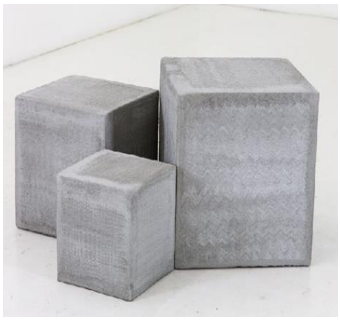
# Properties of concrete lab manual

**Prepared by : eng Haneen Abbadi**



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# Normal consistency

## Introduction

The consistency test of cement is a laboratory procedure used to determine the amount of water required to produce a cement paste of specific consistency.

This test helps evaluate the workability and setting time of cement, which are vital factors in construction.

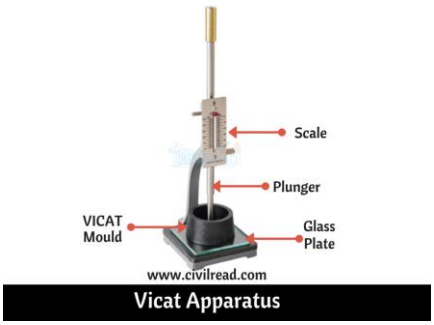
The consistency of cement paste is influenced by several factors, such as the cement's chemical composition, fineness, and temperature.

Why You Should Do Cement Consistency Tests?

Cement consistency tests are essential for several reasons:

Quality Assurance: Consistency tests ensure that the cement meets quality standards, guaranteeing the performance of the final concrete or mortar.
Workability: By measuring the water-cement ratio required to achieve a specific consistency, the test helps determine the workability of the cement paste. This is crucial for construction and masonry work.
Setting Time: The test also provides insights into the setting time of cement, which is crucial for time-sensitive construction projects.

## Apparatus: vicats apparatus



Vicat Apparatus

## Procedure:

1.Take empty pan free from dirt and other foreign particles.

2. Weight 500 gm of cement, and put that in the pan.

3. Measure an amount of water using graduates cylinder (This amount of water is nearly 26%-33% of the amount of cement).

4. Mix the cement and water thoroughly to get a homogenous mixture. Mixing for 4±3/4 minutes.

5. Fill the cement paste in the mould of Vicat apparatus.

6. The plunger is gently lowered on the paste in the mould until it touch the surface of the paste.

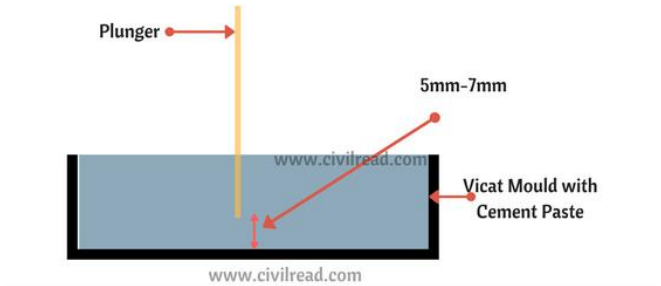
7. Release the plunger immediately to penetrate the paste (this must not exceed 30 seconds after completion of mixing).

8. Read the gauge or the penetration depth taking the distance from the base plate to the tip of the plunger.

## Discussion :

- The standard consistency is achieved when the plunger penetrates the paste to a point 5-7 mm from the bottom of the Vicat mold.

- False set is the rapid development of rigidity in freshly mixed paste, mortar, or concrete without the evolution of much heat. Plasticity can be regained by further mixing



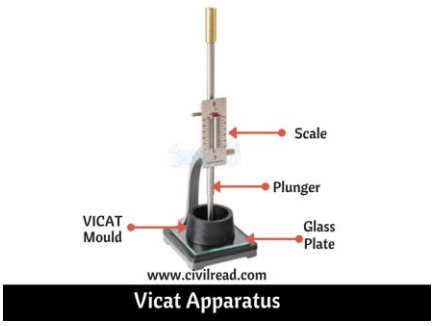
Consistency of Cement 5mm-7mm

# Setting time( cement paste )

## introduction

- initial setting time of cement is important, to know when the cement is starting to lose its plasticity. It is helpful in determining the time needed for the concreting process, i.e. transportation, placing and compaction of concrete.
- Final setting time of cement is important to know when the cement would be set. This testing of cement is helpful to determine safe removal time of side of form (not vertical support) or scaffolding of concrete.

**Apparatus:** vicats apparatus



Vicat Apparatus


Needle used for finding
Initial setting time of cement


Needle with annular attachment used in
Final setting time of cement

## Procedure:

- Take 500 gm of cement for making a paste.
- The required quantity of water ( determined by consistency test ). Water should be potable or distilled water. Prepare a paste of weighed quantity of Cement and water.
- Start a stop-watch at the instant when water is added to the cement. The gauging time is started to count from the time of adding water to the dry cement.
- The mould resting upon a non-porous plate, fill it with this paste
- After completely filling the mould, smoothen the surface of the paste, making it level with the top of the mould. The mould may be slightly shaken for remove the air.

(a) Initial Setting Time of Cement

- Place the mould under the rod bearing the needle. (needle for determining the initial setting time)
- Lower the needle slightly until it comes in contact with the surface of the test block and quickly release, allowing it to penetrate the test block.
- In the starting, the needle will completely penetrate the test block.
- Repeat this procedure until the needle fails to penetrate the block to the 5 mm from the bottom of the mould.
- The period elapsing between the time when water is added to the cement and the time at which the needle fails to penetrate the test block to the 5mm from the bottom of the mould is called the initial setting time.

b) Final Setting Time of Cement

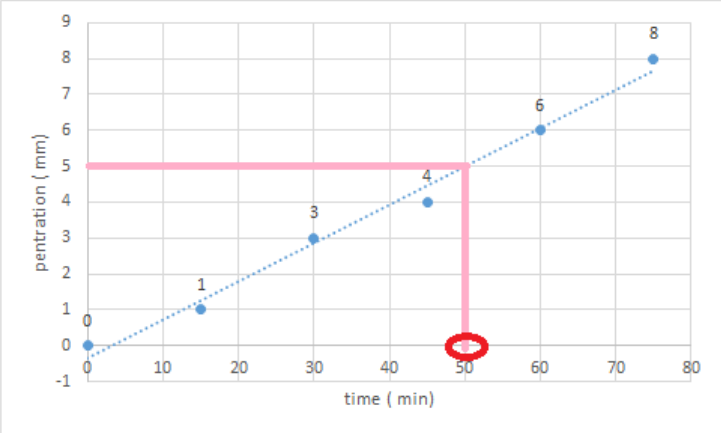
- To determine the final setting time the first needle is replaced by the (needle for determining the final setting time) needle with an annular attachment.
- When applying the needle gently to the surface of the mould, the needle makes an impression thereon.
- Cement called as final set while the attachment fails to make an impression on the surface of the test block.
- The period elapsing between the time when water is added to the cement and the time at which the needle fails to make an impression on the surface of the test block is called the final setting time.

