# Lab Manual

# CONCRETE TECHNOLOGY

## SPRING-2019


Department of Civil Engineering

*NATIONAL INSTITUTE OF TECHNOLOGY*

*HAZRATBAL,SRINAGAR-(190006)*

# Vision of the Institute

To establish a unique identity of a pioneer technical Institute by developing a high-quality technical manpower and technological resources that aim at economic and social development of the nation as a whole and the region in particular keeping in view the global challenges.

## Mission of the Institute

**M1.** To create a strong and transformative technical educational environment in which fresh ideas, moral principles, research and excellence nurture with international standards.

**M2.** To prepare technically educated and broadly talented engineers, future innovators and entrepreneurs, graduates with understanding of the needs and problems of the industry, the society, the state and the nation.

**M3.** To inculcate the highest degree of confidence, professionalism, academic excellence and engineering ethics in budding engineers.

## VISION OF THE DEPARTMENT

To nurture Civil engineers with passion for professional excellence, ready to take global challenges and to serve the society with high human values.

## MISSION STATEMENT OF THE DEPARTMENT

**(1)** To provide facilities and infrastructure for academic excellence in the field of Civil engineering.

**(2)** To inculcate in the student the passion for understanding professionalism, ethics, safety, sustainability and then actively contribute in the society.

**(3)** To nurture creativity and encourage innovative solutions to real life challenging problems in Civil engineering students.

**(4)** To prepare student for lifelong learning in global perspective.

## PROGRAM EDUCATIONAL OBJECTIVES

PEO1: To prepare students to get employment, profession and/or to pursue post-graduation and research in Civil engineering discipline in particular and allied engineering fields in general.

PEO2: To prepare students to identify and analyse Civil engineering problems in an iterative approach that involves defining, quantifying, testing and review of the identified problem.

PEO3: To prepare students to plan, organize, schedule, execute and communicate effectively as an individual, a team member or a leader in multidisciplinary environment.

PEO4: To provide the students, an academic environment that makes them aware of excellence in field of Civil Engineering and enables them to understand significance of lifelong learning in global perspective.

## Introduction

The behavior and properties of structural materials, e.g. concrete, asphalt and steel can be better understood by detailed, well-designed, first hand experience with these materials. The students will become familiar with the nature and properties of these materials by conducting laboratory tests. These tests have been selected to illustrate the basic properties and methods of testing of cement, aggregates, paste, mortar, concrete, asphalt and steel. Test procedures, sometimes simplified because of time limitation, are mostly those outlined by the Indian Standards.

## Course Objectives

1. To prepare the students to effectively link theory with practice and application and to demonstrate background of the theoretical aspects.
2. To prepare the students to generate and analyze data using experiments and to apply elements of data statistics.
3. To prepare the students to have hands on experiments and to have exposure to equipment and machines
4. To prepare the students to solve problems including design elements and related to their course work.
5. To encourage the students to use computers in analyzing the data.
6. To emphasize the knowledge and application of safety regulations.

## Student Responsibilities

1. In the very beginning of the laboratory work, the students will be organized into groups. For this reason, regular attendance is strictly required.
2. Every laboratory session is divided into two parts. In the first part, the instructor will be lecturing on the test objective, procedure and data collection. In the second part, the students, organized in groups, are required to conduct the field work. In order to perform the field work within the assigned period, and to gain the maximum benefit from the field work, the students must familiarize themselves with the purpose, objective, and procedure of the experiment before coming to the laboratory. Relevant lecture notes and laboratory manual should be studied carefully and thoroughly.
3. At the end of the test, every group should submit a draft sheet of the data collected for approval by the instructor.
4. It should be understood that laboratory facilities and instruments are provided to enhance the learning process and to give first hand experience of surveying.
5. The instruments and tools must be properly cared and cleaned during and after every laboratory session. Also, students should always take precautions to avoid any possible hazards. Students must follow laboratory regulations provided at the end of this section.

## Laboratory Regulations

1. Make sure that you know the location of Fire Extinguishers, First Aid Kit and Emergency Exits before you start your experiments.
2. Get First Aid immediately for any injury, no matter how small it is.
3. Do not wear loose dress

4. Always use close shoes (i.e. safety or boots)
5. Do not play with valves, screws and nuts.

*List of experiments as per NIT,Srinagar Curriculum*

## 1. Cement



## 2. Fresh Concrete



## 3. Hardened Concrete



## 4. Aggregates



## 5. Non-destructive testing of concrete

# NORMAL CONSISTENCY OF CEMENT

## EXPERIMENT NO. : 1

## AIM:

To determine the quantity of water required to produce a cement paste of standard consistency.

## APPARATUS:

- Vicat's apparatus conforming to IS: 5513-1976
- Weighing Balance
- Gauging Trowel
- Stop Watch.

## REFERENCE CODE:

- IS: 4031 (Pat 4) – 1988 methods of physical test for hydraulic cement
- IS : 5513-1996 for specification for Vicat's apparatus.

## THEORY:

The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the vicatmould. For finding out initial setting time, final setting time, soundness of cement and compressive strength of cement, it is necessary to fix the quantity of water to be mixed in cement in each case.

## PROCEDURE:

1. Prepare a paste of weighed quantity of cement (300 grams) with a weighed quantity of potable or distilled water, starting with 26% water of 300g of cement.
2. Take care that the time of gauging is not less than 3 minutes, not more than 5 minutes and the gauging shall be completed before setting occurs.
3. The gauging time shall be counted from the time of adding the water to the dry cement until commencing to fill the mould.
4. Fill the vicatmould with this paste, the mould resting upon a non porous plate.
5. After completely filling the mould, trim off the surface of the paste, making it in level with the top of the mould. The mould may slightly be shaken to expel the air.
6. Place the test block with the mould, together with the non-porous resting plate, under the rod bearing the plunger (10mm diameter), lower the plunger gently to touch the surface of the test block and quickly release, allowing it to penetrate into the paste.
7. This operation shall be carried out immediately after filling the mould.
8. Prepare trial pastes with varying percentages of water and test as described above until the amount of water necessary for making the standard consistency as defined above is obtained.

9. Express the amount of water as a percentage by weight of the dry cement. Repetition of the experiment fresh cement is to be taken.

## OBSERVATION AND CALCULATION:

1. Type of cement…….
2. Brand of cement……..
3. Time of Test…….
4. Room Temperature……

| Trail No. | Weight of cement (g) | Percentage by water of dry Cement (%) | Amount of water added (mL) | Penetration (mm) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

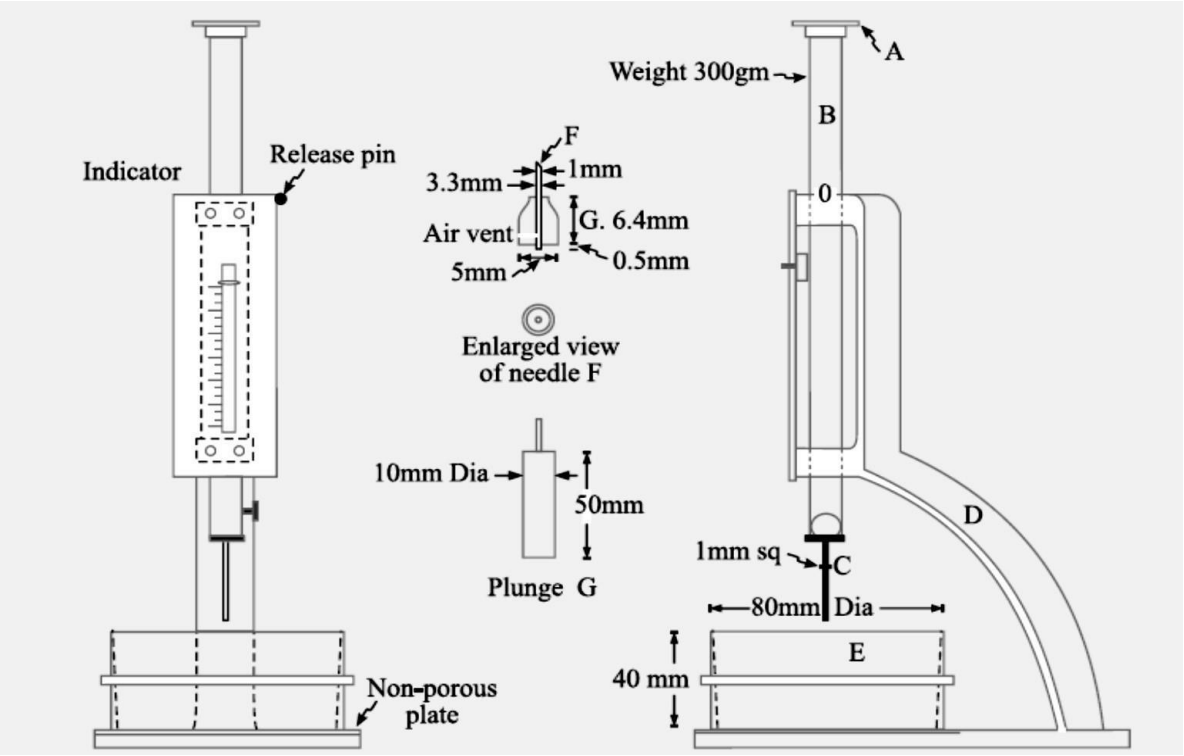


Figure 1: Vicat's Apparatus

## RESULT:

Normal consistency for the given sample of cement is.....%

# DETERMINATION OF SETTING TIME OF STANDARDCEMENT PASTE

## EXPERIMENT NO. : 2

**AIM:** To determine the initial and final setting time of a given sample of cement.

## APPARATUS:

- Vicat apparatus conforming to IS : 5513-1976
- Weighing Balance
- Glass plate
- Gauging Trowel
- Stop Watch

## REFERENCE CODE:

- IS: 4031 (Pat 4) – 1988 methods of physical test for hydraulic cement
- IS : 5513-1996 for specification for Vicat's apparatus.

## THEORY:

Initial setting time is regarded as the time elapsed between the moments that the water is added to the cement to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment the water is added to the cement and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain definite pressure.

