CONCRETE LABORATORY EXPERIMENTS

1. **FINENESS OF CEMENT**
2. **NORMAL CONSISTENCY OF CEMENT**
3. **INITIAL AND FINAL SETTING TIMES OF CEMENT**
4. **SPECIFIC GRAVITY OF CEMENT**
5. **COMPRESSIVE STRENGTH OF CEMENT**
6. **SOUNDNESS OF CEMENT**
7. **FINENESS MODULUS OF FINE AND COARSE AGGREGATE**
8. **SPECIFIC GRAVITY, VOID RATIO, POROSITY AND BULK DENSITY OF COARSE AND FINE AGGREGATES**
9. **BULKING OF SAND**
10. **WORKABILITY TESTS ON FRESH CONCRETE**
11. **COMPACTION FACTOR TEST**
12. **TEST FOR COMPRESSIVE STRENGTH OF CEMENT CONCRETE**

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FINENESS OF CEMENT

(IS: 269-1989 and IS: 4031-1988)

AIM: To determine the fineness of the given sample of cement by sieving.

APPARATUS: IS-90 micron sieve conforming to IS:460-1965, standard balance, weights, brush.

INTRODUCTION: The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and also on the rate of evolution of heat. Finer cement offers a greater surface area for hydration and hence the faster and greater the development of strength. Increase in fineness of cement is also found to increase the drying shrinkage of concrete. Fineness of cement is tested either by sieving or by determination of specific surface by air-permeability apparatus. Specific surface is the total surface area of all the particles in one gram of cement.

FINENESS BY SIEVING:
PROCEDURE:

1. Weigh accurately 100 g of cement and place it on a standard 90 micron IS sieve.
2. Break down any air-set lumps in the cement sample with fingers.
3. Continuously sieve the sample giving circular and vertical motion for a period of 15 minutes.
4. Weigh the residue left on the sieve. As per IS code the percentage residue should not exceed 10%.

PRECAUTIONS: Air set lumps in the cement sample are to be crushed using fingers and not to be pressed with the sieve. Sieving shall be done holding the sieve in both hands and with gentle wrist motion. More or less continuous rotation of the sieve shall be carried out throughout sieving.

OBSERVATIONS:

S.No	weight of sample taken(g)	weight of residue(g)	Fineness (%)

Average fineness of cement =

RESULT: Fineness of given sample of cement =

COMMENTS:

NORMAL CONSISTENCY OF CEMENT

(IS: 269 - 1989 and IS: 4031 - 1988 (Part 4))

AIM: To determine the quantity of water required to produce a cement paste of standard consistency.

APPARATUS: Vicat apparatus (conforming to IS: 5513 - 1976) with plunger (10 mm in diameter) balance, weights, gauging trowel.

INTRODUCTION: The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the vicat mould. For finding out initial setting time, final setting time, soundness of cement and compressive strength of cement, it is necessary to fix the quantity of water to be mixed in cement in each case. This experiment is intended to find out the quantity of water to be mixed for a given cement to give a cement paste of normal consistency and can be done with the help of vicat apparatus.

PROCEDURE:

1. Prepare a paste of weighed quantity of cement (300 grams) with a weighed quantity of potable or distilled water, starting with 26% water of 300g of cement.
2. Take care that the time of gauging is not less than 3 minutes, not more than 5 minutes and the gauging shall be completed before setting occurs.
3. The gauging time shall be counted from the time of adding the water to the dry cement until commencing to fill the mould.
4. Fill the vicat mould with this paste, the mould resting upon a non porous plate.
5. After completely filling the mould, trim off the surface of the paste, making it in level with the top of the mould. The mould may slightly be shaken to expel the air.
6. Place the test block with the mould, together with the non-porous resting plate, under the rod bearing the plunger (10mm diameter), lower the plunger gently to touch the surface of the test block and quickly release, allowing it to penetrate into the paste.
7. This operation shall be carried out immediately after filling the mould.
8. Prepare trial pastes with varying percentages of water and test as described above until the amount of water necessary for making the standard consistency as defined above is obtained.
9. Express the amount of water as a percentage by weight of the dry cement.

PRECAUTIONS: Clean appliances shall be used for gauging. In filling the mould the operator hands and the blade of the gauging trowel shall alone be used. The temperature of cement, water and that of test room, at the time when the above operations are being performed, shall be 27 + 2 C. For each repetition of the experiment fresh cement is to be taken.

