CONTENTS

EXPERIMENT 1

STANDARD CONSISTENCY OF CEMENT

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

DEFNITION: 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.

. **APPARATUS:**
1. Vicat's apparatus, Mould, Plunger.
2. Standard trowel
3. Stop watch.
4. Weighing balance

DESCRIPTION:

The Vicat's apparatus consists of a frame and a moving rod weighing 300 gm. The plunger is kept at the lower end of the rod. It is a cylinder 10 mm. Diameter, A pointer connected to the rod will move along with it when it is released, over a graduated scale kept in front of it. The cement paste to be tested is kept in the Vicat's mould kept below the rod on a glass plate.

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 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.

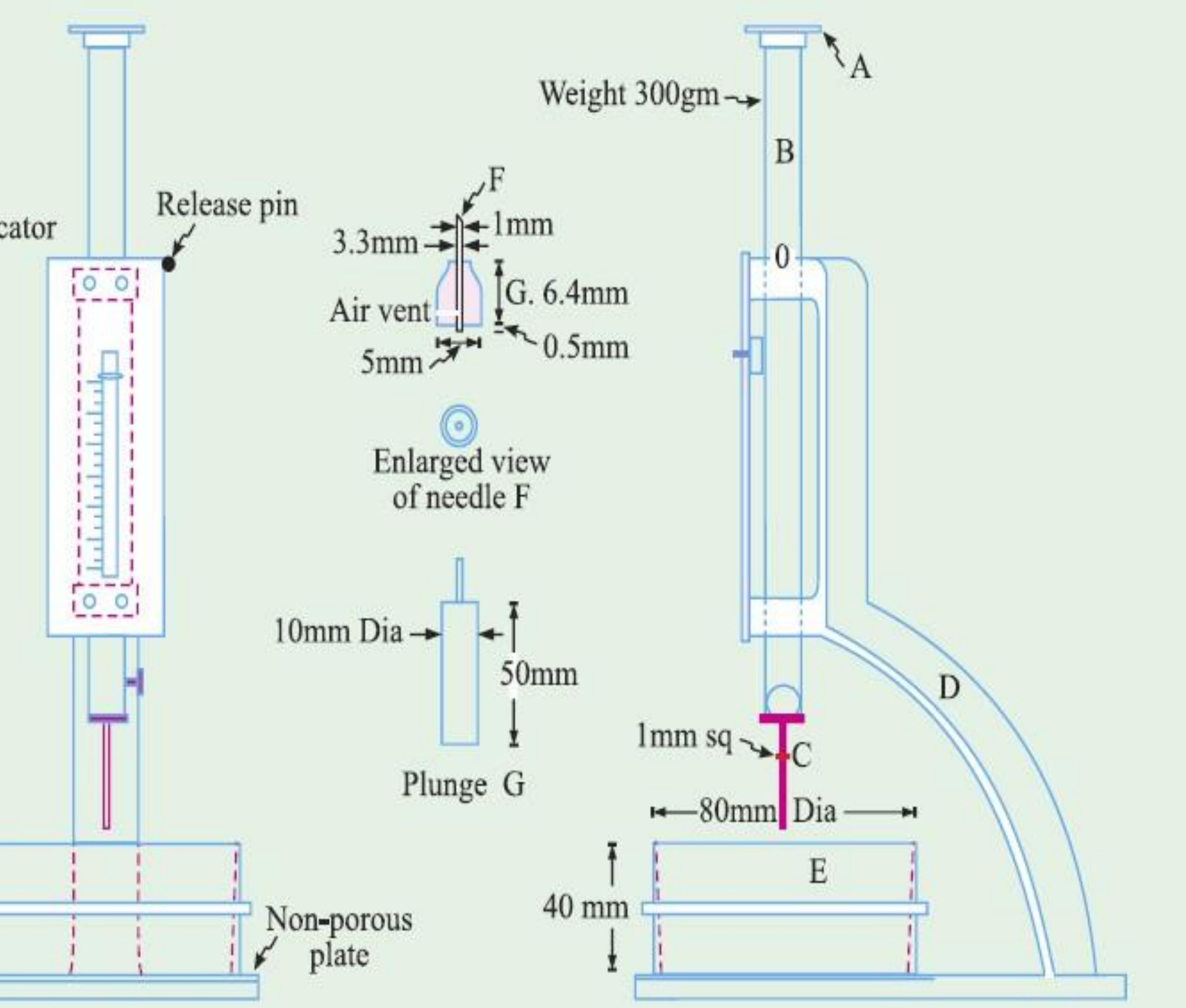
4. Fill the Vicat mould (E) with this paste, the mould resting upon a non-porous plate.

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.

Figure:



OBSERVATIONS:

S.NO	Weight of Cement W1	Weight of Water W2	Reading on Scale mm	W2/W1	Standard Consistency

CALCULATIONS: Weight of cement taken = W1.

