(20A01405) Concrete Materials Lab

- **PREPARED BY**

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COURSE OUTCOMES

CO 1	Determine the consistency and fineness of cement
CO 2	Determine the setting times, specific gravity and soundness of cement
CO 3	Determine the compressive strength and workability of cement
CO 4	Determine the specific gravity and water absorption of coarse aggregates
CO 5	Assess the non-destructive techniques on concrete

Experiments List as per affiliated University

1. Grading Curve of Coarse aggregates
2. Grading Curve of Fine aggregates
3. Bulking of Fine aggregate
4. Specific gravity of coarse aggregate
5. Specific gravity of Fine aggregate
6. Specific gravity of Cement
7. fineness of Cement
8. Normal Consistency of Cement
9. Initial and final setting times of Cement
10. Soundness test of Cement
11. Compressive Strength test of Cement
12. Slump, Compaction factor and Vee-Bee time tests on concrete.
13. Compressive strength of concrete.
14. Split tensile strength of concrete
15. Non destructive tests on concrete (any two)

List with Additional Experiments

1. Flexural Test on Concrete
2. Crushing strength of aggregate

Grading of Aggregate

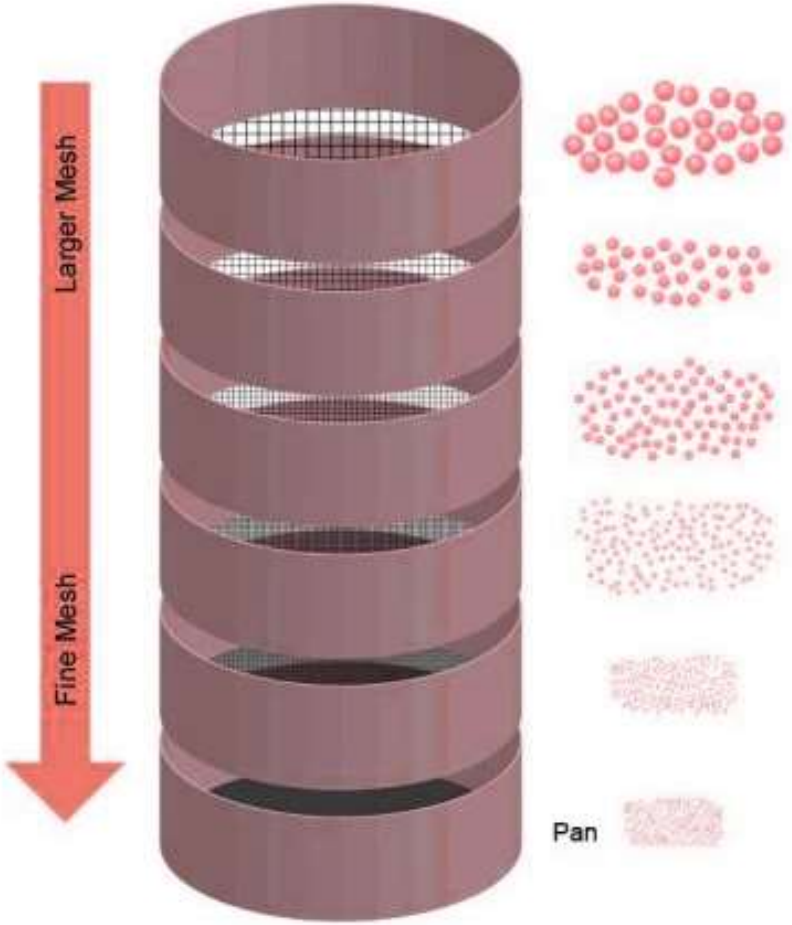
Introduction

This method covers the determination of the particle size distribution of fine aggregate by sieving.

Sieve analysis is the name given to the operation of dividing a sample of aggregate into various fractions, each consisting of particles of the same size. The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate, which is called gradation.

This test method is used primarily to determine the grading of materials proposed for use as aggregates or being used as aggregates. The results are used to determine compliance of the particle size distribution with applicable specification requirements and to provide necessary data for control of the production of various aggregate products and mixtures containing aggregates. The data may also be useful in developing relationships concerning porosity and packing.

Accurate determination of material finer than the 75-µm (No. 200) sieve cannot be achieved by use of this test method alone.