OBSERVATIONS:

S. No	Weight of cement taken in gms (a)	Weight of water taken in gms (b)	Plunger penetration (mm)	Time Taken	Consistency of cement in % by weight b/a * 100

RESULT: Normal consistency for the given sample of cement is

COMMENTS:

INITIAL AND FINAL SETTING TIMES OF CEMENT

(IS: 269- 1989 and IS: 4031- 1988 part 5)

AIM: To determine the initial and final setting times for the given sample of cement.

APPARATUS: Vicat apparatus (conforming to IS: 5513-1976) with attachments, balance, weights, gauging trowel.

INTRODUCTION: In actual construction dealing with cement, mortar or concrete, certain time is required for mixing, transporting and placing. During this time cement paste, mortar, or concrete should be in plastic condition. The time interval for which the cement products remain in plastic condition is known as the setting time. Initial setting time is regarded as the time elapsed between the moment 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 the cement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain pressure. The constituents and fineness of cement is maintained in such a way that the concrete remains in plastic condition for certain minimum time. Once the concrete is placed in the final position, compacted and finished it should lose its plasticity in the earliest possible time so that it is least vulnerable to damages from external destructive agencies. This time should not be more than 10 hours which is referred to as final setting time. Initial setting time should not be less than 30 minutes.

PROCEDURE:

Preparation of Test Block:

1. Prepare a neat cement paste by gauging 300 grams of cement with 0.85 times the water required to give a paste of standard consistency.
2. Potable or distilled water shall be used in preparing the paste.
3. The paste shall be gauged in the manner and under the conditions prescribed in determination of consistency of standard cement paste.
4. Start a stop-watch at the instant when water is added to the cement.
5. Fill the mould with the cement paste gauged as above the mould resting on a nonporous plate.
6. Fill the mould completely and smooth off the surface of the paste making it level with the top of the mould. The cement block thus prepared in the mould is the test block.

DETERMINATION OF INITIAL SETTING TIME:

1. Place the test blocks confined in the mould and rest it on the non-porous plate, under the rod bearing initial setting needle, lower the needle gently in contact with the surface of the test block and quickly release, allowing it to penetrate into the test block.
2. In the beginning, the needle will completely pierce the test block.
3. Repeat this procedure until the needle, when brought in contact with the test block and released as described above, fails to pierce the block to a point 5 to 7 mm measured from the bottom of the mould shall be the initial setting time.

DETERMINATION OF FINAL SETTING TIME:

1. Replace the needle of the Vicat apparatus by the needle with an annular attachment.
2. 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 there on, while the attachment fails to do so.
3. The period elapsed 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 fails to do so shall be the final setting time.

PRECAUTIONS: Clean appliances shall be used for gauging. All the apparatus shall be free from vibration during the test. The temperature of water and that of the test room, at the time of gauging shall be 27 ^{0}C $\pm$ 2^0 C. Care shall be taken to keep the needle straight.

OBSERVATIONS:

Time in minutes :	
Height in mm fails to penetrate	

RESULT: Initial setting time for the given sample of cement =
Final setting time for the given sample of cement =

COMMENTS:

SPECIFIC GRAVITY OF CEMENT
(IS: 269 -1989 AND IS: 4031-1988)

AIM: To determine the specific gravity of given sample of hydraulic cement.

APPARATUS: Physical balance, specific gravity bottle of 50ml capacity, clean kerosene.

INTRODUCTION: Specific gravity is defined as the ratio between weight of a given volume of material and weight of an equal volume of water. To determine the specific gravity of cement, kerosene is used which does not react with cement.

PROCEDURE:

1. Clean and dry the specific gravity bottle and weigh it with the stopper (W1).
2. Fill the specific gravity bottle with cement sample at least half of the bottle and weigh with stopper (W2).
3. Fill the specific gravity bottle containing the cement, with kerosene (free of water) placing the stopper and weigh it (W3).
4. While doing the above do not allow any air bubbles to remain in the specific gravity bottle.
5. After weighing the bottle, the bottle shall be cleaned and dried again.
6. Then fill it with fresh kerosene and weigh it with stopper (W4).
7. Remove the kerosene from the bottle and fill it with full of water and weigh it with stopper (W5).
8. All the above weighing should be done at the room temperature of 27c $\pm$ 1^0c.