Weight of water added when the plunger has a penetration of

5 to 7 mm from the bottom of the mould = W2 Percentage of water for standard consistency p = (W2 / W1) x 100

RESULT: Percentage of water for standard consistency is ---------------

EXPERIMENT 2

SETTING TIME OF CEMENT

Title : Determination of Setting Time of Standard Cement Paste

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

Theory :

For convenience, initial setting time is regarded as the time elapsed between the moments 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 definite pressure.

Apparatus :

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

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

S.NO	Setting Time (Sec)	Penetration (mm)	Remarks
01			
02			
03			
04			

Conclusion / 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 …..

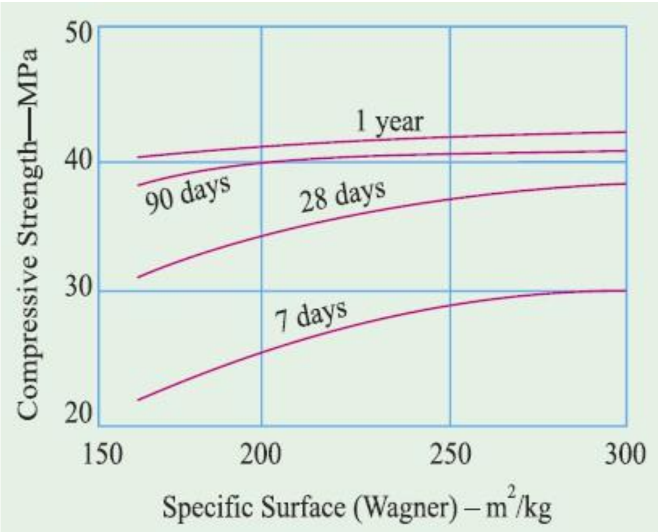
EXPERIMENT 3

FINENESS OF CEMENT

Title : Determination of Fineness of Cement by dry sieving

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 faster the development of strength, (Fig. 3). The fineness of grinding has increased over the years. But now it has got 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 ofcement) 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 100 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
2. 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 100 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.

Conclusion / R : The fineness of a given sample of cement is _ _ _ _ %

EXPERIMENT 4

COMPRESSIVE STRENGTH OF CEMENT

Title : Determination of Compressive Strength of Cement

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

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.

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
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. Moulding Specimens - In assembling the moulds ready for use, treat the interior faces of the mould with a thin coating of mould oil.
5. Place the assembled mould on the table of the vibration machine and hold it firmly in position by means of a suitable clamp. Attach a hopper of suitable size and shape securely at the top of the mould to facilitate filling and this hopper shall not be

removed until the completion of the vibration period.

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.

8. 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 the surface with the blade of a trowel.

9. 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.

10. The water in which the cubes are submerged shall be renewed every 7 days and shall be maintained at a temperature of 27 ± 2°C. After they have been taken out and until they are broken, the cubes shall not be allowed to become dry.

11. Test three cubes for compressive strength for each period of curing mentioned under the relevant specifications (i.e. 3 days, 7 days, 28 days)

12. 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 35 $N/mm^2/min$

Figure :

OBSERVATION

S.N0	Age of Cube	Weight of Cement cube	Cross sectional area (mm²)	Load KN	Compressive strength (N/mm^2)	Average Compressive strength (MPa)
1	7 Days					
2						
3						
1	28 days					
2						
3						

Calculation :

The measured compressive strength of the cubes shall be calculated by dividing the maximum load applied to the cubes during the test by the cross-sectional area, calculated from the mean dimensions of the section and shall be expressed to the nearest 0.5 N/mm^2. In determining the compressive strength, do not consider specimens that are manifestly faulty, or that give strengths differing by more than 10 percent from the

average value of all the test specimens.

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 …..…..

Table 2.5. Physical Characteristics of Various Types of Cement.

Sl.No. Type of Cement	Fineness	Soundness By		Setting Time		Compressive Strength			
	(m^2/kg) Min.	Le chatelier (mm) Max.	Autoclave (%) Max.	Initial (mts) min.	Final (mts) max.	1 Day min. MPa	3 Days min. MPa	7 Days min. MPa	28 Days min. MPa
1. 33 Grade OPC (IS 269-1989)	225	10	0.8	30	600	N S	16	22	33
2. 43 Grade OPC (IS 8112-1989)	225	10	0.8	30	600	N S	23	33	43
3. 53 Grade OPC (IS 12269-1987)	225	10	0.8	30	600	N S	27	37	53
4. SRC (IS 12330-1988)	225	10	0.8	30	600	N S	10	16	33
5. PPC (IS 1489-1991) Part I	300	10	0.8	30	600	N S	16	22	33
6. Rapid Hardening (IS 8041-1990)	325	10	0.8	30	600	16	27	N S	N S
7. Slag Cement (IS 445-1989)	225	10	0.8	30	600	N S	16	22	33
8. High Alumina Cement (IS 6452-1989)	225	5	N S	30	600	30	35	N S	N S
9. Super Sulphated Cement (IS 6909-1990)	400	5	N S	30	600	N S	15	22	30
10. Low Heat Cement (IS 12600-1989)	320	10	0.8	60	600	N S	10	16	35
11. Masonry Cement (IS 3466-1988)	*	10	1	90	1440	N S	N S	2.5	5
12. IRS-T-40	370	5	0.8	60	600	N S	N S	37.5	N S

