DEPARTMENT OF CIVIL ENGINEERING

LABORATORY MANUAL FOR

3RD SEMESTER

CIVIL ENGINEERING LAB-I

EXPERIMENT-1 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.

THEORY: 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%.

OBSERVATIONS:

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

Average fineness of cement =

RESULT: Fineness of given sample of cement =

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EXPERIMENT-2 NORMAL CONSISTENCY OF CEMENT

AIM: To determine the normal consistency of a given sample of cement.

APPARATUS: Vicat apparatus conforming to IS : 5513-1976, Balance, Gauging Trowel, Stop Watch, etc.

THEORY: For finding out initial setting time, final setting time and soundness of cement, and strength a parameter known as standard consistency has to be used. The standard consistency of a 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.

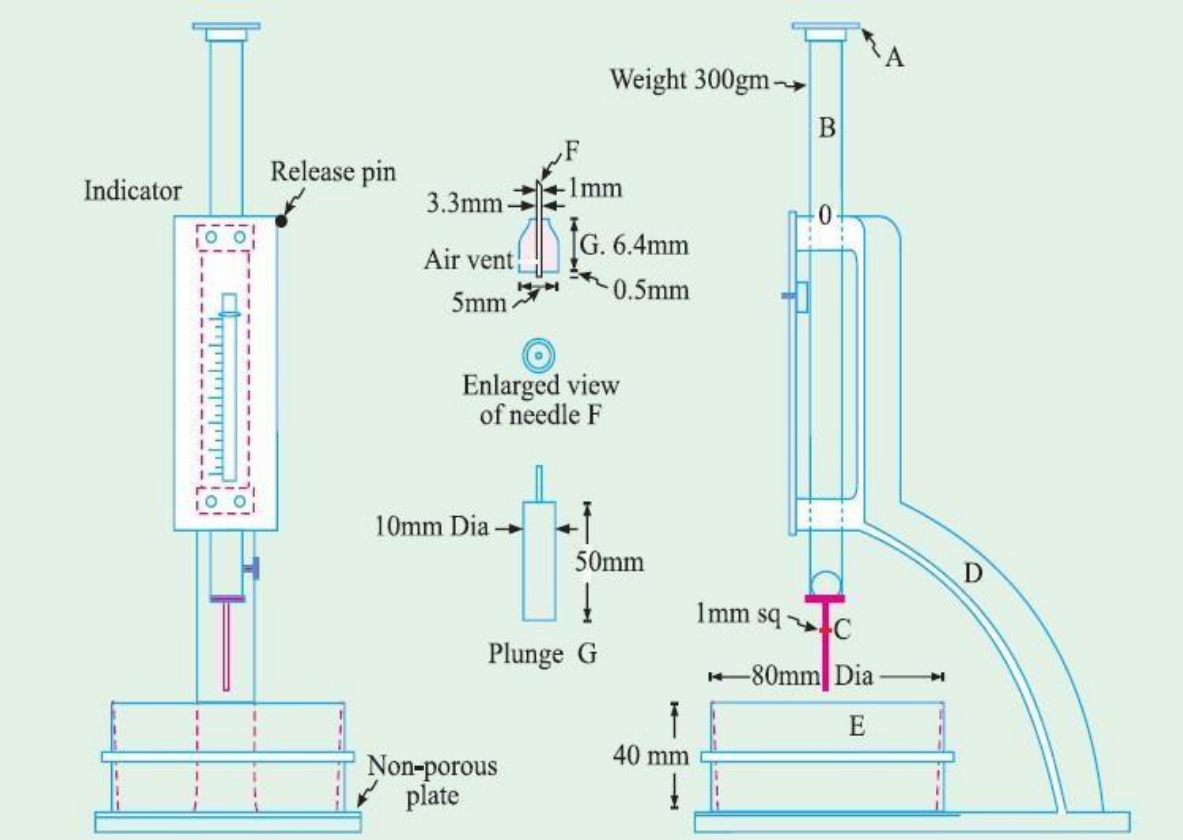
PROCEDURE

1. 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
2. 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.
3. Prepare a paste of 300 g of Cement with a weighed quantity of potableor 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.
4. 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.
5. 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.
6. Prepare trial pastes with varying percentages of water and test as described above until the amount 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 first place of decimal.

