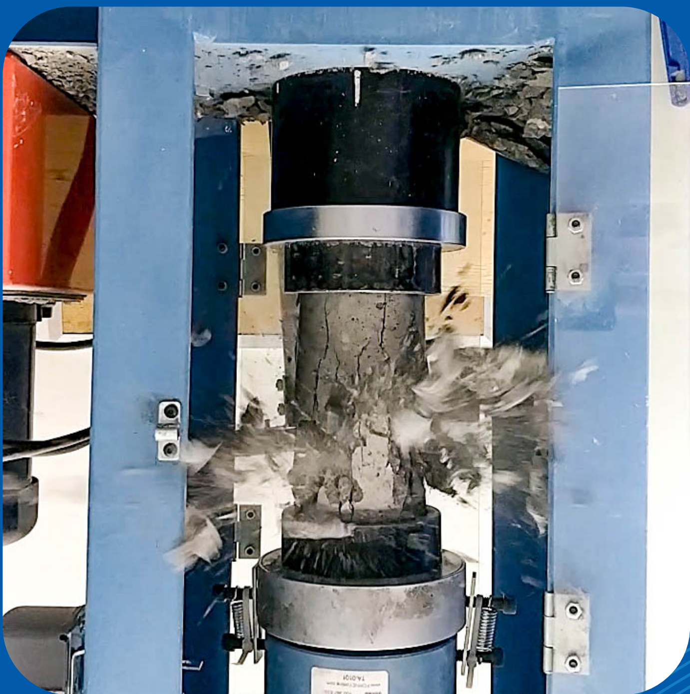
Bulletin No. 6

RMCMA

TESTING OF FRESH AND HARDENED CONCRETE



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PRESIDENT'S MESSAGE

Greetings to all!

Today, Ready Mix Concrete (RMC) continues its journey of excellence to become greener & more sustainable. Its applications are limitless in nation building viz. the general-purpose concrete for projects and individual house builders. Additionally, there are various specialty concrete varieties viz high strength concrete (M50 and above), Temperature Controlled Concrete, Self Compacting concrete, Fibre Reinforced concrete, Decorative concrete, etc. All these products undergo mandatory quality testing and surpass the stipulated passing criteria.

Testing of concrete as well as its ingredients requires trained and skilled technicians. Errors in sampling and testing process may lead to undesirable doubts on the quality of concrete. Oftentimes, such disputes lead to repetitive in-situ testing or anticipatory overdesigning of concrete. This makes it important for all construction professionals to develop a proper understanding about testing of concrete.

In this context, this bulletin carries an elaborate method of testing of concrete at fresh & hardened state which is figured in various codes with special reference to the methodology adopted, equipment used, and their relevance to concrete community.

However, I urge concrete community, industry leaders, premier institutes to take aggressive measures for capability building of site supervisors and technicians by promoting various skill development programs run by various institutes like NCCBM, RMCMA etc. There is also need to rethink, innovate & develop new ways of concrete testing & develop digital monitoring tools like sensors, which can give instant & accurate results, thereby helping in making faster decisions among concrete community at all levels of the industry.

Er. Ramesh Joshi
(President, RMCMA)

1.0 Introduction

Concrete is a heterogeneous material composed of locally available materials like stone aggregates, sand, binders and other additives. The materials used for producing concrete normally vary in quality and the effect is reflected in the properties of concrete. The efforts in mix proportioning, batching and mixing of concrete are directed to minimise the variation in quality of concrete. To achieve consistency in quality from batch to batch, testing of concrete becomes necessary at frequent intervals. Various codes of practices have specified the frequency of testing of raw materials and fresh as well as hardened concrete. IS: 4926 and IS: 456 codes for Ready-Mixed Concreteand Reinforced concrete respectively prescribe types of tests and their frequencies. The correct assessment of concrete quality can be made only through specified tests conducted in correct manner as prescribed in various standards and codes of practice. In this bulletin an effort has been made to describe the correct procedure of conducting some important tests to evaluate quality of concrete in its fresh and hardened state.