## Discussion & calculations:

The time period elapsed between the moment water is added to the cement and the time, the needle (1mm diameter) fails to penetrate the mould of 5mm when measured from the bottom of the mould, is the initial setting time of cement.

| time ( min) | penetration (mm) |
|---|---|
| 0 | |
| 15 | |
| 30 | |

| | |
|---|---|
| 45 | |
| 60 | |
| 75 | |




## Final setting time

The period elapsing between the time when water is added to the cement and the time at which the needle (1 mm diameter) makes an impression on the surface of test block while the attachment (5 mm diameter) fails to do so shall be the final setting time.

# Compressive strength of cement mortar

## Introduction

Cement Mortar is one of the most common and cheapest binding materials used in construction industry. Cement mortar is basically a mixture of cement, sand & water. It is used in various aspects of civil engineering works such as masonry, brickwork, plastering, flooring etc.

## Apparatus:

Metal cube , compaction rod and trawl .

## Procedure:

1. Measure 2220g of cement and 6660g of standard sand in a 1:3 ratio by weight.
2. The sand utilized must conform to specified standards .
3. Mix the dry cement and sand thoroughly for one minute, then gradually add water. The water quantity should be proportional to the combined weight of cement and sand, determined by a predefined formula based on the paste's standard consistency.
4. Continue mixing until a uniform consistency is achieve.
5. Transfer the mortar mixture into cube molds, compacting it by prodding the mixture 25 times to eliminate entrapped air.
6. Place the cube molds in an environment with a temperature of 27±2°C and 90% relative humidity for 24 hours.
7. After 24 hours, remove the cubes from the molds and submerge them in clean water until testing.
8. Curing of Specimen : After completion of 24 hours, remove the cube from the mould and immediately keep in clean fresh water for 7 days

## Discussion & calculations:

- Strength tests are not made on neat cement paste because of difficulties of excessive shrinkage and subsequent cracking of neat cement, difficulties in moulding and testing with consequent large variability of result.

• Standard sand:
* The sand used for making test specimens shall be natural silica sand of one size.
*passing sieve No.18 (850 µm) and 90% of it retained on sieve No.25 (650 µm).
*such as sweileh sand

• Ratio of mix is 1: 3 in which one part is cement and 3 part is sand.
*Use a water-cement ratio of 0.4.
*The quantities of materials to be mixed at one time in the batch of mortar for making three test specimens (cubes) shall be as follows:
2220g cement
6660g sand
888ml water
Mould should have a size of 10 cm x 10 cm x10 cm. Three moulds are required for each test.

**CALCULATION**

$$Compressive Strength = \frac{P}{A}$$

| Specimen No | Load (kN) | Area (mm²) | Compressive Strength (MPa) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |

Average compressive strength of the cement mortar cube =…….MPa (at 7 days)
Average compressive strength of the cement mortar cube=……..MPa (at 28 days)
£ =| (Compressive Strength _ Average Compressive Strength)/ Average Compressive Strength|*100% ≤ 15%
The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than 15 percent of the average.
If one sample get exceeded then ignore it and recalculate the average.
If more, the test results of the sample are invalid, and the test is failed.

Where,
P=Maximum load applied to the cube. (N)
A=Cross sectional area (Calculated from the mean dimensions) ($mm^2$).
*A= 100 $cm^2$
MPa = $N/mm^2$
*The seven-day strength is (2/3) of the 28-day strength .

# Bulk density and specific gravity

## Introduction

'Aggregate' is a term for any particulate material. It includes gravel, crushed stone, sand, slag, and recycled concrete and geosynthetic aggregates. Aggregate may be natural, manufactured or recycled.

*Aggregates make 75% of the concrete mix. They provide compressive strength and bulk to concrete.

• Aggregates in any particular mix of concrete are selected for their durability, strength, workability.

• Aggregates are divided into either 'coarse' or 'fine' categories.

Classification of aggregates

Based on Size

If you separate aggregates by size, there are two overriding categories:

- Fine
- Coarse

The size of fine aggregates is defined as 4.75mm or smaller. That is, aggregates which can be passed through a number 4 sieve, with a mesh size of 4.75mm. Fine aggregates include things such as sand.
Coarse aggregates measure above the 4.75mm limit.

Based on Shape

* Rounded

*Angular

## Apparatus:

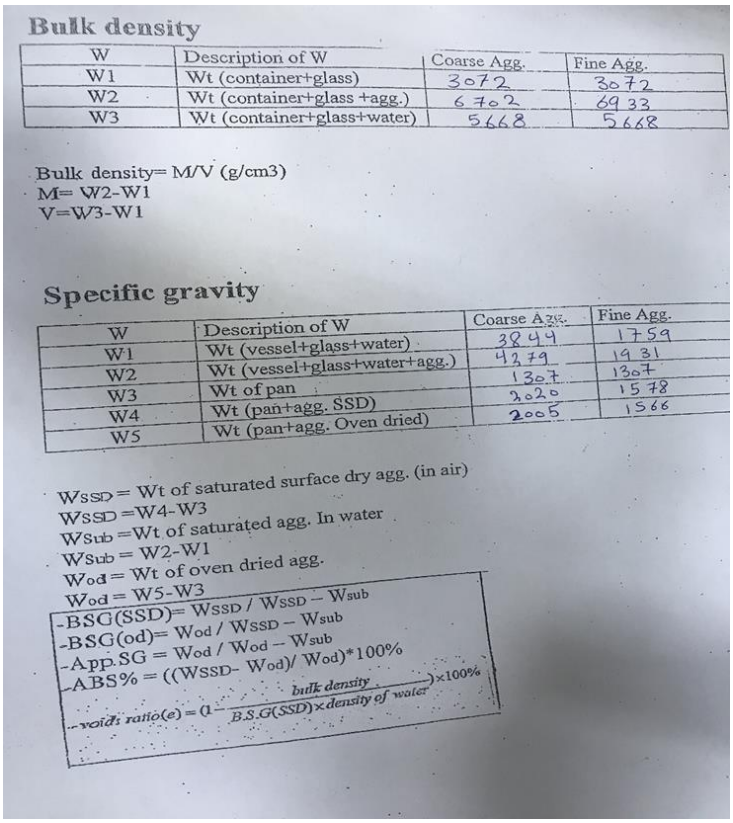
Balance: a balance

flask: a volumetric flask with a mark to indicate a volume of approximately 500 mL.

Metal Mold

Oven up to 200 c .

