S/NO	NAME OF EXPERIMENT	DATE OF PERFORM	DATE OF SUBMISSION	SIGN
1.	Determine Grading of Aggregate and finenessmodulus a. Fine aggregate. b. Coarse aggregate.			
2.	Determine Bulking of sand.			
3.	Determine Water absorption of bricks.			
4.	Determine Compressive strength of bricks.			
5.	Determine fineness of cement.			
6.	Perform consistency test of cement.			
7.	Determine initial and final setting time of cement			
8.	Determine Tensile strength of cement mortar.			
9.	Determine compressive strength of cement cube.			
10.	Determine soundness of cement.			

Experiment-01

<u>OBJECTIVE:</u> To study the particle size distribution of coarse and fine aggregate anddetermine its fineness modulus.

<u>APPARATUS REQUIRED:</u> IS sieves, weighing balance, sieve shaker, trays.

<u>THEORETICAL BACKGROUND:</u>

Aggregates are broadly classified as coarse and fine aggregates based on their particle sizes. As per Indian standards, particles retaining on 4.75mm sieves are considered coarse, and finer particles are classified as fine aggregates. Sieve sizes recommended by Indian standards are the following:

1. **Coarse aggregate:** Square hole, perforated plate type80, 63, 50, 40, 31.5, 25, 16, 12.5, 10, 6.3, 4.75mm
2. **Fine aggregate:** Fine mesh, wire cloth type3.35, 2.36, 1.18mm, 600, 300, 150, 75micron

The need to determine the aggregate size properties arise from the fact that the concrete mix should have least voids for higher strength and durability. Additionally, the concrete mix should have good workability requiring least work for mixing and compacting, meanwhile not segregating during transportation, or placing. With the particle size distribution known, it can be compared to the values recommended by Indian standards and the suitability of aggregates for use can be determined.

Sands (fine aggregates) are generally obtained from rivers, land quarrying or crushing larger aggregates. Such variation in source leads to variation in particle size distribution. IS 2386 has, therefore, divided fine aggregates into 4 zones. The zone of sand can be determined and necessary steps during design mixing can be taken up.

The size distribution is indicated by the Fineness Modulus of the given aggregate. It is calculatedby finding the sum of cumulative percentages of aggregate retained on each sieve and dividing the sum by 100.

<u>PROCEDURE:</u>

As per IS: 2368 (Part-1) – 1963

(a) <u>For Coarse Aggregate</u>

- Take 5kg of coarse aggregate sample.
- Arrange the sieves in decreasing order of size from the top. Place the pan belowthe smallest sieve.
- Place the sample on the top sieve and close it. Shake the sieve for 20-30 minutesin a sieve shaker.
- Weigh the amount of material retained in each sieve, including the pan.

(b) For Fine Aggregate

Take 2kg of sample and repeat the steps as performed for coarse aggregate, but with the recommended sieves for fine aggregates. Note the weight of material in each sieve and find the cumulative percent retained. From the cumulative percent retained, calculate the fineness modulus for coarse and fine aggregates.

OBSERVATION TABLE:

(a) Fine aggregates

S.no.	Sieve Size	Wt. retained (kg)	Wt. retained (%)	Cum. wt. retained (%)	Wt. passing (%)
1	4.75mm				
2	2.36mm				
3	1.18mm				
4	600µ				
5	300µ				
6	150µ				
7	PAN				

SUM=

Coarse aggregates (10mm)

S.no.	Sieve Size (mm)	Wt. retained (kg)	Wt. retained (%)	Cum. wt. retained (%)	Wt. passing (%)
1	12				
2	10				
3	4.75				
4	2.36				
9	PAN				
			SUM (∑W)		

FORMULA:

Fineness modulus (both for CA and FA) = (∑W)/100

=

RESULT:

a.Coarse Aggregate=

b.Fine Aggregate=

EXPERIMENT-2

Determine Bulking of sand.