## PROCEDURE:

1. Preparation of Test Block: - Prepare a neat 300 gms cement paste by gauging the cement with 0.85 times the water required to give a paste of standard consistency. Potable or distilled water shall be used in preparing the paste.
2. Start a stop-watch at the instant when water is added to the cement. Fill the Vicat mould with a cement paste gauged as above and the mould resting on a nonporous plate. Fill the mould completely and smooth off the surface of the paste making it level with the top of the mould.
3. Immediately after moulding, place the test block in the moist closet or moist room and allow it to remain there except when determinations of time of setting are being made.
4. Determination of Initial Setting Time: - Place the test block confined in the mould and resting on the non-porous plate, under the rod bearing the needle lower the needle gently until it comes in contact with the surface of the test block and quickly release, allowing it to penetrate into the test block
5. Repeat this procedure until the needle, when brought in contact with the test block and released as described above, fails to pierce the block beyond 5.0 ± 0.5 mm

measured from the bottom of the mould shall be the initial setting time.

6. Determination of Final Setting Time: - Replace the needle of the Vicat apparatus by the needle with an annular attachment.
7. The cement shall be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression there on, while the attachment fails to do so.
8. The period elapsing between the time when water is added to the cement and the time at which the needle makes an impression on the surface of test block while the attachment fails to do so shall be the final setting time.

## OBSERVATION:

1. Type of cement=……
2. Brand of cement = ……..
3. Weight of given sample of cement is =.....g
4. The normal consistency of a given sample of cement is=.....%
5. Volume of water addend for preparation of test block = ..... mL

| S. No. | Setting Time (min) | Penetration (mm) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

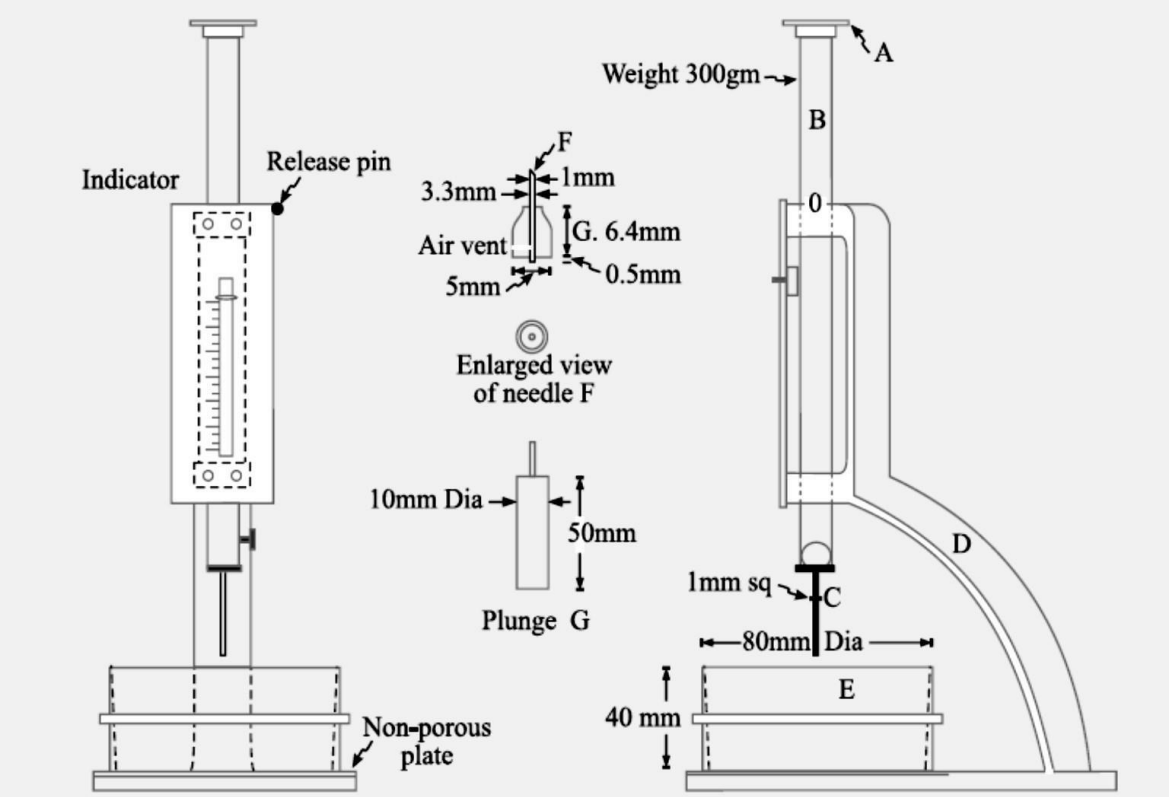


Figure: Vicat's Apparatus

## RESULT:

1. The initial setting time of the cement sample is found to be..... minutes
2. The final setting time of the cement sample is found to be..... minutes

# SPECIFIC GRAVITY OF CEMENT

## EXPERIMENT NO. : 3

## AIM:

To determine the specific gravity of given sample of cement.

## APPARATUS:

- Weighing balance
- specific gravity bottle (50ml capacity)
- kerosene
- funnel

## INTRODUCTION:

Specific gravity is defined as the ratio between weight of a given volume of material and weight of an equal volume of water. To determine the specific gravity of cement, kerosene is used which does not react with cement.

## PROCEDURE:

1. Clean and dry the specific gravity bottle and weigh it with the stopper (W1).
2. Fill the specific gravity bottle with cement sample at least half of the bottle and weigh with stopper (W2).
3. Fill the specific gravity bottle containing the cement, with kerosene (free of water) placing the stopper and weigh it (W3) ,While doing this do not allow any air bubbles to remain in the specific gravity bottle.
4. After weighing the bottle, the bottle shall be cleaned and dried again.
5. Then fill it with fresh kerosene and weigh it with stopper (W4).
6. Remove the kerosene from the bottle and fill it with full of water and weigh it with stopper (W5).

## OBSERVATIONS:

| Description of item | Trial 1 | Trial 2 |
|---|---|---|
| Weight of empty bottle($W_1$ g) | | |
| Weight of bottle + Cement ( $W_2$ g) | | |
| Weight of bottle + Cement + Kerosene( $W_3$ g) | | |
| Weight of bottle + Full Kerosene( $W_4$ g) | | |
| Weight of bottle + Full Water( $W_5$ g) | | |

$$\text{Specific gravity of Cement} = \frac{(W_2 - W_1) \times (W_4 - W_1)}{((W_4 - W_1)-(W_3-W_2)) \times (W_5 - W_1)}$$


Figure: Specific Gravity Bottle

## RESULTS:

Specific gravity of given Cement =----------

# FINENESS TEST OF CEMENT BY SIEVE ANALYSIS

## EXPERIMENT NO. : 4

**AIM:** To determine the fineness of the cement of the given sample by sieve analysis.

## APPARATUS:

- IS: 90μ test sieve
- bottom pan
- weighing balance,
- brush

## REFERENCE CODE:

- IS 4031 (PART1): 1988
- IS460 (PART1): 1985

## THEORY:

The degree of fineness of cement is a measure of the mean size of the grains. The finer cement has quicker action with water and gains early strength without change in the ultimate strength. Finer cement is susceptible to shrinkage and cracking.

**PROCEDURE:**

1. Accurately weigh 100 g of cement sample and place it over the test sieve. Gently breakdown the air set lumps if any with fingers.
2. Hold the sieve with pan in both hands and sieve with gentle wrist motion, in circular and vertical motion for a period of 10 to 15 minutes without any spilling of cement.
3. Place the cover on the sieve and remove the pan. Now tap the other side of the sieve with the handle of brush and clean the outer side of the sieve.
4. Empty the pan and fix it below the sieve and continue sieving as mentioned in the steps 2 and 3.
5. Totally sieve for 15 minutes and weigh the residue (Left over the sieve).

## OBSERVATIONS:

1. Weight of cement taken =.....
2. Weight of cement retained after sieving =.....
3. Type of cement =.....
4. Brand of cement=.....
5. Room temperature=.....

$$\text{Percentage weight of Residue} = \frac{\text{Weight of sample left on the sieve}}{\text{Total weight of sample}}$$

**RESULT:**

Fineness of the given sample is=.....%

# COMPRESSIVE STRENGTH TEST OF HYDRAULIC CEMENT

## EXPERIMENT NO. : 5

## AIM:

To determine the compressive strength of standard cement mortar cubes

## THEORY:

The compressive strength of cement mortars is determined in order to verify whether the cement conforms to IS specifications and whether it will be able to develop the required compressive strength of concrete. The average compressive strength of at least three mortar cubes (area of the face 50 $cm^2$ ) composed of one part of cement and three parts of standard stand should satisfy IS code specifications.

## REFERENCE:

- IS: 4031 ( Pat 6 ) – 1988.

### APPARATUS:

- Vibration Machine
- Poking Rod
- Cube Mould size conforming to IS : 10080-1982
- Weighing Balance
- Trowel
- Stop Watch
- Graduated Glass Cylinders

## INTRODUCTION:

The compressive strength of cement mortars is determined in order to verify whether the cement conforms to IS specifications and whether it will be able to develop the required compressive strength of concrete. The average compressive strength of at least three mortar cubes (area of the face 50 cm2 ) composed of one part of cement and three parts of standard stand should satisfy IS code specifications.

## 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.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 200 g and Standard Sand 600 g

3. Water (P/4+0.3) percent of combined mass of cement and sand, where P is the percentage of water required to produce a paste of standard consistency.
4. Place on a nonporous plate, a mixture of cement and standard sand. 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.
5. Moulding Specimens: In assembling the moulds ready for use, treat the interior faces of the mould with a thin coating of mould oil.
6. Place the assembled mould on the table of the vibration machine and hold it firmly in position by means of a suitable clamp. Attach a hopper of suitable size and shape securely at the top of the mould to facilitate filling and this hopper shall not be removed until the completion of the vibration period.
7. Immediately after mixing the mortar in accordance with step 1 & 2, place the mortar in the cube mould and prod with the rod. Place the mortar in the hopper of the cube mould and prod again as specified for the first layer and then compact the mortar by vibration.
8. The period of vibration shall be two minutes at the specified speed of 12 000 ± 400 vibration per minute.
9. At the end of vibration, remove the mould together with the base plate from the machine and finish the top surface of the cube in the mould by smoothing the surface with the blade of a trowel.
10. Curing Specimens:- keep the filled moulds in moist closet or moist room for 24 ± 1 hour after completion of vibration. At the end of that period, remove them from the moulds, immediately submerge in clean fresh water, and keep there until taken out just prior to breaking.
11. 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.