2.0 Sampling of Fresh Concrete for Testing:

Proper sampling of fresh concrete is very important. A true representative sample will provide an accurate pattern of the whole batch, while a non-representative sample would render the test results invalid and lead to rejection of otherwise good quality concrete. The sampling of fresh concrete is validated by IS: 1199 (Part 1) 2018 and ASTM C-172. As per IS: 1199 (Part 1) 2018, the sampling procedure is as under;

a. Ensure that the container is clean and dampen it with moist cloth but not wet cloth prior to use.

b. Using the scoop, take the required number of increments (quantity of concrete taken by single operation of scoop) uniformly distributed throughout the batch.

c. When sampling from a stationary batch mixer or ready mixed concrete truck, disregard the very first and the very last of the discharge (about 10 to 15 percent)

d. When sampling from a falling stream, the increments shall be taken in such a way as to represent the whole width and thickness of the stream.

e. If the batch is deposited in a heap of concrete, take the increments wherever possible, distributed through the depth as well as over the exposed surface of concrete.

f. Increments shall not be taken from parts of the concrete that appears to be segregated.

g. Increments shall be taken from at least four points and deposited into the container.

h. The samples taken by any of the methods, shall be mixed thoroughly in a non-absorbent container or tray with shovel or by other suitable implement.

i. While transporting and handling samples, care shall be taken to protect against contamination, loss or gain of moisture, excessive vibration and abnormal variations of temperature.

j. The tests for workability, temperature, air content and density shall start within 5 minutes after obtaining the sample.

k) Filling of specimens for strength tests shall commence within 15 minutes after thorough mixing of the composite sample.

l) Spot samples shall not be used for filling of specimens for strength tests.

For correct way of sampling refer fig no. 1

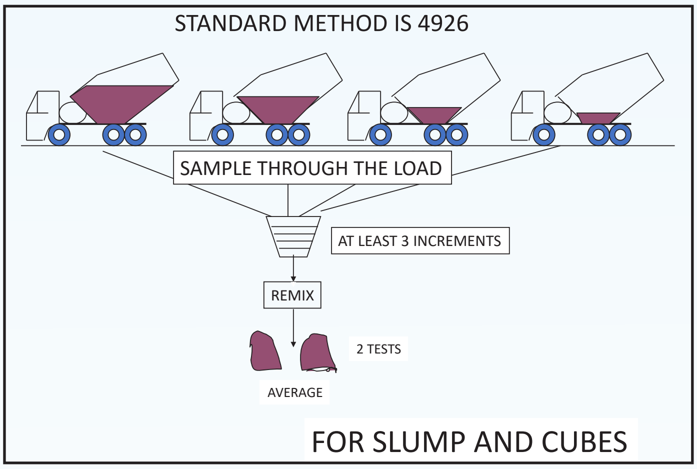

Fig. 1 Sampling of Fresh Concrete for Testing

3.0 Tests on Fresh Concrete:

The quality of fresh concrete mainly determines the performance in its hardened state. The quality of fresh concrete has also direct bearing on its transportation, placing, compaction, segregation, bleeding and temperature behaviour. The following important tests are generally carried out on fresh concrete.

a. Test on Workability

b. Density and Yield

c. Temperature

d. Determination of Air content

e. Forming Specimen for Testing

The importance of these tests as well as the correct method of conducting these tests are described in subsequent paragraphs.

3.1 Test on Workability:

The workability of concrete is decided during mix proportioning based on the type of compaction method available and construction techniques used at site. Majority of concretes are used in general civil construction sites where compaction is done either through needle vibrator or surface/screed vibrator, the workability of concrete in terms of slump is kept within 50 mm to 100 mm. To determine the workability under such situations, the slump cone method is used. However, the situation may arise where workability requirements differ and to meet different requirements, workability is tested by other methods also.

- Slump Cone Test
- Compaction Factor Test
- Flow Test
- Vee-Bee Consistometer Test
- Kelly Ball Test

3.1.1 Slump Cone Test:

It is the most common test since 1922 for workability of fresh concrete, which can be performed either at the working site/field or in the laboratory. A concrete slump test should be performed for each batch of fresh concrete for maintaining the consistency between each batch. Slump test is widely used across the globe due to its simplicity, low cost and immediate results. Slump test is regulated by IS: 1199 (Part - 2) 2018, ASTM C-143 and EN: 12350-2.

This testing method consists of a cone with a base diameter of 200 mm, a top diameter of 100 mm and a height of 300 mm. The cone is filled with concrete in 3 layers and compacted by 16 mm dia steel rod, 25 strokes for each layer. After filling the cone and levelling of top surface, cone is removed without jerk. The shape of the concrete after the removal is assessed to determine the workability.

The slump is then interpreted by the following shapes.