Sr. No.	Weight of Cement (gms)	Percentage by water of dry Cement %	Amount ofd Water added (ml)	Penetration (mm)
1				
2				
3				
4				

CONCLUSION / RESULT : The normal consistency of a given sample of cement is ____%



EXPERIMENT-3 INITIAL & FINAL SETTING TIME OF CEMENT

AIM: To determine the initial and final setting time of a given sample of cement.

APPARATUS: Vicat apparatus conforming to IS : 5513-1976, Balance, Gauging Trowel, Stop Watch, etc

THEORY: For convenience, initial setting time is regarded as the time elapsed between the moments that the water isadded to the cement, to the time that the paste starts losing its plasticity. The final setting time is the timeelapsed 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 definite pressure

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 stop-watch 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 allow it 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 comes in contact with 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 by 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.

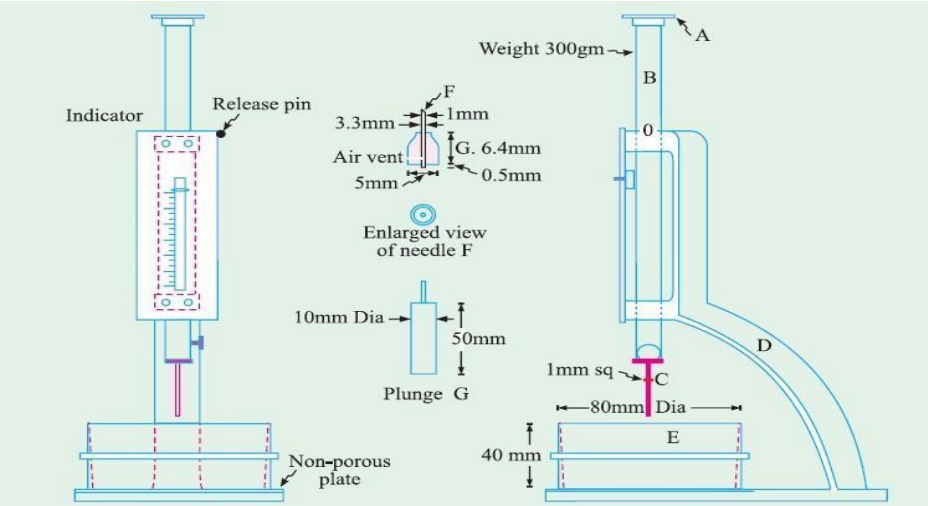
8. The period elapsing between the time when water is added to the cement and the time at which the needle makes an impression on the surface of test block while the attachment fails to do so shall be the final setting time

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

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-4 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.

THEORY: 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 =
Final length - initial length =
Expansion in mm =

RESULT: Expansion in mm

EXPERIMENT-5 COMPRESSIVE STRENGTH OF CEMENT SAMPLE

AIM: To determine the compressive strength sample of cement.

APPARATUS: The standard sand to be used in the test shall conform to IS : 650-1966, Vibration Machine, Poking Rod, Cube Mould of 70.6 mm size conforming to IS : 10080- 1982, Balance, Gauging Trowel, Stop Watch, Graduated Glass Cylinders, etc.

THEORY: The compressive strength of hardened cement is the most important of all the properties. Therefore, it is not surprising that the cement is always tested for its strength at the laboratory before the cement is used in important works. Strength tests are not made on neat cement paste because of difficulties of excessive shrinkage and subsequent cracking of neat cement.

PROCEDURE:

1. Preparation of test specimens - Clean appliances shall be used for mixing and the temperature of water and that of the test room at the time when the above operations are being performed shall be 27 ± 2°C. Potable/distilled water shall be used in preparing the cubes.
2. The material for each cube shall be mixed separately and the quantity of cement, standard sand and water shall be as follows:

   Cement 200 g and Standard Sand 600 g

   Water per cent of combined mass of cement and sand, where P is the percentage of water required to produce a paste of standard consistency determined as described in IS : 4031 (Part 4)-1988 or Experiment 1

3 .Place on a nonporous plate, a mixture of cement and standard sand. Mix it dry with a trowel for one minute and then with water until the mixture is of uniform colour. The quantity of water to be used shall be as specified in step 2. The time of mixing shall in any event be not less than 3 min and should the time taken to obtain a uniform colour exceed 4 min, the mixture shall be rejected and the operation repeated with a fresh quantity of cement, sand and water.