OBSERVATIONS:

Description of item		**Trial 1**	**Trial2**	**Trail3**
Weight of empty bottle	W1 g			
Weight of bottle + Cement	W2 g			
Weight of bottle + Cement + Kerosene	W3 g			
Weight of bottle + Full Kerosene	W4 g			
Weight of bottle + Full Water	W5 g			

Specific gravity of Kerosene Sk = W4 - W1 / W5 - W1

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Specific gravity of Cement Sc = W2 - W1 / ((W4 - W1)-(W3-W2))*Sk

Sc = (W2 - W1)* (W4 - W1) / ((W4 - W1)-(W3-W2))*(W5 - W1)

PRECAUTION:

1. Only kerosene which is free of water shall be used.
2. At time of weighing the temperature of the apparatus will not be allowed to exceed the specified temperature.
3. All air bubbles shall be eliminated in filling the apparatus and inserting the stopper.
4. Weighing shall be done quickly after filling the apparatus and shall be accurate to 0.1 mg.
5. Precautions shall be taken to prevent expansion and overflow of the contents resulting from the heat of the hand when wiping the surface of the apparatus.

RESULT: Average specific gravity of given sample of cement =

COMMENTS:

COMPRESSIVE STRENGTH OF CEMENT

(IS 269-1989, IS 8112-1989, IS 12269 -1987, IS 4031-1988 (Part4) & IS: 4031-1988)

AIM: To determine the compressive strength of standard cement mortar cubes compacted by means of standard vibration machine.

APPARATUS: Vibration machine and cube moulds of size 7.06 cms (Conforming to IS: 4031-1988)

STANDARD SAND: The standard sand to be used in the test shall conform to IS: 650-1991 or sand passing 100 percent through 2 mm sieve and retained 100 percent on 90 micron IS sieve.

2mm to 1mm	33.33 percent
1mm to 500 microns	33.33 percent
500mm to 90 microns	33.33 percent.

INTRODUCTION: The compressive strength of cement mortars is determined in order to verify whether the cement conforms to IS specifications and whether it will be able to develop the required compressive strength of concrete. The average compressive strength of at least three mortar cubes (area of the face 50 cm2) composed of one part of cement and three parts of standard stand should satisfy IS code specifications.

PROCEDURE:

Mix proportions and mixing:

1. Clean appliances shall be used for mixing and the temperature of the water and that of the test room at the time when the above operations are being performed shall be 27 + 2ºC.
2. Place in a container a mixture of cement and standard sand in the proportion of 1:3 by weight mix it dry, with a trowel for one minute and then with water until the mixture is of uniform color.
3. The quantity of water to be used shall be as specified below.
4. In any element, it should not take more than 4 minutes to obtain uniform colored mix.
5. If it exceeds 4 minutes the mixture shall be rejected and the operation repeated with a fresh quantity of cement, sand and water.
6. The material for each cube shall be mixed separately and the quantity of cement standard sand and water shall be as follows:

Cement	200 gms
Standard sand	600 grms
Water	(P/4 + 3.0) percent of combined weight of cement and sand, where p is the percentage of water required to produce a paste of standard consistency.

MOULDING SPECIMENS:

1. In assembling the moulds ready for use, cover the joints between the halves of the mould with a thin film of petroleum jelly and apply a similar coating of petroleum jelly between the contact surfaces of the bottom of the mould and its base plate in order to ensure that no water escapes during vibration.

2. Treat the interior faces of the mould with a thin coating of mould oil.
3. Place the assembled mould on the table of the vibration machine and firmly hold it is position by means of suitable clamps.
4. Securely attach a hopper of suitable size and shape at the top of the mould to facilitate filling and this hopper shall not be removed until completion of the vibration period.
5. Immediately after mixing the mortar, place the mortar in the cube mould and rod with a rod.
6. The mortar shall be rodded 20 times in about 8 seconds to ensure elimination of entrained air and honey combing.
7. Place the remaining quantity of mortar in the hopper of the cube mould and rod again as specified for the first layer and then compact the mortar by vibrations.
8. The period of vibration shall be two minutes at the specified speed of 12,000 + 400 vibrations per minute.
9. At the end of vibration remove the mould together with the base plate from the machine and finish the top surface of the cube in the mould by smoothing surface with the blade of a trowel.

CURING SPECIMEN:

1. Keep the filled moulds at a temperature of $27 + 2^0$ C in an atmosphere of at least 90 % relative humidity for about 24 hours after completion of vibration.
2. At the end of that period remove them from the moulds.
3. Immediately submerge in clean fresh water and keep them under water until testing.
4. The water in which the cubes are submerged shall be renewed every 7 days and shall be maintained at a temperature of $27\ ^0C \pm 2^0C$.
5. After they have been taken out and until they are tested the cubes shall not be allowed to become dry.

