K. S. SCHOOL OF ENGINEERING AND MANAGEMENT

DEPARTMENT OF CIVIL ENGINEERING

BCV503 – CONCRETE TECHNOLOGY IPCC

LABORATORY MANUAL

STUDENT NAME: ___________________________________

USN: ________________________

K S SCHOOL OF ENGINEERING AND MANAGEMENT

Holiday Village Road, Vajarahalli Village, Mallasandra, off, Kanakapura Rd, Bengaluru, Karnataka 560109

VISION

To impart quality education in engineering and management to meet technological business and societal needs through holistic education and research.

MISSION

K. S. School of Engineering and Management shall,

- Establish state-of-art infrastructure to facilitate effective dissemination of technical and managerial knowledge.
- Provide comprehensive educational experience through a combination of curricular and experiential learning, strengthened by industry-institute interaction.
- Pursue socially relevant research and disseminate knowledge.
- Inculcate leadership skills and foster entrepreneurial spirit among students.

DEPARTMENT OF CIVIL ENGINEERING

VISION

- To emerge as one of the leading Civil Engineering Department by producing competent and quality ethical engineers with strong foot hold in the areas of Infrastructure development and research.

MISSION

- Provide industry oriented academic training with strong fundamentals and applied skills.
- Engage in research activities in Civil Engineering and allied fields and inculcate the desired perception and value system in the students.

CONTENTS

Experiment No: 01 **Date:**

NORMAL CONSISTENCY TEST FOR CEMENT

Aim: To determine, the standard consistency of a given cement sample by vicat apparatus.

Apparatus Used: - Vicat apparatus with vicat plunger, vicat Mould, Measuring jar (100 ml capacity), Weighing balance, weigh box, Glass plates,

Brief Theory: - The object of conducting this test is to find out the amount of water to be added to the cement to get a paste of normal consistency, i.e. the paste of a standard solidity, which is used to fix the quantity of water to be mixed in cement before performing tests for setting time, soundness & compressive strength.

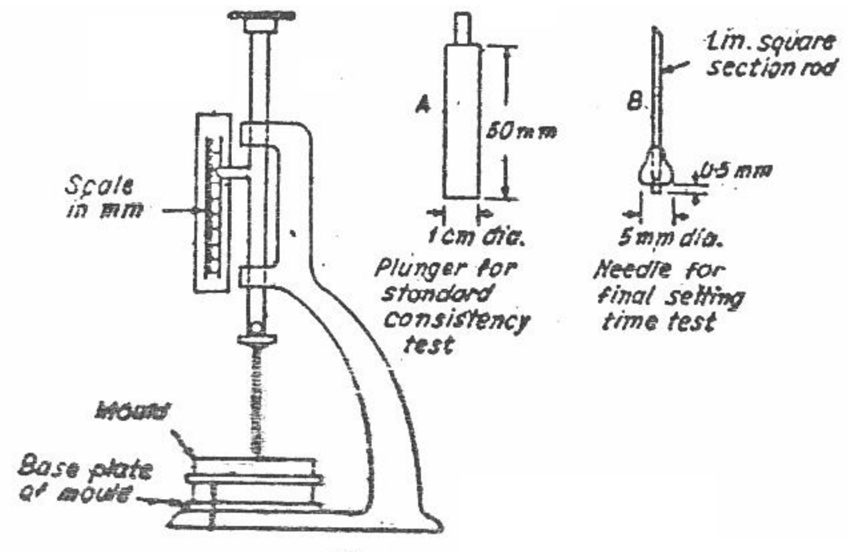
Experimental Procedure: -The standard consistency of a cement paste which permit vicat plunger 'A' to penetrate to a height 5 to 7 mm the bottom of the vicat mould when the cement paste is tested as described below,

- For preparing one mould take 400gm of cement passing 850 micron IS sieve and prepare a paste of cement with a weighed quantity of water, Taking care to see that the time of mixing is between 3 to 5 minutes.
- Fill the vicat Mould resting upon non-porous plate with this paste. After completely filling the mould, smooth off the surface of the paste
- Place the test block in mould with the non-porous testing plate under the rod attached with plunger A. Lower the plunger gently to touch the surface of test block and release it quickly, allowing it to sink into the paste.
- Prepare the trial pastes with varying percentage of water i.e. 24% 28%, 29%, 30% & 32% and the test is done as described above, until the standard consistency is obtained.

Tabular column:

Sl. No.	No of trials	I	II	III	IV
01	Percentage of Water				
02	Initial Reading				
03	Final Reading				
04	Height not Penetrated mm				

Sketch: -



Vicat apparatus.

Result: The normal consistency of cement sample = ... %

IS specification: - The standard consistency of a cement paste which permits vicat plunger to penetrate to a height of 5 to 7 mm from the bottom of the vicat mould is varies from 24% to 34% depending on the sample.

Conclusion: -

Reference Code:

IS 5513 – 1976 Specification for vicat apparatus
IS 4031 – part4 – 1988 Determination of consistency of standard cement paste

Viva Questions

1. What is normal or standard consistency of a cement paste ?
2. Which apparatus used for determining the consistency of cement?
3. What is purpose of determination of normal consistency? How is the normal consistency expressed?
4. What factor in the test procedure will affect the result of normal consistency determination?
5. List out Grades of Cement available in Market.

Experiment No: 02 **Date:**

FINENESS TEST FOR CEMENT

Aim: To determine the fineness value for cement as represented by specific surface expressed as total surface area in sq cm/gm by air permeability apparatus

Apparatus required: Air permeability cell, perforated disc, manometer, filter paper discs, Dibutylpthalate etc

Brief Theory: The fineness of cement is a measure of the size of particles of cement and is expressed in terms of specific surface of the cement. It is an important factor in determining the rate of gain of strength and uniformity of quality. For a given weight of cement, the surface area is more for finer cement than for coarser cement. The finer the cement, the higher is the rate of hydration, as more specific area is available for chemical reaction. This results in early development of the strength. Thus the specific surface of cement is calculated based on the relation between flow air through the cement bed and the surface area of the particles comprising the cement bed. From this the surface area per unit weight of the body material can be related to the permeability of a bed of a given porosity.

Procedure:

1. The cement bed in the permeability cell is 12cm high and 2.5 cm in diameter.
2. Knowing the density of cement the weight required to make a cement bed of porosity of .475 can be calculated.
3. This quantity of cement is placed in the permeability cell in a standard manner.
4. Slowly pass on air through the cement bed at a constant velocity until the flow meter shows a difference in level of 30-50cm.
5. Read the difference in level h_1 of the manometer and the difference in level h_2 of the flow meter.
6. Repeat these observations to ensure that steady conditions have been obtained by a constant value of h_1/h_2. Specific surface is calculated by the formula:

$S_w = K \sqrt{} h_1/h_2$

Where $K = \frac{14}{D\left(1-\xi\right)} \times \frac{\sqrt{\xi^3}\ A}{\sqrt{CL}}$

ξ = porosity i.e. o.475
A = Area of the cement bed
L = Length of the cement bed
D = Density of cement
C = Flow meter constant

Result: The Specific surface of the cement is = ... sq. cm / gm

IS Specification: Fineness requirement of cement as per IS 269 - 1976

	Ordinary	**Rapid Hardening**	**Low Heat**
Specific surface (sq. cm/gm) by air permeability method, not less than	2250	3250	3200

Reference Code: -

IS 5516: 1996Specification for variable flow type air permeability apparatus (Blaine type)

IS 269 – 1976 Specifications for ordinary and low Portland cement.

Viva Questions

1. State the methods to test the fineness of cement
2. Explain the role of gypsum for cement
3. What is the significance of conducting fineness test of cement?

Experiment No: 03 **Date:**

SETTING TIME OF CEMENT

Aim: To determine the initial & final setting time of given cement sample by vicat apparatus.

Apparatus Used: Vicat apparatus with vicat needles, Vicat mould, gauging trowel, measuring jar (of 100 ml capacity), weighing balance, Stopwatch, weigh box, glass plate.

Brief Theory: Setting of cement means "stiffening" of cement paste. Broadly speaking, setting refers to a change from fluid to a rigid state. In order that the concrete should be placed in place conveniently, It is necessary that the initial setting time of cement is not too quick, & after it has been laid, hardening should be rapid so that the structure can be made use of as early as possible. Initial setting time is defined as the period elapsing between the time when water is added to the cement and the time at which a needle of 1mm square section fails to pierce the test block to a depth of about 5mm from the bottom of the mould. Final setting time is defined as the period elapsing between the time when the water is added to the cement and the time at which the needle of 1mm square section makes an impression on the test block, while the attachment fails to make an impression on the test block.