EXPERIMENT 5

PARTICLE SIZE DISTRIBUTION OF FINE AGGREGATE

Title : Particle Size Distribution of Fine Aggregates
Objective : To determine fineness modulus of fine aggregate and classifications based on
IS: 383-1970
Reference : IS : 2386 (Part I) - 1963, IS: 383-1970, IS : 460-1962

Theory :

This is the name given to the operation of dividing a sample of aggregate into various fractions each consisting of particles of the same size. The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate, which we call gradation. Many a time, fine aggregates are designated as coarse sand, medium sand and fine sand. These classifications do not give any precise meaning. What the supplier terms as fine sand may be really medium or even coarse sand. To avoid this ambiguity fineness modulus could be used as a yard stick to indicate the fineness of sand.

The following limits may be taken as guidance: Fine sand : Fineness Modulus : 2.2 - 2.6, Medium sand : F.M. : 2.6 - 2.9, Coarse sand : F.M. : 2.9 - 3.2

Sand having a fineness modulus more than 3.2 will be unsuitable for making satisfactory concrete.

Apparatus :

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

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. Care shall be taken to ensure that the sieves are clean before use.
2. The shaking shall be done with a varied motion, backward sand forwards, left to right, circular clockwise and anti-clockwise, and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions.
3. 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.

4. 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.

5. On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

Observation:

S.NO	**IS Sieve size**	**Weight Retained**	**% Weight Retained**	**Cumulative % retained**	**% Passing**
01	4.75mm				
02	2.36mm				
03	1.18mm				
04	600µ				
05	300µ				
06	150µ				

Calculation :

Fineness modulus is an empirical factor obtained by adding the cumulative percentages of aggregate retained on each of the standard sieves ranging from 4.75 mm to 150 micron and dividing this sum by an arbitrary number 100.

Fineness Modulus, *FM* = *Total of cumulative % retained /100*

Conclusion / Result :

i) Fineness modulus of a given sample of fine aggregate is …….. that indicate Coarse sand/ Medium sand/ Fine sand.

ii) The given sample of fine aggregate is belong to Grading Zones I / II / III / IV

Table 3.15. Grading limits of fine aggregates IS: 383-1970

I.S. Sieve Designation	Percentage passing by weight for			
	Grading Zone I	*Grading Zone II*	*Grading Zone III*	*Grading Zone IV*
10 mm	100	100	100	100
4.75 mm	90–100	90–100	90–100	95–100
2.36 mm	60–95	75–100	85–100	95–100
1.18 mm	30–70	55–90	75–100	90–100
600 micron	15–34	35–59	60–79	80–100
300 micron	5–20	8–30	12–40	15–50
150 micron	0–10	0–10	0–10	0–15

EXPERIMENT 6

SILT CONTENT OF SAND

TITLE :Determination of Silt Content in Fine Aggregate

Objective : To determine silt content in a given sample of fine aggregate by sedimentation method.

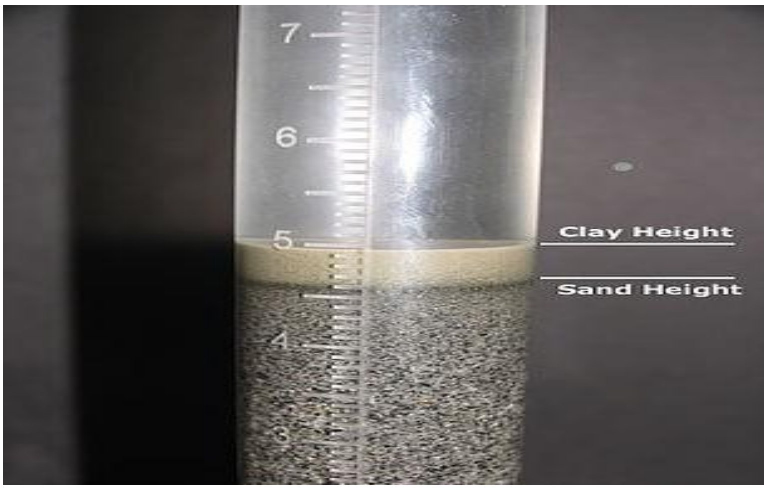
Reference : IS : 2386 (Part II) – 1963

Theory:

Silt content is a fine material which is less than 150 micron. It is unstable in the presence of water. If we use silty sand for bonding, it will reduce the strength and cause rework. You may be experienced this while plastering for a roof where the mason try to plaster the mortar where it gets continually peel off. Excessive quantity of silt, not only reduces the bonding between cement and fine aggregate but also affects the strength and durability of work. In the field, we have to conduct silt test for every 20 Cum [near about] of sand.

