Mix used:
2. Type of cement and aggregate used:
3. Curing Conditions:
4. Age of Concrete:
5. Whether wet or dry:

Sr. No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Rebound Number							
Compressive Strength							

RESULT:

The Compressive strength of the concrete by Rebound Hammer is .... kN./sq.mm

3b. ULTRASOUND PULSE VELOCITY(UPV)

AIM:

The method consists of measuring the time of travel of an ultrasonic pulse passing through the concrete being tested. Comparatively higher velocity is obtained when concrete quality is good in terms of density, uniformity, homogeneity etc.

APPARATUS:

(i) Electrical pulse generator
(ii) Transducer-one pair
(iii) Amplifier
(iv) Electronic timing device

PROCEDURE:

Preparing for use:

Before switching on the 'V' meter, the transducers should be connected to the sockets marked "TRAN" and" REC".
The 'V' meter may be operated with either:
a) the internal battery,
b) an external battery or
c) the A.C line.

Set reference:

A reference bar is provided to check the instrument zero. The pulse time for the bar is engraved on it. Apply a smear of grease to the transducer faces before placing it on the opposite ends of the bar. Adjust the 'SET REF' control until the reference bar transit time is obtained on the instrument read-out.

Range selection:

For maximum accuracy, it is recommended that the 0.1 microsecond range be selected for path length upto 400mm.

Pulse velocity:

Having determined the most suitable test points on the material to be tested, make careful measurement of the path length 'L'. Apply couplant to the surfaces of the transducers and press it hard onto the surface of the material. Do not move the transducers while a reading is being taken, as this can generate noise signals and errors in measurements. Continue holding the transducers onto the surface of the material until a consistent reading appears on the display, which is the time in microsecond for the ultrasonic pulse to travel the distance 'L'. The mean value of the display readings should be taken when the units digit hunts between two values.

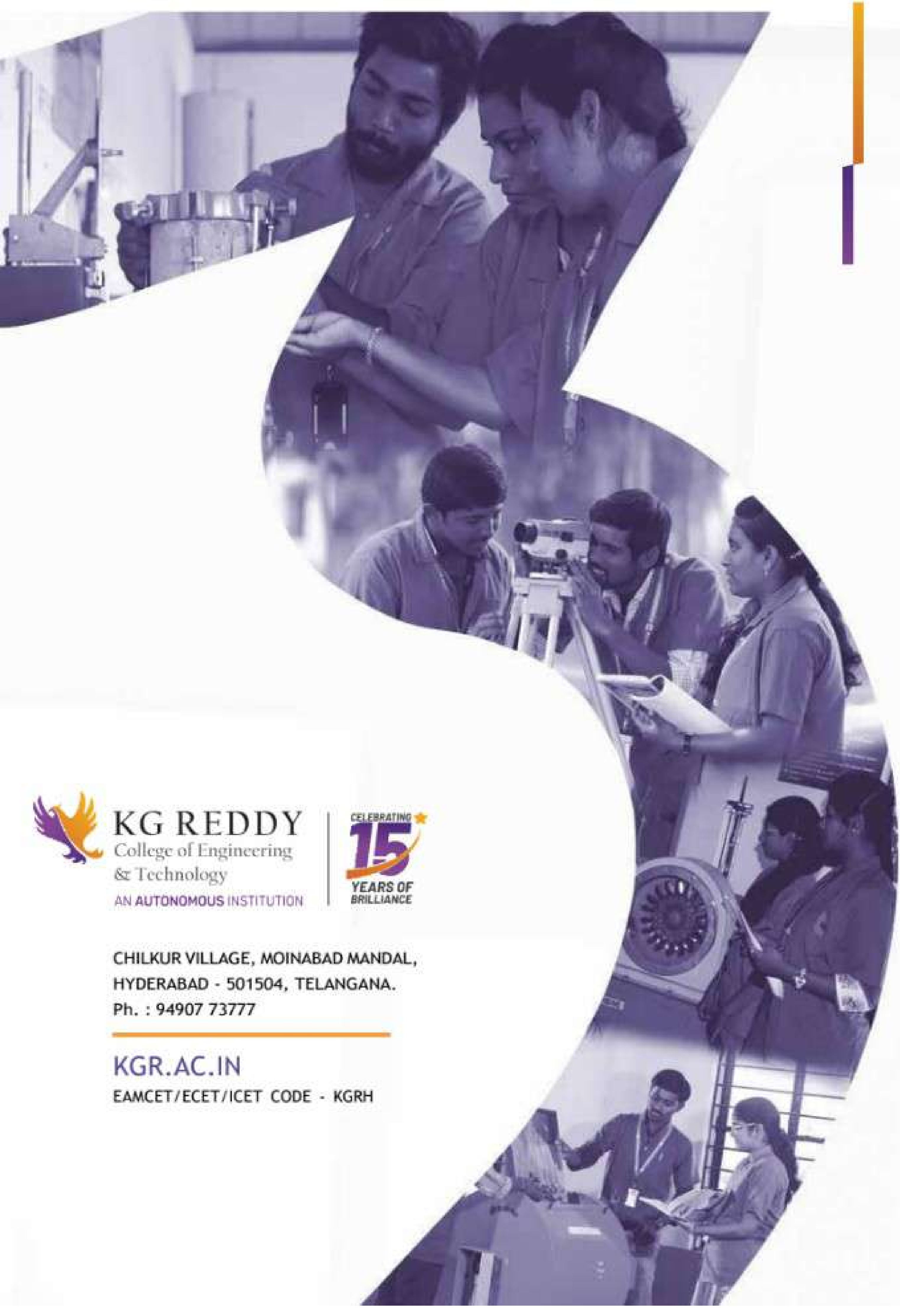
Pulse velocity= (Path length/Travel time)

v) Separation of transducer leads: It is advisable to prevent the two transducer leads from coming into close contact with each other when the transit time measurements are being taken. If this is not done, the receiver lead might pick-up unwanted signals from the transmitter lead and this would result in an incorrect display of the transit time

Interpretation of Results

The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation, etc, indicative of the level of workmanship employed, can thus be assessed using the guidelines given below, which have been evolved for characterizing the quality of concrete in structures in terms of the ultrasonic pulse velocity.

Pulse Velocity (km/second)	Concrete Quality (Grading)
Above 4.5	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Doubtful



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