TESTING:

1. Test three cubes for compressive strength at the periods mentioned under the relevant specification for different hydraulic cements, the periods being reckoned from the completion of vibration.
2. The compressive strength shall be the average of the strengths of three cubes for each period of curing.
3. The cubes shall be tested on their sides without any packing between the cube and the steel platens of the testing machine.
4. One of the platens shall be carried base and shall be self adjusting and the load shall be steadily and uniformly applied starting from zero at a rate of 350 Kgs/Cm2/ min.

The cubes are tested at the following periods

Ordinary portland cement	3, 7 and 28 days.
Rapid hardening portland cement	1 and 3 days.
Low heat portland cement	3 and 7 days.

CALCULATION:

Calculate the compressive strength from the crushing load and the average area over which the load is applied. Express the results in N/mm2 to the nearest 0.05 mm2.

Compressive strength in N/mm2 = P/A =

Where P is the crushing load in N
and A is the area in mm2 (5000 mm2)

PRECAUTIONS: Inside of the cube moulds should be oiled to prevent the mortar from adhering to the sides of the mould.

RESULT: The average compressive strength of the given cement

at 3 days	N/mm2
at 7 days	N/mm2
at 28 days	N/mm2

COMMENTS:

SOUNDNESS OF CEMENT

(IS 269-1989 AND IS 4031-1988 PART 3)

AIM: To determine the soundness of the given sample of cement by "Le Chatelier" Method.

APPARATUS: Le Chatelier apparatus conforming to IS 5514-1969, Balance, Weights, Water bath.

INTRODUCTION: It is essential that the cement concrete shall not undergo appreciable change in volume after setting. This is ensured by limiting the quantities of free lime, magnesia and sulphates in cement which are the causes of the change in volume known as unsoundness. Unsoundness in cement does not come to surface for a considerable period of time. This test is designed to accelerate the slaking process by the application of heat and discovering the defects in a short time. 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 apparatus for conducting the test consists of small split cylinder of spring brass or other suitable metal of 0.5mm thickness forming a mould 30 mm internal diameter and 30mm high. 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.

PROCEDURE:

1. Place the lightly oiled mould on a lightly oiled glass sheet and fill it with cement paste formed by gauging cement with 0.78 times the water required to give a paste of standard consistency.
2. The paste shall be gauged in the manner and under the conditions prescribed in determination of consistency of standard cement paste, taking care to keep the edges of the mould gently together
3. While this operation is being performed cover the mould with another piece of glass sheet, place a small weight on this covering glass sheet and immediately submerge the whole assembly in water at a temperature of $27^0 - 2^0$ C and keep there for 24 hours.
4. Measure the distance separating the indicator points.
5. Submerge the moulds again in water at the temperature prescribed above.
6. Bring the water to boiling, with the mould kept submerged for 25 to 30 minutes, and keep it boiling for three hours.
7. Remove the mould from the water allow it to cool and measure the distance between the indicator points.
8. The difference between these two measurements represents the expansion of the cement.
9. For good quality cement this expansion should not be more than 10mm.

OBSERVATIONS:

Initial distance between the indicator points in mm =

Final distance between the indicator points in mm =

Expansion in mm = final length - initial length =

RESULT: Expansion in mm

FINENESS MODULUS OF FINE AND COARSE AGGREGATE

AIM: To determine the fineness modulus of given fine and coarse aggregates.

APPARATUS: IS test sieves, square hole perforated plate 75mm, 40mm, 20mm, 10mm, and fine wire cloth of 4800, 2400, 1200, 600, 300, and 150 Microns. Weighing balance (Sensitivity 0.1 percent) sieve shaker, tray plates.

INTRODUCTION: Fine aggregate is sand used in mortars. Coarse aggregate is broken stone used in concrete. The size of the fine aggregate is limited to maximum 4.75 mm (4800 microns) beyond which it is known as coarse aggregate. Fineness modulus is only a numerical index of fineness, giving some idea about, the mean size of the particles in the entire body of concrete. Determination of fineness modulus is considered as a method of standardization of grading of aggregates i.e. the main object of finding fineness modulus is to grade the given aggregate for the most economical mix and workability with minimum quantity of cement. It is obtained by sieving known weight of given aggregate in a set of standard sieves and by adding the percent weight of material retained on all the sieves and dividing the total percentage by 100.