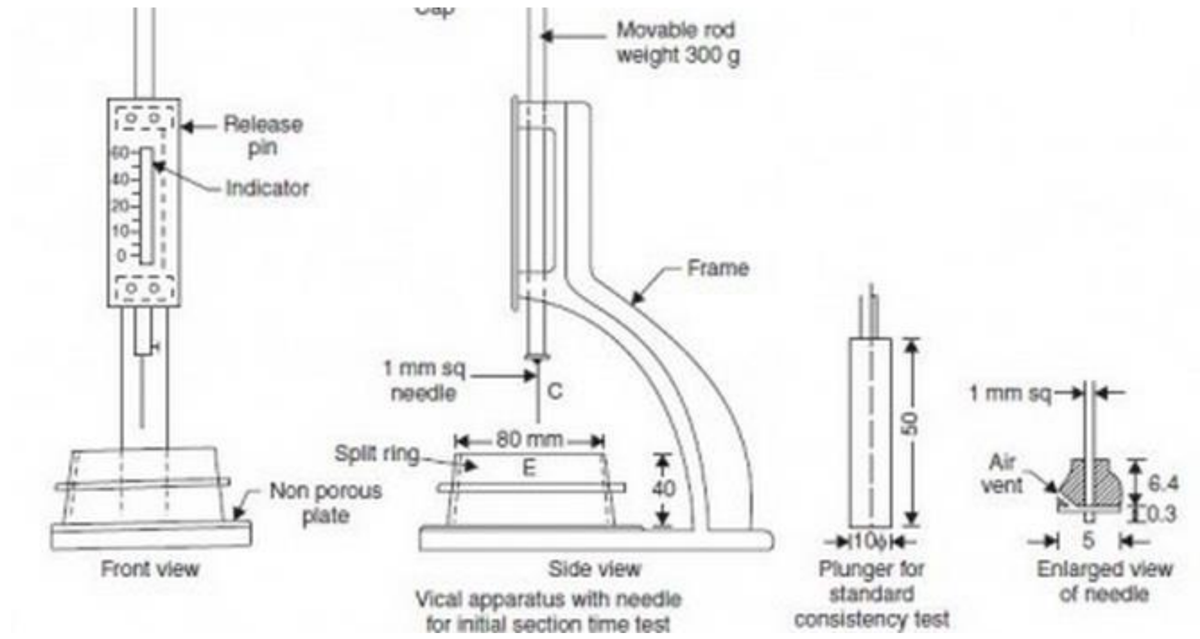
Procedure:

1. Prepare a neat cement paste by mixing the cement with 0.85p water. Where P= Standard consistency.
2. The mixing time is kept between 3 to 5 minutes, Start the timer when water is added to the cement.
3. Fill the vicat mould and smooth off the surface of the paste, & the mould is in the vicat 's apparatus attached with needle 'B' for determination of initial setting time.
4. Lower the needle gently in contact with the surface of the test block and release quickly, allowing it to penetrate in to the test block.
5. Repeat this procedure until the needle fails to pierce the cement paste for about 5-mm measured from the bottom of the mould.
6. The period elapsed between the time when water is added to the cement and the time at which the needle fails to pierce is noted down as the initial setting time.
7. For the determination of final setting time, replace the needle by 'C', the cement is considered finally set, when, applying the needle 'C' gently to the surface of the test block.

Tabular column: -

Sl. No.	No of trials	I	II	III	IV
01	Time in minutes				
02	Initial Reading				
03	Final Reading				
04	Height not penetrated mm				

Sketch:



Result:

IS Specifications: The initial setting time should not be less than 30 minutes & final setting time should not be more than 600 minutes. For quick setting cement initial setting time should not be less than 5 minutes & final setting time should not exceed 30 minutes.

Conclusions:

Reference Code:

IS 5513 – 1976 Specification for vicat apparatus
IS 4031 – 1988 Method of test for determining initial and final setting time of cement

Viva Questions

1. Define setting of cement. Explain difference between setting and hardening.
2. Which one of the Bogue's compounds are highly responsible for setting of cement?
3. Define Initial setting time and final setting time for cement.
4. Significance of setting time.
5. What is meant by false set of cement?
6. What is the dimension of plunger and initial setting time needle?
7. What should be initial setting time and final setting time according to IS Specification?

Experiment No: 04 **Date:**

SPECIFIC GRAVITY TEST FOR CEMENT

Aim: To determine the specific gravity value for cement

Apparatus Required: Density bottle, kerosene, balance

Brief theory: The specific gravity is defined as the ratio of the mass of a given volume of the material to the mass of an equal volume of water.

Procedure:

1. Weigh the specific gravity bottle dry. Let the mass of empty bottle be w_1
2. Fill the bottle with distilled water and weigh the bottle filled with water. Let the mass be w_2
3. Wipe dry the specific gravity bottle and fill it kerosene and weigh. Let this mass be w_3
4. Pour some of the kerosene out and introduce a weighed quality of cement (about 50gms) into the bottle. Roll the bottle gently in inclined position until no further air bubbles rise to surface. Fill the bottle to the top with kerosene and weigh it. Let this mass be w_4.
5. Specific gravity of kerosene $S=W_3-W_1/ W_2-W_1$

Observations & Calculations:

Weight of the specific gravity bottle (w_1)
Weight of the specific gravity bottle filled with water (W_2)
Weight of the specific gravity bottle filled with kerosene(W_3)
Weight of the specific gravity bottle half filled with cement and rest with kerosene (W_4gm) =
Weight of cement = W_5gm
Specific gravity of kerosene = $S=W_3-W_1/ W_2-W_1$
Specific gravity of cement = $W_5 (W_3-W_1)/ (W_5+ W_3-W_4)(W_2-W_1)$

Specific gravity =
Result: The value = **.........................**

IS Specification: The specific gravity of Portland cement is generally about 3.15, but that of cement manufactured from materials other than limestone and clay, the value may vary. Specific gravity is not an indication of quality of cement. It is used in calculations of mixed proportions.

Conclusion:

Reference Code: - **IS 269 – 1976 Specifications for ordinary and low Portland cement.**

Viva Questions

1. Define specific gravity of cement.
2. Name different types, grades and brands of cement available in the market.

3 What is the use of finding specific gravity value?

4. What are the factors affecting specific gravity test?
5. What is the range of specific gravity of cement should be?
6. Why kerosene is used in specific gravity test of cement?

Experiment No: 05 **Date:**

COMPRESSIVE STRENGTH OF CEMENT

Aim: To determine the compressive strength of cement mortar cubes of 1:3 proportion after 3 days and 7 days curing.

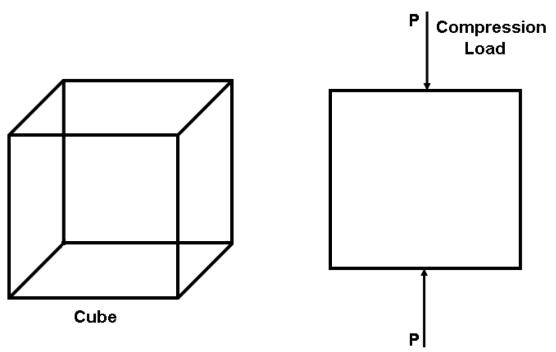
Apparatus Used: CTM, Cube moulds, Vibrating machine, measuring jar, trowels, non- porous plate, balance and weight box etc.

Brief Theory: The compressive strength of cement mortar is determined in order to verify whether the cement conforms to IS specification (IS: 269 - 1976) and to know whether it will be able to get the required compressive strength of cement mortar cubes.

Experimental Procedure: -

1. The material for each cube shall be mixed separately and the quantities of cement and standard sand shall be as follows.
   Cement = 200gm
   Sand = 600gm
   Water = (P/4 +3) %, [P= the percentage of water for standard consistency]
2. Place the mixture of cement and standard sand in the proportion of 1:3 by mass on non-porous plate and mix it dry with a trowel for 1 minute and then with water until the mixture is of uniform colour. The time of mixing shall not be less than 3 minutes.’
3. Place the assembled mould on the table of the vibrating machine firmly.
4. Immediately after mixing the mortar, fill the entire quantity of mortar in the cube mould and compact by vibration.
5. The period of vibration shall be 2minutes.
6. Remove the mould from the machine and keep it at a temperature of 27 ^{0}c for 24 hours.
7. Remove the cube from the mould and immediately submerge in water for 7 days. Keep the cubes wet till they are placed in machine for testing.
8. Test the specimens at the required periods (3 days, 7 days)

Sketch: -



Calculations: Compressive strength of cement = load / area = ... N/mm^2

IS Specifications: For ordinary Portland cement the compression strength at 3 days and 7 days curing should be not less than 16N / mm^2 and 22N/mm^2.

Conclusions:

Result: The compressive strength of cement for given sample = ... N/mm^2

Reference Code: -

IS 7246 – 1974 Recommendations for use of table vibrators consolidating concrete

IS 4031 - part 7 - 1988 Method of test for strength of concrete

IS 269: 1967 Specifications for ordinary and low Portland cement

IS: 650 – 1966 Specification for standard sand for testing of cement.

<u>Viva Questions</u>

1. Define compressive strength of cement
2. Give the different types of cement
3. Standard size of cube for cement mortar (1:3) is ___________
4. Equipment used to test Compressive Strength of Concrete?
5. 53 grade of cement, what it indicates?

Experiment No: 06 **Date:**

SIEVE ANALYSIS OF FINE AGGREGATES

Aim: To determine the fineness modulus and grain size distribution of the given fine aggregate.

Apparatus: Indian standard test sieves, Weighing balance, sieve shaker, trays etc.

Procedure:
1. Take one kg of sand and break the clay lumps if any, in a clean dry ice plate.

2. Arrange the sieves in the order of Indian standard sieve numbers 4.75 mm, 2.36 mm, 1.18 mm, 600 μ, 300 μ,150 μ with 4.75 mm at the top and 150μ at the bottom, fix them in the sieve shaking machine with the pan at the bottom and cover at the top.