## OBSERVATIONS:

- Type of cement=.....
- Brand of cement=.....
- Date of casting=.....

| Trail No | Age of Cube | Dimensions Of the specimen (mm) | | | Weight of Cement Cube (g) | Cross-Sectional area($mm^2$) | Crushing Load (N) | Average Compressive strength(MPa) |
|---|---|---|---|---|---|---|---|---|
| | | L mm | B mm | H mm | | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |

$$\text{Compressive Strength} = \frac{\text{Crushing load}}{\text{Cross section area}}$$


Figure: Cube Testing Machine

## RESULT:

The average compressive strength of the given cement

1. 3 days..... $N/mm^2$
2. 7 days..... $N/mm^2$
3. 28 days..... $N/mm^2$

# SOUNDNESS OF CEMENT

## EXPERIMENT NO. : 6

## AIM:

To determine the soundness of the given sample of cement by: Le-Chatlier's Method.

## APPARATUS:

- Le-chatlier's apparatus
- Weighing Balance
- Water bath
- Measuring cylinder

## REFERENCE CODE:

- IS : 4031 ( Pat 3 ) – 1988 methods of physical test of hydraulic cement
- Part-3 determination of soundness

## THEORY:

Once of the most important properties of cement is its soundness. Unsoundness in cement is caused by expansion of some of the constituents like free lime produced in the manufacturing process of cement. Another possible case of unsoundness is the presence of too high a magnesia content in the cement and presence of excess of lime than that could be combined with acidic oxide at kiln.

## PROCEDURE:

1. Prepare a cement paste formed by gauging cement with 0.78 times water rag to give a paste of standard consistency. The gauging time should not be less than 3 minutes nor greater than 5 min.
2. On the inner surface of mould. Place the mould on glass sheet & fill it with cement paste taking care to keep the edges of the mould gently together cover the mould with another piece of glass sheet & place a small weight on this Covering glass sheet & immediately submerge the whole assembly in water at a temp of 27 $^{o}$C& keep it for 24 hrs.
3. Take out the assembly from water after 24 hrs measure the distance flow the indicator points & record its.
4. Submerge the mould again in water in 25 to 30 minutes.
5. Remove the mould from the water. Allow it to cool & measure the distance the indicator points & record it. The difference b/w two measurements represent the same expansion of cement.

6. The sample should be tested & average of the results should be reported.

## OBSERVATION:

| | |
|---|---|
| Type of Cement Tested | |
| Initial Length Of The Specimen $L_1$ | |
| Final Length Of The Specimen $L_2$ | |
| Expansion Of The Specimen ($L_1$- $L_2$ ) | |

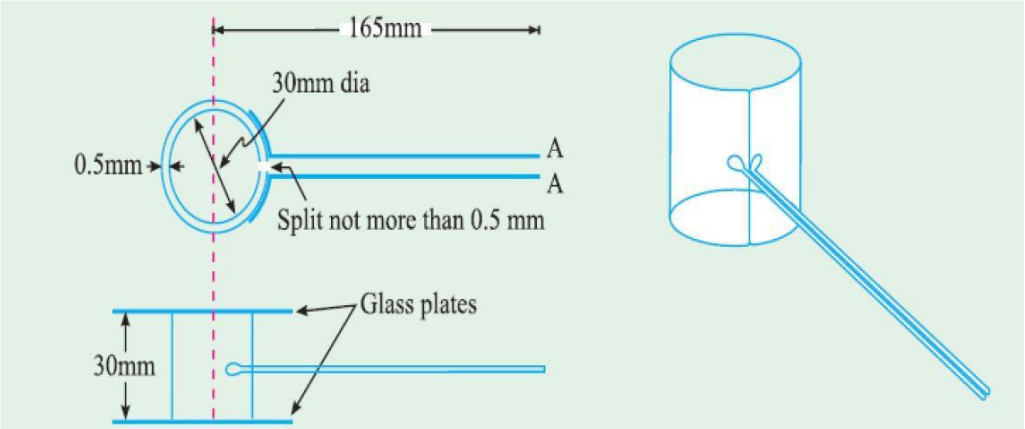


**Fig.: Soundness Testing Apparatus**

## RESULT:

Soundness of cement =……..

# SLUMP TEST

## EXPERIMENT NO. : 7

## AIM:

To determine the workability or consistency of concrete mix of given proportion by slump test.

## APPARATUS:

- pan to mix concrete
- weighing balance
- trowel
- cone
- steel scale
- tamping rod
- mixing tray

## REFERENCE CODE:

- IS: 456-2000, code for plain and reinforced concrete
- IS: 1199-1959 methods of sampling and analysis of concrete

## THEORY:

This is the test extensively used in site work all over the world. Fresh unsupported concrete will flow to the sides and the vertical sinking of concrete is known as slump. The slump cone is a hollow frustum made of thin steel sheet with internal dimensions, as the top diameter 10 cms. The bottom diameter 20 cms, and height 30cms.

## PROCEDURE

1. Mix the dry constituents thoroughly to get a uniform colour and then add water.
2. The internal surface of the mould is to be thoroughly cleaned and placed on a smooth, horizontal and non-absorbent surface.
3. Place the mixed concrete in the cleaned slump cone in 4 layers each approximately 1/4 in height of the mould. Tamp each layer 25 times with tamping rod.Using the tampering rod or a trowel strike of the excess concrete above the concrete cone. Measure the vertical height of cone (h1).
4. Slowly and carefully remove in the vertical direction. As soon as the cone is removed the concrete settles in vertical direction. Place the steel scale above top of settled concrete in horizontal position and measure the height of cone(h2).
5. Complete the experiment in two minutes after sampling.

6. The difference of two heights (h1-h2) gives the value of slump

**OBSERVATIONS:**

1) Type of cement=…….
2) Brand of cement=…….
3) Density of concrete=.....

| Trail No | Proportion | | | | | SLUMP In mm | Remarks |
|---|---|---|---|---|---|---|---|
| | w/c | W litre | C kg | FA kg | CA kg | | |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |

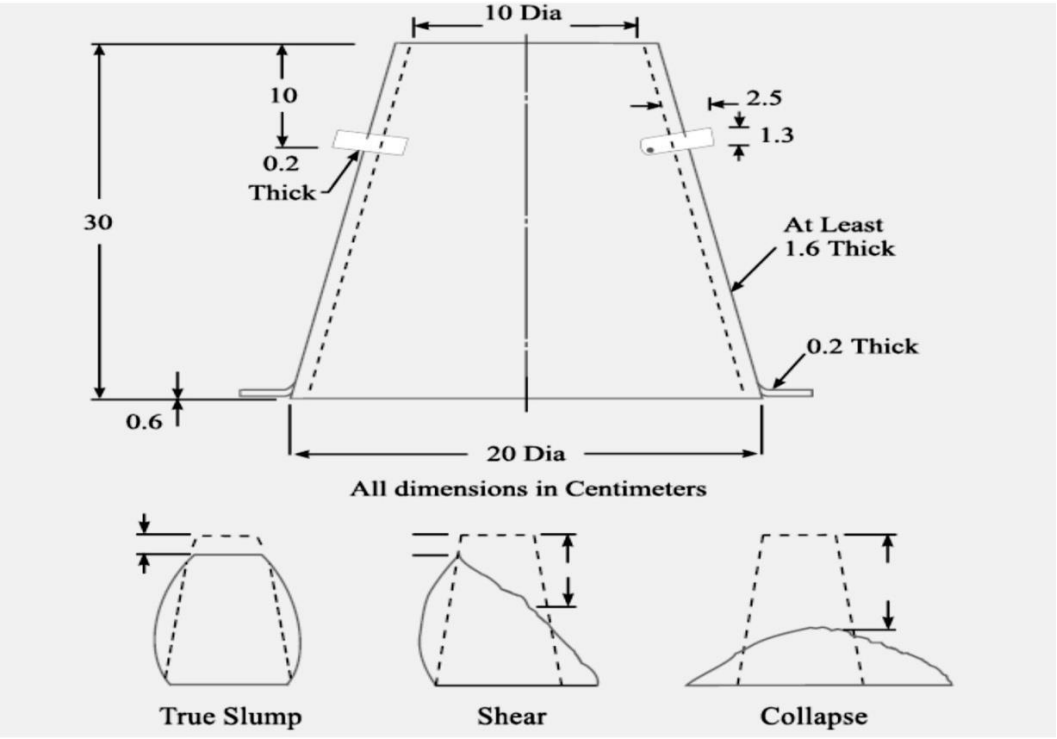


Figure: Different Types of Slump

## Result:

The slump of concrete= ..... mm

(indicate Low/Medium/ High Degree of workability)

# COMPACTION FACTOR TEST

## EXPERIMENT NO. : 8

## AIM:

To determine the workability of freshly mixed concrete by the of Compacting Factor Test.

## APPARATUS:

- Compaction factor apparatus
- Weighing balance
- tamping rod Trowel
- Scoop about 150 mm long
- Tamper( 16 mm in diameter and 600 mm length)
- Ruler
- Tools and containers for mixing or concrete mixer etc.

## REFERENCE CODE:

- IS; 1199-1959 methods of sampling and analysis of concrete
- IS:5515-1983 Specification for compressive factor apparatus

## THEORY:

The compaction factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. The compacting factor test is designed primarily for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and is particularly useful for concrete mixes of very low workability as are normally used when concrete is to be compacted by vibration.

## PROCEDURE:

1. Grease the inner surface of the hoppers and the cylinder and fasten the hopper doors.
2. Weigh the empty cylinder accurately (W1 Kg) an Fix the cylinder on the base with nuts and bolts.
3. Mix coarse and fine aggregates and cement dry until the mixture is uniform in colour and then with water until concrete appears to be homogeneous.
4. Fill the freshly mixed concrete in upper hopper gently with trowel without compacting.
5. Release the trap door of the upper hopper and allow the concrete of fall into the lower hopper bringing the concrete into standard compaction.
6. Immediately after the concrete comes to rest, open the trap door of the lower hopper and allow the concrete to fall into the cylinder, bringing the concrete into standard compaction.