Apparatus Required

Sieve Lid

Sieve With Pan

Weighing Balance

Sieve Shaker

SI	Maximum size of material present in substantial quantities	Weight to be taken for test in Kgs
1	75mm	60Kg
2	40mm	25Kg
3	25mm	13Kg
4	19mm	6.5Kg
5	12.5mm	3.5Kg
6	10mm	1.5Kg
7	6.5mm	0.75Kg
8	4.75mm	0.4Kg

Procedure

1.A sample of aggregate shall be collected as given earlier.
2.Sieves shall be cleaned and arranged in sequence in descending order. Pan shall at the lowermost end and Lid on top.
3.Take around 5 kg of sample and dry it in an oven at a temp of 100-110^0
4.The dried sample shall be then weighed (5 kg preferably) and sieved successively on sieves starting with 40mm and then through 4.75mm (For 20 mm down an aggregate size) and through 2.36 mm (For 12.5/10 mm down an aggregate size).
5.Each sieve shall be shaken at least for two minutes on a clean tray until no more trace passes.
6.The motion shall be varied like back and forth, left to right, circular clockwise and anti-clockwise and with frequent jarring.
7.Material shall not be forced through the mesh. But for coarser than 20mm particles, placing is permitted (passing particles through sieve opening manually).
8.Sieves shall be brushed from underneath of mesh and pass on to the next.
9.On completion of sieving, material retained on each sieve is to weigh Separately.
10.Check for permissible limits for passing.

Reporting Sieve Analysis Test for Coarse Aggregate:

•The cumulative % by weight of the total sample passing each sieve, to the nearest whole number.

Or

•The % by weight of the total sample passing one sieve and retained on the next Smaller sieve to the nearest 1 decimal.

•Check for permissible limits for passing.

Procedure Sive Analysis Test for Fine Aggregate:

1.A sample of sand shall be collected as given earlier.

2.Sieves shall be cleaned and arranged in sequence in descending order. Pan shall at the lowermost end and Lid on top.

3.Take around 1 kg of sample and dry it in an oven at a temp of 100-110^0

4.The dried sample shall be then weighed (1 kg preferably) and sieved successively on sieves starting with 10mm and then through 150 microns.

5.Each sieve shall be shaken at least for two minutes on a clean tray until no more trace passes.

6.The motion shall be varied like back and forth, left to right, circular clockwise and anti-clockwise and with frequent jarring.

7.Material shall not be forced through the mesh. Lumps in fines shall be broken against the wall of a sieve.

8.Sieves shall be brushed from underneath of mesh and pass on to the next.

9.On completion of sieving, material retained on each sieve is to be weighed separately.

Calculations of Sive Analysis Test for Fine Aggregate:

•Fineness Modulus: Add values of Cumulative % Retained on each sieve and Divide by 100.

•Normally the accepted limit of FM is valued between 2.2 to 3.2.

•A higher value of FM indicates coarser sand, whereas lesser value indicates a finer one.

•Grading Zone of Fine Aggregate – Value is shown between I to IV.

•Where zone- I is associates with Coarser Fine aggregate, and Zone IV is Finer.

•Zones are decided from values of 600 microns passing % in sieve analysis. (Refer Table-4 of IS: 383)

•Zone –I – 15-34%, Zone-II – 35-59 %, Zone-III- 60-79%, Zone-IV- 80-100%

Reporting:

•The cumulative % by weight of the total sample passing each sieve, to the nearest whole number.

Or

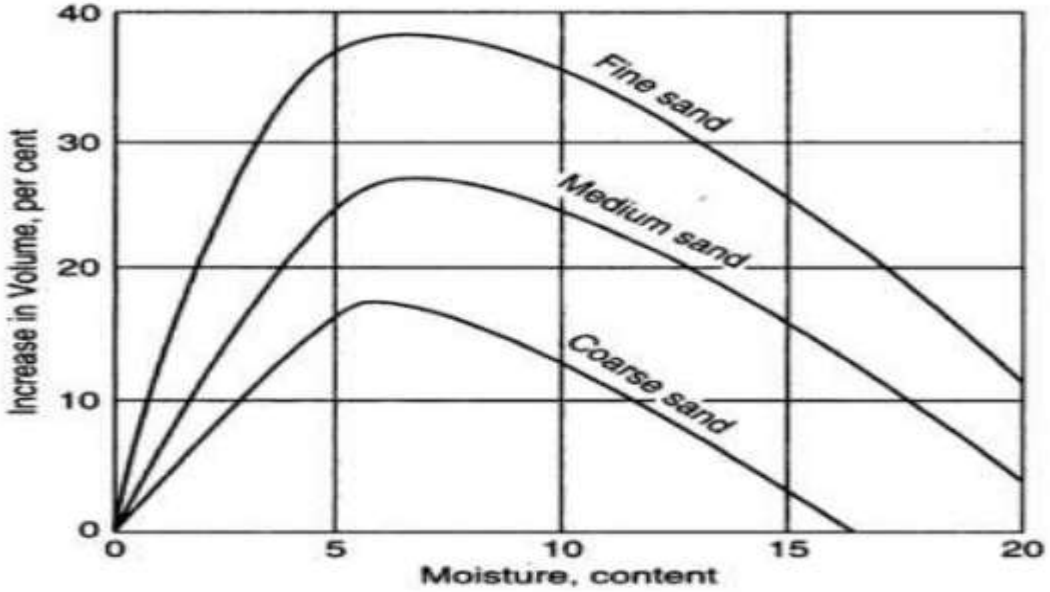
•The % by weight of the total sample passing one sieve and retained on the next smaller sieve to the nearest 1 decimal. Calculate the F.M. of the material and decide to read the Zone of material.