## Procedure and calculations :



**Bulk density**

| W | Description of W | Coarse Agg. | Fine Agg. |
|---|---|---|---|
| W1 | Wt (container+glass) | 3072 | 3072 |
| W2 | Wt (container+glass +agg.) | 6702 | 6933 |
| W3 | Wt (container+glass+water) | 5668 | 5668 |

Bulk density= M/V (g/cm3)
M= W2-W1
V=W3-W1

**Specific gravity**

| W | Description of W | Coarse Agg. | Fine Agg. |
|---|---|---|---|
| W1 | Wt (vessel+glass+water) | 3844 | 1759 |
| W2 | Wt (vessel+glass+water+agg.) | 4279 | 1931 |
| W3 | Wt of pan | 1307 | 1307 |
| W4 | Wt (pan+agg. SSD) | 2020 | 1578 |
| W5 | Wt (pan+agg. Oven dried) | 2005 | 1566 |

$W_{SSD}$ = Wt of saturated surface dry agg. (in air)
$W_{SSD}$ =W4-W3
$W_{Sub}$ =Wt of saturated agg. In water
$W_{Sub}$ = W2-W1
$W_{od}$ = Wt of oven dried agg.
$W_{od}$ = W5-W3

-BSG(SSD)= $W_{SSD} / W_{SSD} - W_{sub}$
-BSG(od)= $W_{od} / W_{SSD} - W_{sub}$
-App.SG = $W_{od} / W_{od} - W_{sub}$
-ABS% = $((W_{SSD} - W_{od})/ W_{od})*100\%$
-void ratio(e) = $(1 - \frac{\text{bulk density}}{B.S.G(SSD) \times \text{density of water}}) \times 100\%$

## Discussion :

Bulk density

The bulk density or unit weight of an aggregate is defined as mass of the aggregate per unit volume.

Bulk-density depends upon how densely the aggregate is packed. It also depends upon the size, distribution and shape of the particles.

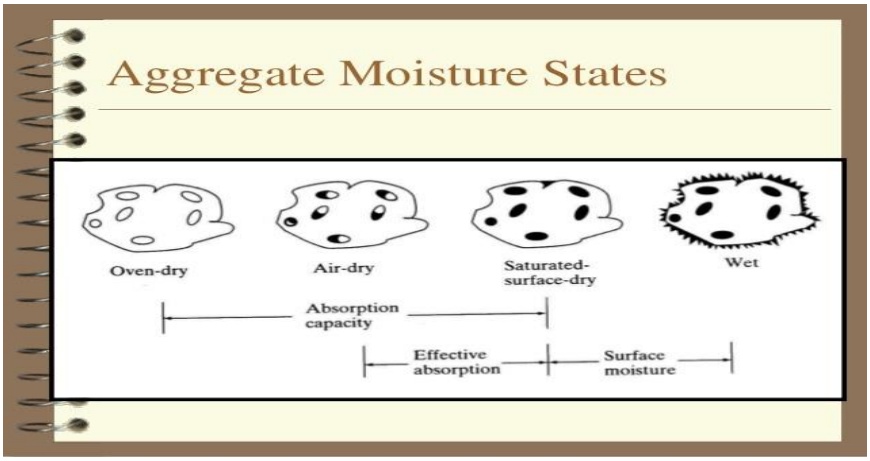
Specific gravity ( relative density)

Moisture States:

Since aggregates contain some porosity, water can be absorbed into the body of the particles or retained on the surface of the particle as a film of moisture. The following four moisture states are defined:

- Oven-dry (OD): All moisture is removed from the aggregate by heating in an oven at 105 C to constant weight (overnight heating usually is sufficient). All pores are empty.
- Air-dry (AD): All moisture removed from surface, but internal pores partially full.
- Saturated-surface-dry (SSD): All pores filled with water, but no film of water on the surface.

- Wet: All pores completely filled with water with a film on the surface




*Specific Gravity is defined as the ratio of the weight of a given volume of a material to the weight of an equal volume of water.

There are three different aggregate specific gravity:

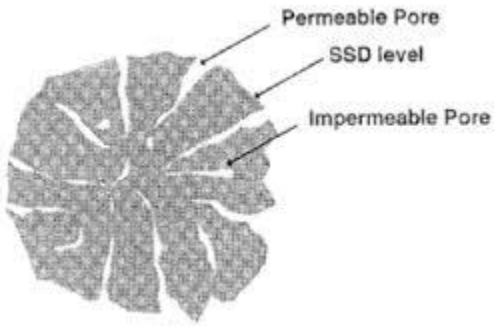
- Apparent specific gravity (APP.SG) (consider the volume of the solid material including the impermeable pores).

- Bulk specific gravity (consider the volume of the solid material including all pores).

*BSG(SSD)

*BSG(OD)

- Absolute specific gravity (consider the volume of the solid material excluding all pores).



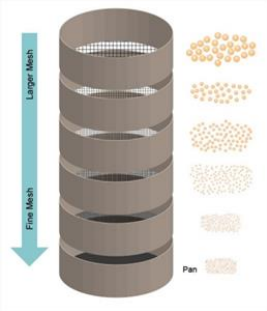

Water absorption (ABS%) : water absorption may be used to determine the amount of free moisture in the aggregate

# Sieve analysis

## Introduction

A sieve analysis (or gradation test) is a practice or procedure used (commonly used in civil engineering) to assess the particle (also called gradation) of a granular material by allowing the material to pass through a series of sieves of progressively smaller mesh size and weighing the amount of material that is stopped by each sieve as a fraction of the whole mass.

## Apparatus:




## Procedure :

- Take around 5 kg of representative dried sample out of 10 kg by the quartering method.
- Arrange the sieve set in such a manner so that the screen size of the opening decrease with each sieve down to the bottom-most sieve, which has the smallest opening size screen.
- Put the aggregate into the top of the sieve, close the top sieve with a top cover, and then the whole sieve set is placed into the sieve shaker and shaken automatically.
- Sieving is carried out in a sieve shaker for not less than 10 minutes.
- Find The final total weights of the retained sample on each sieve .

## Discussion & calculations:

*There are two common methods for sieve analysis of aggregates, dry sieve and sieve analysis using washed (wet) aggregate.

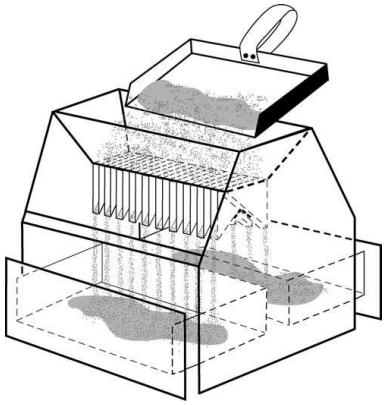
Sieve shaker machines


*A sample is merely a small fraction of the total material so it's important that the sample is truly representative.

The sample for sieving should be prepared from the larger sample either by quartering or by means of a sample divider.

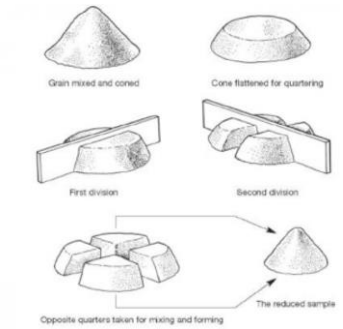
Riffle Box (Sample Splitters)

Mechanical sample splitter shall be equipped with 3 receptacles large enough to hold the sample following splitting. Only these receptacles shall be used when reducing the sample to the required testing size. B. Sample splitters shall have an even numb



**2- Quartering**

The process of reducing a representative sample to a convenient size, or of dividing a sample into two or more smaller samples for testing, is called quartering. This is a non-mechanical method of reducing a sample.