PROCEDURE:

Coarse aggregate:

1. Take 5Kgs of coarse aggregate (nominal size 20mm) from the sample by quartering.
2. Carry out sieving by hand, shake each sieve in order 75mm ,40mm, 20mm, 10mm, and No's 480, 240, 120, 60, 30, & 15 over a clean dry tray for a period of not less than 2 minutes.
3. The shaking is done with a varied motion backward and forward, left to right, circular, clockwise and anticlockwise and with frequent jarring.
4. So that material is kept moving over the sieve surface in frequently changing directions.
5. Find the weight retained on each sieve taken in order

Fine aggregate:

1. Take 1 Kg of sand from sample by quartering in clean dry plate.
2. Arrange the sieves in order of No. 480, 240, 120, 60, 30 and 15 keeping sieve 480 at top and 15 at bottom.
3. Fix them in the sieve shaking machine with the pan at the bottom and cover at the top.
4. Keep the sand in the top sieve no 480, carry out the sieving in the set of sieves and arranged before for not less than 10 minutes.
5. Find the weight retained in each sieve.

OBSERVATIONS:

Coarse aggregate: Wt. of coarse aggregate taken: Kgs.

S.No	Sieve size	Weight retained	% Weight retained	% weight passing	Cumulative % Weights retained
1.	75 mm				
2.	40 mm				
3.	20 mm				

4.	10 mm				
5.	4800 microns				
6.	2400 microns				
7.	1200 microns				
8.	600 microns				
9.	300 microns				
10.	150 microns				

Fine aggregate: Wt. of fine aggregate taken: Kgs

S.No	Sieve size	Weight retained	% Weight retained	% weight passing	Cumulative % Weights retained
1	4800 microns				
2	2400 microns				
3	1200 microns				
4	600 microns				
5	300 microns				
6	150 microns				

Fineness Modulus: Sum of Cumulative percentage Wt. retained /100

PRECAUTIONS:

1. The sample should be taken by quartering.
2. The sieving must be done carefully to prevent the spilling of aggregate.

RESULT: The fineness modulus of given fine aggregate:
The fineness modulus of given coarse aggregate:

COMMENTS: Limits of fineness modulus of aggregates.

Maximum size of aggregate	Minimum retained	Maximum retained
Fine aggregate	2	3.5
Coarse aggregate		
20 mm	6	6.9
40 mm	6.9	7.5
75 m	7.5	8.0
150 mm	8.0	8.5

SPECIFIC GRAVITY VOID RATIO POROSITY AND BULK DENSITY OF COARSE AND FINE AGGREGATES
IS 2386 PART III-1963

AIM: To determine the specific gravity, void ratio, porosity and bulk density of given coarse and fine aggregates.

APPARATUS: 10 Kg capacity balance with weights, cylindrical containers of 1 liter and 5 liter capacities, measuring jar of 1000ml capacity.

INTRODUCTION: The specific gravity of an aggregate is generally required for calculations in connection with cement concrete design work for determination of moisture content and for the calculations of volume yield of concrete. The specific gravity also gives information on the quality and properties of aggregate. The specific gravity of an aggregate is considered to be a measure of strength of quality of the material. Stones having low specific gravity are generally weaker than those with higher specific gravity values.
The bulk density of an aggregate is used for judging its quality by comparison with normal density for that type of aggregate. It is required for converting proportions by weight into proportions by volume and is used in calculating the percentage of voices in the aggregate.

1. **Specific gravity** is the weight of aggregate relative to the weight of equal volume of water.
2**. Void ratio** is the ratio of volume of voids to the volume of solids in an aggregate.
3. **Percentage of voids or porosity** is the ratio of volume of voids to the total volume of a sample of an aggregate.
4. **Bulk density** or unit weight is the weight of material per unit volume.

PROCEDURE: Coarse aggregate
1. Find the weight of the empty container W1.
2. Take coarse aggregate in the container up to approximately half of the container and find out the weight W2.
3. Fill the container with water upto the level of the coarse aggregates so that all void space inside the aggregate is filled with water. Find its weight W3.
4. Fill the container with water after emptying it from mix of coarse aggregate and water.
5. Water should be upto the mark, upto which coarse aggregate is filled. Find its weight W4
6. Repeat the same process for another trail by taking the aggregate upto the full of the container and by filling the water up to same point.