4. Place the assembled mould on the table of the vibration machine and hold it firmly in position by means of a suitable clamp.
6. Immediately after mixing the mortar in accordance with step 1 & 2, place the mortar in the cube mould and prod with the rod. Place the mortar in the hopper of the cube mould and prod again as specified for the first layer and then compact the mortar by vibration.

7. The period of vibration shall be two minutes at the specified speed of 12 000 ± 400 vibration per minute.

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8. Curing Specimens - keep the filled moulds in moist closet or moist room for 24 ± 1 hour after completion of vibration. At the end of that period, remove them from the moulds and immediately submerge in clean fresh water and keep there until taken out just prior to breaking and shall be maintained at a temperature of 27 ± 2°C
9. Test three cubes for compressive strength for each period of curing mentioned under the relevant specifications (i.e. 3 days, 7 days, 28 days)
10. The cubes shall be tested on their sides without any packing between the cube and the steel plattens of the testing machine. One of the plattens shall be carried on a base and shall be self-adjusting, and the load shall be steadily and uniformly applied, starting from zero at a rate of 40N/mm2/min

OBSERVATION

Sr. NO.	Age of Cube	Weight of Cement CuBE	Cross sectional Area (mm^2)	Load (N)	Compressive strength (N/mm^2)
1					
2					
3					
4					
5					
6					

CONCLUSION / RESULT:

i) The average 3 Days Compressive Strength of given cement sample is found to be …..…..

ii) The average 7 Days Compressive Strength of given cement sample is found to be …..…..

iii) The average 28 Days Compressive Strength of given cement sample is found to be…..…..

EXPERIMENT-6 COMPRESSIVE STRENGTH OF BURNT CLAY, FLY ASH BRICKS

AIM: To determine Compressive strength of bricks as per IS: 3495 (Part-I) – 1976.

APPARATUS: Compression Testing Machine

THEORY: Compressive strength or crushing strength is the property of brick which represent the amount of load carried by brick per unit area. According to BIS the minimum compressive strength of brick should be 3.5N/mm2

PROCEDURE:

1. The bed faces of bricks is removed to provide two smooth and parallel
2. faces by grinding
3. It is immersed in water at room temperature for 24 h.
4. The specimen is then removed and any surplus moisture is drained out at
5. room temperature
6. The frog and all voids in the bed face is filled with cement mortar.
7. The specimen is placed with flat faces horizontal, and mortar filled face
8. facing upwards between two 3 ply plywood sheets each of 3mm thickness
9. and carefully centred between plates of testing machine.
10. The maximum load at failure is noted down

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OBSERVATION :

Compressive strength of brick = load at failure / cross section area of brick

Sl no.	**Load in N**	**Area of cross section in mm^2**	**Compressive strength in N/mm^2**	**Remarks**

CONCLUSION/RESULT: Average strength of bricks.....

EXPERIMENT-7 GRADING OF FINE AGGREGATE

AIM: To determine fineness modulus of fine aggregate and classifications based on IS: 383- 1970

APPARATUS : Test Sieves conforming to IS : 460-1962 Specification of 4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300micron, 150 micron, Balance, Gauging Trowel, Stop Watch, etc.