7. Remove the excess concrete above the top of the cylinder by a trowel.
8. Find the weight of cylinder i.e. cylinder filled with partially compacted concrete(W2 kg)
9. Refill the cylinder with same sample of concrete in approx. 4 layers, tamping each layer with tamping for 25 times in order to obtain full compaction of concrete.
10. Level the mix and weigh the cylinder filled with fully compacted concrete (W3 Kg).
11. Repeat the procedure for different for different a trowel.

## OBSERVATIONS AND CALCULATIONS:

Weight of cylinder W1 =..... Kg

| Trail no | Quantity of material | | | | | Mass of cylinder with partially compaction $W_2$ (Kg) | Mass of cylinder withfully compaction $W_3$ (Kg) | Compaction Factor $\frac{W_2 - W_1}{W_3 - W_1}$ |
|---|---|---|---|---|---|---|---|---|
| | w/c | W litre | C kg | FA kg | CA kg | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |

$$\textbf{Compaction factor} = \frac{W_2 - W_1}{W_3 - W_1}$$

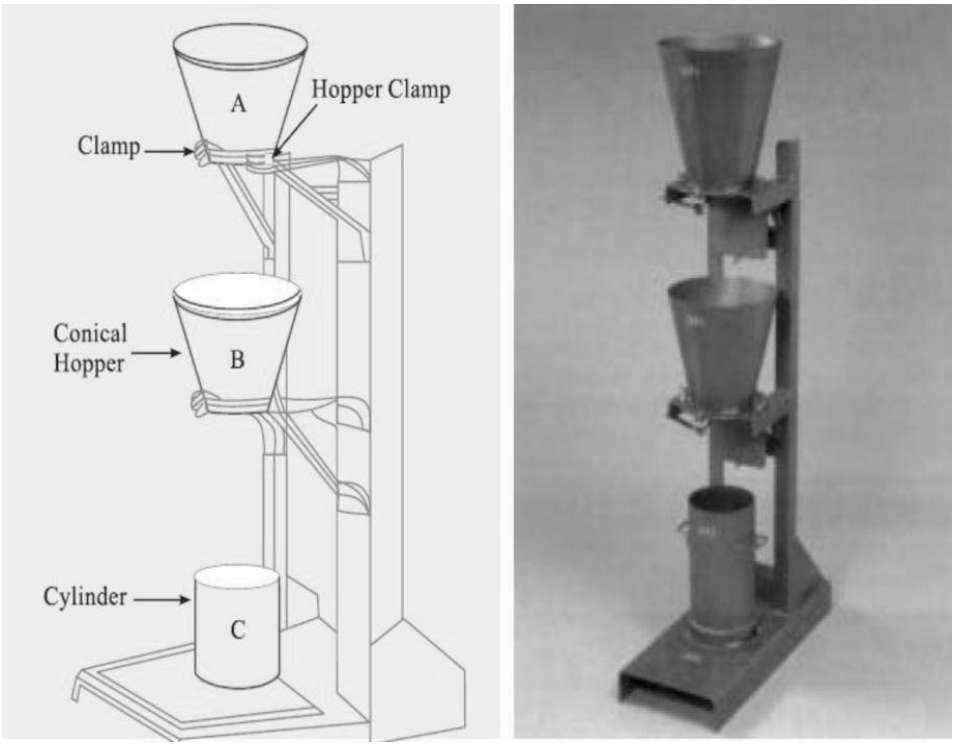


Figure: Compaction factor apparatus

**RESULTS:**

Compaction factor IS =……..

# VEE-BEE CONSISTOMETER

## EXPERIMENT NO. : 9

## AIM:

To measure the workability of concrete by Vee-Bee Consistometer.

## APPARATUS:

- Vee-Bee consistometer test apparatus
- Stopwatch
- Standard iron rod
- Weighing device
- Tamper( 16 mm in diameter and 600 mm length)
- Tools and containers for mixing

## REFERENCE CODE:

- IS: 1199-1959 method of sampling and analysis of concrete
- IS: 456-2000 code of practice for plain and reinforced concrete
- IS: 10510:1983 specification for Vee-Bee consistometer

## THEORY:

The Vee-Bee consistometer (measures the remoulding ability of concrete under vibration. The test results reflect the amount of energy required to remould a quantity of concrete under given vibration conditions. The Veebee consistometer is applicable to concrete with slumps less than 5cm.

## 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 watch is 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.

## OBSERVATIONS:

1. Type of cement=…….
2. Brand of cement=…….

| Trail no | Quantity of material | | | | | Slump mm | The Vee Bee Degree of concrete in sec | Remark |
|---|---|---|---|---|---|---|---|---|
| | w/c | W litre | C kg | FA kg | CA kg | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | ` | | | | |

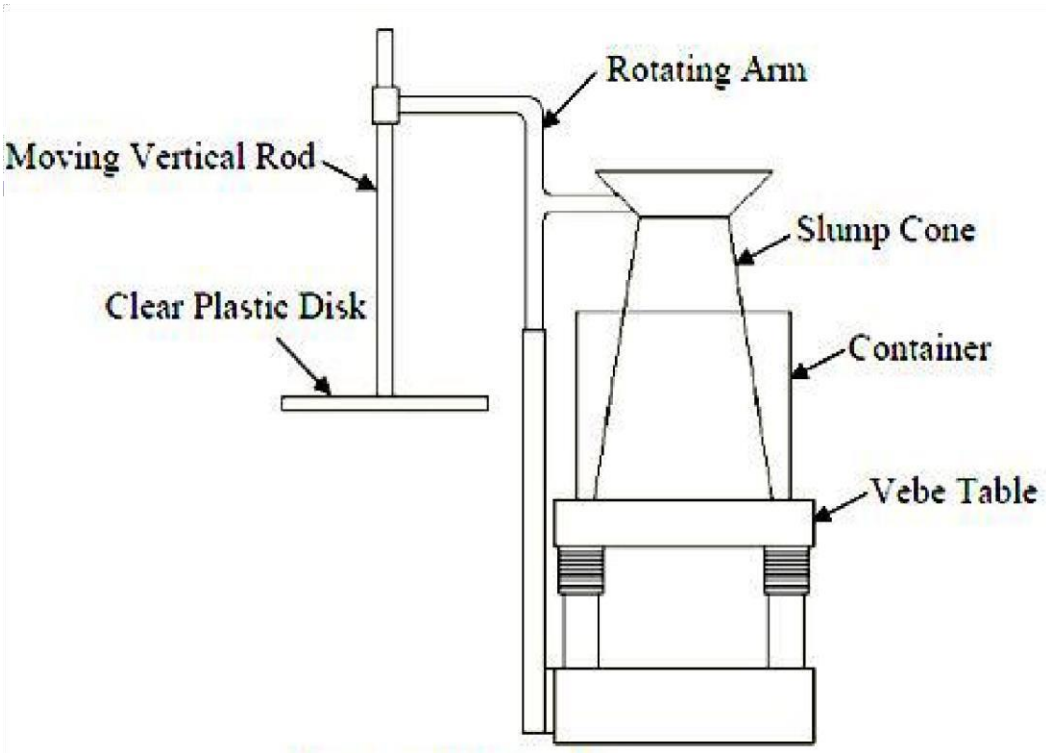


Figure: Vee-bee Consistometer

## RESULTS:

The VEE-BEE Degree for 0.5 W/C = ..... Sec

# Determine Compressive Strength of Cubic Concrete Specimens

## EXPERIMENT NO. : 10

## AIM:

The test method covers determination of compressive strength of cubic concrete specimens.

## REFERENCE CODES:

- IS: 516 - 1959
- IS: 1199-1959
- SP: 23-1982
- 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.

## 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.

**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.

## 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 moulding the desired number of test specimens.
5. **Mould** - Test specimens cubical in shape shall be 15 × 15 × 15 cm. If the largest 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 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 dry ingredients.
8. Placing the Specimen in the Testing Machine - The bearing surfaces of the 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 platens.
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 increasing load breaks down and no greater load can be sustained.
12. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted.

## OBSERVATION:

**Data for the calculating of the mix proportion**

| Sr. No. | Description | Value |
|---|---|---|
| 1 | Compressive strength at 28 days | |
| 2 | Slump | |
| 3 | Type of cement | |
| 4 | Specific gravity of cement | |
| 5 | Type of sand | |
| 6 | Specific gravity of sand | |
| 7 | Fineness modulus | |
| 8 | Type of coarse aggregate | |

**Calculations of Mix Proportion**

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

| Sr. No. | Age of Cube | Weight of Cement Cube (g) | Cross-Sectional area ($mm^2$) | Load (N) | Compressive strength ($N/mm^2$) | Average Compressive strength (MPa) |
|---|---|---|---|---|---|---|
| 1 | 7 Days | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | 28 Days | | | | | |
| 5 | | | ` | | | |
| 6 | | | | | | |

## CONCLUSION:

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

ii) The average 28 Days Compressive Strength of concrete sample is found to be ……..

# Determine Flexural Strength of Concrete Specimens

## EXPERIMENT NO.: 11

## AIM:

This clause deals with the procedure for determining the flexural strength of moulded concrete flexure test specimens

## REFERENCE CODES:

- IS: 516 – 1959
- IS: 1199-1959
- SP: 23-1982
- 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.

## 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 moulding the desired number of test specimens.
5. **Mould -** 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.
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 dry ingredients.
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 20.0 or 13.3 cm apart.
10. The axis of the specimen shall be carefully aligned with the axis of the loading device. No packing shall be used between the bearing surfaces of the specimen and the rollers.
11. The load shall be applied without shock and increasing continuously at a rate such that 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/min for 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 unusual features in the type of failure shall be noted.