3. Keep the sand in the top sieve, carry out the sieving in the set of sieves for not less than ten minutes and find the mass retained in each sieve.

Observations & Calculations:
Weight of sand taken = ………........................... g

Tabular Column

Sl.No	I.S Sieve size	Weight retained (g)	Percentage retained	Percentage passing	Cumulative percentage retained, F	Percentage Fines (100-F)

Σ F=

Fineness Modulus= $\frac{\Sigma F}{100}$ =

Result: Fineness Modulus of the given fine aggregate =
(The range of fineness modulus for fine aggregate is between 2.0 to 3.5)

Experiment No: 07 **Date:**

SPECIFIC GRAVITY OF FINE AGGREGATES

Aim: To determine the specific gravity of the given fine aggregates.

Theory: Specific gravity of an aggregate is defined as the ratio of the mass of the given volume of sample to the mass of an equal volume of water at the same temperature.

Apparatus: Balance, weight box, pycnometer, oven, metal tray etc.

Procedure:

1. Clean and dry the pycnometer and weigh it, M1.

2. Select a mass of sand about 300 g and place the same in pycnometer and weigh it, M2.

3. Fill the pycnometer with distilled water up to half its height and stir the mix with a glass rod and add more water till it reaches conical cap. Dry the pycnometer outside and find the mass M3.

4. Remove the contents of a pycnometer and clean it. Fill the clean water up to the level of the hole in the cap. Weigh it, M4.

5. Now use the following equation to determine specific gravity.

M1 = …………………….kg

M2 = …………………….kg

M3 = …………………….kg

M4 = …………………….kg

$$G = \frac{(M2 - M1)}{(M2 - M1) - (M3 - M4)} = \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Result: Specific gravity of the given fine aggregates = ………………………….

Experiment No: 08 **Date:**

BULKING OF FINE AGGREGATES

Aim: To determine the necessary adjustment for the bulking of fine aggregate and to draw a curve between moisture content and bulking.

Equipment: Graduated cylinder, balance, beaker, metal tray, steel rule, and oven.

Procedure:

1. Weigh the empty graduated cylindrical glass jar.
2. Weigh sufficient quantity of oven dried sand loosely into the graduated cylinder. After filling, level the surface of sand in the cylinder.
3. Push a steel rule vertically down through the sand at the middle to bottom and measure the height of the sand; let it be 'h' mm.
4. Empty the sand into a clean metal tray without any loss.
5. Add 1 % of water by weight to mass of sand. Mix the sand and water thoroughly by hand. Put the wet sand loosely into the cylinder without tamping it.
6. Smooth and level the top surface of moist sand and measure its depth in the middle with the steel rule. Let it be 'h1' mm.
7. Repeat the experiment steps up to step 6 of the above procedure with 2% of water by mass of sand. Go on increasing the percentage till bulking is maximum and yield starts falling down and ultimately bulking is zero.
8. Plot a curve between Water Content v/s Bulking Percentage.

It is seen that bulking increases with increase in moisture content up to a certain point where it is maximum and then it begins to decrease and ultimately bulking is zero, that is saturated sand occupies the same volume as the dry sand.

Observations:

Weight of empty graduated cylinder, W1 = ……………………g

Weight of cylinder + over dried fine aggregate, W2 = …………………….g

Weight of fine aggregate (W) = (W2-W1) = …………………... g

Initial height of dry sand, h = …………………cm

Final height of wet sand, h1 = ………………....cm

Tabular Column:

Weight of sand (g)	**% of water adding**	**Weight of water adding (g)**	**Height of sand (cm)**	**Bulking** (h1-h)/h x100

Result: Maximum Bulking = ………………………%

Experiment No: 09 **Date:**

BULK DENSITY OF FINE AGGREGATES

Aim: Determination of bulk density for fine aggregates.

Theory: Bulk density is the weight of material in a given volume. The higher the bulk density, the lower is the void content. The sample, which gives the minimum voids or the one, which gives the maximum bulk density, is taken as the right sample of aggregate for making economical mix.

Apparatus: Cylindrical mould of capacity 3 liter, tamping rod of 16 mm diameter, weighing balance accurate to 1 g and other accessories.

Procedure:

1. Take about 5 kg of fine aggregate (air dried) passing through 4.75 mm sieve size.

2. Measure the empty weight of cylindrical mould with base plate W1.

3. Fill the sand in cylindrical mould about 1/3 the height each time and tamped with 25 strokes by a tamping rod.

4. The compaction must be uniform over the whole area, and a spatula scratching is done before adding another layer.

5. The filling must be such that the last layer projects in to the collar by about 5mm. After the completion of compaction remove the collar and remove the excess aggregate with the help of straight edge.

6. Find the mass of the mould with the base plate and the fine aggregate W2.

Observations & Calculations:

Empty weight of cylindrical mould with base plate W1 = ………………kg

Weight of the mould with the base plate and the fine aggregate W2 = …………..kg

Height of the mould = ……………….m

Diameter of the mould = …………….m

Volume of the cylindrical mould (V) = ………………………m^3

Bulk density = $\frac{W_1 - W_2}{V}$ = ... kg/m^3

Result: The bulk density of given fine aggregate = …………….kg/m^3

Conclusion:

Experiment No: 10 **Date:**

SPECIFIC GRAVITY AND WATER ABSORPTION OF COARSE AGGREGATES

Aim: To determine the specific gravity and water absorption of coarse aggregates.

Apparatus: Balance of capacity 5 kg or more, weight box, wire basket 200 mm in diameter and 200 mm height 4.75 mm Indian standard sieve, water tub for immersing the wire basket in water, absorbent cloth, and suitable arrangement for suspending the wire basket from the center of scale pan of balance.

Procedure:

1. Take about 5 kg of aggregate by method of quartering rejecting all materials passing a 10 mm IS sieve.

2. Wash thoroughly to remove dust etc. dry to constant mass at a temperature of 105^0C in an oven.

3. Immerse the sample in water at 22 to 32^0 C for 30 minutes for lab practice.

4. Remove aggregates from water and roll the same in a large piece of absorbent cloth.

5. Weigh 3 kg of this sample in the surface dry condition and note its weight 'W1' g.

6. Place the weighed aggregate immediately in wire basket and dip it in water.

7. Weigh this basket with aggregate while keeping it immersed in water with the balance. Note its weight 'W3' g also note the weight of the empty basket, 'W2' g.

8. Dry the sample to constant weight at 100^0C to 110^0C for 24 hrs cool at room temperature and weight 'W4' g.

Observations & Calculations:

Weight of surface dry sample, W1 = …………………………...g

Weight of basket suspended in water, W2 =……………………………g

Weight of material + basket suspended in water, W3 =……………………………g

Weight of oven dried aggregate sample in air W4 =……………………………g

Bulk specific gravity = $\frac{W1}{W1-(W3 - W2)}$ =……………………………g

Apparent specific gravity = $\frac{W4}{W4-(W3 - W2)}$ =……………………………g

Percentage absorption = $\frac{(W1 - W4) \times 100}{W4}$ =……………………………g

Result:

Bulk specific gravity =……………………..

Apparent specific gravity =………………………

Percentage absorption =………………………%

Experiment No: 11 **Date:**

SIEVE ANALYSIS OF COARSE AGGREGATES

Aim: To determine the fineness modulus and grain size distribution of the given coarse aggregate.

Apparatus: Indian standard plates of 80 mm, 20 mm, 10 mm, 4.75 mm, weighing balance, sieve shaker, trays, drying oven.

Procedure:

1. Take 5kg of coarse aggregate of nominal size of 20mm.

2. Carry out sieving by hand, shake each size in the order 80 mm, 40 mm, 20 mm,10 mm,4.75 mm, over a clean dry tray for a period of not less than 2 minutes each. The shaking is done with a varied motion i.e.; back and forward, left and right, circular clock wise and anti-clock wise.

3. Find the mass of aggregate retained on each sieve taken in the order.

Observations & Calculations:

Weight of coarse aggregate taken = ………………………………g

Tabular Column

Sl.No	I.S Sieve size	Weight retained (g)	Percentage retained	Percentage passing	Cumulative percentage retained (F)	Percentage Fines (100-F)

$\Sigma F =$

Result:

Fineness Modulus of coarse aggregate = $\frac{(\Sigma F+500)}{100}$ = ………………………

Experiment No: 12 **Date:**

BULK DENSITY OF COARSE AGGREGATES

Aim: Determination of bulk density for coarse aggregates.

Theory: Bulk density is the weight of material in a given volume. The higher the bulk density, the lower is the void content. The sample, which gives the minimum voids or the one, which gives the maximum bulk density, is taken as the right sample of aggregate for making economical mix.

Apparatus: Cylindrical mould of capacity 15 liter, tamping rod of 16 cm diameter and 60 cm height, weighing balance accurate to 1 g and other accessories.

Procedure:

1. Take about 15 kg of coarse aggregate (air dried) passing through 40 mm and retained on 4.75 mm sieve size.

2. Measure the empty weight of cylindrical mould with base plate W_1.

3. Fill the coarse aggregate in cylindrical mould about 1/3 the height each time and tamped with 25 strokes by a tamping rod.