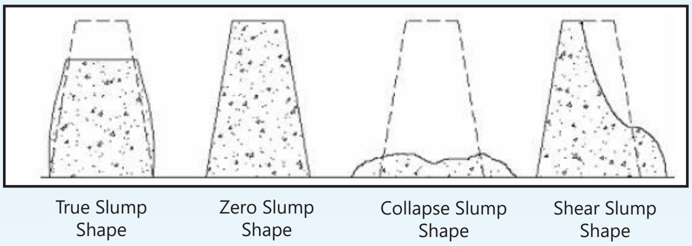

Fig. 2 Slump Cone Test Apparatus

- **True Slump:** It is the only slump that can be measured in the test. The measurement is taken between the top of the cone and the top of the concrete after the cone's removal.
- **Zero Slump:** Very dry mixes aim to have zero slump and are generally used in road construction.
- **Collapsed Slump:** This is an indication that the mix is too wet or that it is a high workability mix, for which a slump test is not appropriate.
- **Shear Slump:** It shows an incomplete result and should be re-tested.

3.1.2 Compaction Factor Test:

It works on the principle of determining degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height.

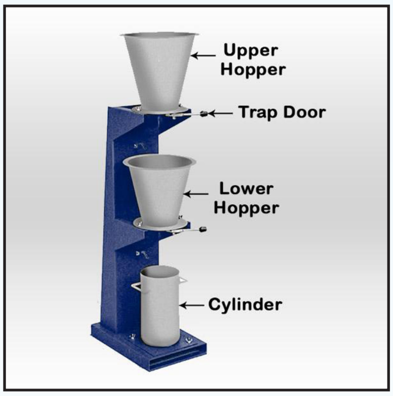

Fig. 3 Compaction Factor Test Apparatus

Compaction factor test is more favourable and useful for low workable concrete or dry concrete. This test is more precise and sensitive than the slump test for low workable concretes. The compaction factor test is regulated by IS: 1199 (Part - 2) 2018, ACI: 211.3-75 and BSEN: 1881.103.

The compaction factor varies from 0.78 to 0.95. The lower value shows the concrete is of very low workability and higher value shows concrete of high workability. Compaction factor test is normally conducted in laboratory but for large project sites, it can also be conducted in the field.

3.1.3 Flow Test:

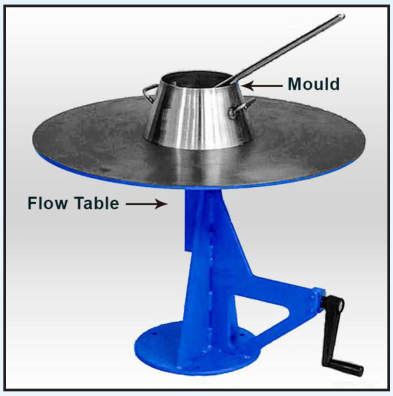

Fig. 4 Apparatus of Flow Test

The flow test is generally used for high to very high workability concrete, which would exhibit the collapsed slump. In this test a standard mass of concrete is subjected to jolting. Similar laboratory test named Flow Table Test was developed in Germany in 1933 and it has been described in IS: 1199 (Part - 2) 2018 and BS: 1881:105, ASTM C-124-39. The value of flow test may range from 0 to 150%.

3.1.4 Vee – Bee Consistometer Test:

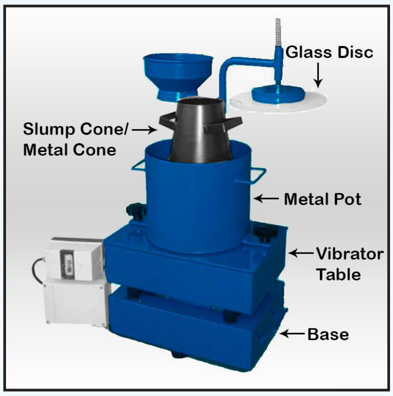

Fig. 5 Vee - Bee Consistometer Test Apparatus

Vee – Bee Test is usually performed on dry concrete and it is not suitable for very wet concrete. Vee – Bee consistometer test determines the mobility and to some extent compatibility of concrete. In Vee – Bee consistometer test, vibrator is used instead of jolting. Vee – Bee test determines the time required for the transformation of concrete by the vibration. The Vee – Bee test is regulated by IS: 1199 (Part - 2) 2018, ACI: 211.3-75 and BSEN 12350-3.