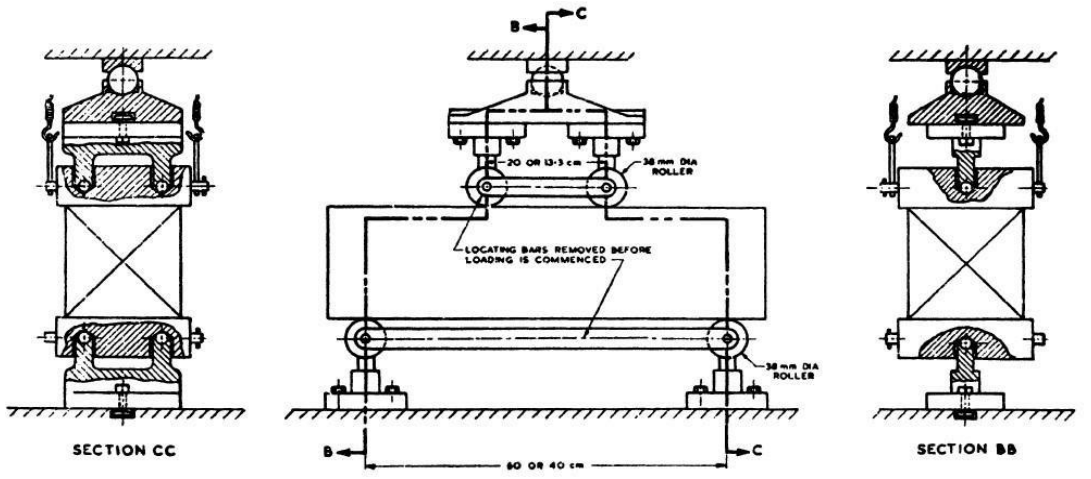


Figure: Flexural strength test of moulded concrete flexure test specimens

Observation :

Calculations of Mix Proportion

| 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 | | |

| Sr. No. | Age of Specimen | Identification Mark | Size of Specimen (mm) | Span Length (mm) | Max. 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 fb, 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:

$$f_b = \frac{P \times l}{a \times d^2}$$

when 'a' is greater than 20.0 cm for 15.0 cm specimen, or greater than 13.3 cm for a 10.0 cm specimen, or

$$f_b = \frac{3P \times a}{b \times d^2}$$

when 'a' is less than 20.0 cm but greater than 17.0 cm for 15.0 cm specimen, or less than 13.3 cm but greater than 11.0 cm for a 10.0 cm specimen

where,

b = measured width in cm of the specimen,

d = measured depth in cm of the specimen at the point of failure,

l = length in cm of the span on which the specimen was supported, and

p = maximum load in kg applied to the specimen.

## CONCLUSION:

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

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

# Determine Splitting Tensile Strength of Cylindrical Concrete Specimens

## EXPERIMENT NO.: 12

## AIM:

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

## REFERENCE CODES:

- IS: 516 – 1959
- IS: 1199-1959
- SP: 23-1982
- 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.

## 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.

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 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 dry ingredients.
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. 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 slightly longer 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 the supplemental bars or plates.
11. Draw diametric lines an 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 along the center of the lower bearing block.
12. 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 plywood strip.
13. 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
14. Record the maximum applied load indicated by the testing machine at failure. Note the typeof failure and appearance of fracture.

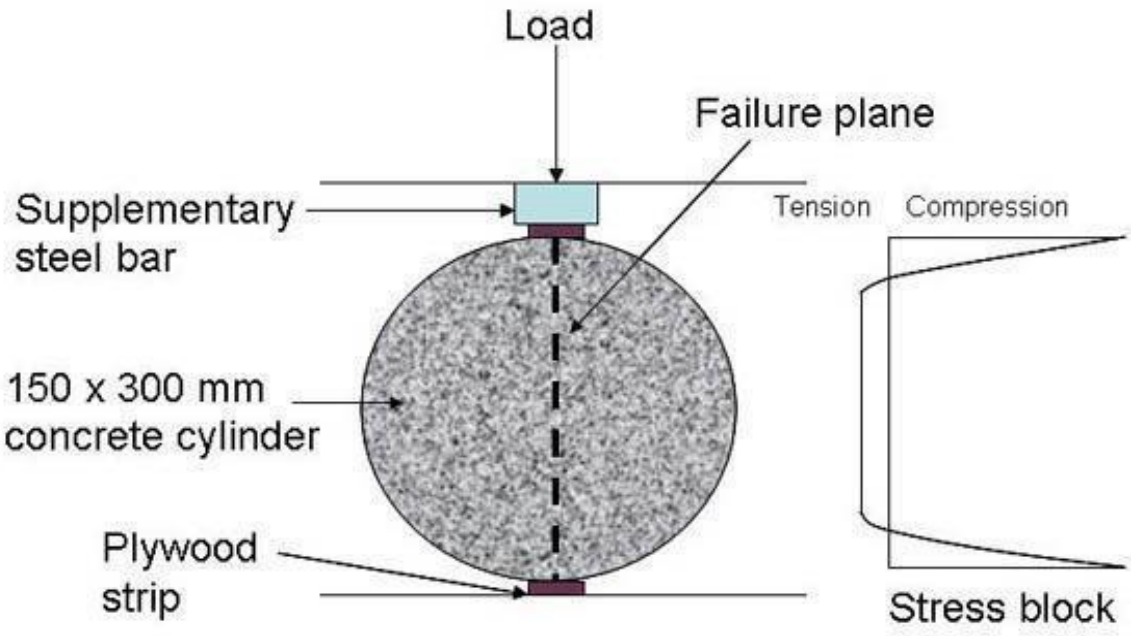


Figure: Loading Arrangement for Determining Split Tensile Strength

Figure: Cylinder in compression machine

## OBSERVATIONS:

Calculations of Mix Proportion

| 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 | | |

| Sr. 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 | 28 Days | | | | | | |
| 5 | | | ` | | | | |
| 6 | | | | | | | |

## CALCULATION:

Calculate the splitting tensile strength of the specimen as follows:

$$T = \frac{2P}{\pi L d}$$

Where

T: splitting tensile strength, kPa

P: maximum applied load indicated by testing machine, kN

L: Length, m

d: diameter

## CONCLUSION:

i) The average 7 Days Tensile Strength of concrete sample is found to be …..…..

ii) The average 28 Days Tensile Strength of concrete sample is found to be …..…..

# Particle Size Distribution of Fine Aggregates

## EXPERIMENT NO. : 13

## AIM:

To determine fineness modulus of fine aggregate and classifications based on IS: 383-1970

## REFERENCE CODES:

- IS 2386 (Part I) – 1963
- IS: 383-1970
- IS: 460-1962

## APPARATUS:

Test Sieves conforming to IS : 460-1962 Specification of 4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300 micron, 150 micron, Balance, Gauging Trowel, Stop Watch, etc.

## Theory:

This is the name given to the operation of dividing a sample of aggregate into various fractions each consisting of particles of the same size. The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate, which we call gradation. Many a time, fine aggregates are designated as coarse sand, medium sand and fine sand. These classifications do not give any precise meaning. What the supplier terms as fine sand may be really medium or even coarse sand. To avoid this ambiguity fineness modulus could be used as a yard stick to indicate the fineness of sand.

The following limits may be taken as guidance: Fine sand : Fineness Modulus : 2.2 - 2.6, Medium sand : F.M. : 2.6 - 2.9, Coarse sand : F.M. : 2.9 - 3.2

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

## PROCEDURE:

1. The sample shall be brought to an air-dry condition before weighing and sieving. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be taken to ensure that the sieves are clean before use.
2. The shaking shall be 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.

3. 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 side of the sieve.
4. Light brushing with a fine camel hair brush may be used on the 150-micron and 75-micron IS Sieves to prevent aggregation of powder and blinding of apertures.
5. On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

## OBSERVATION:

| I S Sieve | Weight Retained on Sieve (g) | Percentage of Weight Retained (%) | Percentage of Weight Passing (%) | Cumulative Percentage of Passing (%) | Remark |
|---|---|---|---|---|---|
| 4.75 mm | | | | | |
| 2.36 mm | | | | | |
| 1.18 mm | | | | | |
| 600 micron | | | | | |
| 300 micron | | | | | |
| 150 micron | | | | | |
| Total | | | | | |

## CALCULATION:

Fineness modulus is an empirical factor obtained by adding the cumulative percentages of aggregate retained on each of the standard sieves ranging from 4.75 mm to 150 micron and dividing this sum by anarbitrary number 100.

$$Finess\ Modulus, FM = \frac{Total\ of\ Cumulative\ Percentage\ of\ Passing\ (\%)}{100}$$

## CONCLUSION / RESULT:

a. Fineness modulus of a given sample of fine aggregate is …….. that indicate Coarse sand/ Medium sand/Fine sand.
b. The given sample of fine aggregate is belong to Grading Zones I / II / III / IV

**Table 3.15. Grading limits of fine aggregates IS: 383-1970**

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

# DETERMINATION OF SPECIFIC GRAVITY OF FINEAGGREGATE

## EXPERIMENT NO. : 14

## AIM:

To determine specific gravity of a given sample of fine aggregate.

## APPARATUS:

- Pycnometer bottle
- Taping rod
- Funnel

## PROCEDURE:

1. Take the empty pycnometer ($w_1$) gms.
2. Take a sample of fine aggregate for which specific gravity is to be find out, transfer that to the pycnometer, and weight ($w_2$).
3. Pour distilled water into pycnometer.
4. Eliminate the entrapped air by rotating the pycnometer.
5. Wipe out the outer surface of pycnometer and weight it ($w_3$).
6. Transfer the aggregate of the pycnometer into a try care being taken to ensure that all the aggregate is transferred.
7. Refill the pycnometer with distilled water up to the mark and it should be completely dry from outside and take the weight $w_4$.

## CALUCULATIONS:

| Trail No | Weight of empty bottle ($W_1$) g | Weight of empty bottle + Fine aggregate ($W_2$) g | Weight of empty bottle + water + Fine aggregate ($W_3$) g | Weight of empty bottle + water ($W_4$) g |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |

$$\text{Specific Gravity of Fine Aggregate } = \frac{(W_2 - W_1)}{(W_2 - W_1)\,(W_3 - W_4)}$$

Figure: Pycnometer bottle

## RESULT:

The Specific Gravity of a given sample of fine aggregate is = _____

# SHAPE TEST

# FLAKINESS INDEX:

## EXPERIMENT NO. :15

## AIM:

To determining the flakiness index of the coarse aggregate.

## APPARATUS:

- metal gauge
- Weighing Balance
- Gauging Trowel
- Sieves.