4. The compaction must be uniform over the whole area.

5. After the completion of compaction remove the excess aggregate with the help of straight edge.

6. Find the mass of the mould with the base plate and the fine aggregate W_2.

Observations & Calculations:

Empty weight of cylindrical mould W1 = ………………….kg

Weight of the mould with coarse aggregate W2 = …………………kg

Height of the mould= ……………….m

Diameter of the mould= …………….m

Volume of the cylindrical mould (V) = ………………..m^3

Bulk density = $\frac{W1 - W2}{V}$ = …………………………………….kg/m^3

Result: The bulk density of given coarse aggregate =……………………kg/m^3

Conclusion:

Experiment No: 13 **Date:**

SHAPE TEST – FLAKINESS TEST

Aim: Determine the flakiness Index of aggregates.

Apparatus:

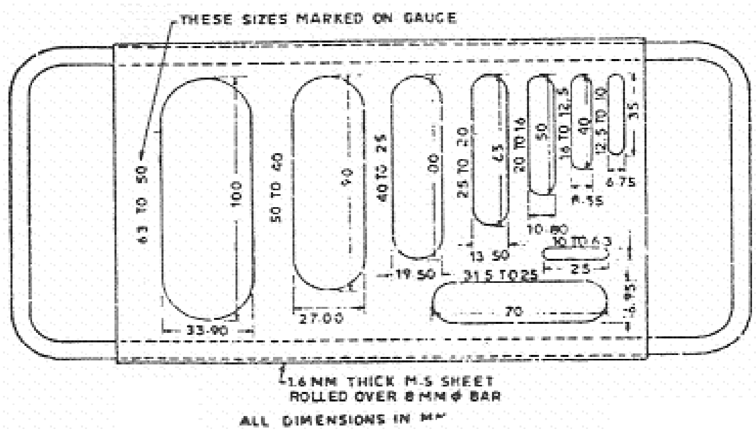
1. Standard thickness gauge.
2. I S sieves of sizes 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10, and 6.3mm
3. Balance.

Brief Theory: An aggregate having least dimensions less than 3/5th of its mean dimension is termed flaky. For base course, construction and cement concrete types, the presences of flaky & elongated particles are considered undesirable as they may cause inherent weakness as possibilities of breaking down under heavy loads.

Procedure:

1. Let the total weight of the sample will be W. Then sample is sieved with the sieves mentioned.
2. A minimum of 200 pieces of each fraction to be tested are taken and weighed.
3. In order to separate flaky materials, each fraction is passed in a specified slot of thickness gauge.
4. The amount of flaky material passing is weighed accurately and noted as w_1, w2, w3 .. .. & so on.

Sketch: -



Thickness Gauge

Observations & Calculation:-

Flakiness Index = $\frac{(W_1 + W_2 + \cdots\cdots)}{W} \times 100$ = ... %

Result: Flakiness Index of Aggregates = ... %

Reference Code: IS 2386-Part I - Indian standard methods of test for concrete

Experiment No: 14 **Date:**

SHAPE TEST – ELONGATION TEST

Aim: To determine the elongation Index of aggregates.

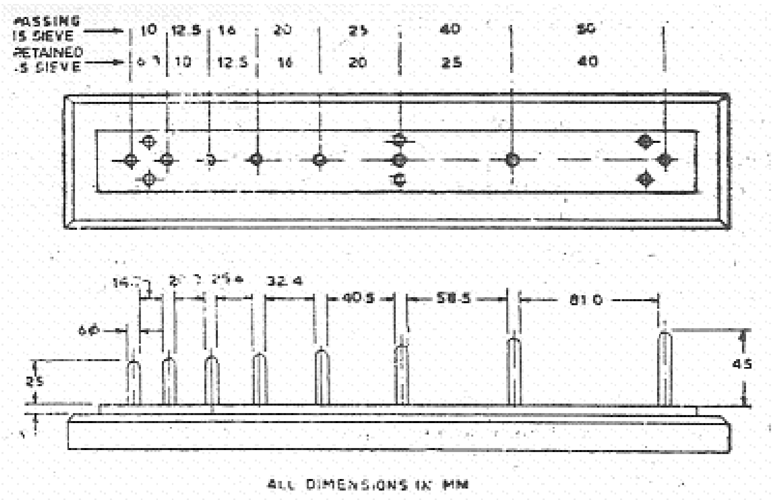
Apparatus: Length gauge, I S sieves 50, 40, 25, 20, 16, 12.5, 10, & 6.3mm, balance

Brief Theory: The elongation index of an aggregate is the particle having the largest dimension (length) is greater than 9/5 times the mean dimension. The presence of excess flaky and elongated particles is considered undesirable as they may cause inherent weakness with possibilities of breaking down under heavy loads. The elongation test is not applicable to sizes smaller than 6.3 mm.

Procedure:

1. Let the total weight of the sample will be W. Then sample is sieved with the sieves mentioned.
2. A minimum of 200 pieces of each fraction to be tested are taken and weighed.
3. In order to separate elongated materials, each fraction is passed in a specified slot of length gauge.
4. The amount of flaky material retained on length gauge slot is weighed accurately and noted as w_1 w_2 w_3 .... & so on.

Sketch:



Length Gauge

Observations & Calculation: -

Elongation Index = $\dfrac{W_1 + W_2 + W_3 + \cdots\cdots}{W}$ = ... %

Result: Elongation Index of Aggregates = ... %

Reference Code: IS 2386 Part I (Indian standard methods of test for concrete)

Experiment No: 15 **Date:**

MOISTURE CONTENT OF COARSE AGGREGATES

Aim: Determination of water content of coarse aggregate by oven drying method.

Theory: Water content ‘w’ of a coarse aggregate is defined as the ratio of mass of water in the voids to mass of solids.

Apparatus: Non-corrodible airtight containers, weighing balance, thermostatically controlled oven to maintain temperature, other accessories.

Procedure:

1. Clean the container with the lid and find the mass M_1.

2. Select the required quantity of moist coarse aggregate, place it in the container, place the lid on it, and weigh it M_2.

3. Keep the container in the oven with lid removed and dry it for at least 24 hr at a temperature of 110^0C till the mass remains constant.

4. Remove the container from the oven, replace the lid, and cool it in the desiccators. Find the mass M^3.

5. Determine the water content ‘w’ by using the equation given below.

Observations & Calculations:

Sl.No	**Particulars**	**1**	**2**	**3**
1	Mass of empty container M_1 (g)			
2	Mass of container + wet coarse aggregate M_2 (g)			
3	Mass of container + dry coarse aggregate M_3			

Specimen Calculation: **w%** $= \frac{(M_2-M_3)}{(M_3-M_1)} \times 100 =$ ……………………………………..

Result: Average w% = ……

Experiment No: 16 **Date:**

CONCRETE MIX DESIGN

Aim: producing a M40 grade concrete of the required, strength, durability, and workability as economically as possible.

Brief theory: The process of selecting suitable ingredients of concrete and determining their required quantities with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the fresh and the hardened states. If the fresh concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, is of vital importance.

Procedure:

A-0 An example illustrating the mix proportioning for a concrete of M40 grade is given in A-1 to A-12.

A-1 STIPULATIONS FOR PROPORTIONING

a) Grade designation : M40
b) Type of cement : PPC conforming to IS 1489 (Part 1)
c) Maximum nominal size of aggregate : 20 mm
d) Minimum cement content and maximum water-cement ratio to be adopted and/or Exposure conditions as per Table 3 and Table 5 of IS 456 : Severe (for reinforced concrete)
e) Workability : 75 mm (slump)
f) Method of concrete placing : Chute (Non pumpable)
g) Degree of site control : Good
h) Type of aggregate : Crushed angular aggregate
j) Maximum cement content not including fly ash : 450 kg/m^3
k) Chemical admixture type : Superplasticizer - normal

A-2 TEST DATA FOR MATERIALS

a) Cement used : PPC conforming to IS 1489 (Part 1)
b) Specific gravity of cement : 2.88
c) Chemical admixture : Superplasticizer conforming to IS 9103
d) Specific gravity of
   1) Coarse aggregate [at saturated surface dry (SSD) Condtion] : 2.74
   2) Fine aggregate [at saturated surface dry (SSD) Condtion] : 2.65
   3) Chemical admixture : 1.145
e) Water absorption
   1) Coarse aggregate : 0.5 percent
   2) Fine aggregate : 1.0 percent
f) Moisture content of aggregate [As per IS 2386 (Part 3)]
   1) Coarse aggregate : Nil
   2) Fine aggregate : Nil
g) Sieve analysis:
   1) Coarse aggregate :

IS Sieve Sizes mm	*Analysis of Coarse Aggregate Fraction*		*Percentage of Different Fractions*			*Remarks*
	I (20-10 mm)	II (10 - 4.75 mm)	I 60 percent	II 40 percent	Conforming 100 percent	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
20	100	100	60	40	100	Conforming to Table 7 of IS 383
10	0	71.20	0	28.5	28.5	
4.75		9.40		3.7	3.7	
2.36		0				

   2) Fine aggregate : Conforming to grading Zone II of Table 9 of IS 383

A-3 TARGET STRENGTH FOR MIX PROPORTIONING

$$f'_{ck} = f_{ck} + 1.65\ S$$
or
$$f'_{ck} = f_{ck} + X$$

whichever is higher.

where

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

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

S = standard deviation, and

X = factor based on grade of concrete.