Apparatus Required

- 250 ml measuring cylinder
- Water
- Sand
- Tray



Procedure

1. First, we have to fill the measuring cylinder with 1% solution of salt and water up to 50 ml.
2. Add sand to it until the level reaches 100 ml.
3. Then fill the solution up to 150 ml level.
4. Cover the cylinder and shake it well.

5.After 3 hours, the silt content settled down over the sand layer.

6.Note down the silt layer volume as V1 ml (settled over the sand).

7 .Then note down the sand volume (below the silt) as V2 ml.

8.Repeat the procedure two more times to get the average.

Observation

SILT CONTENT = [V1 / V2]*100

Limit of Silt Content

The permissible Silt content in sand percentage is only 6%.

EXPERIMENT 7

SPECIFIC GRAVITY OF FINE AGGREGATE

Title : Determination of Specific Gravity of Fine Aggregate

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

Reference : IS : 2386 (Part III) - 1963

Apparatus :

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

Procedure :

1. A sample of about 500 g shall be placed in the tray and covered with distilled water at a temperature of 22 to 32°C. Soon after immersion, air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation with a rod. The sample shall remain immersed for 24 ± l/2 hours.

2. The water shall then be carefully drained from the sample, by decantation through a filter paper, any material retained being return& to the sample. The fine aggregate including any solid matter retained on the filter paper shall be exposed to a gentle current of warm air to evaporate surface moisture and the material just attains a ‗free-running' condition. 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, care being taken to ensure that all the aggregate is transferred. The pycnometer shall be refilled with distilled water to the same level as before, dried on the outside and weighed (weight C).

5. The water shall then be carefully drained from the sample by decantation through a filter paper and any material retained returned to 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 hours, during which period it shall be stirred occasionally to facilitate drying. It 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:

Apparent Specifc Gravity ·

Water Absorption ·

A · weight in g of saturatedsurface - dry sample,

B · weight in g of pycnometer or gas jar containing sample and filled withdistilled water, C · weight in g of pycnometer or gas jar filled withdistilled wateronly, 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 8

SPECIFIC GRAVITY OF COARSE AGGREGATE

Title: Determination of Specific Gravity of Course Aggregate
Objective: To determine specific gravity of a given sample of course aggregate.

Reference: IS : 2386 (Part III) - 1963

Apparatus :
A wire basket of not more than 6-3 mm mesh, A stout watertight container in which the basket may be freely suspended, well-ventilated oven, Taping rod, An airtight container of capacity similar to that of the

Procedure :

1. A sample of not less than 2000 g of the aggregate shall be thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22°C to 32°C with a cover of at least 5 cm of water above the top of the basket.
2. Immediately. after immersion the entrapped air shall be removed from the sample by lifting the basket containing it 25 mm above the base of the tank and allowing it to drop 25 times at the rate of about one drop per second. The basket and aggregate shall remain completely immersed during the operation and for a period of 24 ± l/2 hours afterwards.
3. The basket and the sample shall then be jolted and weighed in water at a temperature of 22°C to 32°C (weight A_1).
4. The basket and the aggregate shall then be removed from the water and allowed to drain for a few minutes, after which the, aggregate shall be gently emptied from the

basket on to one of the dry clothes, and the empty basket shall be returned to the water and weighed in water (weight A_2).

5. The aggregate placed on the dry cloth shall be gently surface dried with the cloth, transferring it to the second dry cloth when the first will remove no further moisture. The aggregate shall then be weighed (weight B).

6. The aggregate shall then be placed in the oven in the shallow tray, at a temperature of 100 to 110°C and maintained at this temperature for 24 ± l/2 hours. It shall then be removed from the oven, cooled in the airtight container and weighed (weight C).

7. Calculations— Specific gravity, apparent specific gravity and water &sorption shall be calculated From the formulas

Conclusion / Result :

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

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

EXPERIMENT 9

PARTICLE SIZE DISTRIBUTION OF COARSE AGGREGATE

Title : Particle Size Distribution of Course Aggregates
Objective : To determination of particle size distribution of coarse aggregates by sieving or screening.
Reference : IS : 2386 (Part I) - 1963, IS: 383-1970, IS : 460-1962

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. Close control of mix proportions is necessary to avoid segregation.

Apparatus Test Sieves conforming to IS : 460-1962 Specification of 80 mm, 40 mm, 20 mm, 10 mm, 4.75 mm, Balance, Gauging Trowel, Stop Watch, etc.

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. Theair-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be taken to ensure that the sieves are clean before use.
2. Each sieve shall be shaken separately over a clean tray until not more than a trace passes, but in any case for a period of not less than two minutes. The shaking shall be done with a varied motion,backward sand forwards, left to right, circular clockwise and anti-clockwise, and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions.
3. 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.