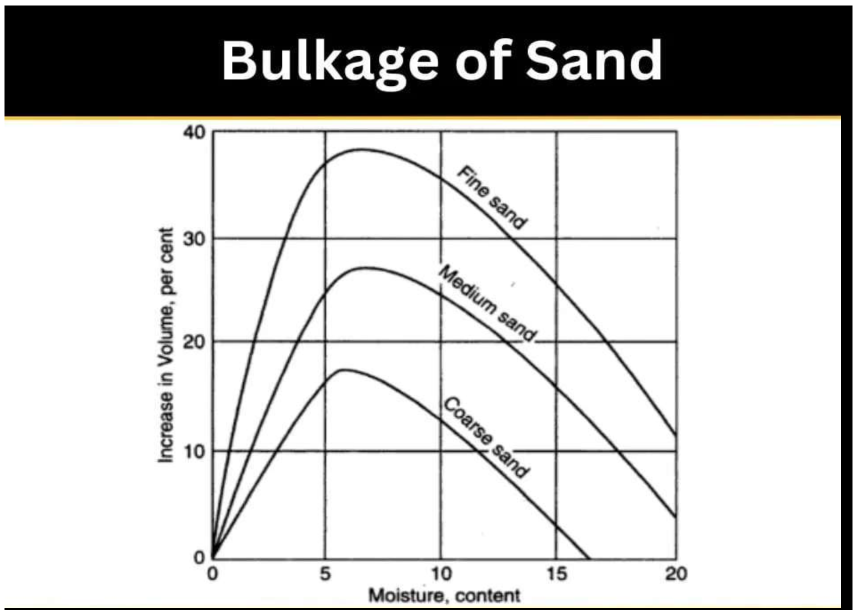
THEORY:

When there is a rise in the moisture content in the sand, it increases the volume of the sand. This process is known as the **Buckling of sand**. The cause for buckling is that moisture present makes the film of water over the surface of sand particles, leading to the rise in the volume of the sand.

If the moisture content is 5 to 8 percent, volume will rise by **20 to 40 percent**.

For finer sand = High increase in volume

For coarse sand = Less increase in volume



Required apparatus: The following apparatus are required for determining the bulkage of sand:

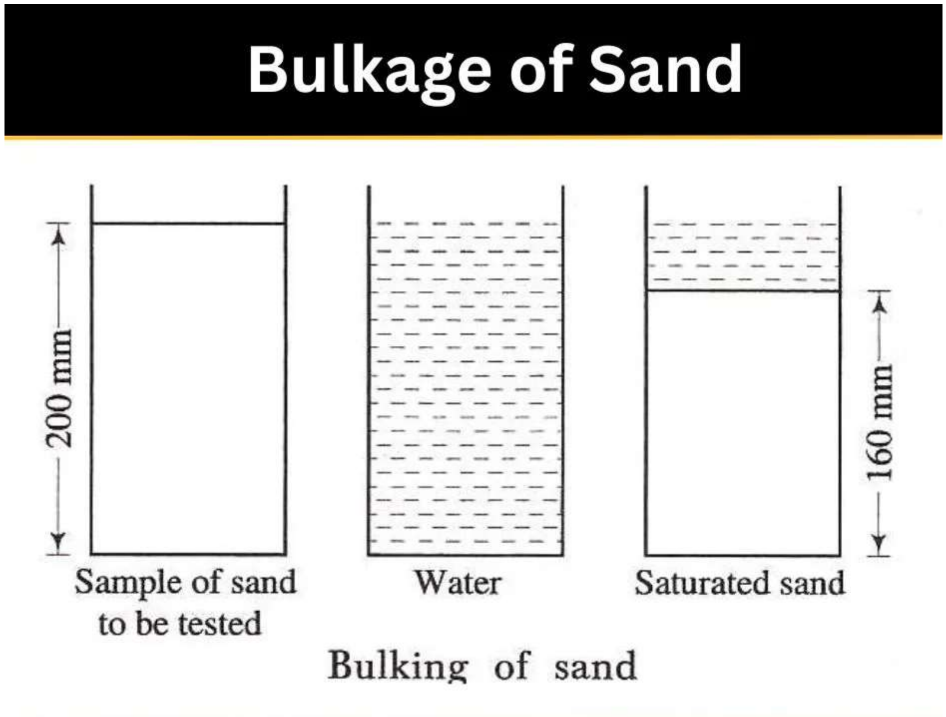
a. Measuring Cylinder
b. Container
c. Steel Rule
d. Steel Rod (6mm Dia)
e. Sample sand

Procedure:

To determine the percentage of bulking of sand, the following steps are carried out.

1. A standard container is used, and it is filled with (2/3)rd of the sand to be tested.
2. The height of sand in a container is measured (H), for example, 200 mm.
3. Now, the sand is removed from the container. More care should be taken to see that no remains of sand should be there in the container during this migration.
4. The identical container is filled with water, say 100ml.
5. Put the **sand** into the container filled with water and slightly move to the sand with a rod.