From Table 2, standard deviation, S = 5 N/mm².

From Table 1, X = 6.5.

Therefore, target strength using both equations, that is,

a) $f'_{ck} = f_{ck} + 1.65\ S$
$= 40 + 1.65 \times 5 = 48.25$ N/mm²

b) $f'_{ck} = f_{ck} + 6.5$
$= 40 + 6.5 = 46.5$ N/mm²

The higher value is to be adopted. Therefore, target strength will be 48.25 N/mm² as 48.25 N/mm² > 46.5 N/mm².

A-4 APPROXIMATE AIR CONTENT

From Table 3, the approximate amount of entrapped air to be expected in normal (non-air-entrained) concrete is 1.0 percent for 20 mm nominal maximum size of aggregate.

A-5 SELECTION OF WATER-CEMENT RATIO

From Fig. 1, the free water-cement ratio required for the target strength of 48.25 N/mm² is 0.36 for OPC 43 grade curve. (For PPC, the strength corresponding to OPC 43 grade curve is assumed for the trial). This is lower than the maximum value of 0.45 prescribed for 'severe' exposure for reinforced concrete as per Table 5 of IS 456.

0.36< 0.45, hence O.K.

A-6 SELECTION OF WATER CONTENT

From Table 4, water content = 186 kg (for 50 mm slump) for 20 mm aggregate.

Estimated water content for 75 mm slump

$$= 186 + \frac{3 \times 186}{100}$$
$$= 191.58 \text{ kg}$$

As superplasticizer is used, the water content may be reduced. Based on trial data, the water content reduction of 23 percent is considered while using superplasticizer at the rate 1.0 percent by weight of cement.

Hence the water content

$$= 191.58 \times 0.77$$
$$= 147.52 \text{ kg} \approx 148 \text{ kg}$$

A-7 CALCULATION OF CEMENT CONTENT

Water-cement ratio = 0.36

Cement content $= \frac{148}{0.36} = 411.11$ kg/m³ ≈ 412 kg/m³

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

412 kg/m³> 320 kg/m³, hence, O.K.

A-8 PROPORTION OF VOLUME OF COARSE AGGREGATE AND FINE AGGREGETE CONTENT

From Table 5, the proportionate volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.50 = 0.62.

In the present case water-cement ratio is 0.36. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.14, the proportion of volume of coarse, aggregate is increased by 0.028 (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 0.36 = 0.62 + 0.028 = 0.648.

Volume of fine aggregate content = 1 – 0.648 = 0.352

A-9 MIX CALCULATIONS

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

a) Total volume = 1 m³

b) Volume of entrapped air in wet concrete = 0.01 m³

c) Volume of cement

$$= \frac{\text{Mass of cement}}{\text{Specific gravity of cement}} \times \frac{1}{1\,000}$$
$$= \frac{412}{2.88} \times \frac{1}{1\,000}$$
$$= \mathbf{0.143\ m^3}$$

d) Volume of water

$$= \frac{\text{Mass of water}}{\text{Specific gravity of water}} \times \frac{1}{1\,000}$$
$$= \frac{148}{1} \times \frac{1}{1\,000}$$
$$= \mathbf{0.148\ m^3}$$

e) Volume of chemical admixture (superplasticizer) (@ 1.0 percent by mass of cementitious material)

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

$$= \frac{4.12}{1.145} \times \frac{1}{1\,000}$$

= 0.003 6 m³

g) Volume of all in aggregate = [(a-b)-(c+d+e)]

= [(1-0.01) – (0.143 + 0.148 + 0.0 036)]

= 0.695 m³

h) Mass of coarse aggregate

= g × Volume of coarse aggregate × Specific gravity of coarse aggregate × 1 000

= 0.695 × 0.648 × 2.74 × 1 000

= 1 233.98 kg ≈ 1 234 kg

j) Mass of fine aggregate

= g × volume of fine aggregate × Specific gravity of fine aggregate × 1 000

= 0.695 × 0.352 × 2.65 × 1 000

= 648.29 kg ≈ 648 kg

A-10 MIX PROPORTIONS FOR TRIAL NUMBER 1

Cement	= 412 kg/m³
Water	= 148 kg/m³
Fine aggregate (SSD)	= 648 kg/m³
Coarse aggregate (SSD)	= 1 234 kg/m³
Chemical admixture	= 4.12 kg/m³,
Free water-cement ratio	= 0.36

NOTE — Aggregates shall 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 shall 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 percentage water absorption of aggregates shall be determined according to IS 2386.

A-11 ADJUSTMENT ON WATER, FINE AGGREGATE AND COARSE AGGREGATE (IF THE COARSE AND FINE AGGREGATE IS IN DRY CONDITION)

a) *Fine Aggregate (Dry)*

$$= \frac{\text{Mass of fine aggregate in SSD condition}}{1 + {}^{\text{Water absorption}}/_{100}}$$

$$= \frac{648}{1 + {}^{1}/_{100}}$$

$= 641.58 \text{ kg/m}^3 \approx 642 \text{ kg/m}^3$

b) *Coarse Aggregate (Dry)*

$$= \frac{\text{Mass of coarse aggregate in SSD condition}}{1 + {}^{\text{Water absorption}}/_{100}}$$

$$= \frac{1\,234}{1 + {}^{0.5}/_{100}}$$

$= 1\,227.86 \text{ kg/m}^3 \approx 1\,228 \text{ kg/m}^3$

The extra water to be added for absorption by coarse and fine aggregate,

1) For coarse aggregate
   = Mass of coarse aggregate in SSD condition – mass of coarse aggregate in dry condition
   = 1 234 – 1 228 = 6 kg
2) For fine aggregate
   = Mass of fine aggregate in SSD condition – mass of fine aggregate in dry condition
   = 648 – 642 = 6 kg

The estimated requirement for added water, therefore, becomes

= 148 + 6 + 6 = 160 kg/m³

A-12 MIX PROPORTIONS AFTER ADUSTMENT FOR DRY AGGREGATES

Cement	= 412 kg/m³
Water (to be added)	= 160 kg/m³
Fine aggregate (Dry)	= 642 kg/m³
Coarse aggregate (Dry)	= 1 228 kg/m³
Chemical admixture	= 4.12 kg/m³
Free water-cement ratio	= 0.36

A-13 The total mass of coarse aggregate shall be divided into two fractions of 20 - 10 mm and 10 - 4.75 mm, in a suitable ratio, to satisfy the overall grading requirements for 20 mm max size aggregate as per Table 7 of IS 383. In this example, the ratio works out to be 60:40 as shown under **A-2** (g).

A-14 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-15 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.

Result:

- The cement content required for M25 grade concrete is ……………..
- The Fine aggregate content required for M25 grade concrete is ……………..
- The coarse aggregate content required for M25 grade concrete is ……………..
- The water content required for M25 grade concrete is ……………..

Conclusion:

Reference Code: **- IS 10262-2019 Guidelines for Concrete Mix design**

IS 269 – 1976 Specifications for ordinary and low Portland cement.

IS 383 Specification for Fine aggregate and Coarse aggregates.

<u>Viva Questions</u>

1. Define concrete mix and factors affecting the concrete mix design.
2. State the requirements of good concrete mix.
3. What is meant by Nominal mix?
4. What is meant by Standard mix?
5. List out various tests on Fine Aggregate?
6. List out various tests on Coarse Aggregate?

Experiment No: 17 (EXTRA) **Date:**

SLUMP TEST

Aim: To determine the consistency of concrete mix of given proportions by the slump test.

Apparatus: Iron pan to mix concrete, weighing platform spatula, trowels, slump test apparatus with 300 mm scale, tamping rod, balance to weigh up to 30 kg

Brief Theory: Unsupported fresh concrete, flows to the sides and a sinking in height takes place. This vertical settlement is known as slump. In this test fresh concrete is filled into a mould of specified shape and dimensions and the settlement or slump is measured when supporting mould is removed. Slump increases as water-content is increased.

Procedure: Four mixes are to be prepared with water cement ratio of 0.50. 0.60.0.70 and 0.80 respectively, for required mix of concrete

1. Dry Mix the constituents thoroughly to get a uniform colour and then add water. Place the mixed concrete in the cleaned slump cone mould in 4 layers, each approximately ¼ of the height of the mould. Tamp each layer 25 times with tamping rod distributing the strokes in a uniform manner over the cross section of the mould. For the second and subsequent layers the tamping rod should penetrate in to the under laying layer.
2. Strike off the top with a trowel or tamping rod so that the mould is exactly filled.
3. Remove the cone immediately, raising it slowly and carefully in the vertical direction.
4. As soon as the concrete settlement comes to a stop, measure the subsidence of concrete (in mm), which will give the slump.

