# SNS COLLEGE OF TECHNOLOGY

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**COIMBATORE**

## DEPARTMENT OF CIVIL ENGINEERING

## 19GET102 – BASIC CIVIL AND MECHANICAL ENGINEERING

## I YEAR / I SEMESTER

## Unit 1 : Civil Engineering Materials and Surveying

## Topic : Tests on Hardened Concrete

# Tests on Hardened Concrete

The test conducted on hardened concrete can be classified into two main categories:

1. Destructive Tests on Concrete
2. Non-destructive Tests on Concrete
3. Chemical Test on Concrete

# Tests on Hardened Concrete

- The suitability of the hardened concrete structure is determined by conducting suitable tests.
- It is preferred to have such testing without any destruction or damage to the concrete structure.
- Non-destructive tests are tests that will undergo no damage to the structure and take the results.
- In Destructive tests, the results can be only taken by slightly damaging the concrete surface.
- Once the surface is tested, the surface has to be repaired.

# Destructive Test

- The common destructive tests conducted on concrete are: The main destructive tests on hardened concrete are as follows.

1. Cube test
2. Tensile Strength Test
3. Concrete core test

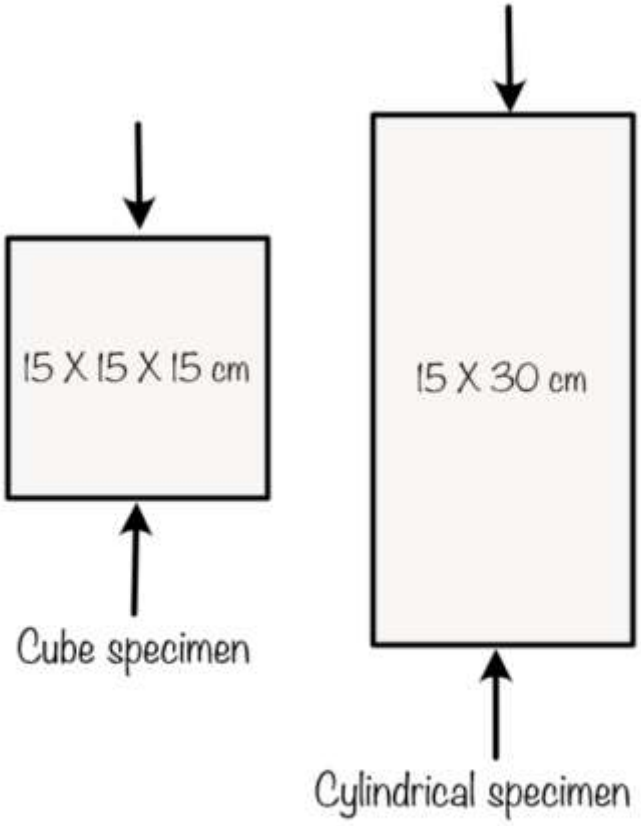
# Cube Test

- Concrete Characteristics is determined by characteristics compressive cube strength test of concrete.
- For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used.
- For most of the works cubical moulds of size 15cm x 15cm x 15cm are commonly used.
- These specimens are tested by compression testing machine after 7 days curing or 28 days curing.
- Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails.

# Cube Test

- It is the strength of concrete require to resist the compressive load.
- Measure the ability of concrete block to resist failure from cracks.
- In this test basically, we apply a compressive load and then note the maximum load a specimen can bear before failure which is equal to the compressive strength of concrete.

# Cube Test



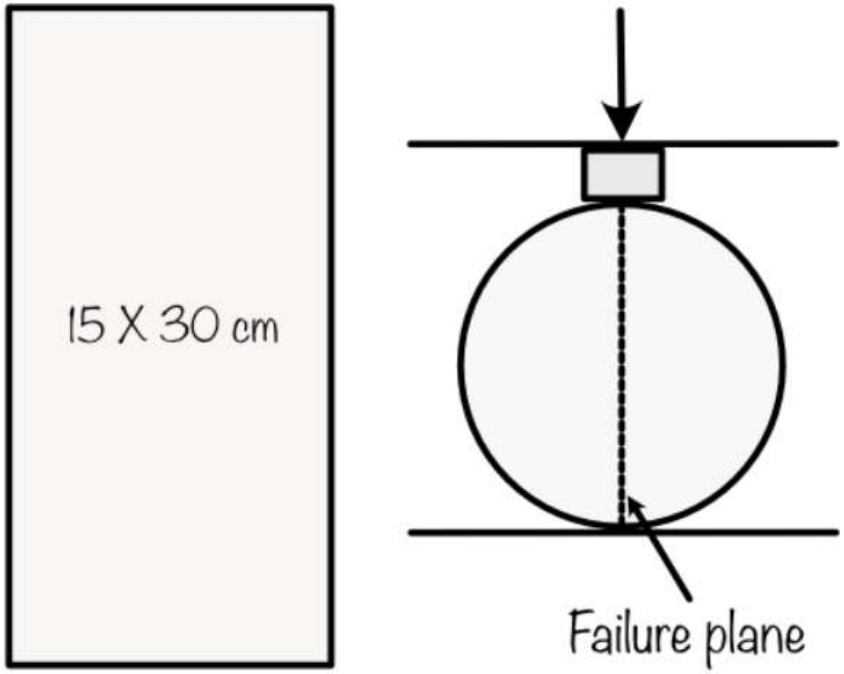

Compressive test specimen

# Tensile Strength Test

**Split Tensile Strength Test:**

- It is a method to determine the tensile strength of concrete, though it is difficult to calculate the tensile strength directly so we test a cylindrical specimen which splits across the vertical diameter.
- In direct tensile strength test it is difficult to apply true axial load.
- The tensile strength calculated from this test is closer to the true tensile strength of concrete.

# Tensile Strength Test




Cylindrical specimen

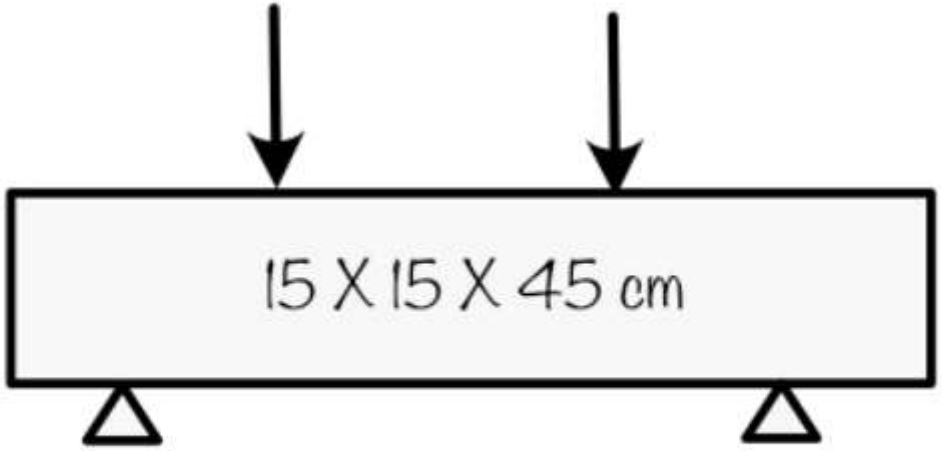
Split tensile strength test specimen

# Tensile Strength Test

**Flexure Strength Test:**

- It is also an indirect method to determine the tensile strength of concrete.
- In this method, we note the maximum stress on the tension face of an un-reinforce concrete beam or slab at the point of failure in bending.
- A plain concrete specimen is examined to failure in bending.
- The theoretical maximum tensile stress at the bottom face at failure is measured. This is called the modulus of rupture.
- It is around 1.5 times the tensile stress obtained with the splitting test.