6. Again, a container's height of fully saturated sand (Y) is measured, say 160 mm.
Bulking of sand is determined through this calculation, = (200-160)/160 = 40/160 = 1/4 (or) 25%



CALCULATION:

Bulking of Sand= {(H-Y)/Y} x 100%

Where,

The height of Unsaturated Sand in a container = **H**

The height of fully Saturated Sand in a container = **Y**

RESULT:

EXPERIMENT-03

Determine Water absorption of bricks.

APPARTUS:

a) Dry bricks
b) Weighing machine

MATERIAL REQUIRED: Bricks.

THEORY: Brick for external use must be capable of preventing rainwater from passing through them to the inside of walls of reasonable thickness. A good brick should aborb water maximum1/7th of the weight of the brick.

PROCEDURE

(a) 20 bricks are taken randomly from a stack.
(b) The bricks are put in an oven at a temperature of 105c for drying.
(c) Bricks are weighed in a digital weighing machine and is record as W1.
(d) The bricks are immersed in water at room temperature for 24 hours.
(e) After 24 hours immersion, the bricks are taken out of water and wiped with adamp cloth for 3minutes.
(f) The bricks are weight again and recorded as W2.
(g) Calculate water absorption of brick.

OBSERVATION

Sl No	Weight W1(Kg)	Weight W2 (Kg)	Water absorption in %	Remarks
1				
2				
3				

RESULT:

Water absorption in % is calculated as...............................

EXPERIMENT-4

Determine Compressive strength of bricks.

APPARATUS: Compressive strength testing machine

MATERIAL REQUIRED: Bricks, Water, Sand, Cement, Trowel

THEORY: Bricks are mostly subjected to compression and tension. The usual crushing strength of common hand molded well burnt bricks is about 5 to 10 N/mm2 (50 to 100/kg/cm2) varying according to the nature of preparation of the clay. Pressed and machine molded bricks made of thoroughly pugged clay are stronger than common hand molded bricks from carelessly preparedclay.

PROCEDURE:

1. Eight bricks are taken for the compressive strength testing.
2. The bricks are then immersed in water at room temperature for 24 hours.
3. Then these are taken out of water and surplus water on the surfaces is wiped off witha moist cloth.
4. The frog of the bricks is flushed level with cement mortar (1:3)
5. The bricks are stored under damp jute bags for 24 hours followed by its immersion inwater at room temperature for three days.
6. The bricks are placed in the compression testing machine with flat faceshorizontal and mortar filled face being upwards.
7. Load is applied at a uniform rate of 14 N/ m^2 per minute till failure.

OBSERVATION:

S/No	Load at Failure (N)	Average area of back faces (mm^2)	Compressive Strength. (N/mm^2)	Remarks
1				
2				
3				
4				
5				

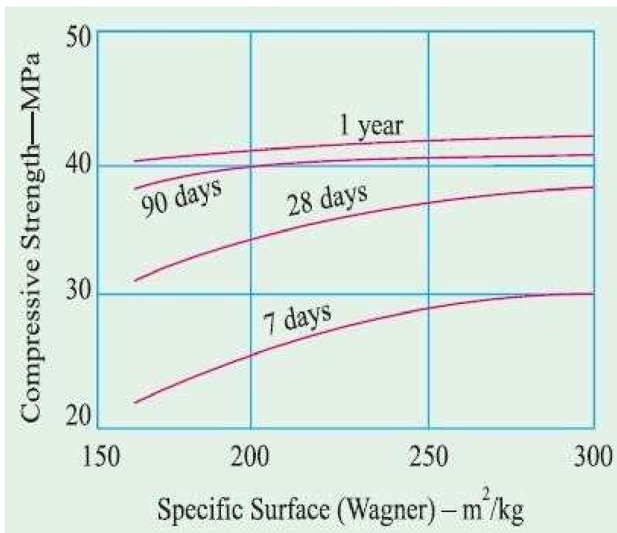
RESULT: Average strength of bricks...........................

EXPERIMENT-05

Determine fineness of cement.

REFERENCE: IS: 4031 (Part 1) – 1988

THEORY: The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and on the rate of evolution of heat. Finer cement offers a greatersurface area for hydration and hence faster the development of strength, (Fig. 3). The fineness of grinding has increased over the years. But now it has nearly stabilized. Different cements are ground to different fineness. The particle size fraction below 3 microns has been found to have the predominant effect on the strength at one day while 3–25-micron fraction has a major influence on the 28 days strength. Increase in fineness of cement is also found to increase the drying shrinkage of concrete.