THEORY: The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate, which is known as gradation . The following limits used to classifie

PROCEDURE:

1. The sample shall be brought to an air-dry condition before weighing and sieving. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest.
2. Material shall not be forced through the sieve by hand pressure. Lumps of fine material, if present, may be broken by gentle pressure with fingers against the side of the sieve.
3. Light brushing with a fine camel hair brush may be used on the 150-micron and 75-micron IS Sieves to prevent aggregation of powder and blinding of apertures.
4. On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

Observation :

I S Sieve	Weight Retained on Sieve	Percentage of Weight Retained (%)	Percentage of Weight Passing (%)	Cumulative Percentage of Passing (%)
4.75 mm				
2.36 mm				
1.18 mm				
600 micron				
300 micron				
Total				

RESULT /CONCULSION :

EXPERIMENT-8 GRADING OF COARSE AGGREGATE

AIM: To determination of particle size distribution of coarse aggregates by sieving

APPARATUS

Test. Sieves conforming to IS : 460-1962 Specification of 80 mm, 40 mm20 mm, 10 mm, 4.75 mm, Balance, Gauging Trowel, Stop Watch, etc.

THEORY: Grading refers to the determination of the particle-size distribution for aggregate. Grading limits and maximum aggregate size are specified because grading and size affect the amount of aggregate used as well as cement and water requirements, workability, pumpability, and durability of concrete. In general, if the water-cement ratio is chosen correctly, a wide range in grading can be used without a major effect on strength. When gap-graded aggregate are specified, certain particle sizes of aggregate are omitted from the size continuum. Gap-graded aggregate are used to obtain uniform textures in exposed aggregate concrete.

PROCEDURE:

1. The sample shall be brought to an air-dry condition before weighing and sieving. This may be achieved either by drying at room temperature or by heating at a temperature of 100‖ to 110°C. The air- dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest.
2. Material shall not be forced through the sieve by hand pressure.
3. On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

OBSERVATION :

I S Sieve	Weight Retained on Sieve	Percentage of Weight Retained (%)	Percentage of Weight Passing (%)	Cumulative Percentage of Passing (%)	Remark
80 mm					
40 mm					
20 mm					
10 mm					
4.75 mm					
Total					

CONCLUSION / RESULT :

EXPERIMENT-9 SPECIFIC GRAVITY OF FINE AGGREGATE

AIM: To determine specific gravity of a given sample of fine aggregate.

APPARATUS: Pycnometer, A 1000-ml measuring cylinder, well-ventilated oven, Taping rod, Filter papers and funnel, etc.

THEORY: Specific gravity of an aggregate is defined as ratio of the mass of a given volume of a sample to the mass of a equal volume of water at the same temperature.

PROCEDURE:

1. Sample of about 500 g shall be placed in the tray and covered with distilled water at a temperature of 22 to 32°C.. The sample shall remain immersed for 24 ± l/2 hours.

2. The water shall then be carefully drained from the sample. The saturated and surface- dry sample shall be weighed (weight A).

3. The aggregate shall then be placed in the pycnometer which shall be filled with distilled water. Any trapped air shall be eliminated by rotating the pycnometer on its side, the hole in the apex of the cone being covered with a finger. The pycnometer shall be dried on the outside and weighed (weight B).

4. The contents of the pycnometer shall be emptied into the tray, The pycnometer shall be refilled with distilled water to the same level as 21 before, dried on the outside and weighed (weight C).

5. The water shall then be carefully drained from the sample. The sample shall be placed in the oven in the tray at a temperature of 100 to 110°C for 24 f l/2 hoursIt shall be cooled in the air-tight container and weighed (weight D).

6. Calculations— Specific gravity, apparent specific gravity and water &sorption shall be calculated as follows:

$$\text{Specific gravity} = \frac{D}{(A-(B-C)}$$

$$\text{Apparent Specific gravity} = \frac{D}{(D-(B-C)}$$

$$\text{Water absorption} = \frac{100\ (A-D)}{D}$$

A = weight in g of saturated surface-dry sample,

B = weight in g of pycnometer or gas jar containing sample and filled with distilled water,