# Tensile Strength Test



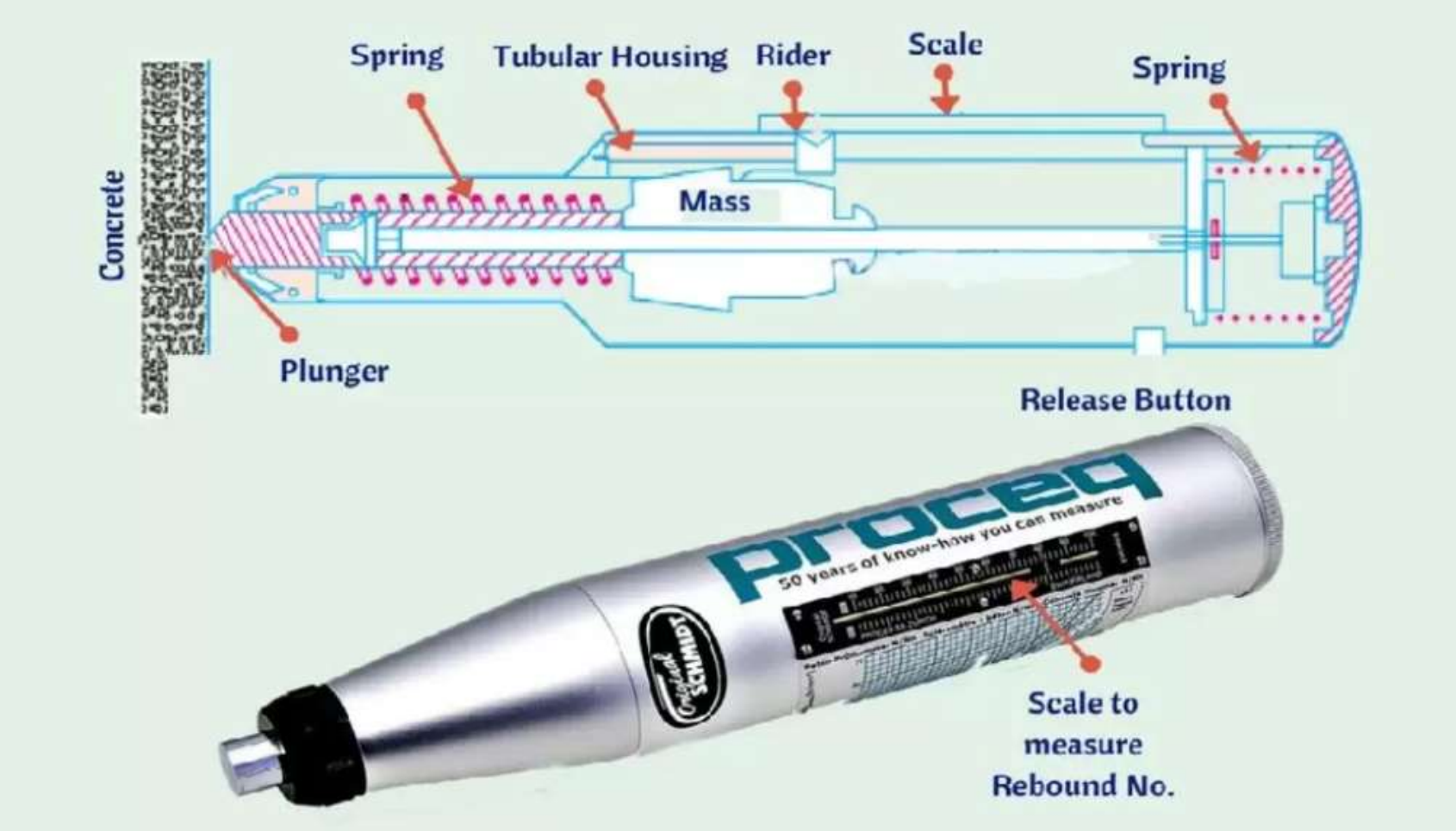

3 point loading method

# Non-Destructive Tests

- The main non-destructive tests for strength on hardened concrete are as follows.

1. Rebound Hammer (Hardness Test)
2. Ultrasonic Pulse Velocity Test
3. Pull Out Test
4. Penetration Resistance
5. Other non-destructive tests

# Rebound Hammer Test

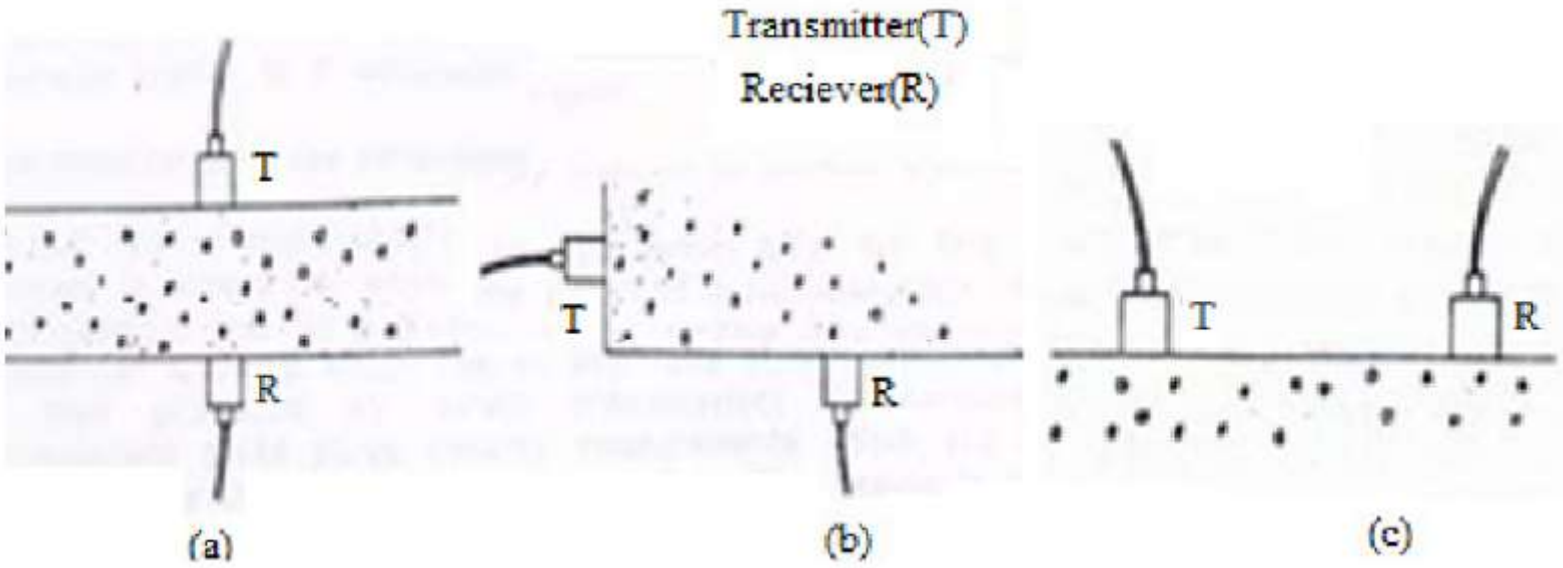


# Rebound Hammer Test

- For the rebound hardness test, the schmidt hammer is utilized.
- Under this test, a metal hammer occupied against the concrete is sustained with another spring-driven metal mass and rebounds.
- The amount of rebound is documented on a scale and this highlights the strength of the concrete.
- As the rebound number is greater, the strength of the concrete will also increase.
- The Schmidt hammer is used in the rebound hardness test in which a metal hammer held against the concrete is struck by another spring-driven metal mass and rebounds.
- The amount of rebound is recorded on a scale and this gives an indication of the concrete strength.
- The larger the rebound number is, the higher is the concrete strength.

# Ultrasonic Pulse Velocity Test

# Ultrasonic Pulse Velocity Test



# Ultrasonic Pulse Velocity Test

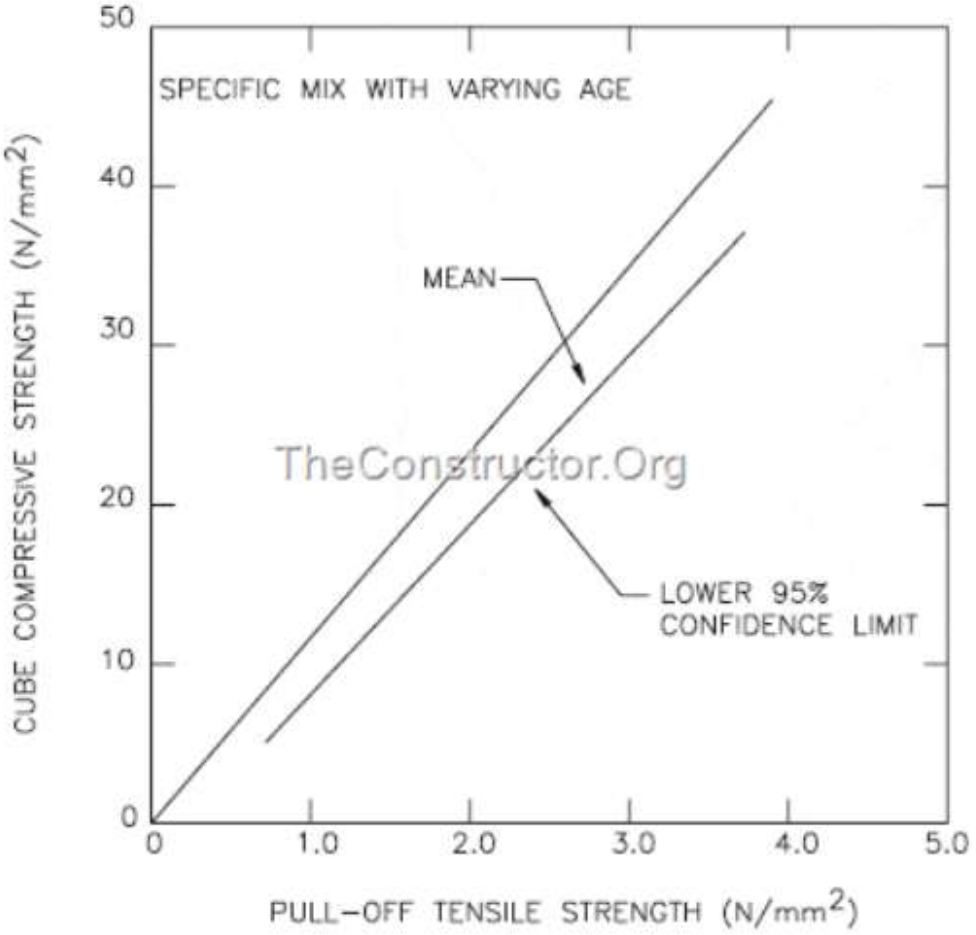
- In the ultrasonic pulse velocity test, the velocity of ultrasonic pulses that pass through a concrete section from a transmitter to a receiver is measured.
- The pulse velocity is correlated against strength. The higher the velocity is, the stronger is the concrete.
- Under the ultrasonic pulse velocity test, the velocity of ultrasonic pulses that transmit through a concrete section from a transmitter to a receiver is calculated.
- The pulse velocity is interrelated opposed to strength. If the velocity becomes higher, the strength of the concrete is increased.