OBSERVATIONS:

S.No			Trail 1	Trail 2
1)	Weight of empty container	W1		
2)	Weight of container with material	W2		
3)	Weight of container + material + water	W3		
4)	Weight of container + water	W4		

i) Void ratio = Vol. of Voids / Vol of Solids

W3 - W1 / ((W4 - W1)-(W3-W2))

ii) Porosity = Vol. of Voids / Total Vol. of aggregate *100
W3 - W2 / (W4 - W1) * 100

iii) Specific gravity = W2 - W1 / ((W4 - W1) - (W3 - W2))

iv) Bulk density = W2 - W1 / (W4 - W1)

Fine aggregate: Void Ratio and porosity

1. Take 150 ml of dry sand (v1 ml) in clean measuring jar of 1000 ml capacity.
2. Add a measured quantity of 100 ml clean water to the above sample (v2 ml) i.e. v2=100 ml
3. Shake the jar thoroughly till all air bubbles are expelled.
4. Now note the readings against the top surface of water in the jar (V3 ml)

Void ratio = v1 + v2 - v3 / v3 - v2
Porosity = v1 + v2 - v3 / v1

Specific gravity of fine aggregates:

1. Weigh the empty measuring jar of 1000 ml capacity = W1
2. Take the weight of empty measuring jar with 150 ml of sand
Empty jar + sand =W2
3. Take the weight of empty measuring jar with 150 ml of sand and 100 ml of water
Empty jar + sand + water = W3
4. Remove the mix of sand and water from bottle and fill it with water up to volume V3 then weigh it.
Empty jar + water = W4

Specific gravity = Weight of solids / Volume of Solids
W2 - W1 / ((W4 - W1) - (W3 - W2))

PRECAUTIONS: While filling the container with water in determining void ratio and porosity of coarse aggregate care should be taken that water should not be in excess of the level of course aggregate.

RESULT:

1) Specific gravity of course aggregate.
2) Void ratio of course aggregate.
3) Porosity of coarse aggregate.
4) Bulk density of course aggregate.
5) Specific gravity of fine aggregate.
6) Void ratio of the given fine aggregate.
7) Porosity of the given time aggregate.

COMMENTS:

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BULKING OF SAND

AIM: To ascertain the bulking phenomena of given sample of sand.

APPARATUS: 1000ml measuring jar, brush.

INTRODUCTION: Increase in volume of sand due to presence of moisture is known as bulking of sand. Bulking is due to the formation of thin film of water around the sand grains and the interlocking of air in between the sand grains and the film of water. When more water is added sand particles get submerged and volume again becomes equal to dry volume of sand. To compensate the bulking effect extra sand is added in the concrete so that the ratio of coarse to fine aggregate will not change from the specified value. Maximum increase in volume may be 20 % to 40 % when moisture content is 5 % to 10 % by weight. Fine sands show greater percentage of bulking than coarse sands with equal percentage of moisture.

PROCEDURE:

1) Take 1000ml measuring jar.
2) Fill it with loose dry sand upto 500ml without tamping at any stage of filling.
3) Then pour that sand on a pan and mix it thoroughly with water whose volume is equal to 2% of that of dry loose sand.
4) Fill the wet loose sand in the container and find the volume of the sand which is in excess of the dry volume of the sand.
5) Repeat the procedure for moisture content of 4%, 6%, 8%, etc. and note down the readings.
6) Continue the procedure till the sand gets completely saturated i.e till it reaches the original volume of 500ml.

OBSERVATIONS:

S.No	Volume of dry loose sand V1	% moisture content added	Volume of wet loose sand V2	% Bulking V2 – V1 / V1
1.	500 ml	2%		
2.		4%		
3.		6%		
4.		8%		
5.				
6.				

GRAPH: Draw a graph between percentage moisture content on X-axis and percentage bulking on Y-axis. The points on the graph should be added as a smooth curve. Then from the graph, determine maximum percentage of bulking and the corresponding moisture content.

PRECAUTIONS:

1) While mixing water with sand grains, mixing should be thorough and uniform.
2) The sample should not be compressed while being filled in jar.
3) The sample must be slowly and gradually poured into measuring jar from its top.
4) Increase in volume of sand due to bulking should be measured accurately.

RESULT: The maximum bulking of the given sand is ----------at ----------% of moisture content.

COMMENTS:

WORKABILITY TESTS ON FRESH CONCRETE

A) SLUMP TEST

OBJECT: To determine the workability or consistency of concrete mix of given proportion by slump test.