Recommended results of Vee – Bee consistometer test are;

- Vee – Bee time upto 20-10 seconds, concrete is considered as very dry consistency.
- Vee – Bee time upto 10-7.5 seconds, concrete is considered as in a dry consistency.
- Vee – Bee time upto 5 to 3 seconds, concrete is considered as in a plastic consistency.
- If Vee – Bee time upto 2-1 seconds, concrete is considered as in a semi-fluid condition.

3.1.5 Kelly Ball Test (Ball Penetration Test):

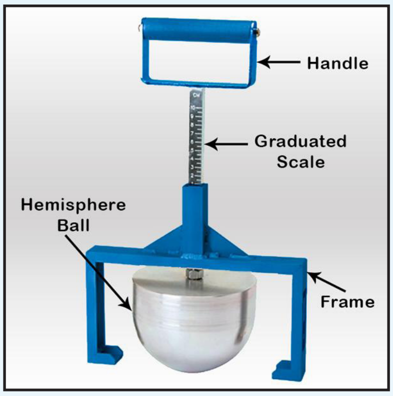

Fig. 6 Kelly Ball Test Apparatus

This test was developed by JW Kelly in United States of America. It is simple and inexpensive field test which measures workability of fresh concrete which is similar to slump test. It is more accurate and faster than slump test. This test uses a device that consists of metal hemisphere (ball), thereby indicating the consistency of fresh concrete by its level of penetration when the metal hemisphere drops. Thus, in this test, depth is determined through metal hemisphere, which sinks under its own weight into fresh concrete. The Kelly Ball test is regulated by ASTM C 360 – 32.

3.2 Suitable Workability Test for Different Degree of Workability:

The table below provides, which workability test is appropriate for mixes of different degree of workability.

Table-1 Suitable Workability Test for Different Degree of Workability

Sl. No.	Degree of Workability	Suitable Workability Test
1	Very Low	Vee – Bee Consistometer Test
2	Low	Vee – Bee Consistometer Test, Compaction Factor Test
3	Medium	Compaction Factor Test, Slump Test
4	High	Slump Test, Flow Test
5	Very High	Flow Test

4.0 Density and Yield of Fresh Concrete:

It is important to find the density of fresh concrete to know the volume and yield as per the batch. The procedure for determination of density of fresh concrete is given in IS: 1199 (Part-3) – 2018.

The fresh concrete is compacted (by vibrator; vibration table or compacting rod) into a calibrated, rigid and watertight container and then is weighed. Volume (V) of container is obtained through calibration as per procedure given in IS: 1199 – (Part -3) 2018. The empty container weight is deducted to know the weight of the compacted concrete inside the container. The density is calculated by dividing the weight (W) of compacted concrete by the volume (V) of the container.

$$d = \frac{W}{V} \; g/cm^3 \quad \text{or} \quad kg/m^3$$

The dimensional requirements of container as per IS code are;

Sl. No.	Nominal Size of Coarse Aggregate	Inside Dimension Dia mm	Inside Height mm	Minimum Thickness of Metal mm
1	Upto 40 mm	250	280	4
2	Above 40 mm	350	285	5

This test method may not be applicable to aerated concrete or very stiff concrete that cannot be compacted by normal vibration and compaction rod.

4.1 Estimation of Yield - Volume Delivered:

The compacted volume to be expected from a given total weight of materials batched or concrete delivered, can be calculated from;

$$\text{Volume } (m^3) \; \frac{\text{(Total weight of materials or concrete)}}{\text{(Plastic Density (PD))}}$$

Plastic density (PD) is determined on a fully representative sample as described above.

For example, if the difference between the gross and tare weight of a truck mixer is 14,380 kg and the plastic density is measured as 2,380 kg/m^3,

$$\text{then the delivered volume} = \frac{14{,}380}{2{,}380} = 6.04 \; m^3$$

Which can be compared with the volume delivered on the delivery docket.

In the plastic density test, about 0.5 to 1.5 percent of air may remain entrapped in the concrete after full compaction. In practice, a higher value, say 1-2 percent may remain entrapped in the construction after compaction. A very slight over-yield could be observed but this will usually be adjusted against the wastage which can occur. However, in case of air-entrained concretes, the results of yield may vary depending upon the quantity of air escaped during compaction at site.

When ordering RMC, allowances should be made for losses subsequent to discharge at site due to handling and placing. The quantity of placed concrete may also vary due to irregularities in the formwork and any settlements during concreting.