4. On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

Observation Table

S.No	**IS Sieve size**	**Weight Retained**	**% Weight Retained**	**Cumulative % retained**	**% Passing**
01	80mm				
02	40mm				
03	20mm				
04	10mm				
05	4.75mm				

Table 3.14. Grading Limits for Coarse Aggregate IS: 383-1970

IS Sieve Designation	*Percentage passing for single-sized aggregate nominal size (by weight)*						*Percentage passing for Graded aggregate of nominal size (by weight)*			
	63 mm	*40 mm*	*20 mm*	*16 mm*	*12.5 mm*	*10 mm*	*40 mm*	*20 mm*	*16 mm*	*12.5 mm*
80 mm	100	–	–	–	–	–	100	–	–	–
63 mm	85–100	100	–	–	–	–	–	–	–	–
40 mm	0–30	85–100	100	–	–	–	95–100	100	–	–
20 mm	0–5	0–20	85–100	100	–	–	30–70	95–100	100	100
16 mm	–	–	–	85–100	100	–	–	–	90–100	–
12.5 mm	–	–	–	–	85–100	100	–	–	–	90–100
10 mm	–	0–5	0–20	0–30	0–45	85–100	10–35	25–55	30–70	40–85
4.75 mm	–	–	0–5	0–5	0–10	0–20	0–5	0–10	0–10	0–10
2.36 mm	–	–	–	–	–	0–5	–	–	–	–

Conclusion / Result :

EXPERIMENT 10

SLUMP TEST

Title : Determination Workability of Fresh Concrete By Slump Cone Test

Objective : To determine the relative consistency of freshly mixed concrete by the use of Slump Test.

Reference : IS: 7320-1974, IS: 1199-1959, SP : 23-1982

Theory :

The word ―workability‖ or workable concrete signifies much wider and deeper meaning than the other terminology ―consistency‖ often used loosely for workability. Consistency is a general term to indicate the degree of fluidity or the degree of mobility.

The factors helping concrete to have more lubricating effect to reduce internal friction for helping easy compaction are given below:

(a) Water Content (b) Mix Proportions (c) Size of Aggregates (d) Shape of Aggregates (e) Surface Texture of Aggregate (f) Grading of Aggregate (g) Use of Admixtures

Measurement of Workability

The following tests are commonly employed to measure workability.

Slump Test: Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete.

The pattern of slump is shown in Fig. It indicates the characteristic of concrete in addition to the slump value. If the concrete slumps evenly it is called true slump. If one half of the cone slides down, it is called shear slump. In case of a shear slump, the slump value is measured as the difference in height between the height of the mould and the average value of the subsidence.

Apparatus :

The Slump Cone apparatus for conducting the slump test essentially consists of a metallic mould in the form of a frustum of a cone having the internal dimensions as under: Bottom diameter : 20 cm, Top diameter : 10 cm, Height : 30 cm and the thickness of the metallic sheet for the mould should not be thinner than 1.6 mm

Weights and weighing device, Tamper (16 mm in diameter and 600 mm length), Ruler, Tools and containers for mixing, or concrete mixer etc.

Procedure :

1. Dampen the mold and place it on a flat, moist, nonabsorbent (rigid) surface. It shall be held firmly in place during filling by the operator standing on the two foot pieces. Immediately fill the mold in three layers, each approximately one third the volume of the mold.

2. Rod each layer with 25 strokes of the tamping rod. Uniformly distribute the strokes over the cross section of each layer.

3. In filling and rodding the top layer, heap the concrete above the mold before rodding start. If the rodding operation results in subsidence of the concrete below the top edge of the mold, add additional concrete to keep an excess of concrete above the top of the mold at all time.

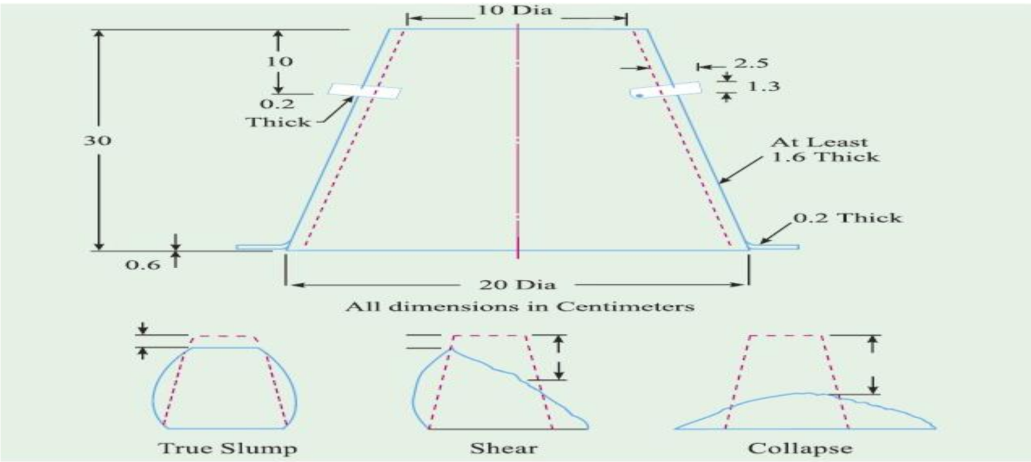
4. After the top layer has been rodded, strike off the surface of the concrete by means of screeding and rolling motion of the tamping rod.