Types of Grading of Aggregates:

1. Gap graded aggregate

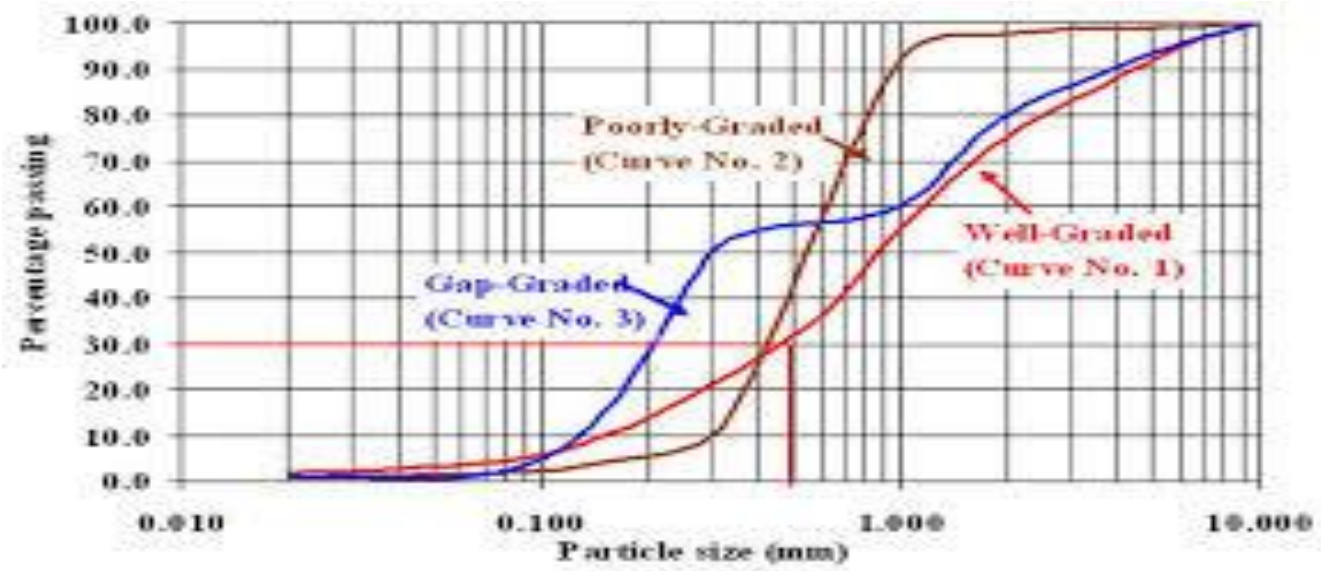
When the particles of certain sizes are missing in aggregate then the grading is termed as gap graded.

On a grading curve, gap grading is represented by a horizontal line over the range of sizes omitted.

2. Well graded aggregate

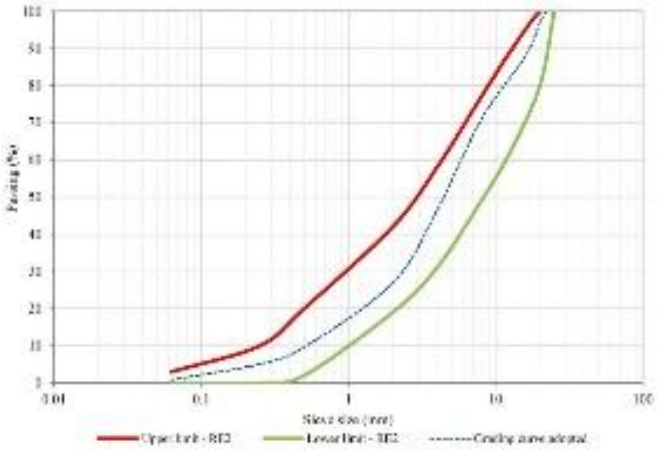
The aggregate is said to be well graded if the voids created by large-sized particles are filled almost by smaller size particles hence leaving minimum voids to be filled by cement paste. Well, graded aggregate contains all sizes of particles, thus leading to a compact and dense mass of concrete mix. This type of grading is considered the best because all sizes of

3. Poor-graded aggregate is characterized by small variation in size. It contains aggregate particles that are almost of the same size.




Upper and lower limits specification:

| Sieve size ( name ) | Cumulative passing percentage | | Sieve opening size (mm) |
|---|---|---|---|
| | Lower limit | Upper limit | |
| 19mm | 70 | 100 | 19 |
| 9.5mm | 50 | 75 | 9.5 |
| No.4 | 35 | 60 | 4.76 |
| No.8 | 27 | 45 | 2.38 |
| No.16 | 20 | 35 | 1.19 |
| No.30 | 12 | 25 | .595 |
| No.50 | 5 | 15 | .297 |
| No.100 | 1 | 5 | .15 |
| No.200 | 0 | 5 | .074 |



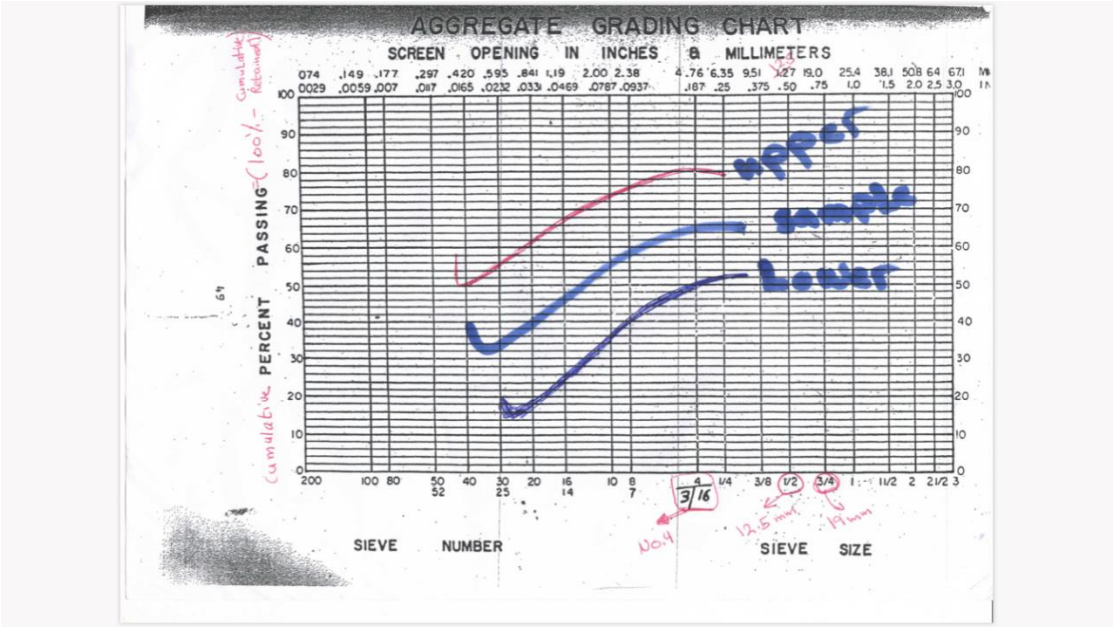
| Sieve size | Mass retained (W1) | %retained (W1/ΣW1 ) | % cumulative retained | %cumulative passing |
|---|---|---|---|---|
| 19mm | | | | |
| 12.5mm | | | | |
| 9.5mm | | | | |
| No.4 | | | | |
| No.8 | | | | |
| No.16 | | | | |
| No.30 | | | | |
| No.50 | | | | |
| No.100 | | | | |
| No.200 | | | | |
| pan | | | | |
| total | | | | |