APPARATUS: Iron pan to mix concrete, weighing machine, trowel slump, cone, scale and tamping rod.

The slump cone is a hollow frustum made of thin steel sheet with internal dimensions, as the top diameter 10 cms. The bottom diameter 20 cms, and height 30cms. It stands on a plane non-porous **s**urface. To facilitate vertical lifting from moulded concrete it is provided with a suitable guide attachment and suitable foot pieces and handles. The tamping rod is 16mm. dia. 60 cm. long and is bullet pointed at the lower end.

THEORY: Unsupported concrete, when it is fresh, will flow to the sides and a sinking in height will take place. This vertical settlement is called slump. Slump is a measu6, 0.7 and 0.8. For each mix take 10 Kg. C.A., 5 Kg., FA and 2.5 Kg. Cement.

1) Mix the dry constituents thoroughly to get a uniform colour and then add water.

2) The internal surface of the mould is to be thoroughly cleaned and placed on a smooth, horizontal, rigid and non absorbent surface.

3) Place the mixed concrete in the cleaned slump cone in 4 layers each approximately 1/4 in height of the mould. Tamp each layer 25 times with tamping rod.

4) Remove the cone immediately, rising it slowly and carefully in the vertical direction.

5) As soon as the concrete settlement comes to a stop, measure the subsistence of the concrete in cms, which gives the slump.

Note: Slump test is adopted in the Laboratory or during the progress of the work in the field for determining consistency of concrete where nominal max., size of aggregates does not exceed 40 mm. Any slump specimen which collapses or shears off laterally gives incorrect results and at this juncture the test is repeated only true slump should be measured.

OBSERVATIONS:

S.No	W/c Ratio	Slump in mm
1	0.5	
2	0.6	
3	0.7	
4	|0.8	

PRECAUTIONS:

1) The strokes are to be uniformly applied through the entire area of the concrete section.

2) The cone should be removed very slowly by lifting it upwards without disturbing the concrete.

3) During filling the mould must be firmly pressed against the base.

4) Vibrations from nearly machinery might also increase subsidence; hence test should be made beyond the range of ground vibrations.

COMMENTS: This test is not a true guide to workability. For example, a harsh coarse mix cannot be said to have same workability as one with a large portion of sand even though they have the same slump.

Recommended slumps of concrete mix of various works

S.No	Description of work	Recommended slump in cms
1	Road work	2.5 to 5.0
2	Ordinary beams to slabs|	5 to 10
3	Columns thin vertical section & retaining Walls etc	7.5 to 12.5
4	Mass concrete(Runway, |Pavements)	2.5 to 5

COMPACTION FACTOR TEST

OBJECT: To determine the workability of concrete mix of given proportion by compaction factor test.

APPARATUS: Compaction factor apparatus, trowel weighing machine conical hoppers mounted vertically above the cylindrical mould. The upper mould has internal dimensions as top dia 25 cm bottom dia 12.5 cm and height 22.5 cm. The lower hopper has internal dimensions, top 22.5cm bottom dia 12.5cm and height 22.5cm. The cylinder has internal dimensions as 15 cm dia and 30cm height. The dimensions between bottom of the upper hopper and top of the lower hopper, bottom of the lower hopper and top of cylinder are 20 cm, each case. The lower ends of the hoppers are filled with quick release trap doors.

THEORY: This test is adopted to determine workability of concrete where nominal size of aggregate does not exceed 40 mm. It is based on the definition, that workability is that property of concrete, which determines the amount of work required to produce full compaction. The test consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction.

The compaction factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. It shall be stated to the nearest second decimal place.

PROCEDURE: Conduct test for W/c ratio 0.5, 0.6, 0.7, and 0.8, for each mix take 10 kg of coarse aggregate 5kg of fine aggregate and 2.5 Kg of cement.

1. Grease the inner surface of the hoppers and the cylinder.

2. Fasten the hopper doors.

3. Weigh the empty cylinder accurately (Wt. Kgs).

4. Fix the cylinder on the base with fly nuts and bolts

5. Mix coarse and fine aggregates and cement dry until the mixture is uniform in colour and then with water until concrete appears to be homogeneous.

6. Fill the freshly mixed concrete in upper hopper gently with trowel without compacting.

7. Release the trap door of the upper hopper and allow the concrete of fall into the lower hopper bringing the concrete into standard compaction.