## REFERENCE:

- IS : 2386 ( Part I) – 1963 Method of tst for aggregates for concrete
- IS: 383-1970 specification for coarse and fine aggregate from natural source for concrete

## THEORY:

The flakiness index of an aggregate is the percentage by weight of particles in it whose least dimension (thickness) is less than three-fifths of their mean dimension. Particle shape and surface texture influence the properties of freshly mixed concrete more than the properties of hardened concrete. Rough-textured, angular, and elongated particles require more water to produce workable concrete than smooth, rounded compact aggregate. Consequently, the cement content must also be increased to maintain the water-cement ratio. Generally, flat and elongated particles are avoided or are limited to about 15 % by weight of the total aggregate.

## PROCEDURE

1. A quantity of aggregate shall be taken sufficient to provide the minimum number of 200 pieces of any fraction to be tested.
2. The sample shall be sieved with sieves specified in Table.
3. Then each fraction shall be gauged in turn for thickness on a metal gauge of the pattern shown in Fig or in bulk on sieves having elongated slots. The width of the slot used in the gauge or sieve shall be of the dimensions specified in column 3 of Table for the appropriate size of material.

4. The total amount passing the gauge shall be weighed to an accuracy of at least 0.1 percent of the weight of the test sample.

## CALUCULATIONS:

$$\text{Flakiness Index } = 100 \text{ x} \frac{\sum w}{\sum W}$$

Where, w is the weights of material passing the various thickness gauges and W is the total weights of aggregate passing and retained on the specified sieves.

Dimensions of Thickness:

| Size of Aggregate (mm) | | Weight Retained on Thickness Gauge | Thickness Gauge (mm) | Weight Of flaky particles W g |
|---|---|---|---|---|
| Passing through IS sieve | Retained on IS sieve | | | |
| 63 | 50 | | 33.90 | |
| 50 | 40 | | 27.00 | |
| 40 | 31.5 | | 21.50 | |
| 31.5 | 25 | | 16.95 | |
| 25 | 20 | | 13.50 | |
| 20 | 16 | | 10.80 | |
| 16 | 12.5 | | 8.55 | |
| 12.5 | 10 | | 6.75 | |
| 10 | 6.3 | | 4.89 | |

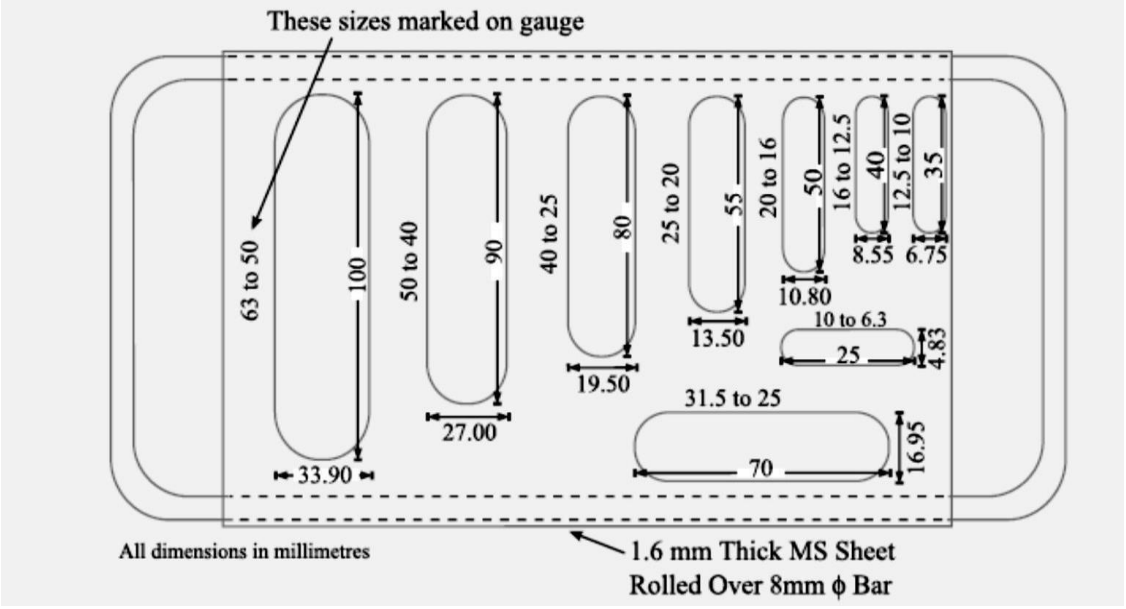


Figure: Thickness Gauge

## Results:

Flakiness index=.....

# ELONGATION INDEX

## EXPERIMENT NO. : 16

## AIM:

To determining the elongation index of the coarse aggregate.

## APPARATUS:

- metal gauge
- weighing Balance
- Gauging Trowel
- Sieves.

## REFERENCE CODE:

- IS : 2386 ( Part I) – 1963 Method of tst for aggregates for concrete
- IS: 383-1970 specification for coarse and fine aggregate from natural source for concrete

## THEORY:

The elongation index of an aggregate is the percentage by weight of particles in it whose greatest dimension (thickness) is greater than one and four-fifths of their mean dimension. The test is not applicable to sizes smaller than 6.3mm.

## PROCEDURE:

1. A quantity of aggregate shall be taken sufficient to provide the minimum number of 200 pieces of any fraction to be tested.
2. The sample shall be sieved with sieves specified in Table.
3. Each fraction shall be gauged in turn for length on a metal gauge of the pattern shown in Fig. The gauge length used shall be of the dimensions specified in column 4 of Table for the appropriate size of material.
4. The total amount of aggregate retained by the length gauge shall be weighed to an accuracy of at least 0.1 percent of the weight of the test sample.

## CALUCULATIONS:

Elongation index=100 x (x/W) %

Where, x is the weight of materials retained on specified gauges and W is the total weights of aggregate passing and retained on the specified sieves.

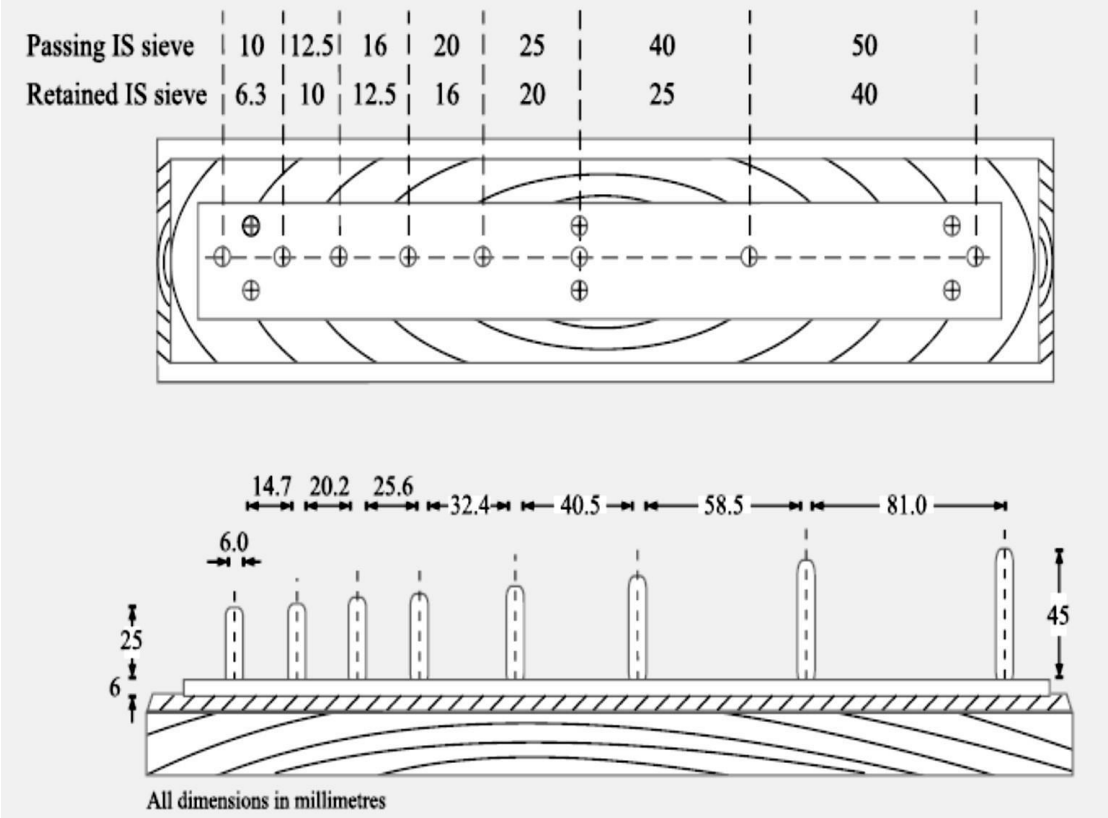


Figure: Length Gauge

Dimensions of Length gauge

| Size of Aggregate (mm) | | Weight Retained on Length Gauge | Length Gauge (mm) | Weight of elongation particles X g |
|---|---|---|---|---|
| Passing through IS sieve | Retained on IS sieve | | | |
| 63 | 50 | | - | |
| 50 | 40 | | 81.0 | |
| 40 | 31.5 | | 58.5 | |
| 31.5 | 25 | | - | |
| 25 | 20 | | 40.5 | |
| 20 | 16 | | 32.4 | |
| 16 | 12.5 | | 25.5 | |
| 12.5 | 10 | | 20.2 | |
| 10 | 6.3 | | 14.7 | |

## RESULTS:

Elongation Particles=.....%

# ANGULARITY NUMBER TEST

## EXPERIMENT NO. : 17

## AIM:

To determine the angularity number of coarse aggregate.

## REFERENCECODE:

- IS : 2386 ( Part I) – 1963 Method of test for aggregates for concrete
- IS: 383-1970 specification for coarse and fine aggregate from natural source for concrete

## APPARATUS REQUIRED:

Metal cylinder, Tamping rod, balance, metal scoop.

## THEORY:

Angularity test helps us to determine the angularity of the coarse aggregate. Higher the angularity number better is the interlocking of the aggregate.

## TEST DESCRIPTION:

First the metal mould calibrated by filling it with water and determining the weight of water in it. Then the mould is filled with clean dried aggregates in three layers. The weight of aggregate in the mould is recorded. Determine the specific gravity of the aggregate. Finally, the angularity number of aggregate is calculated.