Fineness of cement is tested in two ways:

(a) By sieving.

(b) By determination of specific surface (total surface area of all the particles in one gram of cement) by air-permeability apparatus. Expressed as cm^2/gm or m^2/kg. Generally, Blaine Air permeability apparatus is used.

APPARATUS: Test Sieve 90 microns, Balance, Gauging Trowel, Brush, etc.

PROCEDURE:

1. Fit the tray under the sieve, weigh approximately 10 g of cement to the nearest 0.01 g and place it on the sieve, being careful to avoid loss. Fit the lid over the sieve. Agitate the

sieve by swirling, planetary and linear movement until no more fine material passes through it.

2. Remove and weigh the residue. Express its mass as a percentage, R1, of the quantity first placed in the sieve to the nearest 0.1 percent. Gently brush all the fine material off the base of the sieve into the tray.
3. Repeat the whole procedure using a fresh 10 g sample to obtain R2. Then calculate the residue of the cement R as the mean of R1, and R2, as a percentage, expressed to the nearest 0.1 percent.
4. When the results differ by more than 1 percent absolute, carry out a third sieving and calculate the mean of the three values.

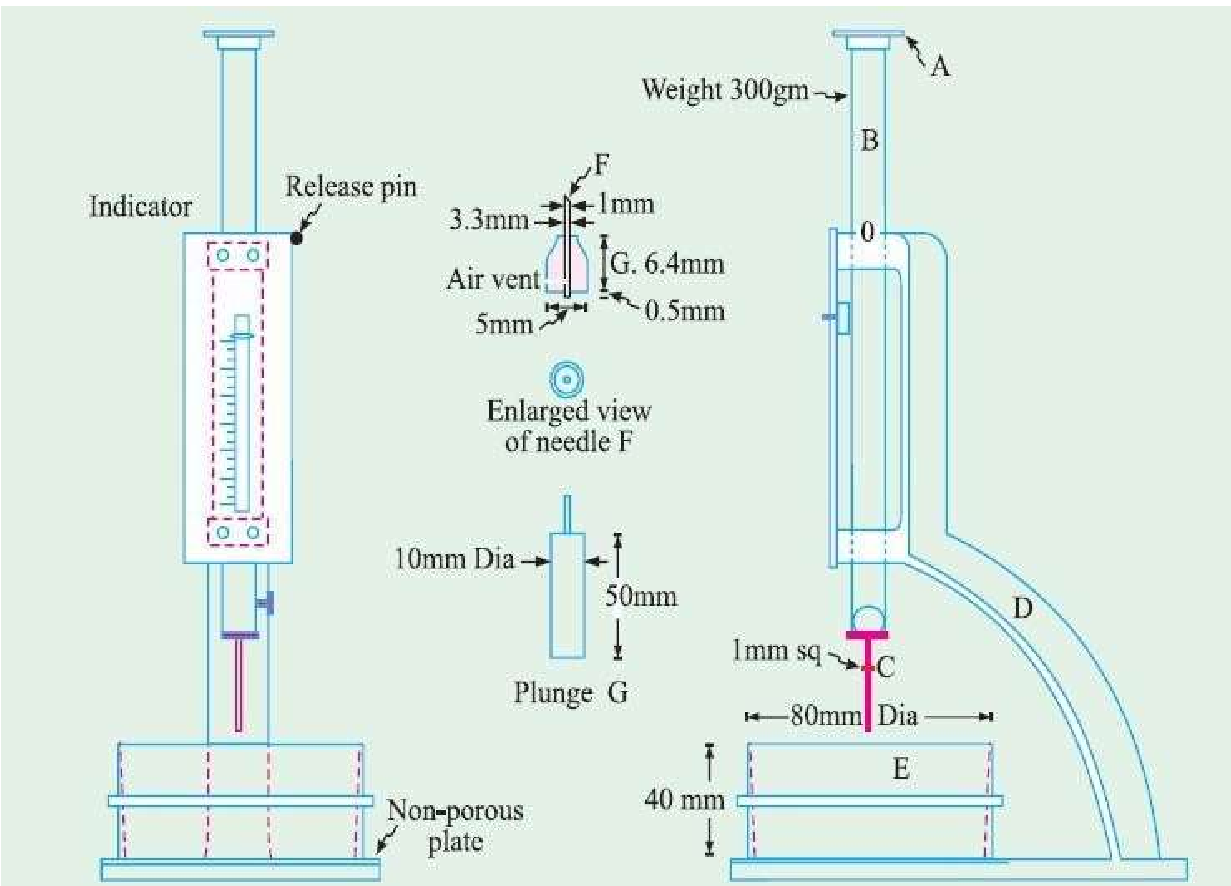
RESULT: The fineness of a given sample of cement is ____________________%

EXPERIMENT-6

Perform consistency test of cement.