*original weight = …… g

Error = (original weight –Σmass retained) / original weight  < 0.003

Fineness modulus (F.M) = Σ Cumulative retained on standard sieve / 100

**The definition of maximum aggregate size in concrete is the smallest sieve through which 100% of the aggregates will pass.**



# Los Angeles Abrasion test

## Introduction :

**What is the L.A. Abrasion Test?**

The Los Angeles (L.A.) Abrasion Test is widely used as an indicator of the relative quality of aggregates. It measures the degradation of standard grading of aggregates when subjected to abrasion and impact in a rotating steel drum with an abrasive charge of steel balls.

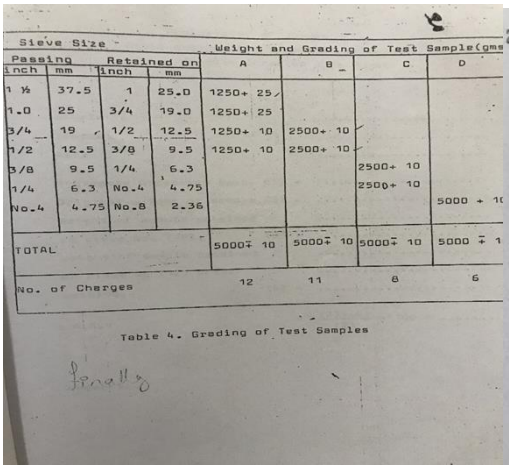
## Apparatus:


Los Angeles abrasion test setup

## Procedure :

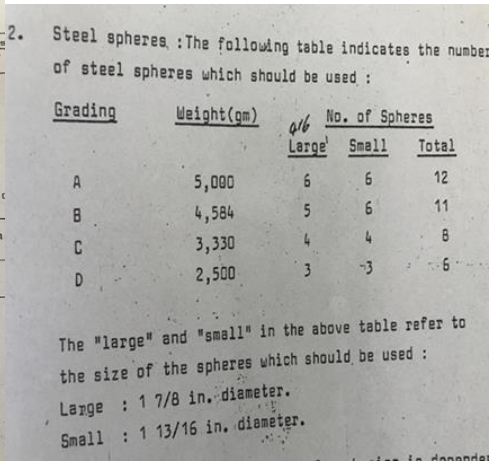
**Sample Preparation**

The test sample should consist of clean aggregates which has been dried in an oven, a substantially constant weight and should conform to one of the grading's shown in the table below:



| Sieve Size | | | | Weight and Grading of Test Sample(gms | | | |
|---|---|---|---|---|---|---|---|
| Passing inch | mm | Retained on inch | mm | A | B | C | D |
| 1 ½ | 37.5 | 1 | 25.0 | 1250+ 25 | | | |
| 1.0 | 25 | 3/4 | 19.0 | 1250+ 25 | | | |
| 3/4 | 19 | 1/2 | 12.5 | 1250+ 10 | 2500+ 10 | | |
| 1/2 | 12.5 | 3/8 | 9.5 | 1250+ 10 | 2500+ 10 | | |
| 3/8 | 9.5 | 1/4 | 6.3 | | | 2500+ 10 | |
| 1/4 | 6.3 | No.4 | 4.75 | | | 2500+ 10 | |
| No.4 | 4.75 | No.8 | 2.36 | | | | 5000 + 1 |
| TOTAL | | | | 5000∓ 10 | 5000∓ 10 | 5000∓ 10 | 5000 ∓ 1 |
| No. of Charges | | | | 12 | 11 | 8 | 6 |

Table 4. Grading of Test Samples



2. Steel spheres :The following table indicates the number of steel spheres which should be used :

| Grading | Weight(gm) | No. of Spheres | | |
|---|---|---|---|---|
| | | Large | Small | Total |
| A | 5,000 | 6 | 6 | 12 |
| B | 4,584 | 5 | 6 | 11 |
| C | 3,330 | 4 | 4 | 8 |
| D | 2,500 | 3 | 3 | 6 |

The "large" and "small" in the above table refer to the size of the spheres which should be used :

Large : 1 7/8 in. diameter.

Small : 1 13/16 in. diameter.

**How Does the L.A. Abrasion Test Work?**

A sample is prepared by separating into individual size fractions of the required masses.

1. The sample of specifically sized aggregates and the abrasive charge is placed in the L.A. Abrasion Machine and rotated at 33rpm.
2. The sample is removed and washed over a No. 12 (1.70mm) sieve and placed in an oven to dry.

## Discussion & calculations:


Aggregate Abrasion Value = ((A-B)/A) X 100%

Where,
A = weight in g of oven-dried sample ( 5000g ).
B = weight in g of fraction retained on sieve No.12 after washing and oven-dried.

- L.A.A.V should not be more than 30 percentage for concrete aggregates.
- L.A.A.V should not be more than 50 percentage for pavement aggregates.

*The value obtained from the Los Angeles abrasion test gives an indication of the abrasion resistance of the material. A low LAV indicates that the material has high abrasion resistance. Conversely, a high LAV indicates that the material has low abrasion resistance.

# Workability

## Introduction:

What is the Workability of Concrete?

Workability of Concrete is a broad and subjective term describing how easily freshly mixed concrete can be mixed, placed, consolidated, and finished with minimal loss of homogeneity.

Workability is a purely physical property of freshly mixed concrete. Workability of concrete simply means the ability to work with concrete. Fresh concrete is said to be workable if it can be easily transported, placed, compacted, and finished without any segregation. The ease of placing, compacting, and finishing of concrete in the desired manner is called its workability.

Factors Affecting Workability

Water/Cement Ratio

Aggregate Size and Shape

Admixtures

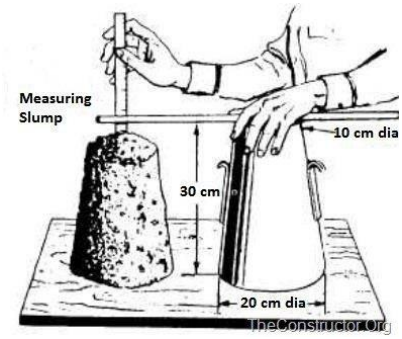
Slump test

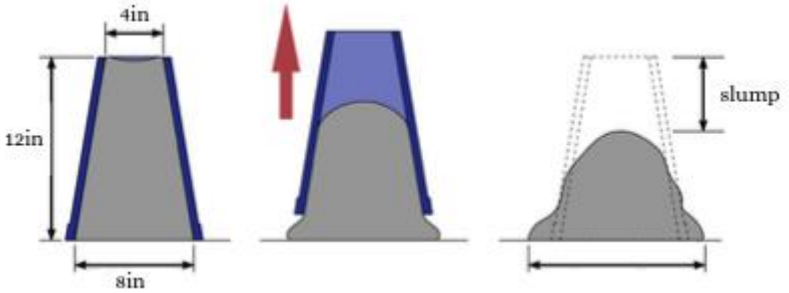
The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for different loads of concrete under field conditions.