5.0 Determination of Air Content in Fresh Concrete:

The air content of fresh concrete is determined as per IS: 1199 (Part 4) – 2018. Sample of fresh concrete is collected as per Clause no. 2.0 in a rigid, watertight, metal container and compacted either through internal vibrator, or vibration table or by using compacting rod/ bar. The air content is determined by any of the following two methods;

- Pressure gauge method
- Water – column method

The pressure gauge method is based on the principle that a known volume of air at a known pressure is merged in a sealed air container with the unknown volume of air in the concrete sample. The dial on the pressure gauge is calibrated in terms of percentage of air for the resultant pressure.

The water column method is based on the principle that water is introduced to a predetermined height above a sample if compacted concrete of known volume in a sealed container and a predetermined pressure is applied over the water. The reduction in the volume of the air in the concrete sample is measured by observing the amount by which the water level is lowered, the water column being calibrated in terms of percentage of air in the concrete sample.

The schematic diagram of both methods is given in figure below.

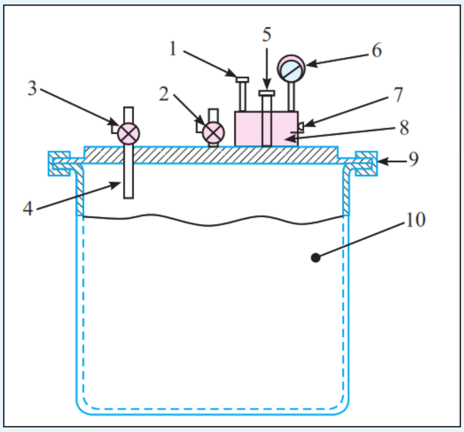

Fig. 7 (a) Pressure Gauge Method

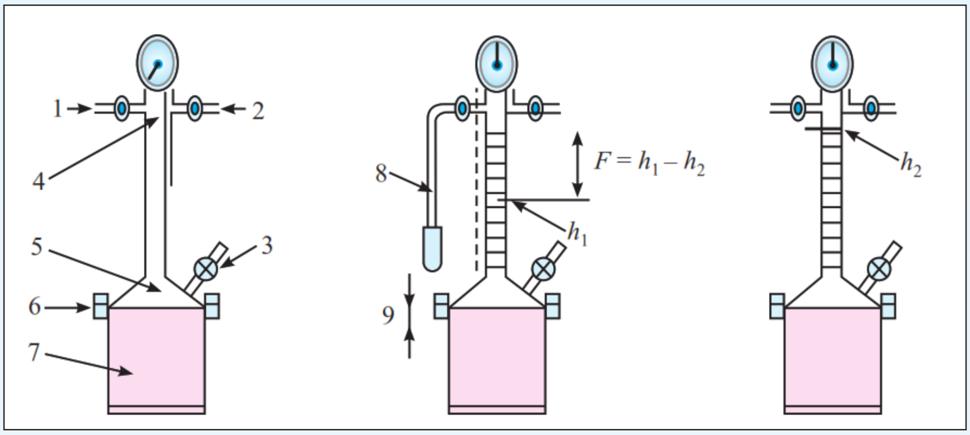

Fig. 7. (b) Water Column Method

6.0 Preparation of sample specimen for testing of Compressive Strength:

It is important to follow the correct procedure in making the test specimen. Following points shall be kept in view;

a) The test specimen shall be 150 mm cubes, if the largest nominal size of aggregate does not exceed 20mm. 100mm cubes may be used as an alternative (IS: 1199 Part – 5 - 2018). However, the acceptance will be based on test result of 150 mm cube.

b) The mould shall conform to requirements of IS: 10086. Moulds shall be water-tight and non-absorbent.

c) The tolerance on various dimensions shall conform to IS: 10086 (l, h, w ±0.5mm, right angle ±0.5 degree).

d) The dimensions of moulds shall be checked at regular intervals, of not more than one year.

e) Individual mould shall be identifiable. The identification number shall either be welded or painted on the mould body or securely tagged to the mould body.

f) When assembling the mould for use, the joints between the sections of the mould shall be thinly coated with mould oil and a similar coating of mould oil shall be applied between the contact surfaces of the bottom of the mould and the base plate in order to ensure that no water escapes during the filling.

g) Concrete sample shall be taken as described in Clause 2.0 and remixed before filling the mould.

h) Place the mould on a rigid horizontal surface.

i) Place the concrete in mould by a scoop in layers not more than 50 mm thick. In order to ensure symmetrical distribution of concrete within the mould, move the scoop around the top edge of the mould.

j) Use the quantity of material in the final layer that is just sufficient to fill the mould without having to remove the excess material. Removal of excess material shall be avoided.