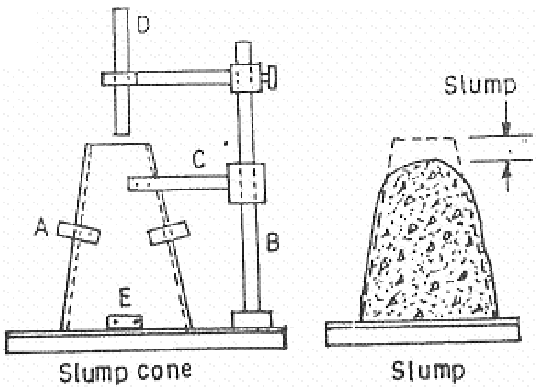
Result:

Water Cement Ratio	Slump
0.5	
0.6	
0.7	
0.8	

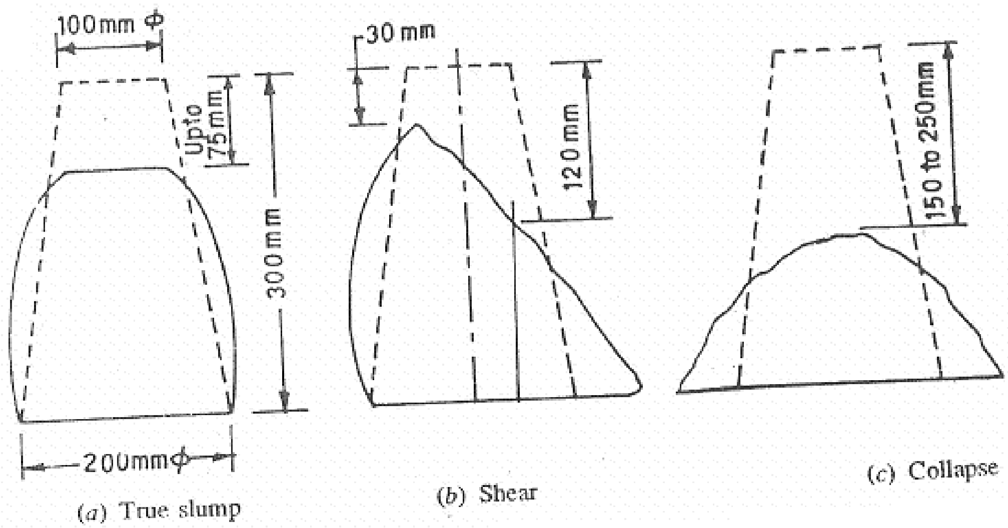
IS Specifications:

Sl. No	Name of Works	Slump mm	Water Cement Ratio
01	Concrete for roads & mass concrete	25 to 50	0.70
02	Concrete for R.C.C beams and slabs	50 to 100	0.55
03	Columns and retaining walls	75 to 125	0.45
04	Mass concrete in foundation	25 to 50	0.70

Conclusion:



. The slump cone and slump.



Types of Slump

Reference Code: - IS: 1199 - 1959

<u>Viva Questions</u>

1. Define Workability.

2. Name the field tests for measuring the workability of fresh concrete**.**

3. How will you measure the slump?

4. State the different types of slump and its practical importance.

5. Sketch and write the detail features of slump cone.

6. Slump of 25mm indicates___________

Experiment No: 18 (EXTRA) **Date:**

COMPACTION FACTOR TEST

Aim: To determine the workability of concrete mix of given proportions by the compaction factor test.

Apparatus: Compaction factor apparatus, trowels, measuring jar, balance, tamping rod.

Theory: Compaction factor is adopted to determine the workability of concrete, where nominal size of the aggregate does not exceed 40 mm. It is based upon the definition, that workability is that property of the concrete which determines the amount of work required to produce full compaction.

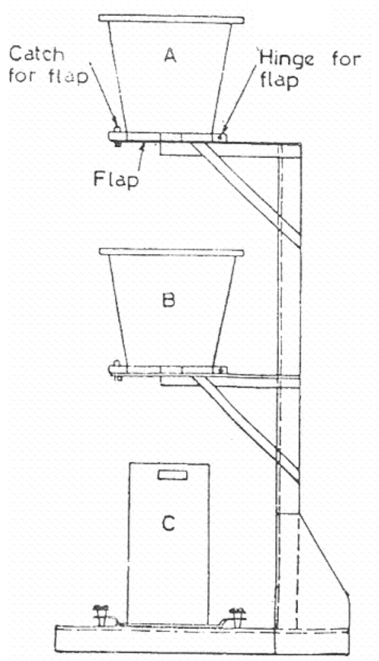
Procedure:

1. Keep the compaction factor apparatus on a leveled ground and apply grease on the inner surface of the hopper and cylinder.
2. Fasten the flap doors.
3. Weigh the empty cylinder accurately and note down the mass as W_1 kg.
4. Four mixes are to be prepared with water cement ratio 0.5, 0.6, 0.7 & 0.8 respectively for required mix of concrete
5. Mix ingredients thoroughly until homogeneous is obtained.
6. Fill the freshly mixed concrete in the upper hopper gently and carefully without compacting
7. After 2 minutes, release the trap door so that the concrete falls in to the lower.
8. Immediately after the concrete has come to rest open the trap door of lower hopper and allow the concrete to fall into the cylinder
9. Remove the excess concrete above the top of the cylinder and find the mass of partially compacted concrete say w_2 kg.
10. Refill the cylinder with the same sample of concrete in 4 layers tamping each layer of 25 times and weigh the cylinder filled with fully compacted concrete say W_3 kg.

Observation & Calculations:

Sl. No	Water Cement Ratio	Mass with partially compacted concrete W_2	Mass with fully compacted concrete W_3	Mass with partially compacted concrete $W_2 - W_1$	Mass with fully compacted concrete $W_3 - W_1$	Compaction Factor = [$W_2 - W_1/W_3 - W_1$]
01	0.5					
02	0.6					
03	0.7					
04	0.8					

Sketches:



Result: Plot a curve between water cement ratio and compaction factor.

Conclusion: It is more precise and sensitive than slump test and is particularly useful for concrete mixes of low workability as are normally used when the concrete is to be compacted by vibration, such concrete may constantly fail to slump.

Reference Code: -

IS: 1199 – 1959 – Specification to find workability of freshly prepared concrete

Viva Questions

1. Compaction factor =
2. How will you compare the slump cone and compacting factor test? Which is most suitable, why?
3. What is meant by Nominal mix?
4. What is meant by Standard mix?
5. Difference between fully compacted and partially compacted concrete?
6. What is the significance of compacting concrete?
7. Define density of concrete & how it affects the strength of concrete?

Experiment No: 19 (EXTRA) **Date:**

VEE – BEE CONSISTOMETER TEST

Aim: To determine the workability of concrete mix of given proportions by the Vee-Bee Consistometer.

Apparatus: Vee-bee apparatus, trowels, measuring jar, balance, tamping rod, a cylindrical container and a sheet metal slump cone.

Procedure:

1. Place the slump cone in the cylindrical container of the Consistometer. Fill the cone in four layers, each approximately one quarter of the height of the cone. Tamp each layer with twenty five strokes of the rounded end of the tamping rod. The strokes are distributed in a uniform manner over the cross-section of the cone and for the second and subsequent layer the tamping bar should penetrate into the underlying layer. After the top layer has been rodded, Struck off level the concrete with a trowel so that the cone is exactly filled

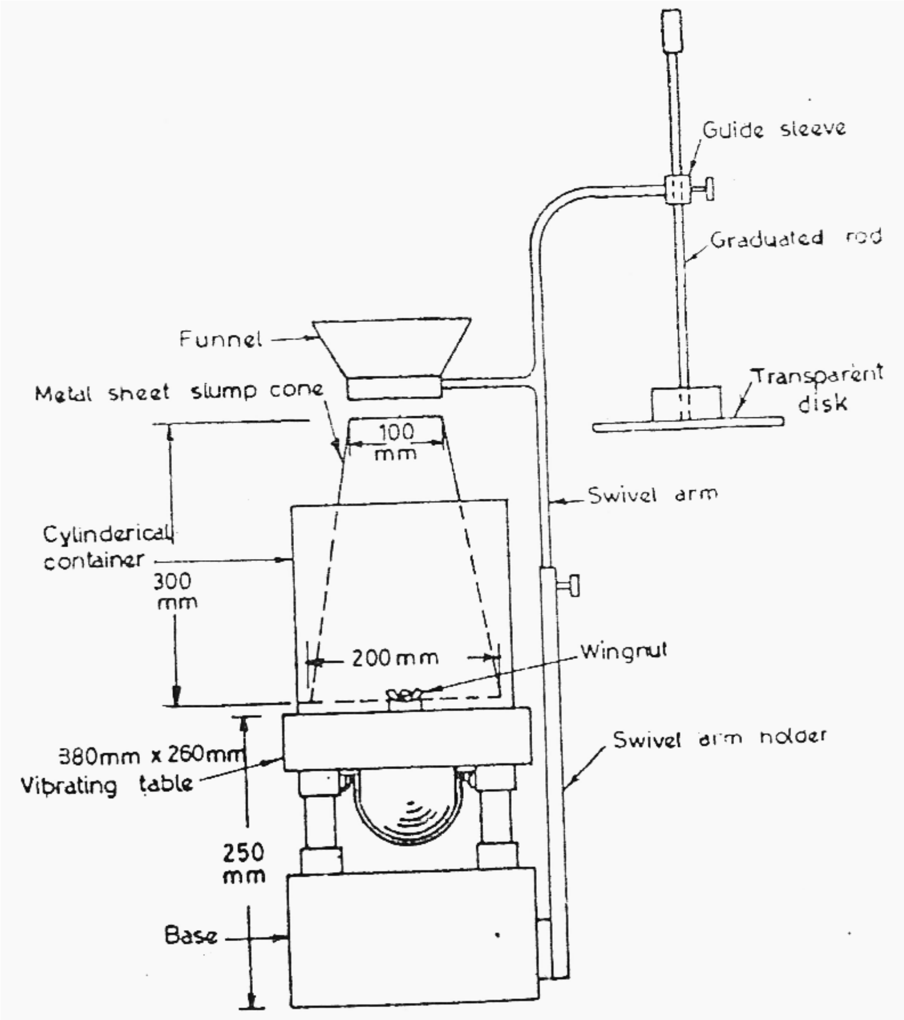
2. Move the glass disc attached to the swing arm and place it just on the top of the slump cone in the cylindrical container. Adjust the glass so as to touch the top of the concrete cone, and note the initial reading on the graduated rod.