REFERENCE: IS: 4031 (Part 4) - 1988, IS: 5513-1976

THEORY: For finding out initial setting time, final setting time and soundness of cement, and strength a parameter known as standard consistency must be used. The standard consistency ofa cement paste is defined as that consistency which will permit a Vicat plunger having 10 mm diameter and 50 mm length to penetrate to a depth of 33-35 mm from the top of the mould.



APPARATUS: Vicat apparatus conforming to IS: 5513-1976, Balance, Gauging Trowel, Stopwatch.

PROCEDURE:

The standard consistency of a cement paste is defined as that consistency which will permitthe Vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould.

1. Initially a cement sample of about 300 g is taken in a tray and is mixed with a known percentage of water by weight of cement, say starting from 26% and then it is increased by every 2% until the normal consistency is achieved.
2. Prepare a paste of 300 g of Cement with a weighed quantity of potable or distilled water, taking care that the time of gauging is not less than 3 minutes, nor more than 5 min, and the gauging shall be completed before any sign of setting occurs. The gauging time shall be counted from the time of adding water to the dry cement until commencing to fill the mould.
3. Fill the Vicat mould (E) with this paste, the mould resting upon a non-porous plate. 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 to expel the air.
4. Place the test block in the mould, together with the non-porous resting plate, under the rod bearing the plunger; lower the plunger gently to touch the surface of the test block, and quickly release, allowing it to sink into the paste. This operation shall be carried out.
   immediately after filling the mould.
5. Prepare trial pastes with varying percentages of water and test as described above until theamount of water necessary for making up the standard consistency as defined in Step 1 is found.

OBSERVATION: Express the amount of water as a percentage by mass of the dry cement to the firstplace of decimal.

Sl. No.	Weight of cement (gm)	Percentage by weight of dry Cement (%)	Amount of water added (ml)	Penetration (mm)
1				
2				
3				
4				

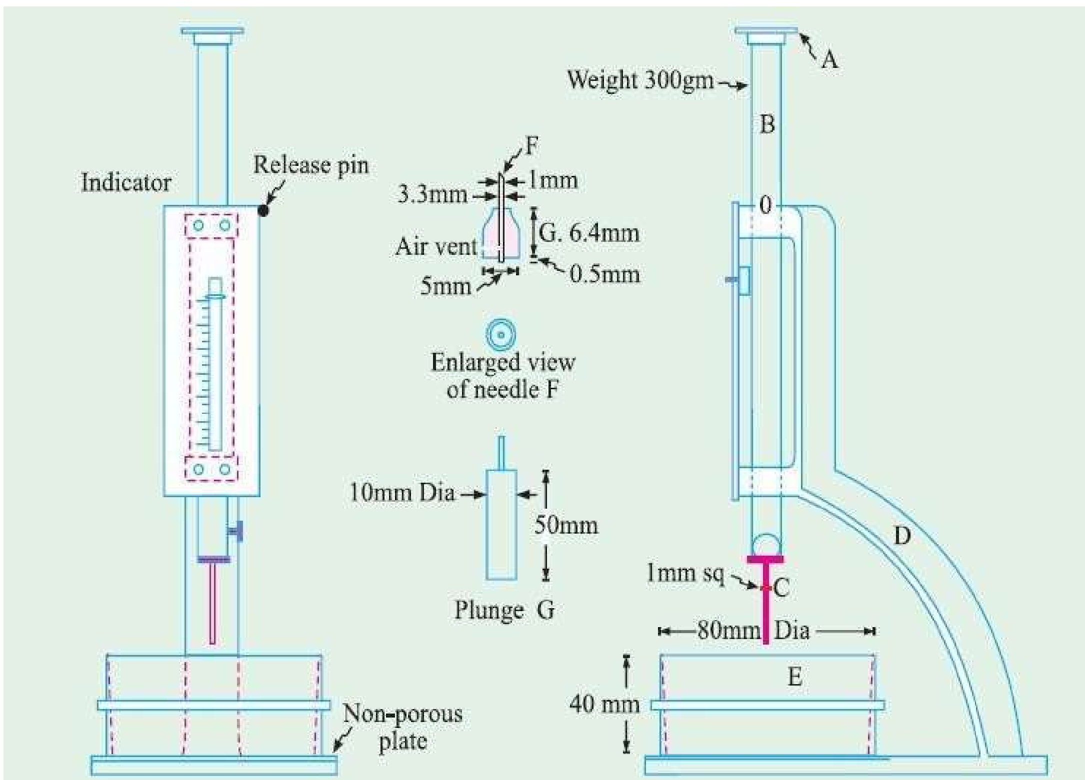
RESULT: The normal consistency of a given sample of cement is ______________ %

EXPERIMENT 7

Determine initial and final setting time of cement.