( procedure )

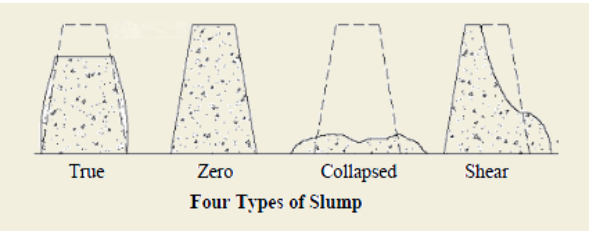
A Slump Cone is placed on a solid, level base and filled with fresh concrete in three equal layers rodded in a specified manner to consolidate. The concrete is struck even with the top of the cone, and the cone is carefully lifted away. The sample then settles, or slumps and the final height is subtracted from the original height of the cone and recorded.

The test should be carried out by filling the slump cone in three equal layers with the mixture being tamped down 25 times for each layer.



The form or profile of the slump is also noted and used to judge the reliability of each test:



Four Types of Slump

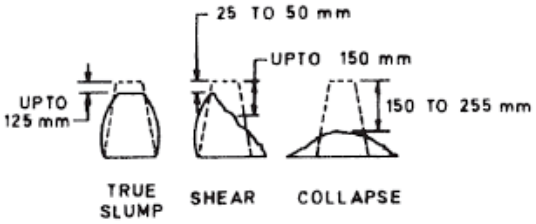


*Fig. 18 Slump: True, Shear and Collapse*

| Degree of workability | Slump (mm) |
|---|---|
| Very low | 0 - 25 |
| Low | 25 - 50 |
| Medium | 50 - 100 |
| High | >100 |

## The compacting factor

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.

The compaction factor is the ratio of weights of partially compacted to fully compacted concrete.

The degree of compaction, called the compacting factor, is measured by the density ratio, i.e. the ratio of the density actually achieved in the test to the density of the same concrete fully compacted

Procedure ( compaction factor test )

The test will be done in two stages. First stage fill the upper hopper gently with fresh concrete then open the trap door. Remove the stuck concrete gently using the tamping rod then open the door for the bottom hopper. Cut the excess concrete from the cylinder using trowel and level the concrete at top of the cylinder. Clean any concrete stuck outside the cylinder and weight it (W1). This knows as the weight of partially compacted concrete.

The second stage of the test: the cylinder will be filled in layers. Each layer must be compacted heavily using tamping rod to achieve full compaction. The excessive concrete at cylinder top shall be removed and the weight of cylinder measured. This weight knows as fully compacted concrete (W2).

Calculation ( compacting factor test )

Compaction factor= (W1-W)/ (W2-W)

Where

W is the weight of empty cylinder

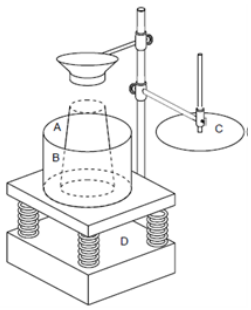
Compacting factor test Apparatus

Vee bee test

Vee bee test is suitable for very dry concrete whose slump value can't be measured by slump test .

In the vee bee Consistometer test, the shape of concrete is changed from the slump cone shape to the cylindrical shape through the vibration process; this is called remoulding effect

Vee bee time: the time required for transforming by vibration, a concrete specimen in the shape of conical frustum into a cylinder. This is a good laboratory test, particularly for very dry mixes.



Procedure of Vee-Bee Consistometer Test for Concrete-

1- The sheet metal slump cone is filled with four layers of concrete. Each layer of concrete is one fourth the height of the cone.
2- The sheet metal slump cone is placed inside the sheet metal cylindrical container that is placed in the Consistometer.
3- The glass disc attached to the swivel arm is turned and placed on the top of the concrete in the slump cone placed inside the cylindrical container.
4- Then the electrical vibrator is switched on and at the same time a stop watch is started. The concrete is allowed to spread out in the sheet metal cylindrical container.
5- Until the slump conical shape of the concrete disappears and the concrete assumes a cylindrical shape, the vibration is continued. This can be decided by observing the glass disc from the top for disappearance of transparency.
6- When the concrete fully changed to a cylindrical shape, immediately the stop watch is switched off.
7- The time required for the shape of concrete to change from slump cone shape to cylindrical shape in seconds is recorded. This time is expressed as Vee Bee time. It gives us the measure of workability of the fresh concrete.

**General discussion**

For Concrete Mix Ratio the components are — Cement Aggregates and Water.

6 (ratio 1 :)

Cement: aggregate

1:2:2:2 (ratio)

Cement: coarse aggregate: medium Aggregate: sand

Water content =w/c + absorption

Water content = 0.5 + 0.35 = 0.85

Quantities:

2.5 Kg cement

5kg coarse aggregate

5kg medium aggregate

5kg sand

2125 ml water

# Compressive Strength( hardened concrete )

## Introduction :

The most common test preformed on concrete is for compressive strength. There several reasons for this: (1) it is assumed that the most important properties of concrete as directly related to compressive strength; (2) concrete has little tensile strength and is used primarily in compression; (3) structural design codes are based on compressive strength; (4) the test is relatively simple and inexpensive to perform.

## Apparatus :

Compression machine 2000 Kn

## Procedure :

This concrete is poured in the mould and tempered ( in 3 layers ) properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth.

Cuing : Concrete curing is the process of maintaining adequate moisture in concrete within a proper temperature range in order to aid cement hydration at early ages

Capping : Proper end preparation ensures that the ends of concrete test cylinders have smooth, parallel bearing surfaces perpendicular to the applied axial load to assure uniform distribution of forces during testing.

These specimens are tested by compression testing machine after 7 days curing or 28 days curing.

Before testing capping should be done

Capping : Proper end preparation ensures that the ends of concrete test cylinders have smooth, parallel bearing surfaces perpendicular to the applied axial load to assure uniform distribution of forces during testing. The thickness of sulphur cap was strictly controlled within 1.5-3mm.



Load should be applied gradually till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.


The standard size specimen used for compressive strength acceptance testing is a 15cm × 30 cm cylinder.