3. Remove the cone from the concrete immediately by raising it slowly and carefully in the vertical direction. Lower the transparent disc on the top of concrete. Note down the reading on the graduated rod.

4. Determine the slump by taking the difference between the readings on the graduated rod recorded in the steps (2) and (3) above.

5. Switch on the electrical vibrator and start the stop watch simultaneously. Allow the concrete to remould by spreading out in the cylindrical container. The vibrations are continued until the concrete is completely remolded that is the surface becomes horizontal

6. Record the time required for complete remolding in second which measures the workability expressed as number of Vee – Bee seconds.



Consistometer (IS : 1199-1959).

Result: The consistency of the concrete is .... Vee – Bee Seconds

Reference Code: - IS: 1199 - 1959

Viva Questions

1. Describe the factors affecting the choice of the method of test.
2. What are the advantages and disadvantages of Vee-Bee method of test over the Other Methods?
3. What is meant by segregation and bleeding of concrete mix?
4. What is meaning of Consistency in concrete?

Experiment No: 20 (EXTRA) **Date:**

SLUMP FLOW TEST

Aim: To assess the horizontal free flow of Self Compacted Concrete in absence of obstruction.

Apparatus: The following apparatus are required for the test.

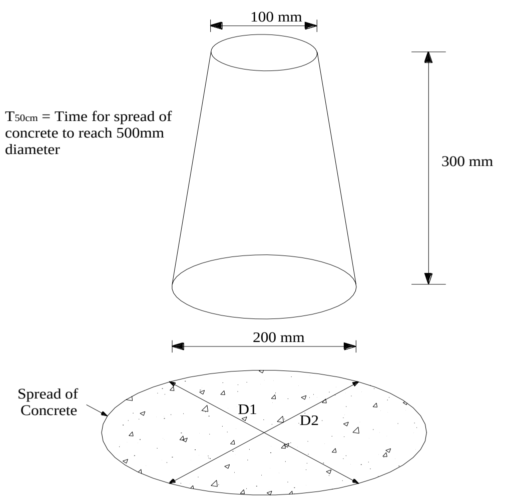
1. Mould in the shape of a truncated cone with the internal dimensions 200 mm diameter at the base, 100mm diameter at the top and a height of 300 mm.
2. Base plate of a stiff none absorbing material, at least 1000 mm square, marked with a concentric circle of 200 mm, 500mm, 650mm, 800mm,
3. Trowel, Scoop, Ruler, Stopwatch (optional)

Brief Theory: The slump flow test aims at investigating the filling ability of SCC. It measures two parameters: flow spread and flow time T50 (optional). The former indicates the free, unrestricted deformability and the latter indicates the rate of deformation within a defined Flow distance.

Procedure:

- About 15 Kgs concrete is needed to perform the test, sampled normally. Moisten the base plate and inside of slump cone.
- Place base plate on level stable ground and the slump cone centrally on the base plate and hold down firmly.
- Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with the trowel.
- Remove any surplus concrete from around the base of the cone
- Raise the cone vertically and allow the concrete to flow out freely
- Simultaneously, start the stopwatch and record the time taken for the concrete to reach the 500 mm spread circle.
- Measure the final diameter of the concrete is three perpendicular directions.
- Calculate the average of three measured diameter (This is the slump flow in mm)

Sketch:



Slump Flow = $(D_1 + D_2 + D_3) / 3$.

Where, D_1 , D_2 , D_3 are approximate perpendicular to each other

Result: The slump flow of self-compacted concrete is .... mm

Conclusion:

Reference Code: -

ASTM Standards: C 1611/C 1611M– 05 and EFNARC guidelines

Viva Questions

1. What is application of slump flow test for SCC?
2. What is slump flow test?
3. What are the acceptable values for slump flow?

Experiment No: 21 **Date:**

COMPRESSIVE STRENGTH OF CONCRETE

Aim: To determine the compressive strength of concrete

Apparatus: Standard size mould, tamping rod, balance, weight box & compression testing machine

Brief Theory: The strength of compression has a definite relationship with all the properties of concrete. The height of the specimen and its lateral dimensions greatly influences the result.

Procedure:

1. Calculate the material required for the mix (1:2:4) with water cement ratio 0.6
2. Sieve the fine aggregate using 4.75mm and coarse aggregate using 10mm IS sieve.
3. Weigh the required quantity of materials.
4. Add the required quantity of water to the dry mix and mix thoroughly.
5. Fill the mould with the mix in three layers by giving 25 blows in each layer.
6. After 24 hours remove the specimen from the mould.
7. Place the specimen in water for curing.
8. After 28 days curing the specimen is placed in compression testing machine for testing.
9. The load is increased until the specimen fails. Note down the maximum loading at which specimen fails.

Observations & calculations:

Dimension = ...

Volume of the cube = ...

Density of cement concrete = 2400 kg /m^3

Weight of cement concrete = ...

Add 10 % wastage to total weight of cement concrete = ...

For 1:2:4 proportion

Weight of cement = 1/7x total weight

Weight of sand = 2/7 x total weight

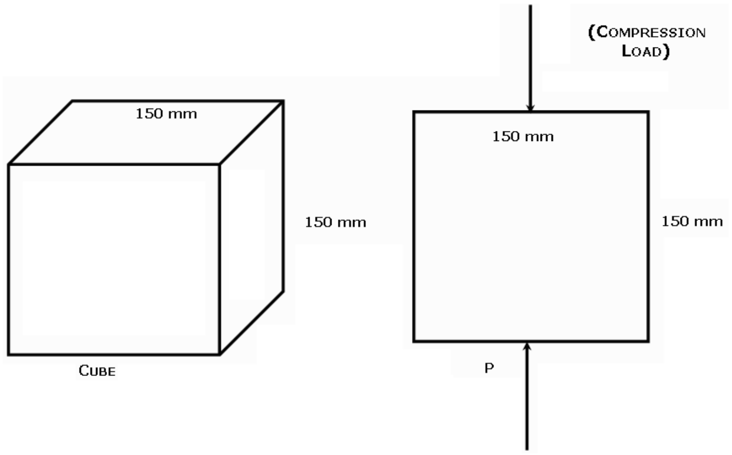
Weight of coarse aggregate = 4/7x total weight

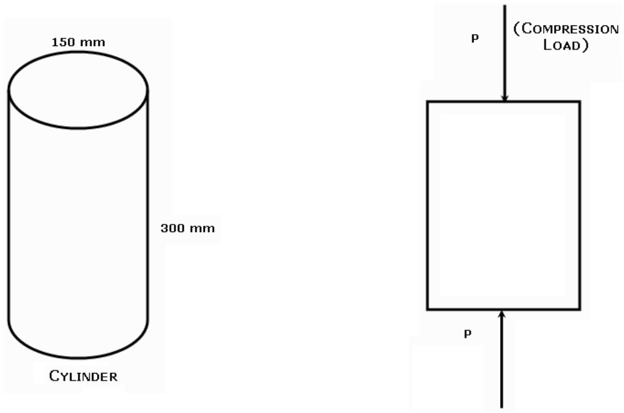
Assume 0.6 water cement ratio, weight of water = ...

Area = ...

Compressive stress = load /area = ...

Sketch: -





Result: The compressive strength of cement concrete = **..............................**

Reference Code: IS 516 – 1959 Method of test for strength

<u>Viva Questions</u>

1. How does strength correlate with other properties of hardened concrete?
2. Define grade of concrete and give the IS practice.
3. Define compressive strength of concrete. How compressive strength of concrete is Determined and give the IS specifications.
4. Give the sequence of process in the preparation of concrete
5. What are the requirements for curing the specimens?

Experiment No: 22 (EXTRA) **Date:**

SPLIT TENSILE STRENGTH OF CONCRETE

Aim: Determine the split tensile strength of the given concrete mix

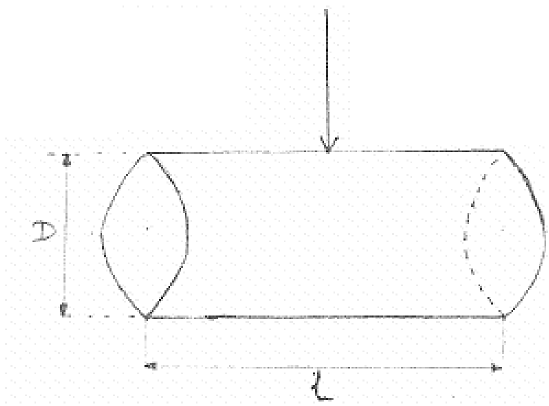
Apparatus: CTM, bearing plate, trowel, mould, tamping rod etc.