## PROCEDURE:

1. The aggregate is compacted in three layers, each layer being given 100 blows using the standard tamping rod at a rate of 2 blows/second by lifting the rod 5 cm above the surface of the aggregate and then allowing it to fall freely.
2. The blows are uniformly distributed over the surface of the aggregate.
3. After compacting the third layer, the cylinder is filled to overflowing and excess material is removed off with temping rod as a straight edge.
4. The aggregate (water) with cylinder is then weighed. Three separate determinations are made and mean weight of the aggregate in the cylinder is calculated.

## OBSERVATION AND CALCULATION:

| Trail No | Volume of metal measures $V_1$(ml) | Volume of water required to fill the metal measures containing aggregate $V_2$ (ml) | Percentage of voids $(V_2/V_1)x100$ |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |

$$\text{Percentage of voids} = \frac{V_2}{V_1} x10$$

= _____

Angularity number = V-33=.....

## RESULT:

Aggregate angularity number=……..

# AGGREGATE IMPACT VALUE TEST

## EXPERIMENT NO. : 18

## AIM:

To determine the aggregate impact value of given aggregates

## APPARATUS REQUIRED:

- Impact testing machine
- cylinder, tamping rod
- IS Sieve
- Weighing balance.

## REFERENCE CODE:

- IS : 2386 ( Part IV) – 1963 methods of test for aggregate for concrete
- IS:383:1970- specification for coarse and fine aggregate from natural source for concrete
- IS:9377:1979-specification for apparatus for aggregate impact value test

## THEORY:

The aggregate impact value gives a relative measure of the resistance of an aggregate to sudden shock or impact, which in some aggregates differs from its resistance to a slow compressive load.

## PROCEDURE:

1. The test sample consists of aggregates passing 12.5mm sieve and retained on 10mmsieve and dried in an oven for 4 hours at a temperature of 100oC to 110oC
2. The aggregates are filled up to about 1/3 full in the cylindrical measure and tamped 25 times with rounded end of the tamping rod
3. The rest of the cylindrical measure is filled by two layers and each layer being tamped 25 times.
4. The overflow of aggregates in cylindrically measure is cut off by tamping rod using it has a straight edge.
5. Then the entire aggregate sample in a measuring cylinder is weighed nearing to
6. 0.01gm
7. The aggregates from the cylindrical measure are carefully transferred into the cup
8. Which is firmly fixed in position on the base plate of machine. Then it is tamped 25 times.

9. The hammer is raised until its lower face is 38cm above the upper surface of

aggregate in the cup and allowed to fall freely on the aggregates. The test sample is subjected to a total of 15 such blows each being delivered at an interval of not less than one second. The crushed aggregate is than removed from the cup and the whole of it is sieved on 2.366mm sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to 0.1gm. Repeat the above steps with other fresh sample.

10. Let the original weight of the oven dry sample be W1gm and the weight of fraction passing 2.36mm IS sieve be W2gm. Then aggregate impact value is expressed as the % of fines formed in terms of the total weight of the sample.

## OBSERVATION AND CALCULATION:

$$\text{Aggregate impact value} = \frac{W_2}{W_1} X\ 100 = \_\_\_\_\_\%$$

| Description | **Trail 1** | **Trail 2** | **Trail 3** |
|---|---|---|---|
| Total weight of the aggregate filling the cylindrical metal measures $W_1$ (g) | | | |
| Weight of aggregate passing through 2.36 mm sieve $W_2$ (g) | | | |
| Aggregate impact = ($W_2/W_1$) X 100 % | | | |

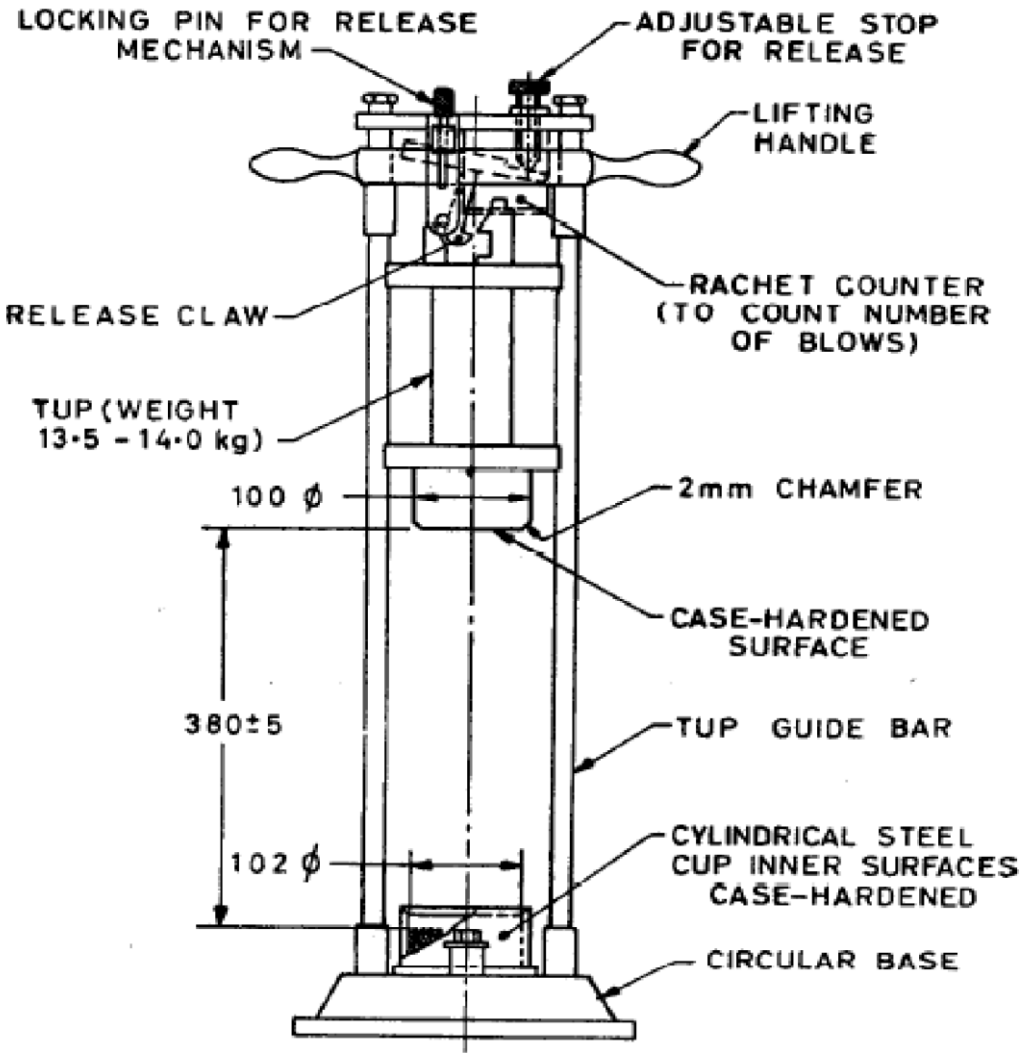


**Fig.: Aggregate Impact Test Machine**

## RESULT:

Aggregate Impact Value…….

# AGGREGATE CRUSHING VALUE TEST

## EXPERIMENT NO. : 19

**AIM:**To determine the crushing value of the road aggregates

## APPARATUS:

The apparatus of the aggregate crushing value test as per IS 2386 (Part IV)-1963consists of:

1. A 15cm diameter open-ended steel cylinder with plunger and base plate, of the general form.
2. A straight metal tamping rod of circular cross-section 16mm diameter and 45 to 60 cm long, rounded at one end.
3. A balance of capacity 3 kg
4. IS Sieves.
5. A compression-testing machine capable of applying load up to 40tonnes.
6. Cylindrical measure having internal dia. of 11.5cm & height 18 cm for measuring the sample.

## REFERENCE CODE:

1. IS : 2386 ( Part IV) – 1963 method of test for aggregates for concrete
2. IS:383:1970 specification for coarse and fine aggregate from natural source for concrete
3. IS: 9376:1979 Specification for apparatus for measuring aggregate crushing value

## THEORY:

The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. Crushing value is a measure of the strength of the aggregate. The aggregates should therefore have minimum crushing value.

## PROCEDURE:

The test sample: It consists of aggregates sized 12.5 mm - 10.0 mm (minimum3kg). The aggregates should be dried by heating at 1000-1100 C for a period of 4 hours and cooled.

1. Sieve the material through 12.5 mm and 10.0 mm IS sieve. The aggregates passing through 12.5 mm sieve and retained on 10.0 mm sieve comprises the test material.
2. The cylinder of the test shall be put in position on the base-plate and the test sample added in thirds, each third being subjected to 25 strokes with the tamping rod.
3. The surface of the aggregate shall be carefully leveled.
4. The plunger is inserted so that it rests horizontally on this surface, care being taken

to ensure that the plunger does not jam in the cylinder

5. The apparatus, with the test sample and plunger in position, shall then be placed between the plates of the testing machine.
6. The load is applied at a uniform rate as possible so that the total load is reached in 10 minutes. The total load shall be 40 tones.
7. The load shall be released and the whole of the material is removed from the cylinder and sieved on 2.36mm IS Sieve.
8. The fraction passing the sieve shall be weighed and recorded

## OBSERVATION AND CALCULATION:

| | Trail 1 | Trail 2 | Trail 3 |
|---|---|---|---|
| Total weight of dry sample taken $W_1$ (g) | | | |
| Weight of aggregate passing through 2.36 mm sieve $W_2$ (g) | | | |
| Aggregate crushing ($W_2/W_1$) x100 (%) | | | |

$$\text{Aggregate impact value} = 100 \text{ X } \frac{W_2}{W_1}$$

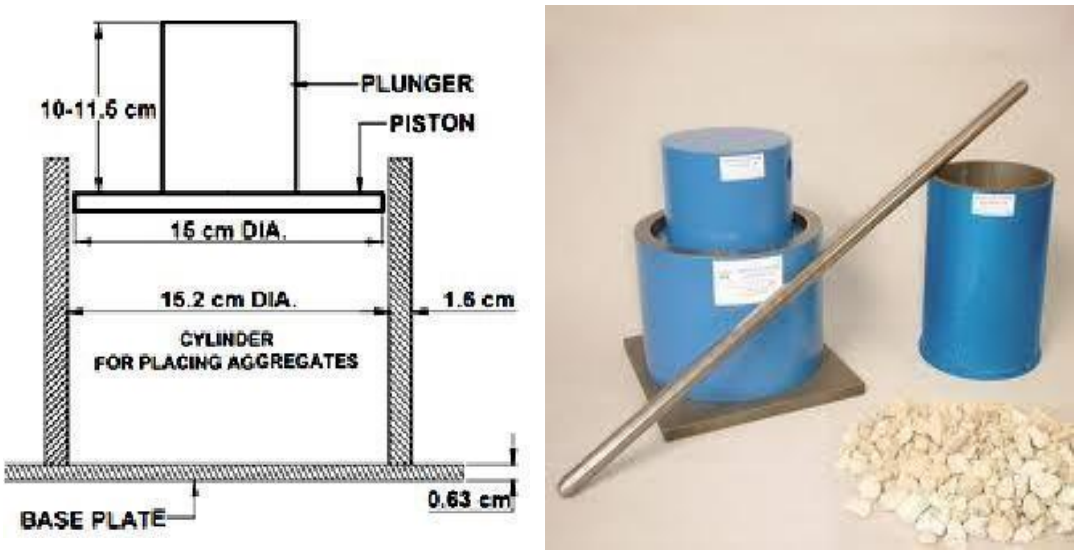


Figure: Aggregate Crushing Test Apparatus

## RESULT:

Aggregate Crushing Value=……

# AGGREGATE ABRASION VALUE TEST

## EXPERIMENT NO. : 20

## AIM:

To determining the abrasion value of coarse aggregate by the use of Los Angeles machine.