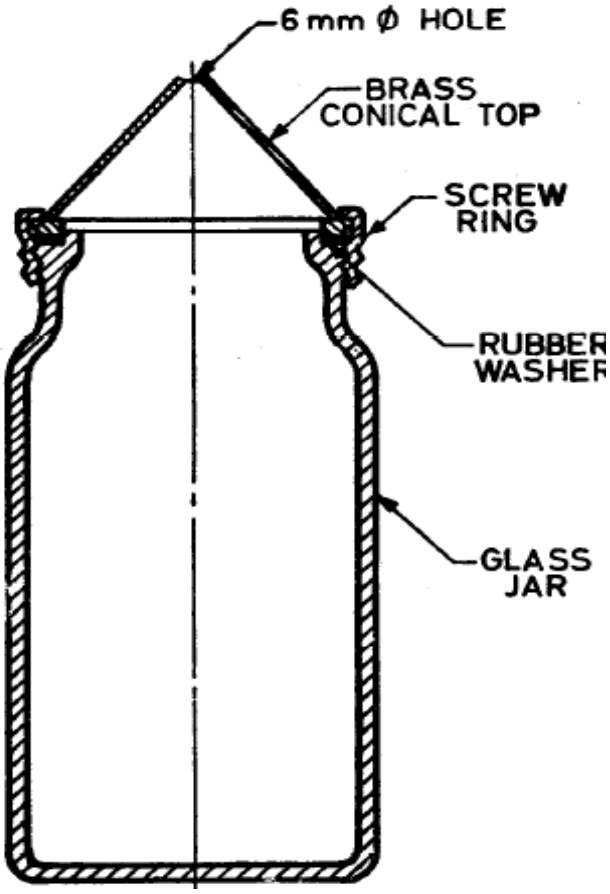
C =weight in g of pycnometer or gas jar filled with distilled water only and

D = weight in g of oven-dried sample.

CONCLUSION / RESULT:

i) The Specific Gravity of a given sample of fine aggregate is found to be …….

ii) The Water Absorption of a given sample of fine aggregate is found to be ……. %



EXPERIMENT-10 BULKING OF SAND

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

APPARATUS: 1000ml measuring jar, brush.

THEORY: 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:

SL. 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.

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

EXPERIMENT-11 SPECIFIC GRAVITY & BULK DENSITY OF COARSE AGGREGATE

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.

THEORY: 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. **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		

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

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

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RESULT:

1) Specific gravity of course aggregate.
2) Bulk density of course aggregate.

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EXPERIMENT-12 CRUSHING VALUE AGGREGATE

AIM: To determine crushing value of course aggregate.

APPARATUS: A 15-cm diameter open-ended steel cylinder, with plunger and base-plate, of the general form straight metal tamping rod, A balance of capacity 3 kg, readable and accurate to one gram, IS Sieves of sizes 12.5, 10 and 2.36 mm, For measuring the sample, cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of the following internal dimensions: Diameter 11.5 cm and Height 18.0 cm .

THEORY: The _aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. With aggregate of aggregate crushing value' 30 or higher, the result may be anomalous, and in such cases the ten percent fines value' should be determined instead.

PROCEDURE:

1. The material for the standard test shall consist of aggregate passing a 12.5 mm IS Sieve and retained on a 10 mm IS Sieve, and shall be thoroughly separated on these sieves before testing.
2. The aggregate shall be tested in a surface-dry condition. If dried by heating, the period of drying shall not exceed four hours, the temperature shall be 100 to 110°C and th aggregate shall be cooled to room temperature before testing.
3. The appropriate quantity may be found conveniently by filling the cylindrical measure in three layers of approximately equal depth, each layer being tamped 25 times with the rounded end of the tamping rod and finally leveled off, using the tamping rod as a straight-edge.
4. The weight of material comprising the test sample shall be determined (Weight A) and the same weight of sample shall be taken for the repeat test.
5. The apparatus, with the test sample and plunger in position, shall then be placed between the platens of the testing machine and loaded at as uniform a rate as possible so that the total load is reached in 10 minutes. The total load shall be 400 kN.
6. The load shall be released and the whole of the material removed from the cylinder and sieved on a 2.36 mm IS Sieve for the standard test. The fraction passing the sieve shall be weighed (Weight B).