## CALCULATION:

$$Compressive Strength = \frac{P}{A}$$

| Specimen No ( cube) | Load (kN) | Area ($mm^2$) | Compressive Strength (MPa) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |

Average compressive strength of the concrete cube =…….MPa (at 7 days)
Average compressive strength of the concrete cube=……..MPa (at 28 days)

£ =| (Compressive Strength _ Average Compressive Strength)/ Average Compressive Strength|*100% ≤ 15%

The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than 15 percent of the average.
If one sample get exceeded then ignore it and recalculate the average.
If more, the test results of the sample are invalid, and the test is failed.

Where,
P=Maximum load applied to the cube. (N)
A=Cross sectional area (Calculated from the mean dimensions) ($mm^2$).
*A= (15*15)$cm^2$

MPa = $N/mm^2$

For cylinder specimen

$$Compressive Strength = \frac{P}{A}$$

Where,

P=Maximum load applied to the cylinder. (N)

A=Cross sectional area (Calculated from the mean dimensions) ($mm^2$).

MPa = $N/mm^2$

## General dissuasion :

Testing concrete cylinders and cubes is the most widely used test for measuring the compressive strength. Strength is usually the basis for acceptance or rejection of the concrete in the structure.

For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used.

Concrete strength measured using concrete cubes produce a results different than concrete cylinders. Conservative estimates put concrete cylinders at 80% of concrete cubes

The compressive strength of concrete can be calculated by the failure load divided with the cross sectional area resisting the load and reported in mega Pascal's (MPa) .

## WHAT IS THE RATIO FOR MIXING CONCRETE?

For Concrete Mix Ratio the components are — Cement, Aggregates and Water.

1:6 (ratio)

Cement: aggregate

1:2:2:2 (ratio)

Cement: coarse aggregate: medium Aggregate: sand

Water content =w/c + absorption

Water content = 0.5 + 0.35 = 0.85

Quantities:

7.5 Kg cement

15kg coarse aggregate

15kg medium aggregate

15kg sand

6375 ml water

# Tensile Strength (Brazilian Test)

## Introduction :

There is as yet no standard test for directly determining tensile strength. However there are two common methods for estimating tensile strength through indirect tensile tests. The first, is the splitting test carried out on a standard cylinder specimen by applying a line load along the vertical diameter. It is not practical to apply the true line load to the cylinder because the side are not smooth enough and because it would induced high compressive stresses at the surface. Therefore, a narrow loading strip made of soft material is used.

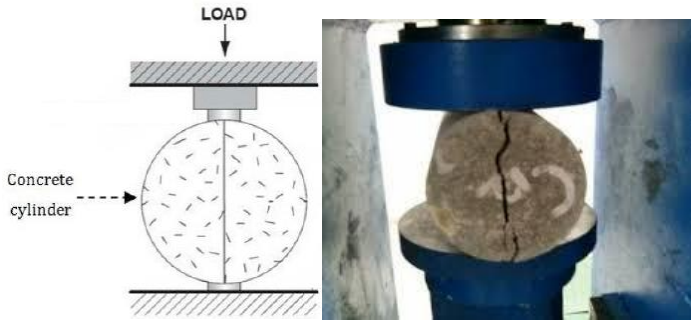
## Procedure :

This concrete is poured in the mould and tempered ( in 3 layers ) properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing.

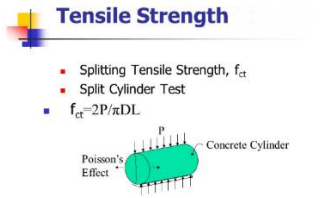
Cuing : Concrete curing is the process of maintaining adequate moisture in concrete within a proper temperature range in order to aid cement hydration at early ages

In this test, a standard cylinder of concrete specimen is placed horizontally between the loading surfaces of CTM. The compression load is applied along diametrically opposite lines, that is, along the generatrix of the cylinder until failure along the vertical plane.

The sample size is cylinder of diameter 15 cm and height of 30 cm.




# Calculations




In which fct is the splitting tensile strength (MPa); *P* is the maximum load on the specimen (kN); *D* is the diameter of the specimen (mm); and *L* is the length of the specimen (mm).

Where,

P=…….kN , D= 150mm , L=300mm

## General dissection :

Direct tension measurement is very complicated and therefore indirect methods are used. One of the methods of determining the tensile strength is indirectly by splitting tensile test or modified Brazilian test.

The sample size is cylinder of diameter 15 cm and height of 30 cm.

### WHAT IS THE RATIO FOR MIXING CONCRETE?

For Concrete Mix Ratio the components are — Cement, Aggregates and Water.

1:6 (ratio)

Cement: aggregate

1:2:2:2 (ratio)

Cement: coarse aggregate: medium Aggregate: sand

Water content =w/c + absorption

Water content = 0.5 + 0.35 = 0.85

Quantities:

7.5 Kg cement

15kg coarse aggregate

15kg medium aggregate

15kg sand

6375 ml water

# Flexural Strength(hardened concrete)

Flexural strength is an indirect measure of the tensile strength of concrete. It is a measure of the maximum stress on the tension face of an unreinforced concrete beam or slab at the point of failure in bending. It is measured by loading 150 x 150-mm (or (100 x 100-mm) concrete beams with a span length at least three times the depth.

Another way of estimating tensile strength is the flexural test. A specimen beam 10cm x 10cm x 50cm is molds in two equal layers each rodded 51 times

Many structural components are subject to flexing or bending, such as pavement, beams and slabs.
It's important that concrete mixtures have a flexural strength able to resist bending or tensile forces.

The flexural strength is expressed as Modulus of Rupture.

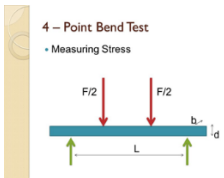
## Apparatus :

Flexural testing machine up to 150 kn .



## Calaulation

$$f_{bt} = \frac{Pl}{bd^2}$$



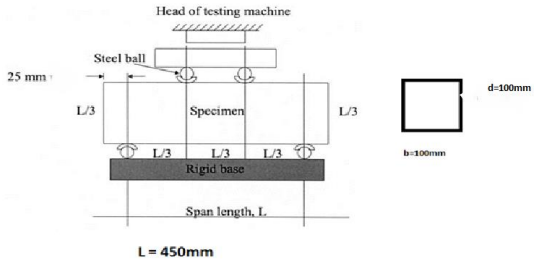
$P = Load\ at\ failure$

$L = Beam\ span\ between\ supports$

$d = Depth\ of\ beam$

$b = Width\ of\ beam$

$f_{bt} = Modulus\ of\ rupture$




**Take P = ……. kN**

## General discussion :

Third point loading test, in this test method, half the load is applied at each third of the beam's span length. In this test, the maximum stress is present over the center one-third portion of the beam.

### WHAT IS THE RATIO FOR MIXING CONCRETE?

For Concrete Mix Ratio the components are — Cement, Aggregates and Water.