Brief Theory: Tensile strength is one of the basic and important properties of concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However the determination of tensile strength of concrete is necessary to know the load at which the concrete member may crack. The cracking is a form of tension failure.

Procedure:

1. Calculate the materials required for the given proportion and quantity of water.
2. Weigh the required materials.
3. Mix the materials thoroughly to obtain a uniform mix.
4. Add the required quantity of water and mix well.
5. Fill the mould in three different layers and each layer should be tamping with 25 blows.
6. After 24 hours remove the specimen from the mould.
7. Place the specimen in water for curing for 28 days.
8. After curing it is tested in compression testing machine.

Sketch:



Observations & Calculations:

Split tensile strength = **2P/ Π DL = ... N/mm^2**
P =load in Newton, D =diameter of specimen, l =length of specimen

Result: The split tensile strength is .... N/mm^2

Reference Code: IS 5816 – 1970 Splitting Tensile Strength of Concrete Method of test.

Viva Questions

1. Define Tensile strength of concrete?
2. What is relation of compressive strength and split tensile strength?
3. What are the different methods of determining the tensile strength of concrete?
4. What is significance of split tensile test?
5. What is difference between direct tensile strength and indirect tensile strength?

Experiment No: 23 **Date:**

TEST ON FLEXURAL STRENGTH OF BEAMS

Aim: To determine, the strength of concrete using flexural test

Apparatus: The following apparatus are required for the test.

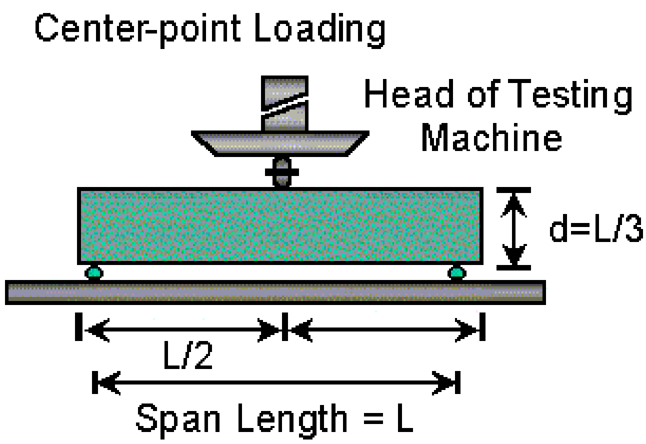
1. Prism mould (15 cm x 15 cm x 70 cm)
2. Universal Testing Machine

Brief Theory: Concrete is relatively strong in compression and weak in tension. In RCC concrete members, little dependence is placed on tensile strength of concrete since steel reinforcing bars are provided to resist all tensile forces. However, tensile stresses are likely to develop in concrete due to drying shrinkage, rusting of steel reinforcement, temperature gradient and many other reasons. Therefore, the knowledge of tensile strength of concrete is of importance.

Procedure:

1. Test specimens are stored in water at a temperature of 24^{o} C to 30^{o} C for 48 hours before testing. The dimension of each specimen should be noted before testing.
2. The bearing surface of the supporting and loading rollers is wiped and clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers.
3. The specimen is then placed in the machine in such manner that the load is applied to the upper most surface as cast in the mould
4. The axis of specimen is carefully aligned with the axis of the loading device. No packing is used between the bearing surfaces of the specimen and rollers.
5. The load is applied without shock and increasing continuously at a rate of the specimen. The rate of loading is 4kN/min for the 15cm specimen and 18 kN/min for the 10cm specimen.
6. The load is increased until the specimen fails and the maximum load applied to the specimen during the test is recorded

Sketch:



Flexural Testing on concrete

Result: The flexural strength of concrete is .... N/mm^2

IS Specification:

Conclusion:

Reference Code: -

IS 7246 – 1974 Recommendations for use of table vibrators consolidating concrete

IS 4031 - part 7 - 1988 Method of test for strength of concrete

IS 269: 1967 Specifications for ordinary and low Portland cement

IS: 650 – 1966 Specification for standard sand for testing of cement

Viva Questions

1. What does the flexure test measure?
2. Why is the flexure test preferred against tension test?
3. What is the size requirement for flexure test specimen?
4. How are flexure test result expressed?
5. What is approximate ratio of compressive strength to the tensile strength and to the flexural strength?
6. What is the bending equation?
7. What is the bending stress for ‘T’ section?
8. What is the significance of moment of inertia with respect to bending stress?
9. How does the centroid affects the bending stress for different shapes of beams?

Experiment No: 24 (EXTRA) **Date:**

NDT TEST BY REBOUND HAMMER AND PULSE VELOCITY TEST

Aim: Assessing the quality of the concrete in relation to standard requirements

Apparatus: The following apparatus are required for the test.

1. Rebound hammer

2. Ultra-sonic pulse velocity equipment (Electrical pulse generator, Transducer One pair, Amplifier, Electronic timing device)

Brief Theory:

The rebound hammer method could be used for

(a) Assessing the likely compressive strength of concrete with the help of suitable co relations between rebound index and compressive strength.

(b) Assessing the uniformity of concrete

(c) Assessing the quality of the concrete in relation to standard requirements

(d) Assessing the quality of one element of concrete in relation to another

The ultrasonic pulse velocity method could be used to establish

(a) The homogeneity of the concrete,

(b) The presence of cracks, voids and other imperfections

(c) Changes in the structure of the concrete which may occur with time,

(d) The quality of the concrete in relation to standard requirements,

(e) The quality of one element of concrete in relation to another

(f) The values of dynamic elastic modulus of the concrete

Procedure:

REBOUND HAMMER TEST

1. Hammer should be held at right angles to them surface of the concrete member
2. The test can thus be conducted horizontally on vertical surfaces or vertically upwards or downwards on horizontal surfaces
3. Around each point of observation six readings of rebound indices are taken 2nd average of these readings after deleting outliers as per IS 8900: 1978 becomes the rebound index for the point of observation.

ULTRA-SONIC PULSE VELOCITY TEST

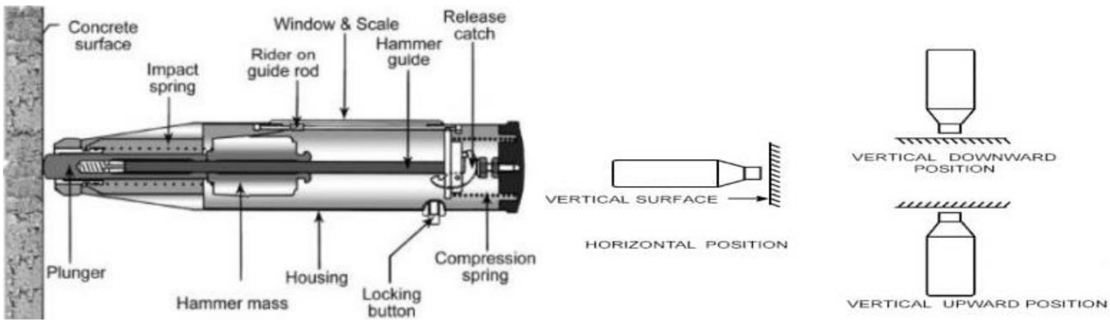
1. Test essentially consists of measuring travel time, T of ultrasonic pulse of 50 to 54 kHz, produced by an electro-acoustical transducer, held in contact with one surface of the concrete member under test and receiving the same by a similar transducer in contact with the surface at the other end.

2. The path length L, (i.e. the distance between the two probes) and time of travel T, the pulse velocity (V=L/T) is calculated.

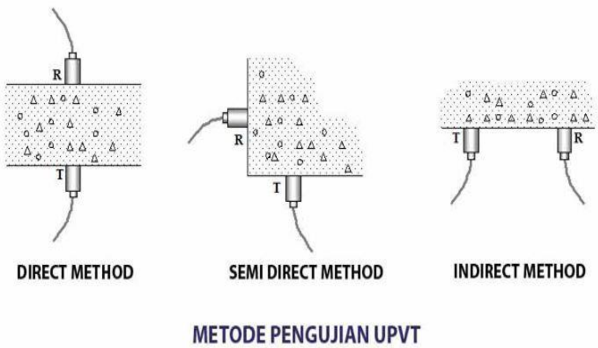
3. Higher the elastic modulus, density and integrity of the concrete, higher is the pulse velocity. The ultrasonic pulse velocity depends on the density and elastic properties of the material being tested.

Sketch:

REBOUND HAMMER



ULTRA SONIC PULSE VELOCITY



Result:

REBOUND HAMMER TEST

After obtaining the correlation between compressive strength and rebound number, the strength of structure can be assessed. In general, the rebound number increases as the strength increases and is also affected by a number of parameters i.e. type of cement, type of aggregate, surface condition and moisture content of the concrete, curing and age of concrete, carbonation of concrete surface.

ULTRA-SONIC PULSE VELOCITY

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

IS Specification:
Conclusion:

Reference Code: -

IS: 13311 (Pat 2) - 1992, Methods of non-destructive testing of concrete Rebound Hammer.

Viva Questions

1. What is rebound hammer?
2. What is significance and use of this test?
3. What are the factors affecting rebound hammer of concrete mixtures?
4. What is relation between rebound number and the strength of the existing structure?
5. What are the factors influencing the pulse velocity in concrete?
6. How does resonance method differ from pulse velocity method