CALCULATION:

The ratio of the weight of fines formed to the total sample weight in each test shall be expressed as a percent

Aggregate Crushing Value = $\frac{B}{A}$ 100

A = weight (gm.) of saturated surf ace - dry sample,

B = weight (gm) of fraction passing through appropriate sievs

CONCLUSION / RESULT:

The aggregate crushing value of given samp

EXPERIMENT-13 LOS ANGLE ABRASION TESTING AGGREGATE

AIM: To determine the abrasion value of given aggregate sample by conducting Los - Angeles abrasion test

APPARATUS:

1. Los Angeles machine with inside diameter 70cm and inside length of 50cm.
2. Abrasive charges having diameter 4.8cm and weight 390 to 445 gm.
3. I.S Sieve with 1.7 mm opening.
4. Weighting Balance of 0.1gm accuracy.
5. Metallic Tray

THEORY:

The principle of Los Angeles abrasion test is to find the percentage wear due to the relative rubbing action between the aggregates and steel balls used as abrasive charge pounding action ofthese balls also exist while conducting the test. Maximum Allowable Los Angeles Abrasion Values of Aggregates in Different types of pavement layers as per Indian Road Congress (IRC) are: -

1. For sub-base course a value of 60%. For base course such as WBM, Bituminous Macadam (B.M.), Built – Up spray grout base course and etc. value of 50%.
2. For surface course such as WBM, BM, Bituminous Penetration Macadam, Built-Up spray grout binder course and etc. a value of 40%.
3. If aggregates are used in surface course as bituminous carpet, bituminous surface dressing, single or two coats, cement concrete surface course and etc. a value of 35%.
4. If aggregates are used for bituminous concrete, Cement concrete pavement as surfacecoarse than aggregate abrasion value of 30% maximum.

PROCEDURE

1. Clean and dry aggregate sample confirming to one of the grading A to G is used for thetest. (Refer Table 1).
2. Aggregates weighing 5 kg for grading A, B, C or D and 10 kg for grading E, F or G maybe taken as test specimen and placed in the cylinder.
3. The abrasive charge is also chosen in accordance with table no.1 and placed in thecylinder of the machine, and cover is fixed to make dust tight.

4. The machine is rotated at a speed of 30 to 33 revolutions per minute.
5. The machine is rotated for 500 revolutions for grading A, B, C and D, for grading E, Fand G, it shall be rotated for 1000 revolutions.
6. After the desired number of revolutions, the machine is stopped and the material isdischarged from the machine taking care to take out entire stone dust.
7. Using a sieve of size larger than 1.70 mm I.S sieve, the material is first separated intotwo parts and the finer position is taken out and sieved further on a 1.7 mm I.S sieve.
8. Let the original weight of aggregate be W_1 gm, weight of aggregate retained on 1.70 mm I.S sieve after the test be W_2 gm.

Los Angeles abrasion value % = [(W1-W2)/W2] x100

OBSERVATION:

Sl.No	Details of sample	Observations	
		1	2
1	Weight of specimen= W_1 g		
2	zWeight of specimen retain on 1.7 mm IS Sieve after abrasion test = W_2 g		
3	Los Angeles abrasion value		
4	Mean value		

CONCLUSION : The abrasion value is found to be……

EXPERIMENT-14 IMPACT VALUE TEST OF AGGREGATE

AIM: To determine the impact value of course aggregate

APPARATUS:

1. An impact testing machine of the general form shown in Fig. 2 and complying with the following:
2. A cylindrical steel cup of internal dimensions: Diameter 102 mm, Depth 50 mm and not less than mm thick
3. A metal hammer weighing 13.5 to 14.0 kg, the lower end of which shall be cylindrical in shape, 100.0 mm in diameter and 5 cm long, with a 2 mm chamfer at the lower edge, and case-hardened. The hammer shall slide freely between vertical guides so arranged that the lower (cylindrical) part of the hammer is above and concentric with the cup.
4. Means for raising the hammer and allowing it to fall freely between the vertical guides from a height of 380.0 mm on to the test sample in the cup, and means for adjusting the height of fall within 5 mm.

Sieves-The IS Sieves of sizes 12.5, 10 and 2.36 mm, Tamping Rod, balance of capacity not less than 500 g, Oven etc.

THEORY: The aggregate impact value' gives a relative measure of the resistance of an aggregate to sudden shock or impact, which in some aggregates differs from its resistance to a slow compressive load.