# Ultrasonic Pulse Velocity Test

- This test measures the velocity of an ultrasonic wave passing through the concrete.
- The length between transducers/the travel time = average velocity of wave propagation.
- It is used to detect discontinuities, cracks and internal deterioration in the structure of concrete.

# Pull Out Test

# Pull Out Test

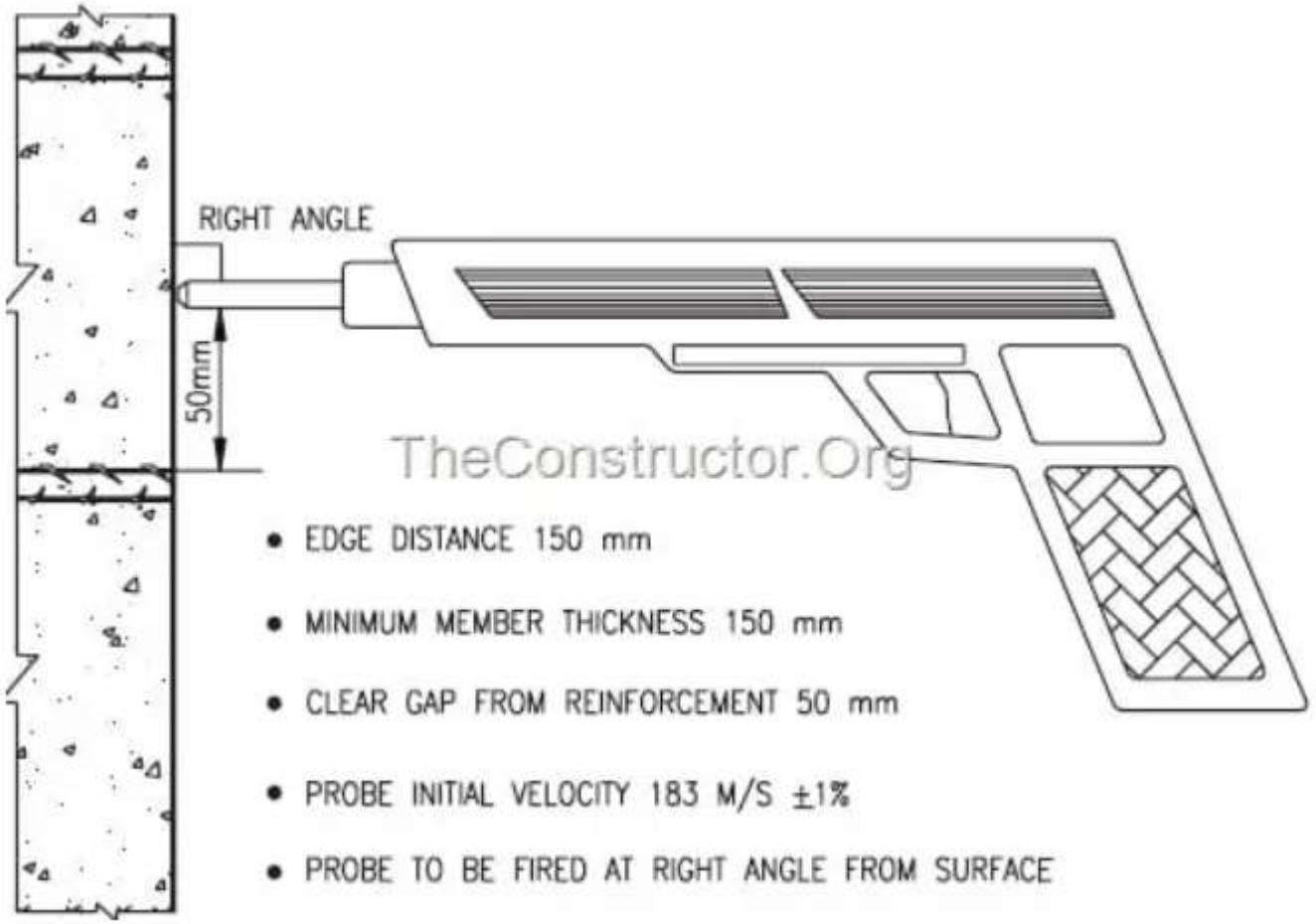


# Pull Out Test

- The pull-out test will determine the force that is required to pull out a steel rod specially shaped from hardened concrete to which the steel was cast.
- Pulling out of steel is done with a cone of concrete that has a slope of 45 degrees.
- The force required to pull the concrete out is related with the compressive strength of the concrete.

# Penetration Resistance Test

# Penetration Resistance Test




- EDGE DISTANCE 150 mm
- MINIMUM MEMBER THICKNESS 150 mm
- CLEAR GAP FROM REINFORCEMENT 50 mm
- PROBE INITIAL VELOCITY 183 M/S ±1%
- PROBE TO BE FIRED AT RIGHT ANGLE FROM SURFACE

# Penetration Resistance Test

- Penetration resistance tests on concrete offer a means of determining relative strengths of concrete in the same structure or relative strength of different structures.
- Because of the nature of the equipment, it can not and should not be expected to yield absolute values of strength.
- ASTM C-803 gives this standard test method titled “Penetration Resistance of Hardened Concrete”

# Other NDT Test

- These tests are done through Equipment to compute the following :-

1. Crack widths and depths
2. Water permeability and the surface dampness of concrete
3. Depth of cover and the location of reinforcing bars
4. The electrochemical potential of reinforcing bars and therefore the existence of corrosion

# Chemical Tests

- A complete range of chemical tests is available to measure

1. Depth of carbonation
2. The cement content of the original mix
3. The content of salts such as chlorides and sulfates that may react and cause the concrete to disintegrate or cause corrosion of the reinforcement
4. Alkali Content

# *Thank You!!*

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## Topic : Tests on Fresh Concrete

# Tests on Fresh Concrete

**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.

# Tests on Fresh Concrete

- 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

# Slump Cone Test

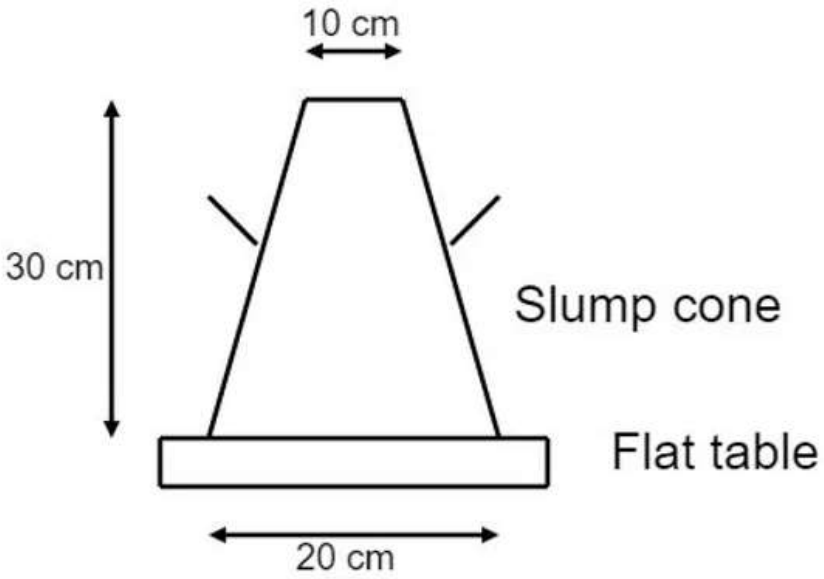
**Slump test:**

- It is the most common test performed on fresh concrete used to measure consistency.
- Though it does not measure all the factors contributing to workability, it is used as a control test as it gives an indication of the uniformity of the concrete from batch to batch.
- Information on the workability and quality of concrete can be obtained by observing the manner in which concrete slumps.
  - It can be performed on both field and lab
  - It is not suitable for very wet or dry mixes (for very dry mixes compacting factor test is recommended and for very wet mixes flow test is recommended)