Reference: IS: 4031 (Part 4) - 1988, IS: 4031 (Part 5) – 1988, IS: 5513-1976

Theory: For convenience, initial setting time is regarded as the time elapsed between themoments that the water is added to the cement, to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment the water is added to thecement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain definite pressure.



Apparatus: Vicat apparatus conforming to IS: 5513-1976, Balance, Gauging Trowel, STOPWATCH.

PROCEDURE:

1. **Preparation of Test Block -** Prepare a neat 300 gms cement paste by gauging the cement with 0.85 times the water required to give a paste of standard consistency. Potable or distilled water shall be used in preparing the paste.

2. Start a stopwatch at the instant when water is added to the cement. Fill the Vicat mould with a cement paste gauged as above, the mould resting on a nonporous plate. Fill the mould completely and smooth off the surface of the paste making it level with the top of the mould.
3. Immediately after moulding, place the test block in the moist closet or moist room and allowit to remain there except when determinations of time of setting are being made.
4. **Determination of Initial Setting Time** - Place the test block confined in the mould and resting on the non-porous plate, under the rod bearing the needle (C); lower the needle gently until it meets the surface of the test block and quickly release, allowing it to penetrate into the test block.
5. Repeat this procedure until the needle, when brought in contact with the test block and released as described above, fails to pierce the block beyond 5.0 ± 0.5 mm measured from the bottom of the mould shall be the initial setting time.
6. **Determination of Final Setting Time -** Replace the needle (C) of the Vicat apparatus with the needle with an annular attachment (F).
7. The cement shall be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression thereon, while the attachment fails to do so.
8. The period elapsing between the time when water is added to the cement and the time at which the needle makes an impression on the surface of test block while the attachment failsto do so shall be the final setting time.

OBSERVATION:

1. Weight of given sample of cement is___________ gms
2. The normal consistency of a given sample of cement is ___________%
3. Volume of water addend (0.85 times the water required to give a paste of standard consistency) for preparation of test block _________ ml

Sr. No.	Setting Time (Sec)	Penetration (mm)	Remark
1			
2			
3			

RESULT i) The initial setting time of the cement sample is found to be ……

ii) The final setting time of the cement sample is found to be …..

EXPERIMENT 8

Determine Tensile strength of cement mortar.

THEORY:

Splitting tensile strength is generally greater than the direct tensile strength and lower than the flexural strength (modulus of rupture). Splitting tensile strength is used in the design of structural light weight concrete members to evaluate the shear resistance provided by concrete and to determine the development length of the reinforcement.

This test method consists of applying a diametrical force along the length of a cylindrical concrete at a rate that is within a prescribed range until failure. This loading induces tensile stresses on the plane containing the applied load and relatively high compressive stresses in the area immediately around the applied load. Although we are applying a compressive load but due to Poisson's effect, tension is produced, and the specimen fails in tension. Tensile failure occurs rather than compressive failure because the areas of load application are in a state of triaxial compression, thereby allowing them to withstand much higher compressive stresses than would be indicated by a uniaxial compressive strength test result. Thin, bearing strips are used to distribute the load applied along the length of the cylinder. The maximum load sustained by the specimen is divided by appropriate geometrical factors to obtain the splitting tensile strength.

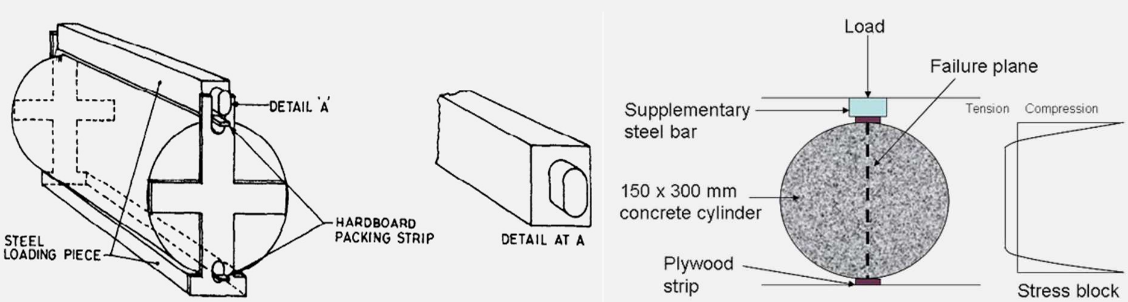


Figure 10: Arrangement for loading of splitting tensile test specimen.