5. Remove the mold immediately from the concrete by raising it carefully in the vertical direction. Raise the mold a distance of 300 mm in 5 ± 2 sec by a steady upward lift with no lateral or torsional motion.

6. Immediately measure the slump by determining the vertical difference between top of the mold and the displaces original center of the top surface of the specimen. Complete the entire test from the start of the filling through removal of the mold without interruption and complete it within 2½ min.

7. If a decided falling away or shearing off of concrete from one side or portion of the mass occurs, disregard the test and make a new test on another portion of the sample. If two consecutive tests on a sample of concrete show a falling away or shearing off of a portion of concrete from the mass of specimen, the concrete lacks necessary plasticity and cohesiveness for the slump test to be applicable.

8. After completion of the test, the sample may be used for casting of the specimens for the future testing.



Observation :

1. The vertical difference between top of the mold and the displaces original center of the top surface the specimen ………… mm

2. The pattern of slump is shown True Slump/Shear Slump/ Collapse Slump.

SPECIFICATIONS:

As per I.S: 456 the degree of workability is classified as follows.

Degree of workability	Slump
Very low	0mm to 25mm
Low	25mm to 50mm
Medium	50 mm to 100 mm.
High	100 mm to 175 mm.

EXPERIMENT 11

COMPACTION FACTOR TEST

Title : Determination Workability of Fresh Concrete By Compacting Factor Test

Objective : To determine the relative consistency of freshly mixed concrete by the use of Compacting Factor Test

Reference : IS; 1199-1959, SP : 23-1982

Theory :

Compacting Factor Test: The compacting factor test is designed primarily for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and is particularly useful for concrete mixes of very low workability as are normally used when concrete is to be compacted by vibration. The method applies to plain and air-entrained concrete, made with lightweight, normal weight or heavy aggregates having a nominal maximum size of 40 mm or less but not to aerated concrete or no-fines concrete.

Apparatus :

Compacting Factor Apparatus, Trowel, Scoop about 150 mm long., Balance capable of weighing up to 25 kg with the sensibility of 10 g. Weights and weighing device, Tamper (16 mm in diameter and 600 mm length), Ruler, Tools and containers for mixing, or concrete mixer etc.

Procedure :

1. The internal surface of the hoppers and cylinder shall be thoroughly clean and free from superfluous moisture and any set of concrete commencing the test.
2. The sample of concrete to be tested shall be placed gently in the upper hopper using the scoop. The trap door shall be opened immediately after filling or approximately 6 min after water is added so that the concrete fails into the lower hopper. During this process the cylinder shall be covered.
3. Immediately after the concrete has come to the rest the cylinder shall be uncovered, the trap door of the lower hopper opened and the concrete allowed falling to into the cylinder.
4. For some mixes have a tendency to stick in one or both of the hoppers. If this occurs the concrete shall be helped through by pushing the tamping rod gently into the concrete from the top.
5. The excess of concrete remaining above the level of the top of the cylinder shall then be cut off by holding a trowel in each hand, with the plane of the blades horizontal, and moving them simultaneously one from each side across the top of the

cylinder, at the same time keeping them pressed on the top edge of the cylinder. The outside of the cylinder shall then be wiped clean. This entire process shall be carried out at a place free from vibration or shock.

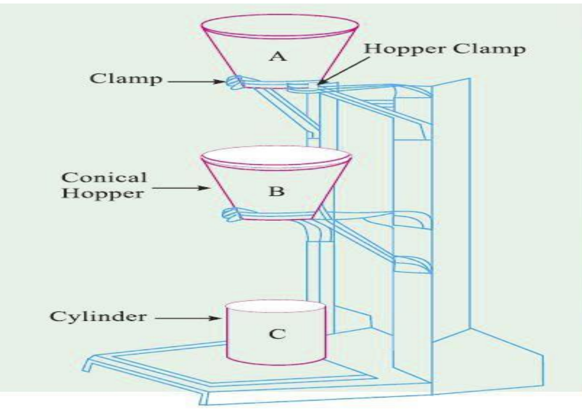
6. Determine the weight of concrete to the nearest 10 g. This is known as "weight of partially compacted concrete", W_p.

7. Refill the cylinder with concrete from the same sample in layers approximately 50 mm depth. The layers being heavily rammed with the compacting rod or vibrated to obtain full compaction. The top surface of the fully compacted concrete shall be carefully struck off and finished level with the top of the cylinder. Clean up the outside of the cylinder.

8. Determine the weight of concrete to the nearest 10 g. This is known as "weight of fully compacted concrete", W_f.

9. The compacting factor, Fc can be calculated as follows:

$$\text{The compacting factor} = \frac{\text{"weight of partially compacted concrete",W}}{\text{"weight of fully compacted concrete",W}}$$



Compacting Factor Apparatus

S. No.	W/C	W1	W2	W2-W1	W3	W3-W1	C.F. =(W2-W1 / W3-W1)
01							
02							

CALCULATIONS:

Weight of cylinder W1 =

Weight of cylinder + partially compacted W2 =

Weight of Partially compacted concrete (W2-W1) =

Weight of cylinder + fully compacted concreteW3 =

Weight of fully compacted concrete (W3-W1) =

Compacting factor (W2-W1) / (W3-W1). =

RESULTS:

Maximum workability of concrete is occurring at a water / cement ratio of ___________

SPECIFICATIONS:

According to IS 456, the degree of workability in classified as follows:

Degree of workability	**Compacting factor.**
Very Low	0.75 to 0.8
Low	.8-.85
Medium	.85-.92
High	.92 & above

EXPERIMENT 12

WORKABILITY OF CONCRETE - VEE BEE TEST

AIM: To find workability of concrete by Vee-Bee consistency test in terms of Vee Bee Seconds

APPARATUS:

Vee Bee consistometer, Stopwatch, Balance, Tray, Tamping rod, measuring jar, Weights and Trowels.

THEORY:

The consistometer is used for determining the consistency of concrete by vibrating and transforming a concrete specimen from the shape of conical frustum into a cylinder.

DESCRIPTION:

The consistometer consists of a

1. A vibrator table, which vibrates a rate of 3000 vibrations / min.
2. A metal pot, which holds the specimen when the concrete is vibrated. It is secured to the vibrator table by bolts.
3. Slump cone of 300 mm high, 200 mm at the bottom and 100 mm at the top (Open both ends).
4. Swivel arm holder: A tube, which is fixed the rear of the base of the vibrator table. It has 4 positioning slots for swivel arm to position the metal cone over the slump cone or Perspex disc on the specimen or to position both of them away.
5. Swivel arms the Swivel moves freely inside the swivel arm holder. A metal rod and a guide sleeve are fixed to the swivel arm. The graduated metal rod passes through the guide sleeve.
6. Metal cone - this is in the form of a frustum of cone with open ends (funnel). This is fixed to the swivel arm
7. Graduated rod
8. Tamping rod. A metal rod of 16 mm x 60 cm. long with one end bullet ended.

PROCEDURE:

1. Position the metal cone over the slump cone. Place the concrete inside the slump cone in 4 layers each approximately 1/4 of the height. Strokes are applied by the rounded end of the tamping rod. Distribute the strokes in a uniform manner over the cross section.
2. After the top layer has been rodded, position the metal cone of the swivel arm away, and strike off the concrete, level with the top of the cone using a trowel so that the mould is exactly filled.
3. Remove any material spilled inside the metal pot or sticking on to the side of the slump filled.
4. Position the Perspex disc over the cone and note down the reading on the graduated rod (L1). After keeping the disc away, lift the slump cone vertically and remove.
5. Position the disc over the concrete. Note down the reading of the graduated rod (L2). The difference in the readings gives the slump in Centimeters.
6. Switch on the vibrator starting a stopwatch simultaneously. Allow the concrete to spread out in the pot. When the whole concrete surface uniformly adheres to the Perspex disc, stop the watch, simultaneously, switch off the vibrator. Note down the time in seconds. Also note the reading on the graduated rod (L3).
7. The consistency of the concrete is expressed in Vee-Bee degrees which are equal to the time in seconds.
8. Repeat the procedure of different W/C ratios viz.: 0.4, 0.5, 0.55, 0.6 & 0.65.
9. Draw a graph between slump in centimeters and Vee - Bee Degrees.
10. Knowing the dia of the disc and the height of the concrete after Vibration (30+ L1 - L3), the Volume of the concrete can be computed.

Observation

S. No.	**W/C Ratio**	**Slump (mm)**	**Vee-Bee Seconds**

EXPERIMENT 13

CUBE COMPRESSIVE STRENGTH OF CONCRETE

AIM: To determine the compressive strength of concrete using 15 x 15 x 15 cm concrete cubes.

APPARATUS: Compressive testing machine, Balance, Trays, Weights, Moulds and Trowels.

PROCEDURE:

1. Place the cube at the centre of the lower platen of the compression testing machine in such a manner that the load shall be applied to opposite sides of the cube as cast, that is, not to the top and bottom.

2. The axis of the specimen shall be carefully aligned with the centre of the thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine.

3. The load shall be applied without shock and increased continuously at a rate of approximately 140kg/cm^2/min. until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.

4. The maximum load applied to the specimen shall then be recorded.

OBSERVATIONS: Measured side of cube= cm

Weight of the cube = kg.

Load at first crack = kg.

Load at ultimate failure = kg.

CALCULATIONS:

Compressive Strength = LOAD/Area

EXPERIMENT 14

Title : Determine Flexural Strength of Cubic Concrete Specimens

Objective : This clause deals with the procedure for determining the flexural strength of moulded concrete flexure test specimens

Referen : IS : 516 - 1959, IS: 1199-1959, SP : 23-1982, IS : 10086-1982

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 dry ingredients.

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

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. The permissible error shall be not greater than ± 2 percent of the maximum load.

Beam Moulds - The beam moulds shall conform to IS: 10086-1982. The standard size shall be 15 × 15 ×70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 19 mm, specimens 10 ×10 × 50 cm may be used.

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

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 -** The standard size shall be 15 × 15 × 70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 19 mm, specimens 10 × 10 × 50 cm may be used.

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 the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers.

9. The specimen shall then be placed in the machine in such a manner that the load shall be applied to the uppermost surface as cast in the mould, along two lines spaced 20.0 or 13.3 cm apart.

10. The axis of the specimen shall be carefully aligned with the axis of the loading device. No packing shall be used between the bearing surfaces of the specimen and the rollers.

11. The load shall be applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at approximately 7 kg/sq cm/min, that is, at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens.

12. The load shall be increased until the specimen fails, and the maximum load applied to the specimen during the test shall be recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure shall be noted.

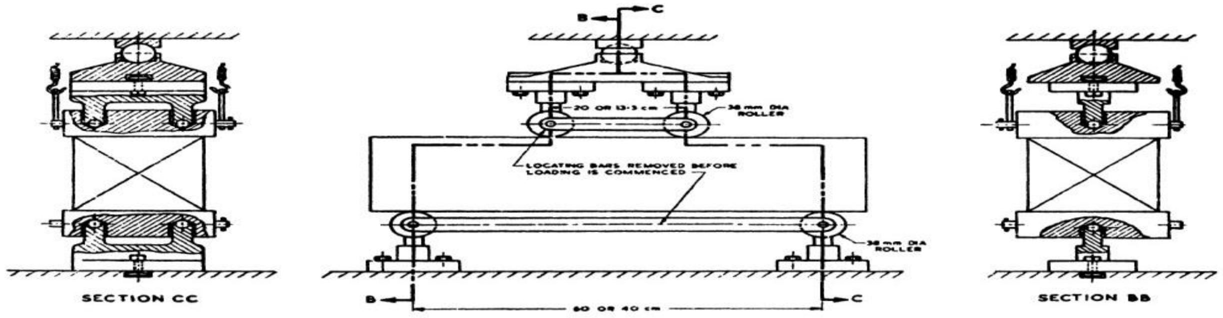


FIG. 3 ARRANGEMENT FOR LOADING OF FLEXURE TEST SPECIMEN

Sr. No.	Age of Specimen	Identification Mark	Size of Specimen	Span Length (mm)	Maximum Load (N)	Position of Fracture	Modulus of Rupture
1	7days						
2							
3							
4	28days						
5							
6							

Calculation :

The flexural strength of the specimen shall be expressed as the modulus of rupture f_b, which, if _a‘ equals the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen, in cm, shall be calculated to the nearest 0.5 kg/sq cm as follows:

$fb = PL/ad^2$

when _a‘ is greater than 20.0 cm for 15.0 cm specimen, or greater than 13.3 cm for a 10.0 cm specimen $fb = 3Pa/bd^2$

when _a‘ is less than 20.0 cm but greater than 17.0 cm for 15.0 cm specimen, or less than 13.3 cm but greater than 11.0 cm for a 10.0 cm specimen where

b = measured widthin cm of the specimen,

d = measured depthin cm of the specimen at the pointof failure,

l = length in cm of the span on which the specimen w as supported,and

p = maximum load in kg appl ed

Conclusion / R :

i) The average 7 Days Modulus of Rupture of concrete sample is found to be ……..…..

ii) The average 28 Days Modulus of Rupture of concrete sample is found to be ……..…..

EXPERIMENT 15

Title : Determine Splitting Tensile Strength of Cylindrical Concrete Specimens

Objective : This method covers the determination of the splitting tensile strength of cylindrical concrete specimens.

Reference : IS : 516 - 1959, IS: 1199-1959, SP : 23-1982, IS : 10086-1982

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 dry ingredients.

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

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. The permissible error shall be not greater than ± 2 percent of the maximum load.

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.

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 -** 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 the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with 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 an each end of the specimen using a suitable device that will ensure that they are in the same axial plane. Center 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 typeof failure and appearance of fracture

Fig.(19) The jig for aligning concrete cylinder and bearing strips

Fig.(20) Fitting the cylinder in the compression machine.

Calculation :

Calculate the splitting tensile strength of the specimen as follows:

T= 2Pl/ñd

Where T= split tensile strength

P :maximum applied load indicated by testing machine, kN

L :Length

d:diameter

Conclusion / R :

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

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