## APPARATUS:

- Los Angeles Machine: It consists of a hollow steel cylinder, closed at both the ends with an internal diameter of 700 mm and length 500 mm and capable of rotating about its horizontal axis.
- Cast iron or steel balls, approximately 48 mm in diameter and each weighing between 390 to 445 g; 6 to 12 balls are required.
- IS sieve.
- Balance.

## REFERENCE CODE:

IS 2386 (Part IV) – 1963, IS 383-1970.

## THEORY:

The abrasion value of the aggregates is determined in order to determine their Resistance against wearing. In this the aggregate sample is mixed with abrasive charge consisting standard balls & rotated in closed inclined cylinders for specific number of revolutions.

## PROCEDURE:

1. The test sample shall consist of clean aggregate which has been dried in an oven at 105 to 110°C to substantially constant weight and shall conform to one of the grading shown in Table 3.22. The grading or grading used shall be those most nearly representing the aggregate furnished for the work.
2. The test sample and the abrasive charge shall be placed in the Los Angeles abrasion testing machine and the machine rotated at a speed of 20 to 33 rev/min. For grading A, B, C and D, the machine shall be rotated for 500 revolutions; for grading E, F and G, it shall be rotated for 1 000 revolutions.
3. The machine shall be so driven and so counter-balanced as to maintain a substantially uniform peripheral speed. If an angle is used as the shelf, the machine shall be rotated in such a direction that the charge is caught on the outside surface of the angle.
4. At the completion of the test, the material shall be discharged from the machine and a preliminary separation of the sample made on a sieve coarser than the l.70 mm IS

Sieve.

5. The material coarser than the 1.70 mm IS Sieve shall be washed dried in an oven at 105 to 110°C to a substantially constant weight, and accurately weighed to the nearest gram

## Specified Abrasive Charge

| Grading | Number of spheres | Weight of charge (gm) |
|---|---|---|
| A | 12 | 5000 ± 25 |
| B | 11 | 4584 ± 25 |
| C | 8 | 3330 ± 20 |
| D | 6 | 2500 ± 15 |
| E | 12 | 5000 ± 25 |
| F | 12 | 5000 ± 25 |
| G | 12 | 5000 ± 25 |

## Grading of Test Samples

| Sieve Size | | Weight in gm. of Test Sample For Grade | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Passing | Retained on | A | B | C | D | E | F | G |
| mm | mm | | | | | | | |
| 80 | 63 | - | - | - | - | 2500 | - | - |
| 63 | 50 | - | - | - | - | 2500 | - | - |
| 50 | 40 | - | - | - | - | 5000 | 5000 | - |
| 40 | 25 | 1250 | - | - | - | - | 5000 | 5000 |
| 25 | 20 | 1250 | - | - | - | - | - | 5000 |
| 20 | 12.5 | 1250 | 2500 | - | - | - | - | - |
| 12.5 | 10 | 1250 | 2500 | - | - | - | - | - |
| 10 | 6.3 | - | - | 2500 | - | - | - | - |
| 6.3 | 4.75 | - | - | 2500 | - | - | - | - |
| 4.75 | 2.36 | - | - | - | 5000 | - | - | - |

## OBSERVATIONS:

| | Trail 1 | Trail 2 | Trail 3 |
|---|---|---|---|
| Total weight of dry sample taken $W_1$ g | | | |
| Weight of portion passing 1.7 mm sieve $W_2$ g | | | |
| Aggregate abrasion value = ($W_2$/$W_1$) x100 Value (%) | | | |

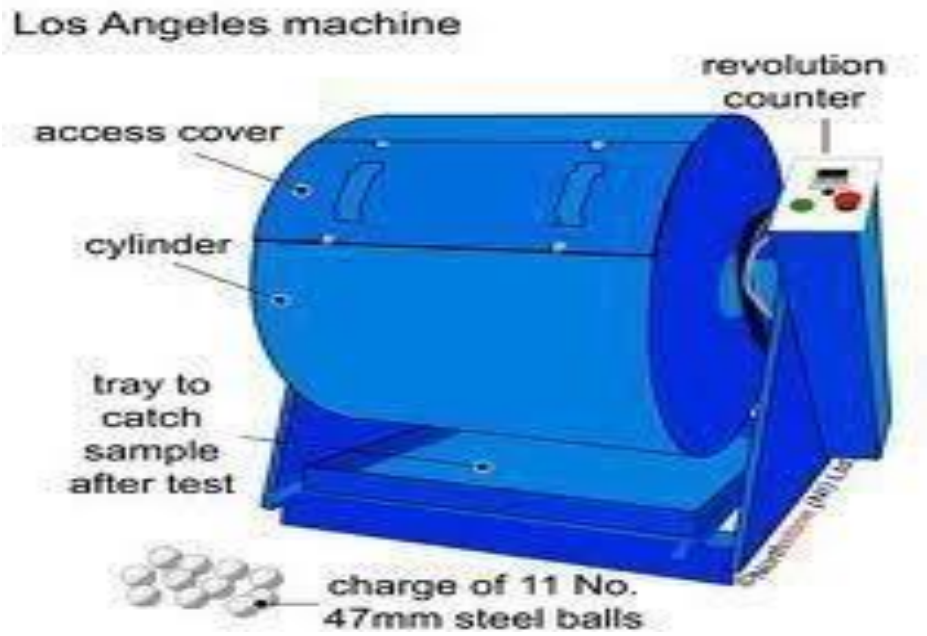


Figure: Los Angeles Abrasion Testing Machine

**RESULT:**

Mean Los Angeles Abrasion value = .....%

# NON-DESTRUCTIVE TESTING OF CONCRETEREBOUND HAMMER TEST

## EXPERIMENT NO. : 21

## AIM:

To determine the compressive strength of concrete by using the rebound hammer.

## APPARATUS:

- Rebound Hammer instrument.
- Abrasive Stone

## PROCEDURE:

Hold the instrument firmly so that the plunger is perpendicular to the test surface. Gradually push the instrument toward the test surface until the hammer impacts. After impact, maintain pressure on the instrument and if necessary depress the button on the side of the instrument to lock the plunger in its retracted position. Read the rebound number on the scale to the nearest whole number and record the rebound number. Take ten readings from each test area. No two impact tests shall be closer together than 25 mm (1 in). Examine the impression made on the surface after impact, and if the impact crushes or breaks through a near-surface air void, disregard the reading and take another reading.

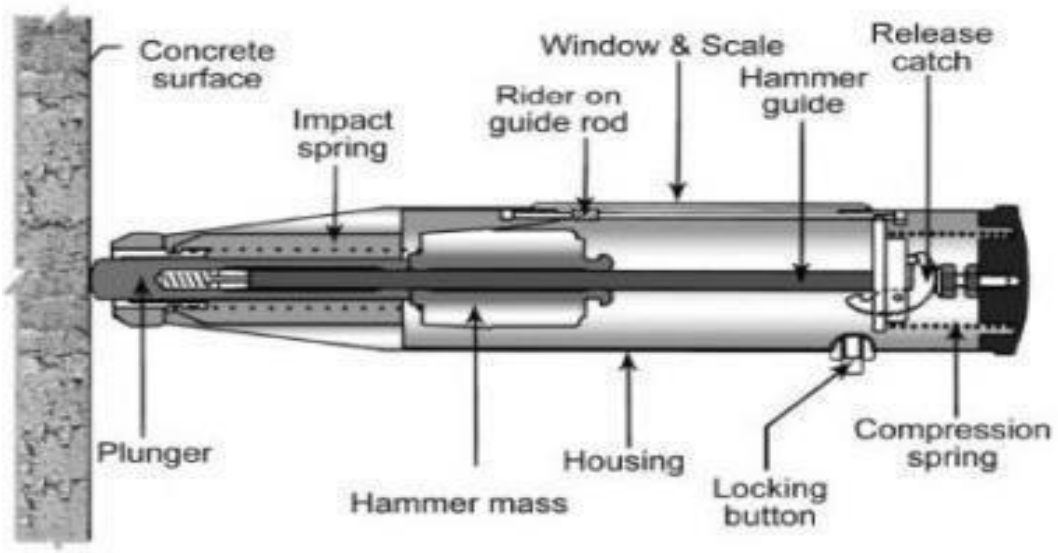


Figure: Rebound Hammer

## READING YOUR RESULTS:

Make at least ten readings from a concrete surface and discard the highest and lowest rebound numbers. Average the remaining eight numbers. If desired, take a few test readings before you complete your series of ten regular tests. Use the average rebound number to estimate the strength of the concrete. Compare your average rebound number to the chart shown on your Concrete Rebound Hammer.

| Average Rebound Number | Quality of Concrete |
|---|---|
| >40 | Very good hard layer |
| 30 to 40 | Good layer |
| 20 to 30 | Fair |
| <20 | Poor concrete |