REFERENCE: IS: 5816 - 1999, IS: 1199-1959, SP: 23-1982, IS: 10086-1982.

APPARATUS: Cylindrical mould confirming to IS: 10086-1982 for splitting tensile strength,tamping rod, metallic sheet, universal testing machine.

MATERIAL: Cement, sand, aggregate and water, grease

PROCEDURE:

1. Sampling of Materials: Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material.

2. Proportioning: The proportions of the materials, including water, in concrete mixes used for determining the suitability of the materials available, shall be similar in all respects to those to be employed in the work

3. Weighing: The quantities of cement, each size of aggregate, and water for eachbatch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.

4. Mixing of concrete: The concrete shall be mixed by hand, or preferably, in a laboratory batch mixer, in such a manner as to avoid loss of water or other materials. Each batch of concrete shall be of such a size as to leave about 10 percent excess after moulding the desired number of test specimens.

5. Mould: The cylindrical mould shall be of 150 mm diameter and 300 mm height conforming to IS: 10086-1982.

6. Compacting: The test specimens shall be made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance.

7. Curing: The test specimens shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27° ± 2°C for 24 hours ± ½ hour from the time of addition of water to the dry ingredients.

8. Placing the specimen in the testing machine: The bearing surfaces of thesupporting and loading rollers shall be wiped clean, and any loose sand orother material removed from the surfaces of the specimen where they are to contact the rollers.

9. Two bearings strips of nominal (1/8 in *i.e* 3.175mm) thick plywood, free of imperfections, approximately (25mm) wide, and of length equal to or slightly longer than that of the specimen should be provided for each specimen.

10. The bearing strips are placed between the specimen and both upper and lower bearing blocks of the testing machine or between the specimen and the supplemental bars or plates.

11. Draw diametric lines and each end of the specimen using a suitable device that will ensure that they are in the same axial plane. Canter one of the plywood strips along the center of the lower bearing block.

12. Place the specimen on the plywood strip and align so that the lines marked on the ends of the specimen are vertical and centered over the plywood strip.

13. Place a second plywood strip lengthwise on the cylinder, centered on the lines marked on the ends of the cylinder. Apply the load continuously and without shock, at a constant rate within, the range of 689 to 1380 kPa/min splitting tensile stress until failure of the specimen.

14. Record the maximum applied load indicated by the testing machine at failure. Note the type of failure and appearance of fracture.

OBSERVATION

- Length of Specimen (*l*) :________mm
- diameter of the specimen (*d*) :________mm

Sl. No.	Age of specimen	Maximum load (P) in N	Spitting tensile strength in MPa ($T = 2P/\pi ld$)	Average spitting tensile strength (MPa)
	7 days			
	28 days			

RESULTS:

- The average 7 days tensile strength of concrete sample is :________MPa
- The average 28 days tensile strength of concrete sample is :_______MPa

EXPERIMENT-9

To determine the compressive strength of concrete cubes.

THEORY:

Concrete mix design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workabilityas economically as possible, is termed as concrete mix design. Concrete mix design is done in accordance with IS:10262-2009.

Compressive Strength of Concrete

The compressive strength of concrete is the utmost important and useful property of concrete. When a uniaxial load is applied upon a concrete specimen, it not only exhibits compressive strains in the direction of load, it would also exhibit some expansion in lateral directions due to Poisson's effect, as manifested by the introduction of lateral tensile strains. The measured compressive strength decreases with increase in height/lateral dimension ratio and is approximately equal to the uniaxial compressive strength of concrete for values of this ratioequal to or greater than 2. For standard cylinders this ratio is two and as such concrete cylinder strengths is only about 0.75-0.80 times the cube strength whose height/lateral dimension ratio is one.