# Slump Cone Test

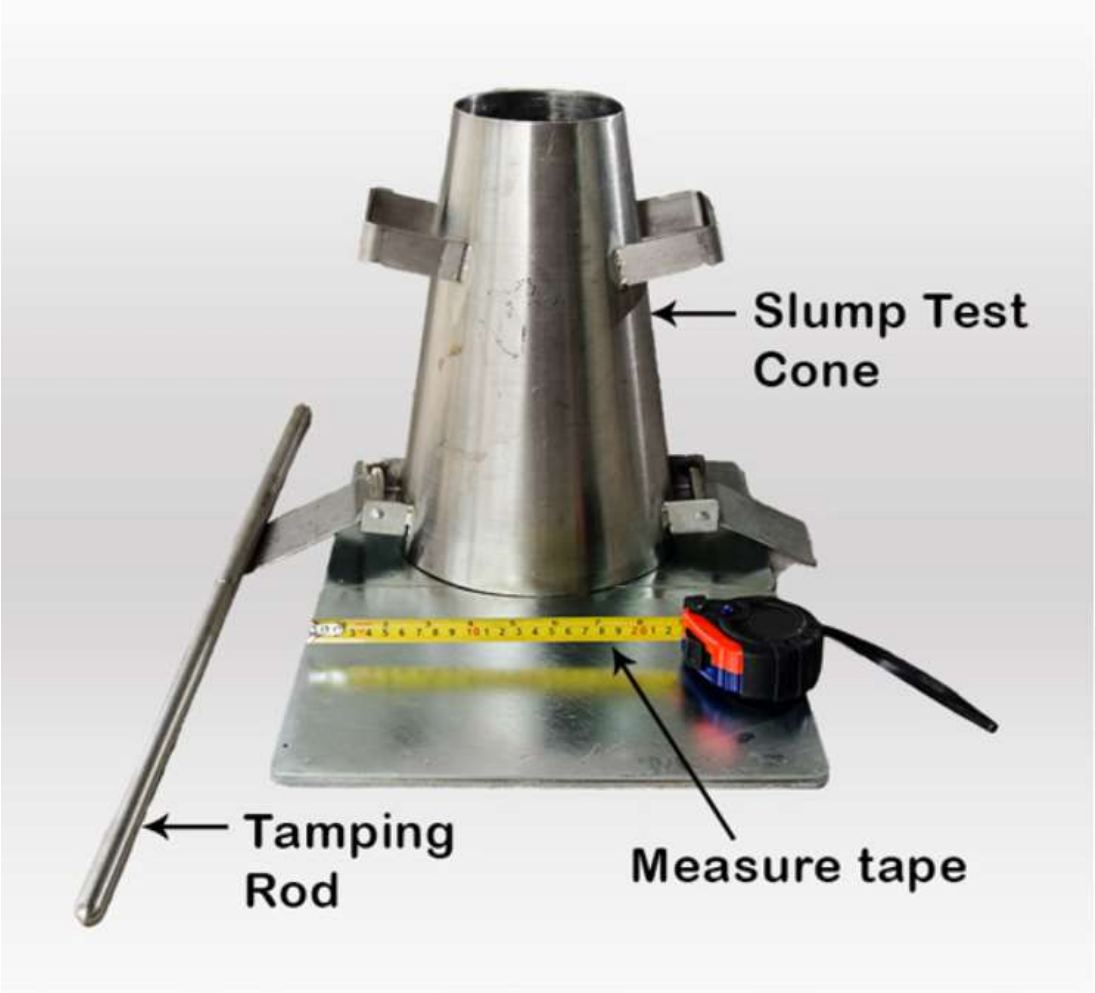
**Apparatus:**

The apparatus required for the slump test is shown below. Other than this, a steel tamping with bullet end is used for tamping.




Slump Cone Apparatus

# Slump Cone Test



# Slump Cone Test

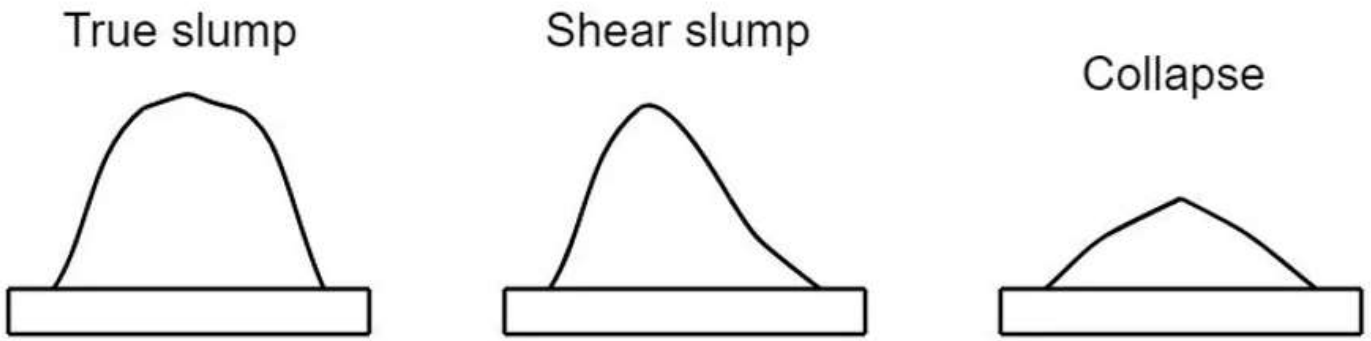
**Procedure**

- The surface of the mould is cleaned and freed from moisture and adherence of any old concrete
- Mould is then placed on a smooth, horizontal, non-absorbent surface
- The mould is then filled with concrete in 4 equal layers with each layer being tamped 25 times
- After tamping the top layer, the concrete is struck off level with a trowel
- The mould is raised slowly and carefully in a vertical direction immediately after filling with concrete
- Concrete subsides and this subsidence is called the slump of the concrete

# Slump Cone Test

- The difference in height of the mould and that of the highest point of the subsided concrete is measured in mm and is called the slump value of concrete
- The pattern of slump indicates the quality of concrete. There are three slump patterns.
    - ✓ True slump - slumps evenly
    - ✓ Shear slump - one half of the cone slides down - indicates non-cohesiveness
    - ✓ Collapse

# Slump Cone Test

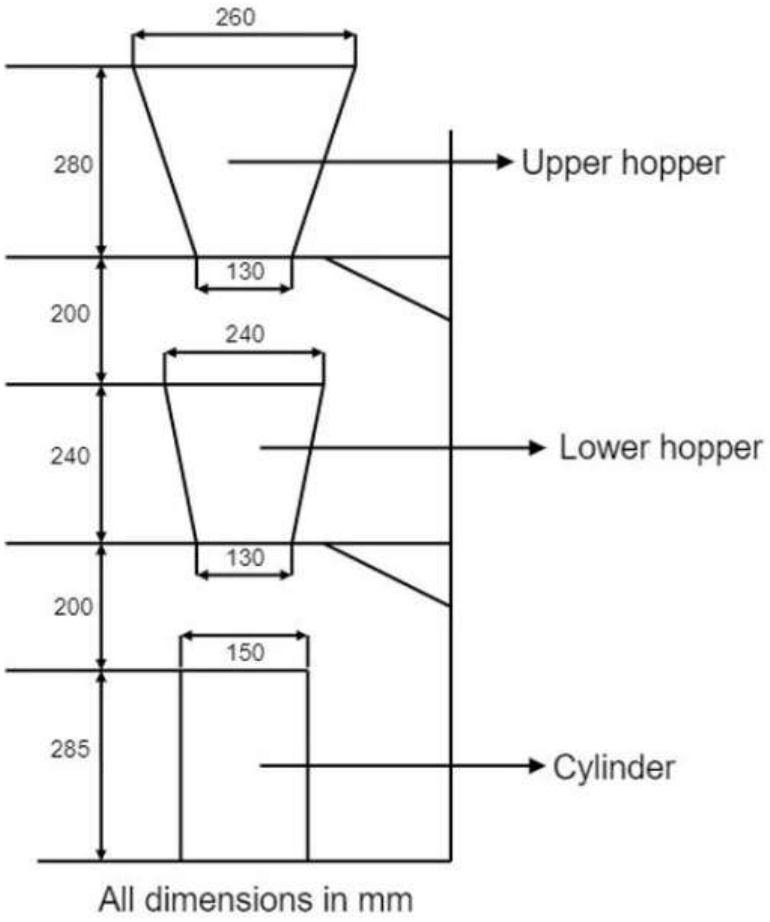



Types of Slump

# Compacting factor Test

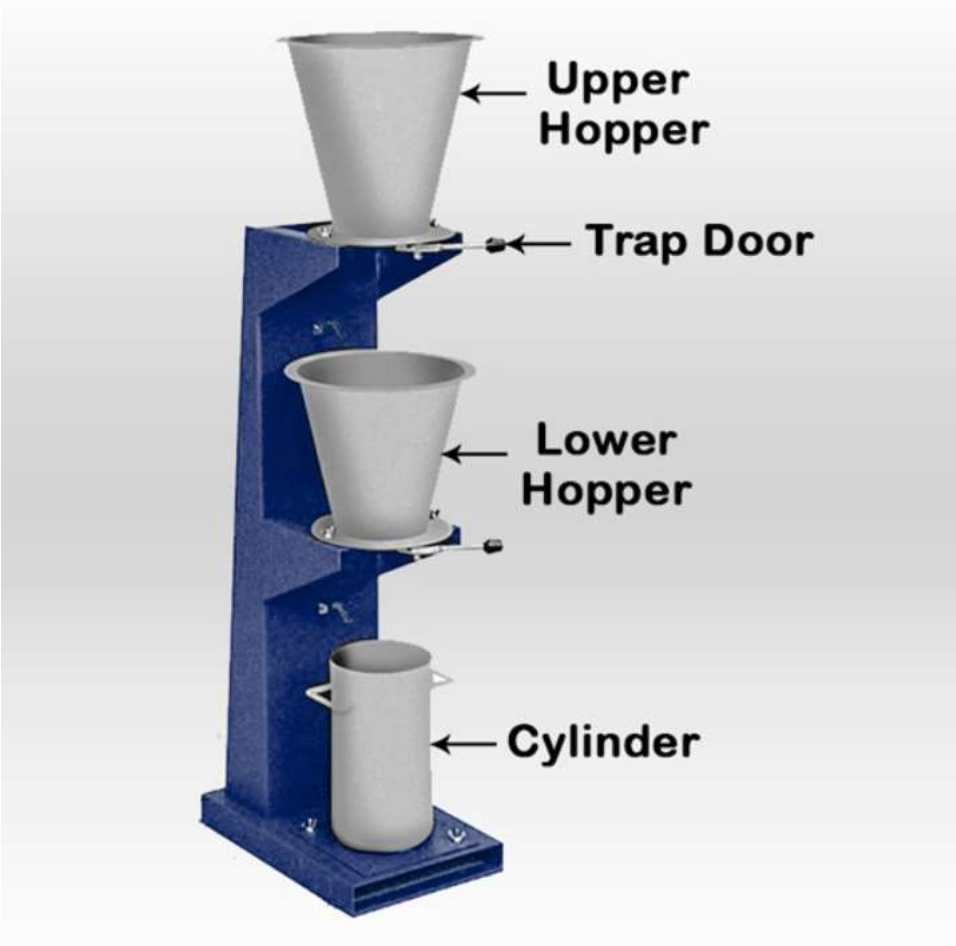
- Compacting test is more precise and sensitive than a slump cone test.
- This test works on the principle of determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height.
- Then the degree of compaction called the compacting 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 when fully compacted.
  - This test was designed as a laboratory test but can be used in the field as well
  - This test is designed for concrete of very low workability i.e., dry mix

# Compacting factor Test




Compacting Factor Test

# Compacting factor Test



# Compacting factor Test

**Procedure**

- The concrete is placed in the upper hopper up to the brim
- The trap door is opened so that the concrete falls into the lower hopper
- Then the trap door of the lower hopper is opened and the concrete is allowed to fall into the cylinder. Slight poking shall be used to set the dry concrete in motion
- Excess concrete above the top level of the cylinder is removed and the outer surface of the cylinder is wiped
- Concrete along with the cylinder is weighed and this weight is called the weight of the partially compacted concrete

# Compacting factor Test

**Procedure**

- The concrete is removed from the cylinder and is refilled with concrete from the same sample in layers with each layer being heavily rammed or vibrated
- Excess concrete above the top level of the cylinder is removed and the outer surface of the cylinder is wiped
- Concrete along with the cylinder is then weighed and this weight is called the weight of fully compacted concrete
- The compacting factor is then calculated as, compacting factor = weight of partially compacted concrete/weight of fully compacted concrete

# Compacting factor Test

- The compacting factor is then related to the workability of the concrete i.e., a value of 0.78 to 0.8 represents low workability and a value of more than 0.95 represents high workability.
- Compacting factor test measures all the contributing factors to workability and therefore it is one of the good tests to depict workability.

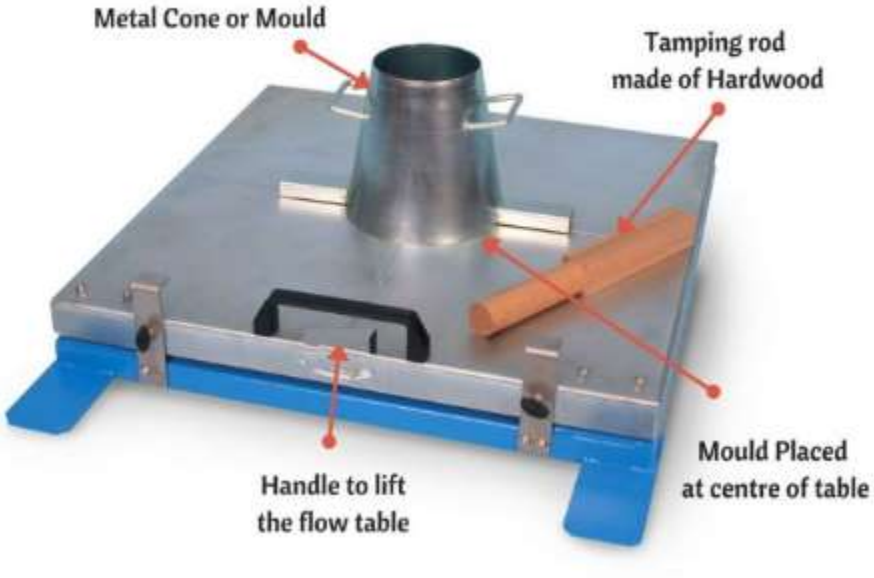
# Flow Table Test

- Flow test gives an indication of the quality of concrete with respect to consistency, cohesiveness and the proneness to segregation. In this test, concrete is subjected to jolting and then the spread of concrete is measured and this flow is related to workability.
  - ✓ This test is performed on laboratory
  - ✓ This test is performed for very wet mixes

# Flow Table Test

## Apparatus

- The apparatus for performing the flow test contains a table with a jolting arrangement, slump cone-like mould apparatus to fill the concrete. A wooden tamping rod is also required.



# Flow Table Test

**Procedure**

- The top of the table and mould is cleaned of all gritty materials and is wiped with a damp cloth
- Mould is kept on the centre of the table and is filled in two layers with each layer being tamped 10 times
- The excess concrete is removed from the top of the mould
- The mould is lifted vertically upward after half a minute of removing excess concrete
- Then the top of the table is raised by the handle and allowed to fall 15 times in 15 seconds
- The diameter of the spread concrete is measured in two directions parallel to the table edge eg and the average spread is noted as flow

# Flow Table Test

## Procedure

**Flow% = (Spread diameter in cm – 25) / 25 * 100**

The value of flow test varies from 0 to 150%.

# Vee-Bee Consistometer Test

- Vee bee consistometer test is a good laboratory test on fresh concrete to measure the workability in an indirect way by using a Vee-Bee consistometer.
- 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 the 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.

# Vee-Bee Consistometer Test

# Vee-Bee Consistometer Test

- Slump test as described in "IS 1199:1959 Specifications for Concrete Slump Test Apparatus (Fourth revision). Reaffirmed- Dec 2013". is performed, placing the slump cone inside the sheet metal cylindrical pot of the consistometer.
- The glass disc attached to the swivel arm shall be moved and placed just on the top of the slump cone in the pot and before the cone is lifted up, the position of the concrete cone shall be noted by adjusting the glass disc attached to the swivel arm. The cone shall then be lifted up and the slump noted on the graduated rod by lowering the glass disc on top of the concrete cone. The electrical vibrator shall then be switched on and the concrete shall be allowed to spread out in the pot.
- 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.

# Vee-Bee Consistometer Test

- 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.
- 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.

# Vee-Bee Consistometer Test

- **Slump value** = Initial Reading on the graduated scale (a) – Final Reading on the graduated scale (b)
- Consistency of concrete is measured in **Vee Bee Seconds**

| Description | Vee-Bee Seconds |
|---|---|
| Extremely Dry | 32-18 |
| Very Stiff | 18-10 |
| Stiff | 10-5 |
| Stiff Plastic | 5-3 |
| Plastic | 3-0 |

# Vee-Bee Consistometer Test

**Recommended Result of Vee Bee Consistometer Test**

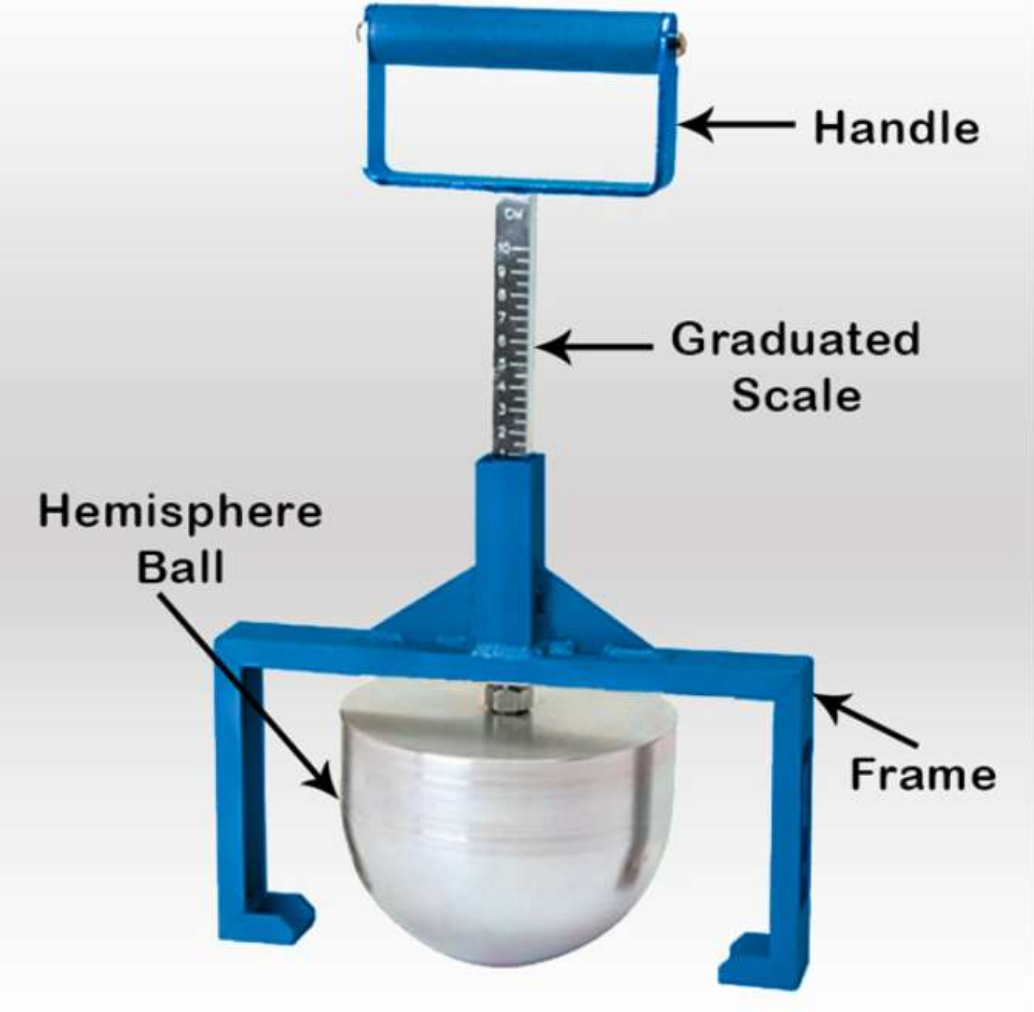
According to 'IS 1199:1959' (Methods of Sampling and Analysis of Concrete),

- If vee bee time is up to 20 to 15-10 seconds than concrete is considered as in a very dry consistency.
- If vee bee time is up to 10 to 7-5 seconds than concrete is considered as in a dry consistency.
- If vee bee time is up to 5 to 4-3 seconds than concrete is considered as in a plastic consistency.
- If vee bee time is up to 3 to 2-1 seconds than concrete is considered as in a semi-fluid consistency.

# Kelly Ball Test

- This test is developed by J.W Kelly, hence it's known as a Kelly ball test.
- Kelly ball test is a simple and inexpensive field test which measures workability of fresh concrete with the similar to the concrete slump test, but it is more accurate and faster than a slump test.
- This test uses a device that consist 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.

# Kelly Ball Test



# Kelly Ball Test

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## Topic : Properties of Hardened Concrete

# Properties of Hardened Concrete

The properties of hardened concrete are as follows:-

- Strength
- Shrinkage
- Durability
- Impermeability

# Strength

The strength of concrete is basically called compressive strength and depends on three factors.

- Paste strength
- Interfacial bonding
- Aggregate strength

# Strength

**Paste Strength:**

It is mainly due to the binding properties of cement that the material is compacted together. If the paste has a high binding strength, it will have a high concrete strength.

**Interfacial Bonding:**

Interfacial bonding is very essential with respect to strength. Clay disrupts the bonding relationship between paste and aggregate. The aggregates should be washed for better bonding between the paste and the aggregate.

**Aggregate strength:**

It is mainly aggregates that give strength to concrete, especially coarse aggregates that act like bones in the body. Rough and angular aggregates provide better bonding and higher strength.

# Strength

**Factors affecting the strength of concrete:**

Following are the factors that affect the strength of concrete:

a. Water-cement ratio

b. Type of cementing material

c. Cement content

d. Type of aggregates

e. Air content

f. Admixtures

# Strength

**a. Water-cement ratio:**

It is the water cement ratio that basically controls the strength property. The lower the water cement ratio, the higher the strength.

**b. Type of cement:**

The type of cement affects the hydration process and therefore the strength of concrete.

**c. Amount of cementing material:**

It is the paste that holds or binds all the materials. Thus the greater the cement content the stronger it will be.

# Strength

**d. Aggregate Type:**

Since they provide greater bonding, rough and angular aggregates are better.

**e. Admixtures:**

Chemical mixtures such as plasticizers reduce the water to cement ratio and increase the strength of concrete at the same water cement ratio. Mineral mixtures affect strength in later stages and increase strength by increasing the amount of cement content.

# Shrinkage

- Concrete is subjected to either autogenous or induced volume changes.
- Volume change is one of the most damaging properties of concrete, affecting long-term strength and durability.
- For the practical engineer, the aspect of volume change in concrete is important from the point of view that it produces unsightly cracks in the concrete.
- Hard concrete undergoes three types of shrinkage that are important with respect to its dimensional stability:

    1. Plastic shrinkage.
    2. Drying Shrinkage.
    3. Thermal shrinkage.

# Shrinkage

**Plastic shrinkage:**

- It is the shrinkage that freshly placed concrete passes through until it is completely set. It can also be called initial shrinkage.
- There is such a major volumetric change from evaporation, bleeding, seepage and soaking by the formwork to water loss from fresh concrete.
- Excessive shrinkage in the initial stages may develop extensive cracking in the concrete at the setting.
- Therefore, all precautions should be taken to avoid excessive loss of water due to evaporation.
- The rate of plastic shrinkage mainly depends upon the rate of evaporation of water and the temperature during the casting of the concrete. The plastic shrinkage of the concrete is higher if the cement content in the concrete is more.

# Shrinkage

**Drying Shrinkage:**

- As the concrete is completely set and hardened, some further shrinkage may result in moisture, or further loss of drying, due to contraction of the gel-structure.
- Such shrinkage is practically an essential and irreversible property of concrete.
- Careful design of reinforcement has to be met to avoid its side effects.
- The main cause of the drying shrinkage is the loss of the water content because of the evaporation from the freshly hardened concrete which is exposed to the environment.

# Shrinkage

**Thermal shrinkage:**

- This may be due to a drop in the temperature of the concrete being held until it is fully set.
- Thus, when the concrete is placed at 30 ° C, cooled to 15 ° –18 ° C, some shrinkage can be expected.
- This may be negligible in its account. But when drying is added to shrinkage, it becomes necessary.

# Durability

- The durability of the concrete can be defined as the capacity of the concrete to bear all the forces of the deterioration.
- Environmental forces such as weathering, chemical attack, heat, freezing and thawing seek to destroy concrete.
- The period of existence of concrete without being adversely affected by these forces is known as durability.
- Usually dense and strong concretes have better durability.
- Cube crushing strength alone is not a reliable guide to durability.
- Concrete should have a sufficient amount of cement content and a low water-to-cement ratio.

# Impermeability

- It is the resistance of concrete to the flow of water through its pores.
- The excess water during concreting leaves a large number of continuous pores leading to permeability.
- Since permeability decreases the durability of concrete, it should be kept very low by low water-cement ratios, dense and well graded aggregates, good compaction and continuous curing in low temperature conditions.
- The cement material used should be sufficient to provide adequate workability with low water cement ratio and available compaction method.

# Modulus of Rupture

- Modulus of rupture is a measure of the tensile strength of concrete beams or slabs.
- Flexural strength identifies the amount of stress and force an unreinforced concrete slab, beam or other structure can withstand such that it resists any bending failures.
- Modulus of rupture is also known as flexural strength, bond strength or fracture strength.

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## Unit 1 : Civil Engineering Materials and Surveying

## Topic : Properties of Fresh Concrete

# Properties of Fresh Concrete

1. Workability.
2. Temperature.
3. Water Cement Ratio.
4. Seggregation.
5. Bleeding.
6. Plastic shrinkage.
7. Setting Time.
8. Hydration.

# Properties of Fresh Concrete

- The diverse requirements of transportability, compatibility, mobility, stability, mixability, playability, and finish ability of fresh concrete mentioned above are collectively referred.
- The workability of fresh concrete is thus a composite property. It is difficult to define precisely all the aspects of the workability in a single definition.
- IS 6461 (Part-VII)-1973 defines workability as that Property of freshly mixed mortar or concrete that determines the ease and homogeneity by which it could be mixed, placed, compacted, and completed.

# Properties of Fresh Concrete

**Factors Affecting Workability**

- Influence of Mix Proportions
- Influence of Aggregate Properties
- Influence of Admixtures
- Effect of Time

# Temperature of Fresh Concrete

- Concrete is not recommended to be placed at a temperature above 40°C without proper precautions, as laid down in IS:7861(part -1).
- Special problems are encountered in the preparation, placement, and curing of concrete in hot weather.
- The First 24 to 72 hours after placing fresh concrete are of extreme importance.
- In this period, hydration of concrete occurs, which is a chemical process in which concrete gains its strength.

# Temperature of Fresh Concrete

- If the temperature of concrete is not controlled and it goes beyond maximum range during hydration, then stresses are produced, and cracks are formed in concrete.
- Also if the temperature falls below the minimum temperature, then concrete takes a large time to set, and the hydration process slows down.
- It is necessary to understand here that concrete can be done at any temperature unless the temperature is controlled.

# Water Cement Ratio of Fresh Concrete

- It is the ratio of cement and water utilized in the preparation of concrete. The quantity of water used at mixing concrete is very important.
- If the percentage of water used is less, then there will not be a sufficient quantity of water to hydrate cement. It will result in weak and porous concrete.
- Therefore, the usual tendency is to use too much water that gives a more workable mix, but it doesn't give sound concrete. Too much water results in the segregation of aggregates and gives porous concrete of low strength and low density.
- A certain minimum proportion of water is necessary to hydrate the cement completely. To create the concrete sufficiently workable to be placed in position, some more water is needed.

# Water Cement Ratio of Fresh Concrete

- So long as the concrete is sufficiently workable, for the way of placing used, its strength depends on the proportion of water to the cement in the mix.
- The water-cement ratio shouldn't be allowed to exceed the specified limits for various types of concrete and should usually be kept as low as the methods of placing will allow.
- Abrahms, as a result of a large number of experiments, states that "with given materials and conditions of the test, the ratio of the quantity of mixing water into the quantity of cement alone determines the potency of concrete as long as the mix is of workable plasticity."

# Water Cement Ratio of Fresh Concrete

**Water-Cement Ratio Table**

| IS 10262 | Minimum Cement Content | W/C Ratio | Grade | Minimum Cement Content | W/C Ratio | Grade |
|---|---|---|---|---|---|---|
| **Mild** | 220 | 0.60 | | 300 | 0.55 | M20 |
| **Moderate** | 240 | 0.60 | M15 | 300 | 0.50 | M25 |
| **Severe** | 250 | 0.50 | M20 | 320 | 0.45 | M30 |
| **Very Severe** | 260 | 0.45 | M20 | 340 | 0.45 | M35 |
| **Extreme** | 280 | 0.40 | M25 | 360 | 0.40 | M40 |

# Segregation of Fresh Concrete

- Segregation is usually caused by excessive vibration of cement. The different materials that make up the concrete mix have different weights, so while the concrete is in a liquid state, there is a tendency for heavier materials to settle to the bottom, and the lighter slurry to rise to the top.
- Isolation means the separation of newly designed solid ingredients from each other in a non-uniform mixture.
- More specifically, it implies the separation of coarse aggregates from the mortar in which they are composed due to differences in the size, density, shape, and other properties of the material.

# Segregation of Fresh Concrete

- Due to the separation, the hive is made into concrete, and it basically affects the strength of the concrete and its porosity.
- During concrete work, isolation in concrete can occur on-site, and this affects the durability of your structures. In fine concrete, all the ingredients are properly distributed and form a homogeneous mixture.
- If a concrete sample exhibits a tendency to separate coarse aggregates from the rest of the material, it indicates the separation in the concrete.

# Segregation of Fresh Concrete

**Harmful Effects Due to the Segregation of Concrete**

- To comb the concrete honey.
- The high permeability of concrete.
- Low compressive strength.
- Poor finishing of surfaces.

# Segregation of Fresh Concrete

# Segregation of Fresh Concrete

# Bleeding of Fresh Concrete

- Bleeding in concrete is sometimes referred to as water gain.
- This is a special form of separation, in which some water from the concrete flows to the surface of the concrete, with the lowest specific gravity among all concrete components.
- Excessive bleeding is seen in thin members such as roof slabs or road slabs, and when the concrete is placed in sunny weather.

# Bleeding of Fresh Concrete

**Prevention of bleeding in concrete**

- Bleeding can be reduced with appropriate proportions and uniform and complete mixing.
- Bleeding is reduced by the use of finely divided pozzolanic materials, making a long way to cross the water.
- The air-penetrating agent is very effective for reducing blood.
- Bleeding can be reduced by the use of fine cement or cement with low alkali content.

# Plastic Shrinkage of Fresh Concrete

- If water is removed from the concrete before it sets, the volume of the concrete is reduced by the amount of water removed. This volume reduction is known as plastic shrinkage.
- This is the shrinkage that the fresh concrete undergoes until it sets completely.
- Water may be removed from the plastic concrete by evaporation or by being absorbed by dry surfaces such as soil or old concrete or by the dry wooden formwork.

# Setting Time of Fresh Concrete

- When concrete changes its state from fresh to hardened then this process is called setting.
- And the time required to complete this process is known as Setting Time of Concrete.

# Hydration in Fresh Concrete

- When cement comes in contact with water, a chemical reaction begins. This reaction is known as hydration.
- If the mixing water dries out too rapidly before the cement has fully hydrated, the curing process will stop, and the concrete will not harden to its intended strength.
- Hydration occurs more rapidly at higher air temperatures. Hydration itself also generates heat. This heat of hydration can be helpful during cold-weather construction but harmful during hot-weather construction.

# *Thank You!!*

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**COIMBATORE**

## DEPARTMENT OF CIVIL ENGINEERING

# 19GET102 – BASIC CIVIL AND MECHANICAL ENGINEERING

## I YEAR / I SEMESTER

## Unit 1 : Civil Engineering Materials and Surveying

## Topic : Mix Specifications

# Concrete Mix Ratio

- Concrete mix ratios are the proportions of concrete components such as cement, sand, aggregates and water.
- These mix ratios are decided based on type of construction and mix designs.
- However, building codes provides nominal and standard concrete mix ratios for various construction works based on experience and testing.

# Types of Concrete Mix Ratio – Mix Designs

1. Nominal Concrete Mix Ratios
2. Standard Mixes or Ratio
3. Designed Mix Ratio of Concrete

# Nominal Concrete Mix Ratios

- In the past the specifications for concrete prescribed the proportions of cement, fine and coarse aggregates.
- These mixes of fixed cement-aggregate ratio which ensures adequate strength are termed nominal mixes.
- Nominal mixes offer simplicity and under normal circumstances, have a margin of strength above that specified.
- However, due to the variability of mix ingredients the nominal concrete for a given workability varies widely in strength.
- Nominal mix ratios for concrete are 1:2:4 for M15, 1:1.5:3 for M20 etc.

# Standard Mixes or Ratio

- The nominal mixes of fixed cement-aggregate ratio (by volume) vary widely in strength and may result in under or over-rich mixes.
- For this reason, the minimum compressive strength has been included in many specifications.
- These mixes are termed standard mixes. IS 456-2000 has designated the concrete mixes into a number of grades as M10, M15, M20, M25, M30, M35 and M40.
- In this designation the letter M refers to the mix and the number to the specified 28 day cube strength of mix in $N/mm^2$.
- The mixes of grades M10, M15, M20 and M25 correspond approximately to the mix proportions (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively.

# Designed Mix Ratio of Concrete

- In these mixes the performance of the concrete is specified by the designer but the mix proportions are determined by the producer of concrete, except that the minimum cement content can be laid down.
- This is most rational approach to the selection of mix proportions with specific materials in mind possessing more or less unique characteristics.
- For the concrete with undemanding performance nominal or standard mixes (prescribed in the codes by quantities of dry ingredients per cubic meter and by slump) may be used only for very small jobs, when the 28-day strength of concrete does not exceed 30 $N/mm^2$.
- No control testing is necessary reliance being placed on the masses of the ingredients.

# Normal Grade of Concrete

| Concrete Grade | Mix Ratio | Compressive Strength | |
|---|---|---|---|
| | | MPa(N/mm2) | psi |
| M5 | 1:5:10 | 5 | 725 |
| M7.5 | 1:4:8 | 7.5 | 1087 |
| M10 | 1:3:6 | 10 | 1450 |
| M15 | 1:2:4 | 15 | 2175 |
| M20 | 1:1.5:3 | 20 | 2900 |

# Standard Grade of Concrete

| Concrete Grade | Mix Ratio | Compressive Strength | |
|---|---|---|---|
| | | MPa(N/mm2) | psi |
| M25 | 1:1:2 | 25 | 3625 |
| M30 | Design Mix | 30 | 4350 |
| M35 | Design Mix | 35 | 5075 |
| M40 | Design Mix | 40 | 5800 |
| M45 | Design Mix | 45 | 6525 |

# High Strength Concrete Grades

| Concrete Grade | Mix Ratio | Compressive Strength | |
|---|---|---|---|
| | | MPa(N/mm2) | psi |
| M50 | Design Mix | 50 | 7250 |
| M55 | Design Mix | 55 | 7975 |
| M50 | Design Mix | 60 | 8700 |
| M65 | Design Mix | 65 | 9425 |
| M70 | Design Mix | 70 | 10150 |

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## I YEAR / I SEMESTER

## Unit 1 : Civil Engineering Materials and Surveying

## Topic : Manufacturing Process of Concrete

# Manufacturing of Concrete

1. Proportioning of Concrete
2. Batching of Materials
3. Mixing
4. Transporting
5. Placing
6. Compacting
7. Curing

# Proportioning of Concrete

- Selection of the proper quantity of cement, coarse aggregate, sand and water to obtain the desired quality is known as proportioning of concrete.
- Concrete is formed by successive filling of voids in aggregate by sand, the voids in the sand by cement and voids in cement by water and undergoing a chemical reaction.

# Proportioning of Concrete

**The concrete formed by proper proportioning of ingredients should satisfy the following properties:**

- The fresh concrete should have adequate workability for uniform placement.
- The hardened concrete after setting should have the desired strength and durability.
- The concrete should be cheap considering the materials and labour.

# Batching of Materials

- Batching is the process involves in measuring concrete mix ingredients by either mass or volume and pouring ingredients into the mixer.
- To produce a uniform quality concrete during manufacturing process, the ingredients must be measured accurately for each batch.

# Batching of Materials

**Types of Batching:**

a) Volume Batching

b) Weigh Batching

The factors affecting the choice of batching method are the size of job, required production rate, and required standards of batching performance. For most important works weigh batching is recommended.