6.1 Compaction of Concrete:

Compact the concrete immediately after each layer is placed in the mould to achieve full compaction without excessive segregation or laitance. Each layer shall be compacted as given below depending on the slump of concrete;

Sl. No.	Slump	Preferred Method of Compaction
1	Less than 50 mm	Vibrating table or internal vibrator
2	50-100 mm	Vibrating table or internal vibrator or tamping bar/tamping rod
3	More than 100 mm	Tamping bar/tamping rod

While compacting with tamping rod, distribute the strokes in uniform manner over the cross-section of mould. Ensure that tamping rod does not penetrate significantly any previous layer nor forcibly strike the bottom of the mould. For cubes and cylinders having size of 150 mm, subject the concrete to a minimum of 35 stokes or tamps per layer and for cubes and cylinders of 100 mm size, a minimum of 25 strokes/tamps.

In order to remove voids or pockets of entrapped air but not the entrained air, after compaction of each layer, tap the sides of the mould with the wooden mallet until large bubbles of air cease to appear on the surface and the depressions left by the tamping rod are removed. The number of strokes or tamps shall be recorded.

6.2 Surface Levelling:

After the top layer has been compacted, remove the concrete above the upper end of the mould using a trowel or a float and level the surface with the top of the mould. Cover the surface with suitable material to prevent evaporation of water.

6.3 Marking:

Identify the test specimen with a clear and durable marking, and without damaging the specimen. Keep records to ensure that the specimen identity is known from sampling to testing.

6.4 Curing of Test Specimens:

Leave the test specimen in the mould at least for 16 hours, but not longer than three days. Protect the specimens from shock, vibration and water evaporation. Store the specimen at a temperature 27 ± 2^{0}C.

After removal from the mould, submerge the test specimens in clean, fresh water immediately. Store the test specimens in water at a temperature of 27 ± 2^{0}C and take it out just prior to testing. Alternatively store the test specimens in a chamber at a temperature of 27 ± 2^{0}C and relative humidity (RH) of at least 95 percent until just before testing. If the test specimens are to be sent to a test laboratory, cover the test specimens with wet cloth/wet sand or other suitable material or seal the test specimens in plastic bags containing water to ensure that the test specimens are delivered in the test laboratory in damp condition not less than 24 hours before the time of testing. At the test laboratory, store the test specimens in water at a temperature of 27 ± 2^{0}C until taking it out just prior to testing.

7.0 Determination of Compressive Strength of Specimens:

The test specimen shall be a cube or cylinder or a core. Damaged or honeycombed specimen shall not be tested and shall not be regarded as being representative of the quality of concrete. The test shall be carried out using a compression testing machine, the test machine shall be in calibration at the time of testing. Test shall be made at recognised ages of the test specimens, say 1, 3, 7, 28, 56, or 90 days. At least 3 specimens shall be tested at each selected age.

7.1 Compressive Strength Testing Procedure:

For specimens stored in water, excess moisture shall be wiped from the surface of the specimens before placing them in the testing machine. The dimensions of the specimens to the nearest 0.2 mm, and their weight shall be noted before testing. The time between the extraction of the specimen from the curing tank and testing shall not be more than 2 hours. During the time, the specimen remains outside the curing tank, it shall be covered with a wet cloth.

The bearing surface of testing machine shall be wiped clean and any loose material in contact with the plattens shall be removed. Do not use packing, other than auxiliary plattens or packing blocks. Cubes shall be compressed perpendicular to the direction of casting. The specimen shall be centred on the lower platten to an accuracy of 1 percent of the designated size of the specimen.

The load shall be applied without shock and shall be increased continuously at a constant rate of 14 N/mm^2/minute until no greater load can be sustained. The maximum load indicated shall be recorded. The failure pattern of test specimens shall be noted and recorded. The compressive strength is given by the equation;

fc = F/Ac

fc = Compressive strength in MPa

F = Maximum load in N, and

Ac = Cross sectional area of specimen in mm^2.

Average 3 values shall be taken as representative of the batch provided individual variation is not more than ± 15 percent of the average. Otherwise repeat test shall be made. If there is no further sample, then average of two closest values may be taken as the average result.

8.0 Non-Destructive Testing of Concrete:

In many situations, non-destructive testing methods of testing of hardened concrete are required. There are two most popular methods under this category.