Cylinder Strength = 0.8 Cube strength

PROCEDURE: **As per IS: 516-1959**

- The concrete mix is prepared by mixing the ingredients in the proportion as given belowin the table.
- Mix the concrete in a laboratory batch mixer.
- Clean the mounds and apply oil.
- Fill the concrete in the molds in layers approximately 5cm thick.
- Level the top surface and smoothen it with a trowel.
- The test specimens are stored in moist air for 24hours and after this period the specimens are marked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.
- The specimen from water after specified curing time and wipe out excess water from the surface.
- Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
- Align the specimen centrally on the base plate of the machine.
- Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
- Apply the load gradually without shock and continuously till the specimen fails.
- Record the maximum load and note any unusual features in the type of failure.

OBSERVATIONS:

Test Specimen Properties

Description	Cubes
Dimensions (in mm)	150 X 150 X 150
Loading Rate	140 $kg/cm^2/min.$

Mix Design:

	Water	Cement	Sand	10mm	20mm
Ratio by weights	**0.45**	**1**	**1.5**	**1.2**	**1.8**
Weights					

Sample Type	Sample No.	Strength (MPa)		Average Comp Str.	
		at 7 days	at 28 days	at 7 days	at 28 days
Mix 1	1				
	2				
	3				

RESULTS:

EXPERIMENT-10

Determine soundness of cement.

Theory: The ability of cement to maintain a constant volume is known as the soundness of the cement. It is essential that the cement concrete shall not undergo appreciable change in volume after setting. Unsoundness produces cracks, distortion, and disintegration there by giving passage to water and atmospheric gases which may have injurious effects on concrete and reinforcement. The soundness of cement is ensured by limiting the quantities of free lime, magnesia and sulphates as these compounds undergo a large change in volume.

Unsoundness in cement does not come to surface for a considerable period. Thus, this test is designed to accelerate the hydration of free lime by the application of heat thus discovering the defects in a short time. Further, to minimize the shrinkage of cement paste, the test setup is kept immersed in water bath.

This test is carried out with the help of "Le Chatelier's apparatus" which consists of asmall split cylinder of spring brass or other suitable metal of 0.5mm thickness forming a mould 30 mm internal diameter and 30mm high (Figure 2). On either side of the split mould are attached to indicators with pointed ends, the distance from these ends to the center of the cylinder being 165 mm. The mould shall be kept in good condition with the jaws not more than 50mm apart.

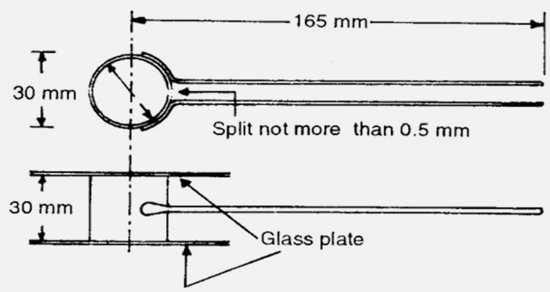


Figure 2: Le- Chatelier apparatus

REFERENCE: IS 4031 (Part-3):1988.

APPARATUS: Le-Chatelier apparatus conforming to IS: 5514-1969; Measuring cylinder;Gauging trowel; Balance; Water bath.

MATERIAL: Ordinary Portland cement; Water; Grease

PROCEDURE:

1. Weigh accurately 100 g of cement to the nearest 0.15 g and add to it 0.78times the water required to give a paste of standard consistency (i.e. 0.78×P).
2. Place the lightly greased mould on a lightly greased glass sheet and fill it withcement paste, taking care to keep the edges of the mould gently together.

3.Cover the mould with another piece of lightly grease glass sheet, place a small weight on this covering glass sheet and immediately submerge the whole assembly in water at a temperature of $27 \pm 2^0\ C$.

4.Keep this assembly under water for 24 hrs. After this, take the mould out of water and measure the distance between two indicators. Submerge the mould again in the water.

5.Bring the water to boiling with the mould kept submerged and keep it boiling for 25 to 30 minutes.

6.Remove the mould from the water allow it to cool and measure the distance between the indicator points.

7.The difference between these two measurements represents the expansion of the cement.

8.Repeat the whole procedures two more times each using fresh 100 g sample.

OBSERVATIONS:

Samples:	
Distance between pointers before boiling (D_1) in mm	
Distance between pointers after boiling (D_2) in mm	
Expansion of the cement = E_1 = (D_2- D_1) in mm	
Average expansion of the cement in mm	

RESULT:

Average expansion of the cement obtained is ____________mm.

CONCULSION:

Average expansion of the cement as per Le- Chatelier test is less than/ more than 10 mm.Therefore, the given sample of cement is found to be sound/ unsound as per IS code.