1:6 (ratio)

Cement: aggregate

1:2:2:2 (ratio)

Cement: coarse aggregate: medium Aggregate: sand

Water content =w/c + absorption

Water content = 0.5 + 0.35 = 0.85

Quantities:

7.5 Kg cement

15kg coarse aggregate

15kg medium aggregate

15kg sand

6375 ml water

# Rebound hammer (Schmidt Hammer)

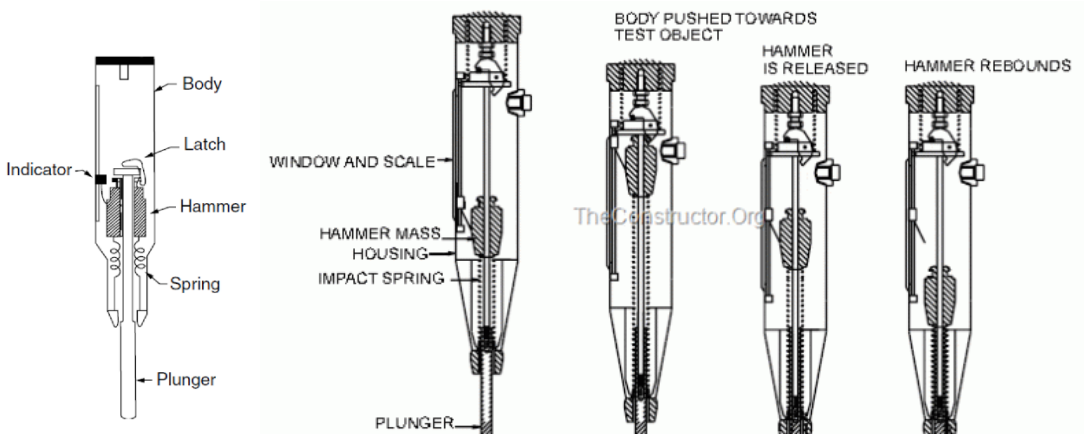
## Introduction :

The rebound hammer test and the ultrasonic device are used in the field of non-destructive tests to determine respectively the compression strength.

The rebound hammer, developed by Ernst Schmidt, provides an inexpensive and quick method for nondestructive testing and evaluation of the hardness of concrete.

The test has widely been used, since its introduction in 1948. The main reason behind its popularity is its simplicity, and convenience of use for field applications

The rebound hammer is a nondestructive testing apparatus, whereby the rebound of the spring driven mass is measured after its impact with concrete surface. The output of the rebound hammer is referred to as rebound number and are correlated with surface hardness of concrete. The internal mechanism of a typical Schmidt Hammer is illustrated in Figure .The plunger is pushed against the concrete, perpendicular to the surface. As the hammer body is pushed towards the concrete, the force of the causes the latch to release, and make an impact on the concrete. At this point, the hammer impacts the shoulder of the plunger rod & rebounds. During the rebound the slide indicator is moved from the hammer mass, and the rebound distance is recorded.




Procedure :

Preparing Test Surface

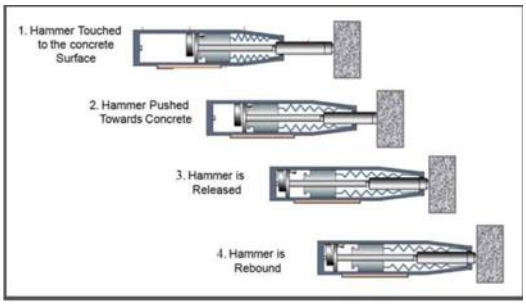
Inspectors should pay attention to the following considerations prior to conducting a rebound hammer test:

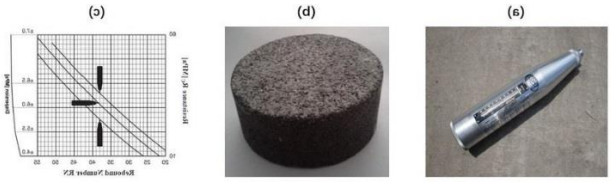
- The testing surface must be at least 150 mm diameter.
- Concrete surface should be cured for 24 hours.
- Grind concrete surface (until it's flat) if it is heavily textured or contains loose mortar. Note: It is essential to know that the results from prepared surface are generally not comparable to those obtained from

unprepared so do not test frozen concrete. Note: Concrete should only be tested after it has thawed, since frozen concrete tends to have high rebound numbers.

- Avoid direct testing over steel reinforcement when cover thickness is less than 20 mm.

*The hammer can be placed in many configurations; upwards, downwards, horizontal vertical & at any intermediate angle




## Calculations and discussion :

What Affects Rebound Hammer Readings?

Although the rebound hammer provides a quick, inexpensive means of checking the uniformity of concrete, the results can be affected by the following parameters:

- Smoothness of test surface
- Size, shape, and rigidity of the specimens
- Age of test specimens
- Surface and internal moisture conditions of the concrete
- Type of coarse aggregate
- Type of cement
- Type of mold
- Carbonation of the concrete surface

Taking Measurements

Once the device is lined up, and the angle has been recorded, the inspector then gradually pushes the instrument toward the test surface until the hammer impacts. After impact, maintain pressure on the instrument and, depress the side button of the instrument to lock the plunger in its retracted position. The rebound number is then recorded to the nearest whole number.

In order to ensure accuracy, 10 readings should be taken from each test area at least. In addition, the distances between impact points should be at least 25 mm, and the distance between impact points and edges of the member should be at least 20 mm. It is also important to note that if the impact crushes or breaks through a near surface air void the reading must be disregarded and another reading should be taken.

# CORE DRILLING

## Introduction :

the compressive strength of concrete is a direct requisite of all concrete structures that need to resist applied forces of whatever nature. Actually, the concrete compressive strength is a good index of most other properties of practical significance. To ensure concrete quality, standard test specimens are examined during construction. These specimens, which give the potential strength of concrete, are prepared, cured and tested according to relevant standard specifications and codes.

## Aapurtus :

## Procedure :

A core drill is a drill specifically designed to remove a cylinder of material, much like a hole saw. The material left inside the drill bit is referred to as the core.

Concrete core drilling is the process of drilling clean, circular holes in a concrete surface. Drilling can be done in homes, businesses, highways, and more, either inside or outside.

A core is usually cut by means of a rotary cutting tool with diamond bits. The concrete core drilling machine is portable, but it is heavy and must be firmly supported and braced against the concrete to prevent relative movement which will result in a distorted or broken core, and a water supply is also necessary to lubricate the cutter.

Cores were tested after after being submerged for at least 40 hours – 48 hours

**CAPPING**

unless their ends are prepared by grinding, cores should be capped with high alumina cement mortar or sulfur-sand mixture to provide parallel end surfaces normal to the axis of the core.

It is essential that the cap be thin, preferably 1.5 to 3 mm. The capping material must be no weaker than the concrete in the specimen.

## Discussion and calculations :

Length-to-diameter ratios are ideally 2:1, L/D cannot be less than 1. Note that for compressive strength to be considered structurally adequate, an average of 3 cores should be 85% of specified strength with no core falling below 75% of specified strength.

**Some Factors Affecting Core Strength**

• Core size

• Location of core

• Moisture conditioning

• Length-diameter ratio

• End preparation

• Embedded steel

- Temperature should be more than zero.