- Rebound Hammer Test
- Ultrasonic Pulse Velocity Test

8.1 Rebound Hammer Test:

Rebound Hammer Test is mainly used for two purposes, firstly to assess the compressive strength of concrete by developing suitable co-relation between rebound index and compressive strength and secondly to assess the uniformity of concrete.

The Rebound hammer works on the principle that when its plunger is pressed against the surface of the concrete, the spring controlled mass rebounds and the extent of such rebound depends upon the surface hardness of concrete. Based on the rebound distance after it impacts the plunger, a rebound number is produced. The surface hardness and consequent rebound is taken to be related to compressive strength of concrete. The rebound is read off along a graduated scale and designated as the rebound number or rebound index.

The relationship between rebound number and concrete strength are provided by the instrument manufacturers. For bigger projects, it may be desirable to establish relationship either through testing of concrete cubes or by extracting few cores from different locations (at least 6) on the structure.

8.1.1 Procedure:

- Concrete surfaces shall be thoroughly cleaned before taking any measurement. Surface shall be clean, smooth and dust free from any loosely adhering scale.
- The point of impact shall be at least 25 mm away from any edge or shape discontinuity.
- The rebound hammer shall be held at right angles to the concrete surface.
- Around each point of observation, six readings of rebound indices shall be taken and average of these readings after deleting outliers, becomes the rebound index for the point of observation.

8.1.2 Factors Influencing Test Results:

- Type of cement (Alumina cements gives higher number and super sulphated cement gives lower).
- Type of aggregates and their percentage.
- Surface condition and moisture content.
- Age of concrete and extent of carbonation

The Rebound hammer method provides a convenient and rapid indication of the compressive strength of concrete. In general the rebound number increases as the strength increases but it is also affected by number of parameters. Rebound hammers are indicative of strength of concrete to a limited depth from the surface. If there are flaws or heterogeneity across the cross-section, rebound hammer will not be able to indicate it. Therefore the estimation of strength of concrete by rebound hammer method cannot be held to be accurate and probable accuracy can be upto 25 percent depending upon co-relation established between rebound number and compressive strength of concrete.

8.2 Ultrasonic Pulse Velocity Testing (USPV):

Pulse velocity method is a convenient technique investigating the quality of in-situ concrete. The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformity is good. In case of poorer quality, lower velocities are obtained. If there is a crack, void or flaw inside the concrete, lower velocities are obtained. The actual pulse velocity obtained depends upon the materials, mix proportions and the quality of placed concrete.

8.2.1 Procedure: At the point of observation, the concrete surface, shall be suitably prepared, any plaster coating shall be removed to expose the concrete surface. Two transducers are placed on opposite faces or on adjacent faces, or on the same face as shown in fig. 8.

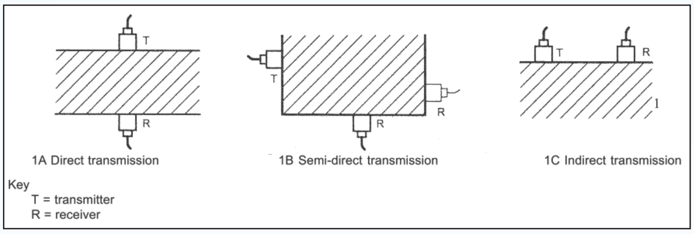

Fig. 8 Positioning of Transducers

The ultrasonic pulse is produced by the transducer which is held in contact with one surface of the concrete member under test. After traversing a known path length L in the concrete, the pulse of vibrations is converted into an electrical signal by the second transducer held in contact with the other surface of the concrete member and an electric timing circuit enables the transit time

(T) of the pulse to be measured. The pulse velocity V is given by;

$$V = \frac{L}{T}$$

IS: 516 (Part 5 – Section1) provides guidelines for concrete quality as given in Table - 2;

Table 2– Velocity Criterion for Concrete Quality Grading

Sl. No.	Average Pulse Velocity (km/s)	Concrete Quality Grading
1	Above 4.40	Excellent
2	3.75 to 4.40	Good
3	3.00 to 3.75	Doubtful
4	Below 3.00	Poor

(In case of 'Doubtful' quality, it may be necessary to carry out further tests.)

Ultrasonic pulse velocity values are used to assess only concrete quality grading and not the grade of concrete. When the compressive strength tests conducted either on cubes or cylinders are non-conclusive, the non-descriptive tests such as Rebound Hammer Test or Pulse Velocity Test are carried out. If the results still remain non-conclusive, concrete cores are extracted from different locations and are tested in accordance with IS: 516 (Part 4) – 2018, to find the compressive strength of concrete in-situ.