PROCEDURE :

1. The test sample shall consist of aggregate the whole of which passes a 12.5 mm IS Sieve and is retained on a 10 mm IS Sieve. The aggregate comprising the test sample shall be dried in an oven for a period of four hours at a temperature of 100 to 110°C and cooled.

2. The measure shall be filled about one-third full with the aggregate and tamped with 25 strokes of the rounded end of the tamping rod. The net weight of aggregate in the measure shall be determined to the nearest gram (Weight A)

3. The impact machine shall rest without wedging or packing upon the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.

4. The cup shall be fixed firmly in position on the base of the machine and the whole of the test sample placed in it and compacted by a single tamping of 25 strokes of the tamping rod.

5. The hammer shall be raised until its lower face is 380 mm above the upper surface of the aggregate in the cup, and allowed to fall freely on to the aggregate. The test sample shall be subjected to a total of 15 such blows each being delivered at an interval of not less than one second.
6. The crushed aggregate shall then be removed from the cup and the whole of it sieved on the 2.36 mm IS Sieve until no further significant amount passes in one minute. The fraction passing the sieve shall be weighed to an accuracy of 0.1 g (Weight. B).
7. The fraction retained on the sieve shall also be weighed (Weight C) and, if the total weight (C+B) is less than the initial weight (Weight A) by more than one gram, the result shall be discarded and a fresh test made. Two tests shall be made.

CALCULATION :

The ratio of the weight of fines formed to the total sample weight in each test shall he expressed as a Percentage

$$\text{Aggregate Impact Value} = \frac{B}{A} \quad 100$$

A = weight (gm.) of saturated surf ace - dry sample,

B = weight (gm) of fraction passing through appropriate sievs

CONCLUSION / RESULT :

The aggregate Impact value of given sample of coarse aggregate is .....%

The aggregate impact value should not be more than 45 per cent for aggregate used for concrete other than for wearing surfaces, and 30 per cent for concrete used for wearing surfaces such a runways, roads and air field pavemen

EXPERIMENT-15 WORKABILITY OF CONCRETE BY SLUMP CONE TEST

AIM: 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.

PROCEDURE:

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.
6. Mix the dry constituents thoroughly to get a uniform colour and then add water.
7. The internal surface of the mould is to be thoroughly cleaned and placed on a smooth, horizontal, rigid and non absorbent surface.
8. 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.
9. Remove the cone immediately, rising it slowly and carefully in the vertical direction.
10. 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	0.38	
2	0.40	
3	0.50	
4	0.60	

CONCLUSION/RESULT:

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

EXPERIMENT-16 WORKABILITY OF CONCRETE BY COMPACTION FACTOR TEST

AIM: 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.

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

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

10. 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.

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

12. 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					

CONCLUSION: The compaction factor is found to be……

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

EXPERIMENT-17 COMPRESSIVE STRENGTH OF CONCRETE

Objective: To determine compressive strength of concrete cube specimen.

APPARATUS:

Testing Machine - The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified in 5.5

Cube Moulds - The mould shall be of 150 mm size conforming to IS: 10086-1982.

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

Weights and weighing device, Tools and containers for mixing, Tamper (square in cross section) etc.

THEORY : Age at Test - Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours ± ½ hour and 72 hours ± 2 hours. The ages shall be calculated from the time of the addition of water to the 63 dry ingredients.

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

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 each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.
4. **Mixing 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 -** Test specimens cubical in shape shall be 15 × 15 × 15 cm. If the largest nominal size of the aggregate does not exceed 2 cm, 10 cm cubes may be used as an alternative. Cylindrical test specimens shall have a length equal to twice the diameter.
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.

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 specimen which are to be in contact with the compression platens

Sr. No.	**Age of Cube**	**Weight of Cement Cube (gms)**	**Cross-Sectional area** (mm^2)	**Load (N)**	**Compressive strength (N/mm2)**	**Average Compressive strength** (MPa)
1	7 Days					
2						
3						
4	28 Days					
5			`			
6						

CONCLUSION / RESULT :

i) The average 7 Days Compressive Strength of concrete sample is found to be …..…..

ii) The average 28 Days Compressive Strength of concrete sample is found to be …..…..