Bulking of fine aggregate

Definition Bulking of fine aggregate or sand is the phenomenon of increase in sand volume due to the increase of moisture content.. Bulking test on fine aggregates has to be performed before using it in construction.

Causes of Bulking of Sand: The moisture content in the sand makes thin films around sand particles. Hence, each particle exerts pressure. Thus they move away from each other causing increasing in volume. The bulking of the aggregates is dependent on two factors: ▪ The fineness of the aggregates ▪ Percentage moisture content

As shown in figure-1 below, the bulking of the sand increases with the increase in moisture content. This happens up to a limit beyond which any moisture addition will decrease the volume



Apparatus :

1. 250ml measuring cylinder
2. Weighing balance 3
3. Fine aggregate

Procedure :

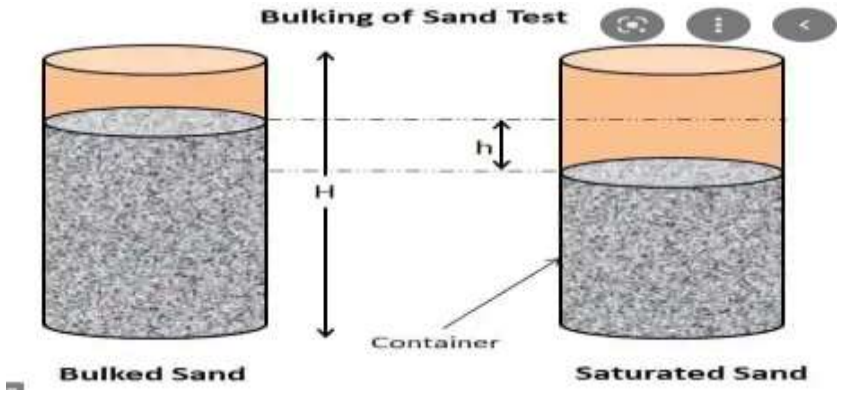
1. Take 500 grams of fine aggregate over dried at a temperature of 100 to 110 degree Celsius for 24 ± 0.5 hours. This weight is measured as W1

2. The cooled sand is taken in an airtight container. This weight is measured as W2 .

3.Take the reading at the sand surface (Y ml) Calculations Percentage Bulking of Sand = [(200/Y)- 1] x100 Result Percentage bulking of field sample=

Significance of Determining Percentage Bulking :

Unrealistic volume is shown by fine aggregate due to bulking. When concrete proportioning is to be performed, the sand bulking issues is a concern. If the effect of bulking is not studied properly, the concrete designed will have an insufficient amount of sand resulting in a harsh mix and segregation. Bulking of sand will affect the yield of concrete for a given cement content.



SPECIFIC GRAVITY AND WATER ABSORPTION OF AGGREGATE

Apparatus Required

- Wire basket with 2.36mm aperture size,200mm diameter and 60mm height.
- weigh balance 2kg capacity
- suitable container for immersing the wire basket in water
- suitable apparatus for suspending the wire basket from center of scale pan balance
- Pycnometer 1 Liter capacity fitted with glass disk

Procedure of the test

Fine Aggregate (Pycnometer method)

- The sand sample shall be immersed in clean water for 24 hrs and dried to saturated surface dry condition.
- A representative sample of about 1200 gms to be taken of the above sample is thus divided into two equal parts(600 gms each).
- One sample is placed in an oven and dried to constant weight and the weight is recorded.
- The pycnometer is filled about 3/4th full of water of a known temperature and the SSD sample is added, entrapped air is removed either by agitating the sand.
- The jar is then filled with water and covered with a glass disk by sliding the disk across the top of the jar. the jar is shaken vigorously to remove the entrapped air if any and the disk again refilled with water, make sure that no air voids present the weight of the jar with the disk is measured.
- Weigh the pycnometer filled with water only.