9.0 Sampling and Testing of Concrete Cores:

- **Location:** Cores shall be taken preferably from middle part of the member leaving top and bottom parts where variation can be more and reinforcement shall be avoided as far as possible. Core shall not contain concrete from top 15 to 20 percent depth as top and bottom parts may not contain uniform distribution of aggregates. The locations where micro-cracks can be there due to tension shall be avoided and cores shall preferably be taken from compression zone.
- **Drilling:** Cores shall be drilled perpendicular to the surface in such a way as not to damage the cores. The drilling shall be carried out by an experienced operator using diamond impregnated bit attached to the core barrel. The drilling apparatus shall be rigidly attached to the member to avoid bit wobble. The drill bit shall be lubricated with water and shall be resurfaced periodically. Cores that show abnormal defects or damage during extraction shall not be used. The core shall not contain any reinforcement bars, the reinforcement detector can be used for selecting the drilling location free of reinforcement. The number of cores shall be decided based on the size of pour, but in no case shall be less than 3.
- **Size of Cores:** The diameter of cores shall be preferably 100 or 150 mm, however cores of smaller dia not less than 3 times the nominal maximum aggregate can be used. The length of the core is preferred *l/d* of 2, however, *l/d* values less than 2 can be permitted (length includes capping material also). However, in case of specimen of *l/d* less than 2, the compressive strength correction factor is applied.
- **Preparation of Cores and Testing:** The load bearing surfaces shall be prepared either by grinding or by capping with suitable material. Cores are generally tested in saturated condition, surface dry (SSD). The specimen shall be placed in the CTM, so that the axis of specimen is aligned with the centre of thrust of the spherically seated platen. The load shall be applied without shock and increased continuously at a rate of 14 N/mm^2/min until no greater load can be sustained. The maximum applied load to the specimen is recorded. The compressive strength of specimen is calculated by dividing the maximum load by its cross-section area to the nearest N/mm^2. The correction factor for cores having diameter less than 100 mm is made as under;

Diameter of Core, mm	Correction Factor
75 ±5	1.03
<70	1.06

A correction factor for ratio of specimen is applied as per equation;

$$F = 0.11\,N + 0.78$$

Where, F = Correction factor and N is length/diameter ratio.

The core strength can be converted to equivalent cube strength by multiplying it by 1.25.

The core test is used when cube results and non-destructive methods do not provide conclusive results. However, core test results are affected by many factors like location, direction of placing of concrete and drilling, reinforcement, strength and grade of concrete, etc. Core test shall be interpreted keeping in view the homogeneity, density, workmanship, curing conditions, etc. at site. The acceptance criteria of core results is provided in IS: 456 – 2000.

10.0 Conclusions:

Testing of fresh and hardened concrete requires thorough knowledge of testing procedure as per various codes. It is observed in practice, especially when testing is done at construction sites, that either the required facilities or the qualified staff is not available. In both the cases, correct results will not be obtained. The tests conducted in a well-equipped laboratory (preferably accredited by third party) by well experienced and qualified staff shall be relied more than the field tests. At the same time, attention shall be given to upgrade testing facilities and training of staff at construction sites for getting correct and reliable results.

BIS has recently revised IS: 1199 (Testing of Fresh Concrete) and IS: 516 (Testing of Hardened Concrete) and issued these codes in different parts. It is recommended that the contents of these codes shall be thoroughly studied and implemented for testing of fresh as well hardened concrete.

11.0 References:

The list of revised codes is given under references;

Fresh Concrete:

1. IS: 1199 (Part -1) Sampling of Fresh Concrete.
2. (Part -2) Determination of Consistency of Fresh Concretes
3. (Part -3) Determination of Density of Fresh Concrete
4. (Part -4) Determination of Air Content of Fresh Concrete
5. (Part -5) Making and Curing of Test Specimens
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8. (Part -8) Determination of water soluble and acid soluble chlorides in mortar and concrete
9. (Part -9) Analysis of freshly mixed concrete

Hardened Concrete:

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2. (Part - 2) Determination of properties of hardened concrete other than strength
3. (Part - 3) Making, curing and determining compressive strength of accelerated cured concrete test specimens
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10. (Part - 10) Determination of bond in reinforced concrete
11. (Part - 11) Determination of Portland cement content of hardened hydraulic cement concrete
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