# Batching of Materials

**Volume Batching:**

This batching method involves measuring the materials depending upon their volume. This is nowadays very less used in different construction projects, due to Superior advantages of Weigh Batching over it, which includes the aspect of time.

**Weigh Batching:**

This is the most common and accurate method of Batching which involves measuring the materials depending upon their weight.

# Mixing

- After Batching, the mixing phase takes place which is the actual production of the material Concrete.
- In this phase, the necessity of different construction equipment is immense, which will as well determine the quality of concrete produced.
- The mixing phase can be defined as the phase involving, actual physical mixing of different raw material in the provided proportion along with the controlled operation, which produces the material concrete.

# Mixing

There are widely two types of mixing procedure adopted, which are:

**Hand Mixing:**

- Though the name indicates hand Mixing, it is not actually Mixed through the hand.
- It is generally done using a mixer that is manually operated.
- It is not very popular because of the great amount of effort to be used for the mixing and the mixing speed varies greatly if it is done using human operation.
- It is generally adopted for petty concreting works.

# Mixing

**Machine Mixing:**

- It is the preparation of Concrete, using a Mechanically or electrically operated mixture machine.
- It is the most widely used method, used for large to medium construction projects all over the world.
- The popularity of these methods may be due to the fact that less amount of effort is to be applied in the mixing process and it will yield higher results, resulting in the production of good Concrete.

# Mixing

# Mixing

- There are two types of Mixture machines generally used which are, Drum Type and Pan Type.
- The Drum Type mixture machine can further be classified as:

1. Tilting
2. Non Tilting
3. Reversing, and
4. Force action type.

# Mixing

# Mixing


Types of Concrete Mixers
1.Tilting drum mixers
2.Non-Tilting Drum Mixers
3.Tilting drum mixers
4. Pan type mixers
5. Continues concrete mixers

# Transportation

- Just as the name indicates, it is the transportation of the Concrete from the mixing site to the placing site.
- Most of the time, the place of mixing and the place, where the concrete is to be poured, are not the same.
- So the concrete is needed to be conveyed for some distance, is ordered to pour it in the actual place.
- There are a number of methods and types of equipment used for the purpose of conveying concrete, within which, some are less famous and some are very popular and used in almost all construction projects.

# Transportation

**Vertical Transportation:**

- This is the transportation of concrete to be used in the upper storey of the building or of underground construction and needed to be transported in a vertical direction. For this transportation, some of the equipment used are—
    - Skip and Hoist
    - Chute
    - Crane, Bucket, Ropeway
    - Helicopters

# Transportation

# Transportation

# Transportation

# Transportation

**Horizontal Transportation:**

- This is the transportation of concrete to be conveyed horizontally, that is, from one place to another. Some of the equipment used for this purpose includes-
  - Mortar Plan
  - Truck Mixer
  - Conveyors belt
  - Transit Mixer

# Transportation

# Transportation

# Transportation

- There is another common type of equipment, which is nowadays used for every large construction project and can be operated in both vertical and horizontal directions. The Equipment used is **Pump.**

**Concrete Pump:**

- It is a very common Equipment nowadays.
- The size of the pump depends upon the maximum size of the aggregates used and the distance to which the concrete is to be transported.
- Though there are several Disadvantages of pumps such as blockages, the amount of advantage far exceeds those in number and quality.

# Transportation

# Transportation

# Placing

- It is the process of placing of produced concrete, on the required place, according to the position of the structural member in the Drawing.
- The placing can be of different types, depending upon the methods used, such as placing of concrete for foundation and walls, placing of concrete for Underwater works, etc.
- The placing operation largely involves the Formwork fixing operation.
- Before placing concrete to the required place, the Formworks, planks that can be manufactured of different materials, such as Timber and steel and whose depth and thickness depending upon the depth of the structural member and a number of other factors, are fixed on the four sides.

# Compacting

- It is a method of eliminating air voids on the surface of the concrete.
- Whenever concrete is placed, many times, different sizes of air voids already exist in the concrete.
- If the concrete is not subjected to the Compacting efforts, this air voids remain, which on a later stage results in the reduction of the strength of concrete as well as other different faults.
- So in order to attain full strength so that it can perform safely as per it's pre-decided lifespan, Compacting is necessary.

# Compacting

Compacting may be broadly classified into two types,

**Hand Compaction:**

- Hand Compaction is done by a steel tamping rod.
- By equally distributing the strokes as per the number specified in the design documents(generally 25 times for a layer of 10 cm), the concrete is Compacted.
- This method is used for petty and small concreting works

# Compacting

**Vibration:**

- It is the most popular method which involves Compaction of the concrete using electrically or mechanically operated tools, commonly known as vibrators.
- It is used in every large construction projects, as it provides complete precision.
- There are various types of vibrators depending upon the type of concrete it is to be constructed and the concrete components.

# Compacting

- Some of these are
  - Internal Vibrator
  - External Vibrator
  - Table vibrator
  - Surface vibrator
  - Platform Vibrator, etc.

# Compacting

# Compacting

# Compacting

# Compacting

# Curing

- As we all know, the reaction between cement and water is exothermic, which evolves a considerable amount of heat.
- Due to the hydration of Cement, a large amount of heat develops on the concrete surface as well the water quantity gets reduced.
- Both occurrences pose a great danger to the structural member from the stability point of view.
- So in order to maintain sufficient temperature, as well as providing adequate moisture to the concrete, Curing is necessary.
- So, in other words, curing is the process of making the concrete warm and moist enough so that hydration of cement can continue.

# Curing

**Water Curing:**

- It is the application of water on the surface of the concrete.
- Again, these may be of several types such as immersion, ponding, spraying, and fogging.
- The types of water curing may be different based on the types of elements, as well method of construction (i.e precast or cast in place). Other types of Curing includes-
    1. Membrane Curing
    2. Stream Curing, etc.
- The time of curing generally depends upon the site and weather conditions. But in Normal condition, a Curing of 7 days may be assumed necessary.

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# 19GET102 – BASIC CIVIL AND MECHANICAL ENGINEERING

## I YEAR / I SEMESTER

## Unit 1 : Civil Engineering Materials and Surveying

## Topic : Concrete

# Concrete

- Concrete is a construction material composed of cement, fine aggregates (sand) and coarse aggregates mixed with water which hardens with time.
- Portland cement is the commonly used type of cement for production of concrete.
- Concrete technology deals with study of properties of concrete and its practical applications.
- In a building construction, concrete is used for the construction of foundations, columns, beams, slabs and other load bearing elements.

# Concrete

- Materials are mixed in specific proportions to obtain the required strength.
- Strength of mix is specified as M5, M10, M15, M20, M25, M30 etc, where M signifies Mix and 5, 10, 15 etc. as their strength in $kN/m^2$.
- Water cement ratio plays an important role which influences various properties such as workability, strength and durability.
- Adequate water cement ratio is required for production of workable concrete.

# Concrete

- When water is mixed with materials, cement reacts with water and hydration reaction starts.
- This reaction helps ingredients to form a hard matrix that binds the materials together into a durable stone-like material.
- Concrete can be casted in any shape.
- Since it is a plastic material in fresh state, various shapes and sizes of forms or formworks are used to provide different shapes such as rectangular, circular etc.
- Various structural members such as beams, slabs, footings, columns, lintels etc. are constructed with concrete.

# Concrete

- There are different types of admixtures which are used to provide certain properties.
- Admixtures or additives such as pozzolans or superplasticizers are included in the mixture to improve the physical properties of the wet mix or the finished material.
- Various types of concrete are manufactured these days for construction of buildings and structures.
- These have special properties and features which improve quality of construction as per requirement.

# Components of Concrete

- Components of concrete are cement, sand, aggregates and water.
- Mixture of Portland cement and water is called as paste.
- So, concrete can be called as a mixture of paste, sand and aggregates. Sometimes rocks are used instead of aggregates.
- The cement paste coats the surface of the fine and coarse aggregates when mixed thoroughly and binds them.
- Soon after mixing the components, hydration reaction starts which provides strength and a rock solid concrete is obtained.

# Ingredients of Concrete


Concrete Materials

# Ingredients of Concrete

**1. Cement**

**Cement** is the main binder material used to bind other building concrete materials together. It is used for making mortar and concrete during the construction process.

**2. Coarse Aggregate**

**Coarse Aggregate** forms the major body of concrete. The aggregates contribute to the overall strength of the concrete by increasing density.

**3. Fine Aggregate (Sand)**

Fine aggregate such as sand used to fill in the spaces left between the large coarse aggregate and to “lock” the larger pieces together. Sand helps in reducing the quantity of cement paste required and decreases the amount of shrinkage that could occur.

# Ingredients of Concrete

**4. Admixture**

Admixtures are added to enhance or to modify the properties of fresh & hardened concrete. (Plasticizers, retarders)

**5. Water**

It is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. The water contributes to the hardening of concrete through a process called hydration. Its role is major in concrete because the strength of concrete extensively depends on water to cement ratio and it is the critical factor in the production of “perfect” concrete.

**6. Fly Ash**

Fly ash use in concrete improves the workability of plastic concrete and the strength and durability of hardened concrete. Fly ash use is also cost-effective. Fly ash added to concrete to reduce the amount of cement required for concrete, which contributes to considerable saving of cement and cost of concrete making.

# *Thank You!!*