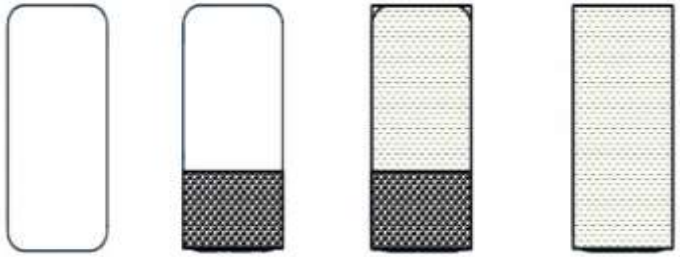
Coarse Aggregate (Basket Method)

- The sample immersed in water having a temperature of 22 to 32°C and the mixture is thoroughly agitated to remove the dust and then allowed to absorb water for 24.
- After weighing, the saturated surface dry sample is placed immediately in the wire basket and its weight in water is determined.
- The sample is then dried to a constant weight at a temperature of 100 to 110° C, then cooled to room temperature and weighed .

Datasheet for specific gravity & water absorption of fine aggregate

Datasheet for specific gravity & water absorption of fine aggregate

Sl. No.	Description	1	2	3	Average
1	Weight of SSD sample in air (A)				
2	Weight of Pycnometer + Water + Sample (B)				
3	Weight of Pycnometer + Water (C)				
4	Weight of Oven Dry Sample (D)				
5	Bulk of Specific Gravity = D/C + A – B				
6	Bulk of Specific Gravity (SSD basis) = A/C + A – B				
7	Apparent Specific Gravity = D/C + D – B				
8	Water Absorption (% of dry basis) = 100 x (A – D)/D				



Empty Container | Container +Dry Soil | Container + Dry Soil + Water | Container +Water

Specific gravity of cement

What is the use of specific gravity of cement?

Cement particle has pore in them and they can absorb moisture from the atmosphere. Considering this behavior of cement particles the specific gravity can either increase or decrease. While we are calculating cement for mix design we consider the specific gravity of cement as standard 3.14. So, any change in cement-specific gravity will affect the mix design. Hence, it is essential to test the specific gravity of the cement procured before the mixing process.

Apparatus Required for Le Chatelier's Principle:-

1. Cement
2. Kerosene
3. Specific Gravity Bottle capacity of 250 ml with stopper.
4. Weighing balance with 0.1 gm accurate

Procedure for finding Specific gravity in cement:-

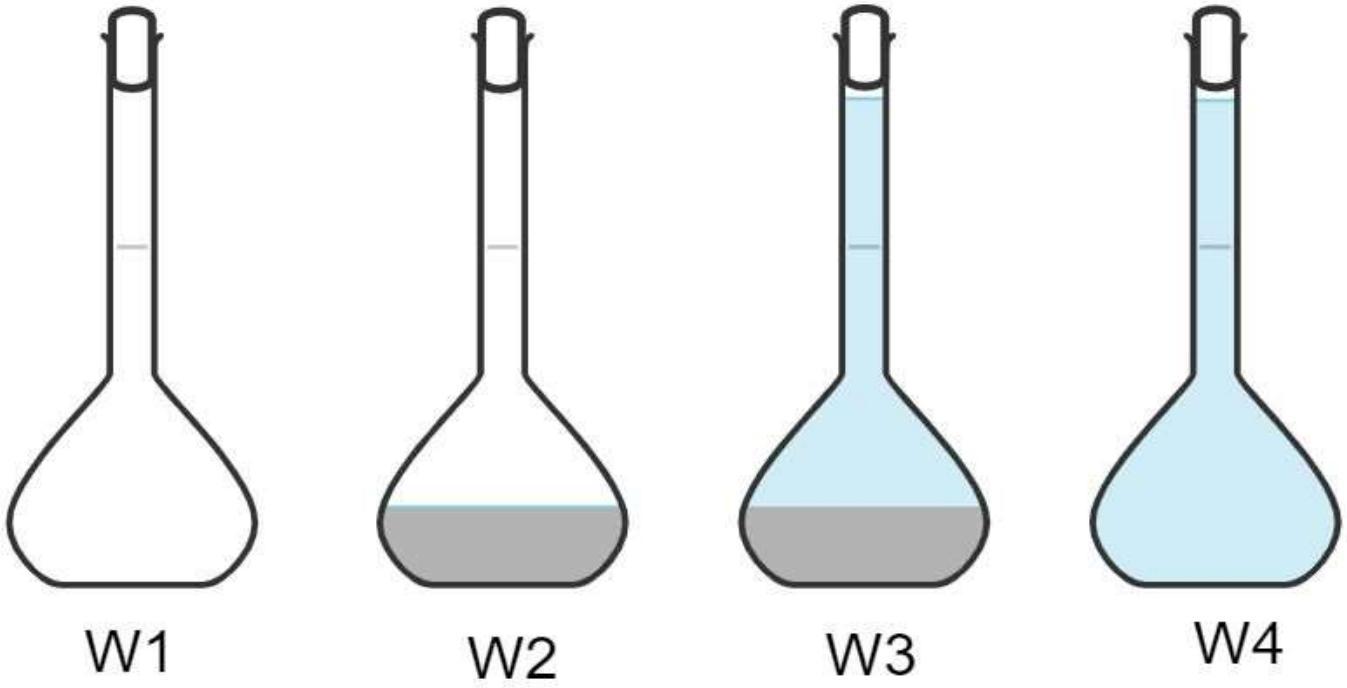
1.The Lechatlier flask should be free from moisture content, that mean flask is thoroughly dried.

2.Now, weigh the empty flask and note it as W_1.

3.Take 50gm of cement and add it in Flask. Now weight the Flask with the stopper as W_2

4.Now pour kerosene in the sample up to the neck of the bottle. Mix thoroughly and see that no air bubbles left in the flask. Note down the weight as W_3

5.Empty the flask and fill the bottle with kerosene up to the tip of the bottle and record the weight as W_4.



W1 = Weight of empty le-chatelier's flask
W2 = Weight of (le-chatelier's flask + Cement)
W3 = Weight of (le-chatelier's flask + Cement + Kerosene)
W4 = Weight of (le-chatelier's flask + Kerosene)

$$\text{Specific Gravity of Cement (Sg)} = \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4) \times 0.79}$$

FINENESS OF CEMENT BY DRY SIEVING

Objective: To determine the finess of a given sample of cement.
Reference: IS : 4031 (Part 1) – 1988.

Overview :

Fineness of cement is measured by sieving it on standard sieve. The proportion of cement of which the grain sizes are larger than the specified mesh size is thus determined.

Apparatus :

- 90 µ Sieve with pan & Lid
- Weighing Balance
- Sieve Shaker

Procedure :

- Weigh approximately 10 gm of cement and place it on the sieve.
- Shake the sieve by sieve shaker.
- Remove and weigh the residue.

Technical Discussion:

- Fineness of cement affects hydration rate and the strength. Increasing fineness causes an increased rate of hydration, high strength, and high heat generation.
- Bleeding can be reduced by increasing fineness. Increased fineness can also lead to the requirement of more water for workability, resulting in a higher possibility of dry shrinkage.

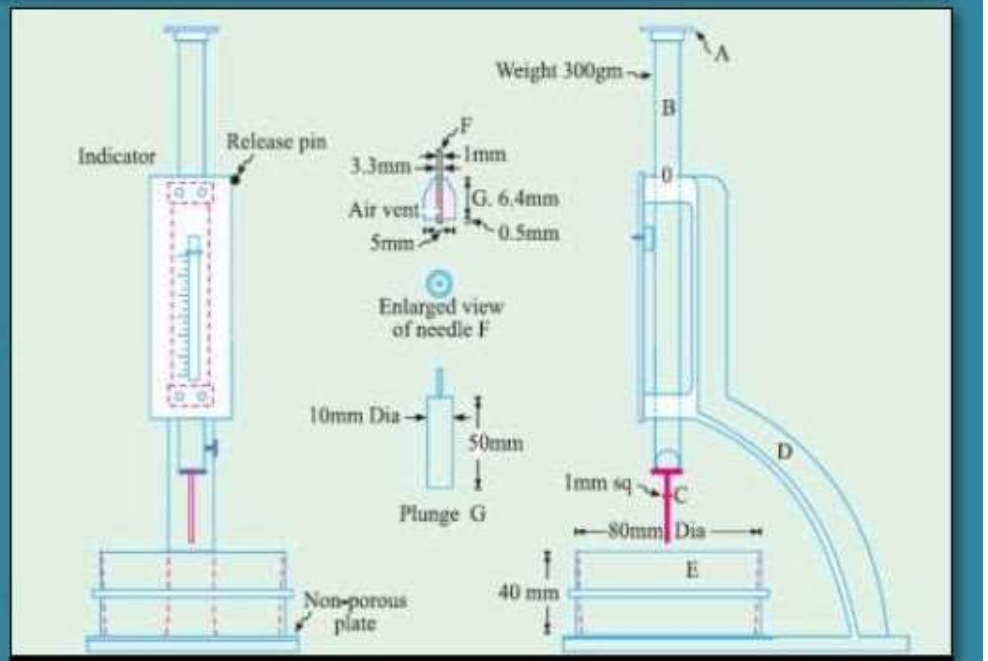
NORMAL CONSISTENCY OF CEMENT

Objective : To determine the normal consistency of a given sample of cement.
Reference : IS : 4031 (Part 4)-1988 & IS : 5513-1976.

Overview :
Standard consistency of a cement paste is defined as that consistency which will permit a vicat plunger having 10 mm dia and 50 mm length to penetrate to a depth of 33-35 mm from top of the mould.

Apparatus :
- Vicat apparatus
- Balance
- Gauging Trowel, Stop Watch, etc.

Procedure :
- Take 400 gm of cement and mix with water.
- Fill the vicat mould with cement paste.
- Place the whole assembly under the rod bearing plunger.
- Release the plunger allowing it to sink into the paste and measure the depth of penetration, until the depth of penetration becomes 33 to 35 mm.



VICAT APPARATUS

Technical Discussion :
Consistency test helps to determine water content for other tests like:
- Initial and final setting time
- Soundness
- compressive strength

SETTING TIME OF STANDARD CEMENT

Objective : To determine the initial and final setting time of a given sample of cement.
Reference : IS : 4031 (Part 4)-1988, IS : 4031 (Part 5) - 1988 & IS : 5513-1976.

Overview : ***Initial setting*** time is that time period between the time water is added to cement and time at which 1 mm^2 section needle fails to penetrate the cement paste.

Final setting time is that time period between the time water is added to cement and the time at which 1 mm needle makes an impression on the paste in the mould but 5 mm attachment does not make any impression.

Apparatus :

- Vicat apparatus
- Balance
- Stop-watch
- Gauging Trowel, Glass plate etc.

VICAT APPARATUS

Procedure :

- Take 300 gm of cement and mix with water.
- Start a stop-watch.
- The paste should be filled within 3-5 minutes.
- Initial and final setting time is noted.

Technical Discussion :

- Initial setting time test is important for transportation, placing and compaction of cement concrete.
- Initial setting time duration is required to delay the process of hydration or hardening.
- Final setting time is the time taken for the cement paste or cement concrete to harden sufficiently and attain the shape of the mould in which it is cast.

SPECIFIC GRAVITY OF CEMENT

Objective : To determine specific gravity of a given sample of hydraulic cement.
Reference : IS : 4031 (Part 11) - 1988.

Overview :
Specific gravity is defined as the ratio between the weight of a given volume of cement and weight of an equal volume of water.

LECHATELIER FLASK

Apparatus :
- Lechatelier flask 250 ml (or) Pycnometer (100 ml)
- Balance & Water bath

Procedure :
- Weigh the empty flask.
- Fill the cement up to half of the flask (about 50gm) and weigh with its stopper.
- Add Kerosene to the cement up to the top of the bottle. Weigh the flask with cement and kerosene.
- Empty the flask. Fill the bottle with kerosene up to the top and weigh the flask.

Technical Discussion: Every material has its own specific gravity, and it usually ranges between 0.1 – 100. If the specific gravity of the material is less than 1, then that material floats in water. If the material has a specific gravity greater than 1, then it sinks in water.

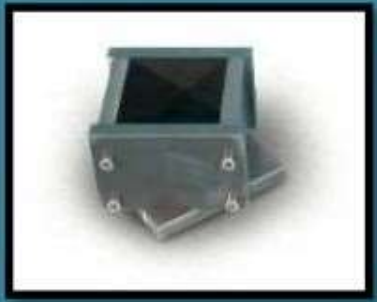
Specific gravity of cement or Density of cement is ranging between 3.1-3.16 g/cc by this, cement is 3.16 times heavier than water of the same volume.

COMPRESSIVE STRENGTH TEST OF CEMENT

Objective : To determine the compressive strength of a given sample of cement.
Reference : IS : 4031 (Part 6)-1988, IS : 10080-1982, IS : 650-1966 & IS: 269-1976

Overview :
Compressive strength of cement is determined by compressive strength test on mortar cubes compacted by means of a standard vibration machine. Standard sand (IS:650) is used for the preparation of cement mortar. The specimen is in the form of cubes 70.6mm x 70.6mm x 70.6mm

Apparatus :
- Cube Mould of 70.6 mm size
- Vibration Machine
- Gauging Trowel, Stop Watch, Graduated Cylinders, etc.



Cube Mould & Cement Cube

Technical Discussion:
- Compression testing provides data on the integrity and safety of materials, and ensure that the finished product is fit-for-purpose and manufactured to the highest quality
- Compressive strength = $\frac{\text{Load}}{\text{Cross sectional area of specimen}}$
- The quantity of cement, standard sand and water shall be as follows: Cement = 200 (g), Standard Sand = 600 (g) and Water = [(P/4)+3] (% of mass of cement+sand), whether P is the % of water required to produce a paste of standard consistency.
- As the compressive strength of the mortar is less then the required strength so it cannot be used for permanent constructions.

SLUMP TEST OF CONCRETE

Objective : To determine the relative consistency of freshly mixed concrete by the use of Slump Test.
Reference : IS: 7320-1974, IS: 1199-1959 & SP : 23-1982.

Overview :
This test is performed to measure consistency or workability of fresh concrete, where the nominal maximum size of aggregate does not exceed 38 mm using slump test apparatus.

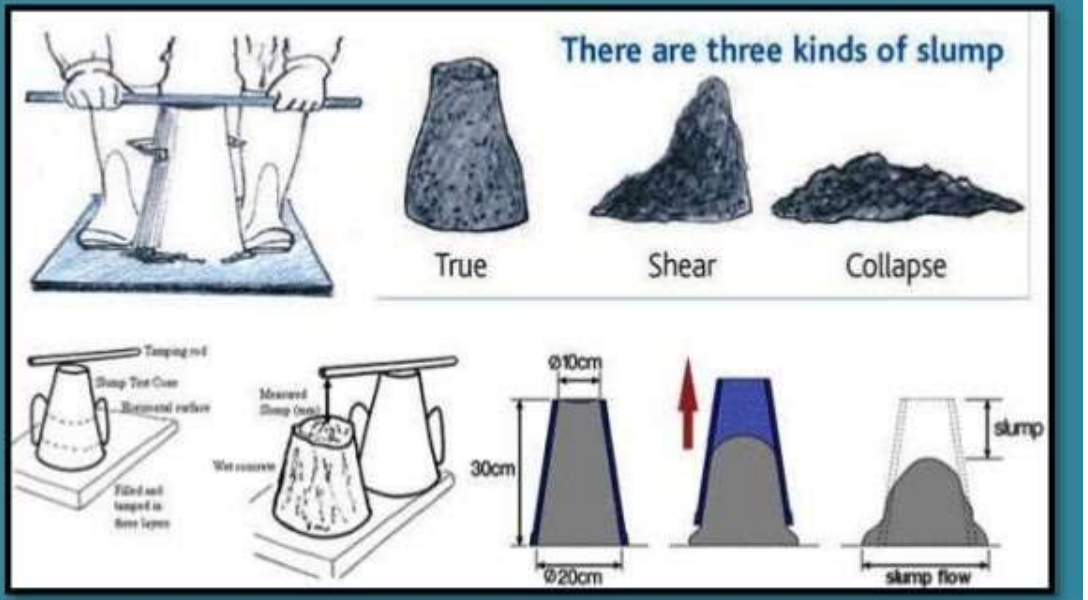
Apparatus :
- Slump cone (Height = 30 cm, Base dia = 20 cm, Top dia = 10 cm)
- Tamping rod (Length = 60 cm, Dia = 16 mm)

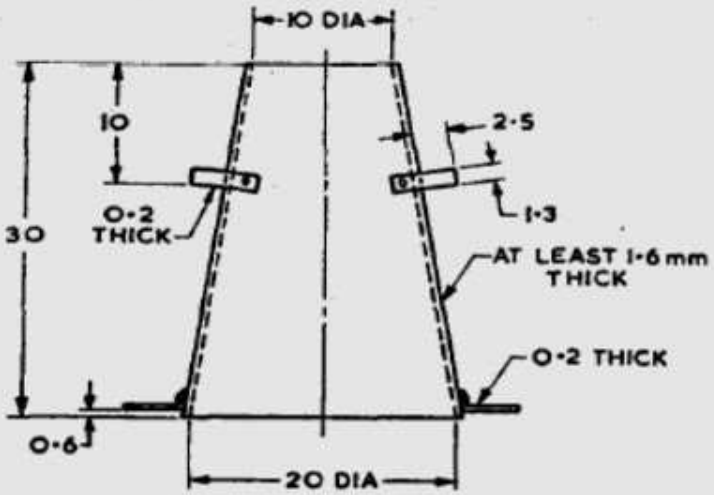
Procedure:
- Place the mixed concrete in the cleaned slump cone in four layers, each layer is temped 25 times with a standard 16 mm diameter steel rod.
- Remove the cone Immediately, rising it slowly and carefully in the vertical direction.
- The decrease in the height of the center of the slumped concrete is called slump.
- As soon as the concrete settlement comes to as stop, measure the subsistence of the concrete in mm/cms which gives the slump value.

Slump Range (mm)	Workability	Slump Class
10-40	Low	S1
50-90	Medium	S2
100-150	High	S3

Types of Slump:

- **True Slump:** The concrete mass after the test when slumps evenly all around without disintegration is called the true slump.
- **Shear Slump:** When one-half of the concrete mass slide down the other is called the shear slump. This type of slump is obtained in a lean concrete mix.
- **Collapse Slump:** When the sample is collapsed due to adding excessive water, it is known as collapse slump.
- **Zero Slump:** For very stiff or dry mixes it does not show any changes of the slump after removing the slump cone





Technical Discussion:

- The slump is measured immediately by determining the difference between the height of the mould and that of the highest point of specimen.
- After completion of the slump test, to get an idea on cohesiveness of concrete, tap slightly the outer perimeter of the slumped concrete. If it subsides further, then it is an indication of good quality concrete having required cohesiveness. But if it gets collapsed or shears away then the concrete lacks cohesiveness and this is an indication of poor quality concrete

VEE-BEE TEST OF CONCRETE

Objective : To determine the workability of the freshly mixed concrete.
Reference : IS: 1199-1956.

Overview :
Vee-bee test is used to determine the consistency of concrete by using a Vee-Bee consistometer.

Apparatus :
- A vibrator table resting on elastic supports
- A sheet metal cone, open at both ends
- A metal pot & A standard iron rod.

The degree of workability in Vee-Bee test is classified based on the time taken in seconds.

Workability	Vee-Bee Time (in Second)
Very low workability	> 20 Seconds
Low workability	6 – 12 Seconds
Medium workability	3– 6 Seconds
High workability	o – 3 Seconds

Procedure:
- Place the slump cone in the sheet metal pot of the consistometer and fill it with fresh concrete.
- Move the glass disc attached to the swivel arm and place it just on top of the slump cone in the pot
- Note the position of the concrete cone by adjusting the glass disc attached to the swivel arm.
- Lift the cone and note the slump on the graduated rod by lowering the glass disc on top of the concrete cone.
- Switch on the electrical vibrator and allow the concrete to spread out in the pot. Continue the vibration until the whole concrete to spread out in the pot. Continue the vibration until the whole concrete surface adheres uniformly to the glass disc.

COMPACTION FACTOR TEST OF CONCRETE

Objective : To determine the workability of the concrete mix of given proportion.
Reference : IS: 1199-1959

Overview :
The compaction factor test is used for concrete which have low workability for which slump test is not suitable. It was developed by Road Research Laboratory in United Kingdom and is used to determine the workability of concrete

Apparatus :
- Compacting factor apparatus, Hand scoop, Weighing balance, etc.

Procedure:
- Fill concrete in the upper hopper and the trap–door is opened so that the concrete falls into the lower hopper.
- When concrete has come to rest in the lower hopper, the trap door of the lower hopper opened and the concrete is allowed to fall into the cylinder.
- The weight of the concrete in the cylinder is measured. This is known as 'the weight of partially compacted concrete.
- Refilled the cylinder with concrete and vibrated to obtain full compaction and weight it

Technical Discussion:
- Compaction Factor $= \dfrac{\text{Weights of partially compacted concrete}}{\text{Weights of fully compacted concrete}}$
- Each test, therefore should be carried out at a constant time interval after the mixing is completed, if strictly comparable results are to be obtained.

Workability	Compaction Factor
Very stiff	0.70
Stiff	0.75
Stiff plastic	0.85
Plastic	0.90
Flowing	0.95

Compacting factor Apparatus

Major Equipments List

S.No	Name of the Experiment	Name of the Equipment
1	Slump, Compaction factor and Vee-Bee time tests on concrete.	Slump cone Apparatus, Compaction Factor Apparatus & Vee-Bee Consistometer with vibrating table
2	Compressive strength of concrete.	Compressive testing machine
3	Split tensile strength of concrete	Compressive testing machine
4	Non destructive tests on concrete (any two)	Rebound Hammer

Do’s and Don’ts

1. **DO’S**
2. Prior permission do not enter into the Laboratory.
3. While entering into the LAB students should wear their ID cards.
4. The student should come with proper uniform.
5. Student should sign.in the LOGIN REGISTER before entering into the laboratory.
6. Students should come with observation and record to the laboratory
7. Student should maintain silence inside the laboratory.
8. After completing the laboratory
9. Without exercise, make sure to shut down the system properly.

DONT’S

1. Students bringing the bags inside the laboratory.
2. Student using the computer improperly.
3. Students scribbling on the desk and mishandling the chairs.
4. Student using the mobile phone inside the laboratory.
5. Student making noise inside the laboratory.

Safety Measures in the Laboratory

Fire Extinguishers

First Aid Box

Miniature Circuit Breaker's (MCB's).

CC Camera surveillance