8. Immediately after the concrete comes to rest, open the trap door of the lower hopper and allow the concrete to fall into the cylinder, bringing the concrete into standard compaction.

9. Remove the excess concrete above the top of the cylinder by a trowel.

10. Find the weight of cylinder i.e cylinder filled with partially compacted concrete (W2 kgs)

11. Refill the cylinder with same sample of concrete in approx. 4 layers, tamping each layer with tamping for 25 times in order to obtain full compaction of concrete.

12. Level the mix and weigh the cylinder filled with fully compacted concrete (W3 Kg)

13. Repeat the procedure for different for different a trowel.

OBSERVATIONS AND CALCULATIONS:

Weight of cylinder = W1 Kgs.

S.No	W/c ration	Wt. With partially compaction W2 (Kgs)	Wt. With fully compaction W3 (Kgs)	Wt. With partially compacted concrete(W2- W3) (Kgs)	Wt. With fully compacted concrete(W3- W1) (Kgs)	Compaction factor (W1- W2)/ (W3- W1)
1	0.5					
2	0.6					
3	0.7					
4	0.8					

PRECAUTIONS:

1. The top hopper must be filled gently.

2. The mix should not be pressed or compacted in the hopper.

3. If the concrete in the hopper does not fall through when the trap door is released, it should be freed by passing a metal rod. A single steady penetration will usually affect release.

COMMENTS: It is more sensitive, precise than slump test and is particularly useful to concrete mixes of low workability.

Suggested ranges of values of compaction factors *for* different placing conditions.

S.No	**Placing condition**	**Degree of workability**	**Values of workability**
1	Concreting shallow section with vibration	Very low	0.75 to 0.80
2	Concreting of lightly reinforced section with vibration	Low	0.8 to 0.85
3	Concreting of lightly reinforced section without vibration or heavily reinforced with vibration	Medium	0.85 to 0.92
4	Concreting of heavily reinforced section without vibration	High	0.92 to above

TEST FOR COMPRESSIVE STRENGTH OF CEMENT CONCRETE
(IS: 516 - 1959)

OBJECT: Determination of the compressive strength of cement concrete specimens.

APPARATUS: Testing Machine, two steel bearing platens with hardened faces (As per IS: 516 - 1959).

THEORY: Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days, ages of 13 weeks and one year are recommended if tests at greater ages are required. Where it may be necessary to obtain the early strength, test may be made at the ages of 24 hours + 1/2 hour and 12 hours + 2 hours. The ages shall be calculated from the time of the addition of water to the dry ingredients.

Number of Specimens
At least three specimens, preferably from different batches, shall be made for testing at each selected age.

PROCEDURE: Specimens stored in water shall be tested immediately on removal from water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fines removed. Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The dimensions of the specimens to the nearest 0.2 mm and their weight shall be noted before testing.

Placing the specimen in the Testing Machine The bearing surfaces of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimens which are to be in contact with the compression platens. In the case of the cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast, that is, not to the top and bottom. The axis of the specimen shall be carefully aligned with the center of thrust of the spherically seated platten. No packing shall be used between the faces of the test specimen and the steel platten of the testing machine. As the spherically seated block is brought to bear on the specimen, that movable portion shall be rotated gently by hand so that uniform section may be obtained. The load shall be applied without shock and increased continuously at a rate of approximately 140 Kg/sq cm/min. Until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted.

CALCULATION: The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test, by the cross sectional area, calculated from the mean dimensions of section and shall be expressed to the nearest Kg/sq.cm. Average of three values shall be taken as the representative of the batch provided the individual variation is not more than + 15% of the average. Otherwise, repeat tests shall be made.

In case of cylinders, a correction factor according to the height to diameter ratio of specimen after capping shall be obtained from the curve shown in fig. 1 of IS: 516-1959. The product of this correction factor and the measured compressive strength shall be known as the corrected compressive strength, this being the equivalent strength of a cylinder having a height/diameter ratio of two. The equivalent cube strength of the concrete shall be determined by multiplying the corrected cylinder strength by 5/4.

REPORTING OF RESULTS:
The following information shall be included in the report on each test specimen:

a) Identification mark
b) Date of test
c) Age of specimen
d) Curing conditions including date of manufacture of specimen in the field
e) Weight of specimen
f) Dimensions of specimen
g) Compressive strength
h) Maximum load and
i) Appearance of fractured faces of concrete and type of fractures if these are unusual

RESULT: Compressive strength of Concrete ----------.

COMMENTS: