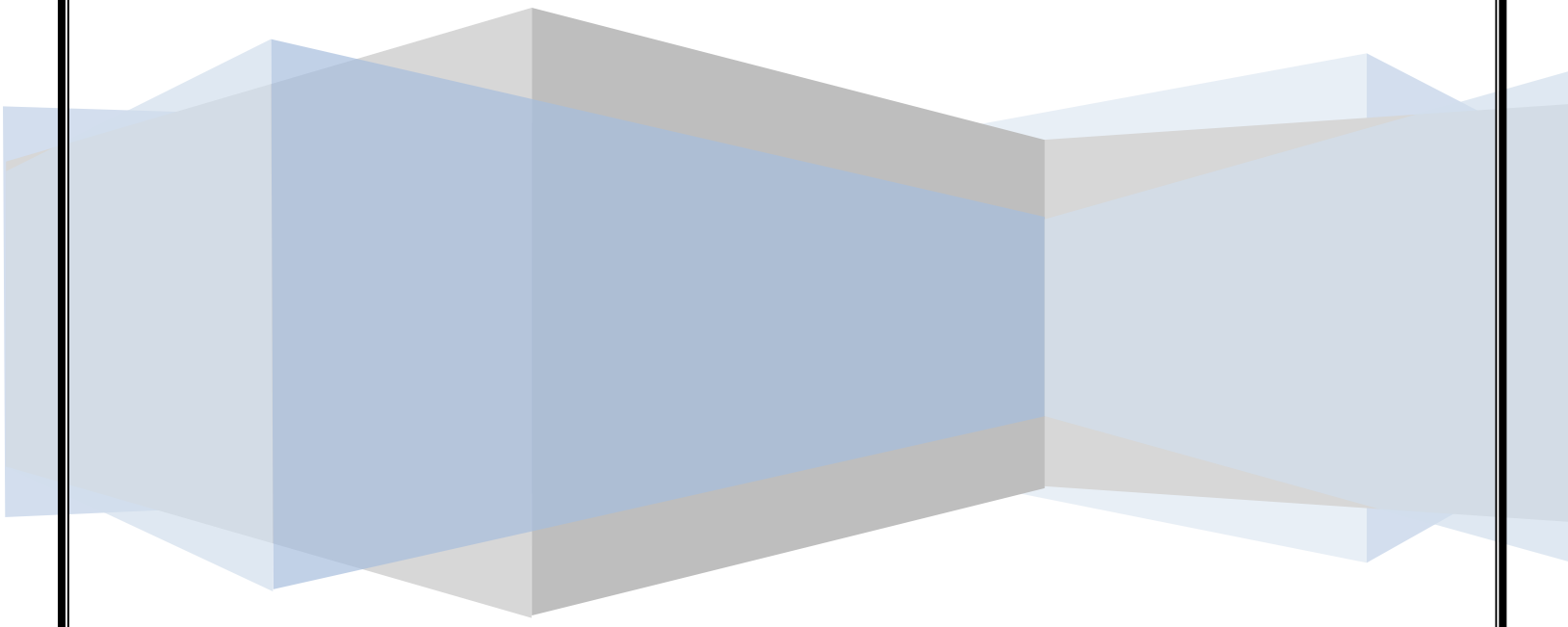
LABORATORY MANUAL

Civil Engineering Materials Lab

Department of Civil Engineering

Central University of Jharkhand, Ranchi



CONTENTS

EXPERIMENT NO. – 1

FINENESS OF CEMENT
(IS: 269-1989 and IS: 4031-1988)

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

APPARATUS REQUIRED: IS-90 micron sieve with lid & pan, balance, trowel, brush etc.

MATERIAL REQUIRED: Cement.

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.

PROCEDURE:

1. Weigh accurately 100 g of cement and place it on a standard 90 micron IS sieve.
2. Continuously sieve the sample giving circular and vertical motion for a period of 15 minutes.
3. Break down any air-set lumps in the cement sample between fingers without stop the sieve.
4. Weight the residue left on the sieve.

OBSERVATION:

S. No.	Weight of sample taken (g)	Weight of residue (g)	Fineness (%) $\frac{wt.\ of\ residue}{wt.\ of\ sample\ taken}$ x 100
1			
2			
3			

Average fineness of cement =.....%

RESULT: Fineness of given sample of cement =…… %.

LIMITS:

As per IS : 269 the residue of cement sample on the sieve 90 micron after sieving should not exceed the following % by weight for different types of cements :

- Ordinary Portland Cement - 10%
- Rapid hardening cement – 5%
- Low heat cement – 5%

IS SIEVE

TROWEL

EXPERIMENT NO. – 2

NORMAL CONSISTENCY OF CMENT
(IS: 269-1989 and IS: 4031- 1988(Part-4))

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

APPARATUS REQUIRED: Vicat's apparatus, plunger (dia. 10 mm & height 50 mm), Balance, measuring jar, Trowel, Stop Watch etc.

MATERIAL REQUIRED: Cement & water.

THEORY: The normal consistency of cement is defined as the percentage of water by weight of cement which produces a consistency which permits a plunger of 10 mm dia. To penetrate upto a depth of 5 mm to 7 mm above the bottom of vicat's mould. For finding out initial setting time, final setting time, soundness of cement and compressive strength of cement, it is necessary to fix the quantity of water to be mixed in cement in each case.

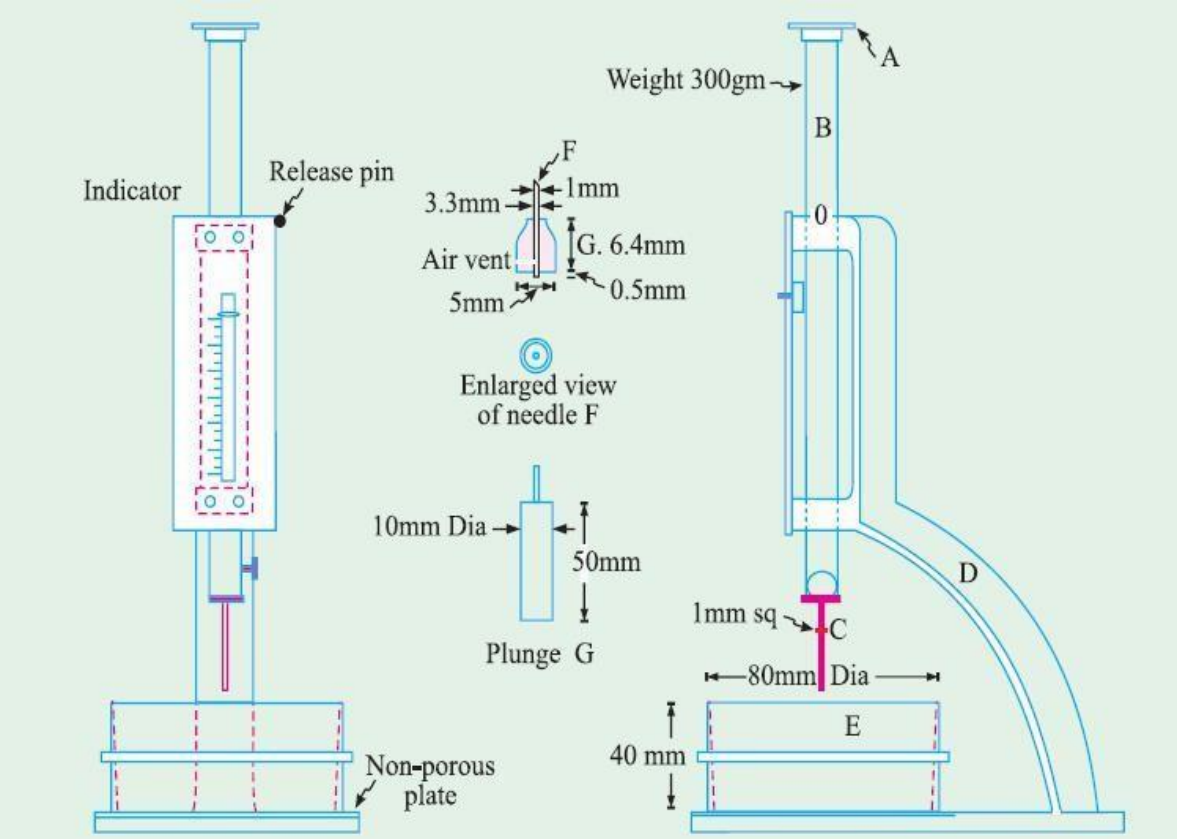
PROCEDURE:

1. Initially a cement sample of about 300 g is taken in a tray and is mixed with a known percentage of water by weight of cement; say 26% and then it is increased by every 2% until the normal consistency is achieved.
2. Prepare a paste of 300 g of cement with a weighed quantity of potable water or distilled water, taking care that the time of gauging is not less than 3 minutes, nor more than 5 minutes, and the gauging shall be completed before any sign of setting occurs. The gauging time shall be counted from the time of adding water to the dry cement until commencing to fill the mould.
3. Fill the Vicat mould with this paste, the mould resting upon a non-porous plate.
4. After completely filling the mould, trim of 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 percentage of water and test as described above until the amount of water necessary for making the standard consistency as defined above is obtained.

OBSERVATION TABLE:

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

RESULT: Normal consistency of cement for given sample of cement is…… %.



VICAT's APARATUS

EXPERIMENT NO. - 3

INITIAL AND FINAL SETTING TIME
(IS: 269-1989 and IS: 4031- 1988(Part-4))

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

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

MATERIAL REQUIRED: Cement water.

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 hasattained sufficient firmness to resist certain definite pressure.

PROCEDURE:

1. **Preparation of Test Block -** Prepare a neat 300 gm 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.

CALCULATION & OBSERVATION:

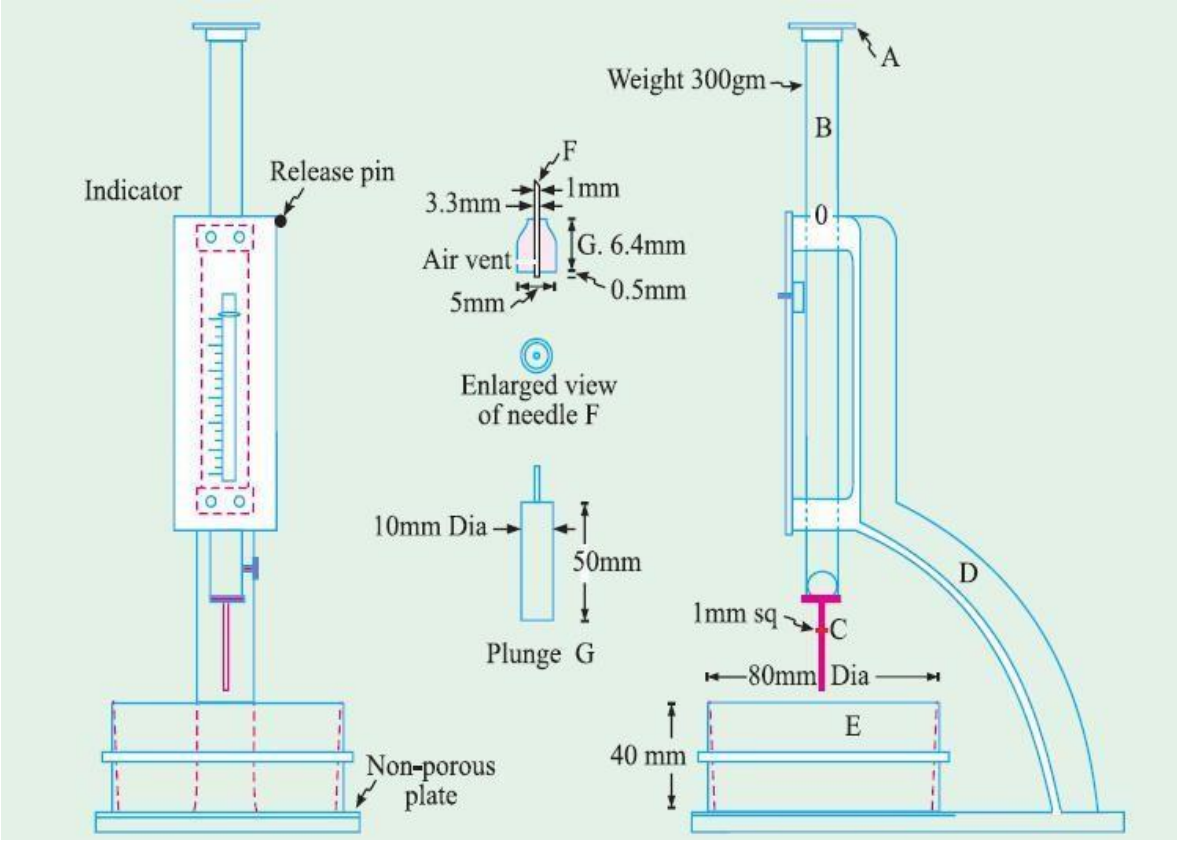
Weight of given sample of cement is _____ gm
The normal consistency of a given sample of cement is _____ %
Volume of water addend (0.85 times the water required to give a paste of standard consistency) for preparation of test block _____ ml

Initial Time - Final Time = ……..
Initial Time - Final Time = ……..

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 …..



VICAT's APPARATUS

EXPERIMENT NO. - 4

SOUNDNESS OF CEMENT
(IS: 269-1976 and IS : 4031- 1988 (Pat 3))

AIM: To determine the soundness of the given sample of cement by Le-Chatelier's method.

APPARATUS REQUIRED: Le- Chatelier test apparatus conform to IS : 5514-1969, Balance, measuring jar, Gauging Trowel, Water Bath etc.

MATERIAL REQUIRED: Cement & water.

THEORY: It is very important that the cement after setting shall not undergo any appreciable change of volume. Certain cements have been found to undergo a large expansion after setting causing disruption of the set and hardened mass. This will cause serious difficulties for the durability of structures when such cement is used. The unsoundness in cement is due to the presence of excess of lime than that could be combined with acidic oxide at the kiln. It is also likely that too high a proportion of magnesium content or calcium sulphate content may cause unsoundness in cement. Soundness of cement may be determined by two methods, namely Le-Chatelier's method and autoclave method

PROCEDURE:

1) Take 100 gm of cement sample and now water is added 0.78 times of standard consistency. Mix it uniformly. Mixing should not be complete within 3-5 minutes till cement paste of uniform consistency is formed.
2) The oiled mould is placed on an oiled glass plate and it is filled by cement paste.
3) Now cover the filled up mould with the other glass plate. A small weight 50 gm is placed at top and submerges the whole assembly in water at a temperature of 27 ± 2ºC for a period of 24 hours.
4) After 24 hours remove the whole assembly from water bath and measure the distance separating the indicator points.
5) Again submerge the whole assembly in water bath and bring the temperature of water bath to boiling temperature in 25 to 30 minutes. Keep it at boiling temperature for a period of 3 hours.
6) After completion of 3 hours, remove the mould from the water allow it to cool and measure the distance between the indicator points
7) The difference between these two measurements represents the expansion of the cement.

OBSERVATIONS:

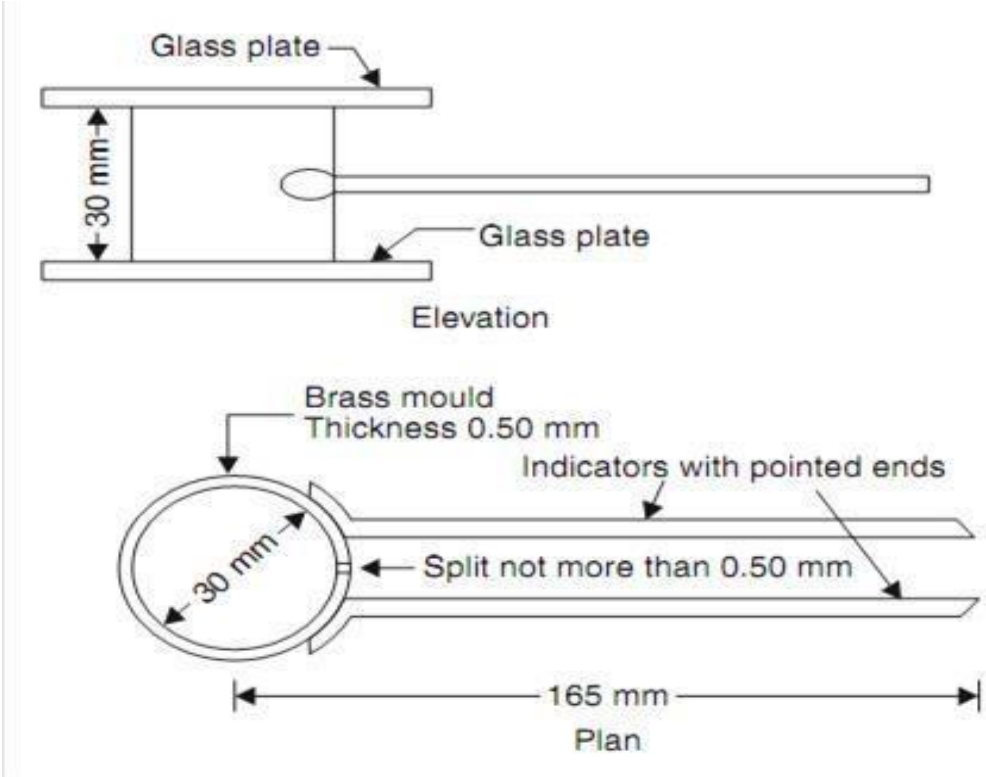
Initial distance between the indicator points (in mm) =

Final distance between the indicator points (in mm) =

Expansion (in mm) = final length - initial length =

RESULT: Expansion is ..... mm.

The given cement is said to be **sound / unsound.**



Le-Chatelier's Apparatus

EXPERIMENT NO. - 5

AGGREGATE IMPACT TEST

(IS : 2386 -1963 (Part IV))

AIM: To determine silt content in a given sample of fine aggregate by volume.

APPARATUS REQUIRED: An impact testing machine of the general form shown in Fig. and complying with the following:

1. A cylindrical steel cup of internal dimensions: Diameter 102 mm, Depth 50 mm and not less than 6.3 mm thick
2. 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.
3. 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.

4. Tamping Rod : 10 mm dia. And 230 mm length.
5. Sieve : 12.5 mm,10 mm & 2.36 mm
6. Balance : capacity not less than 500 g.
7. Oven : A thermostatically controlled drying oven capable of maintain constant temperature between 100°C & 110°C.

MATERIAL REQUIRED: Aggregate size passing of 12.5 mm & retained on 10 mm sieve.

THEORY: Toughness is the property of a material to resist impact. During the construction process of pavement layers, particularly compaction by heavy rollers and also due to movement of heavy wheel loads of traffic, the road aggregates are subjected to impact and there is possibility of some stones breaking into smaller pieces.

PROCEDURE :

1) The test sample consists of aggregates passing 12.5 mm sieve and retained on 10 mm sieve and dried in an oven for 4 hours at a temperature of 100°C to 110°C.
2) The aggregates are filled up to about 1/3 full in the cylindrical measure and tamped 25 times.
3) The rest of the cylindrical measure is filled by two layers and each layer being tamped 25 times.
4) The overflow of aggregates in cylindrical measure is cut off by tamping rod using it has a straight edge.
5) Then the entire aggregate sample in a measuring cylinder is weighed.

6) The aggregate from the cylindrical measure are carefully transferred into the cylindrical cup which is firmly fixed in position on the base plate of machine. Then it is tamped 25 times.
7) The hammer is raised until its lower face is 380 mm above the upper surface of aggregate in the cup and allowed to fall freely on the aggregate. The test sample is subjected to a total of 15 such blow each being delivered at an interval of not less than one second. Thecrushed aggregate is then removed from the cup and the whole of it is sieved on 2.36 mm ISsieve. Repeat the above steps with other fresh sample
8) Let the original weight of the oven dry sample be W_1 g and the weight of the fraction passing 2.36 mm IS sieve be W_2 g. Then aggregate impact value is expressed as the % of fines formed in term of total weight of sample.

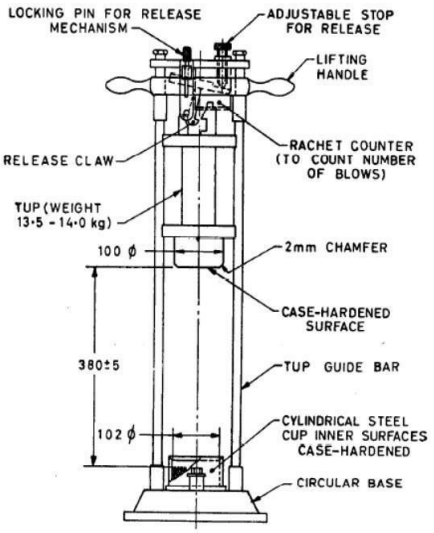
OBSERVATION TABLE :

Sample No.	Total wt. of dry sample, W_1 g	Wt. of aggregate passing 2.36 mm IS sieve after the test, W_2 g	Aggregate impact value = $\frac{W2}{W1}$ x 100 %	Average impact value (%)
1				
2				
3				

RESULT: Average Aggregate impact value = ... %.

LIMITS: 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 pavements.

Aggregate impact value, %	Toughness property
Less than 10	Exceptionally tough
10 to 20	Very tough
20 to 30	Good for pavement surface
Above 35	Weak for pavement surface



All dimensions in millimetres.

FIG. 2 AGGREGATE IMPACT TEST MACHINE

EXPERIMENT NO. - 6

SLUMP CONE TSET

(IS : 1199 -1959)

AIM : To determine the workability of concrete mix of given proportion by slump test.

APPARATUS REQUIRED: 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 theinternal 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.Trowel, Tamping rod (16 mm in diameter and 600 mm length), Ruler, Tools and containersfor mixing, or concrete mixer etc.

MATERIAL REQUIRED: Cement, sand, coarse aggregate & water.

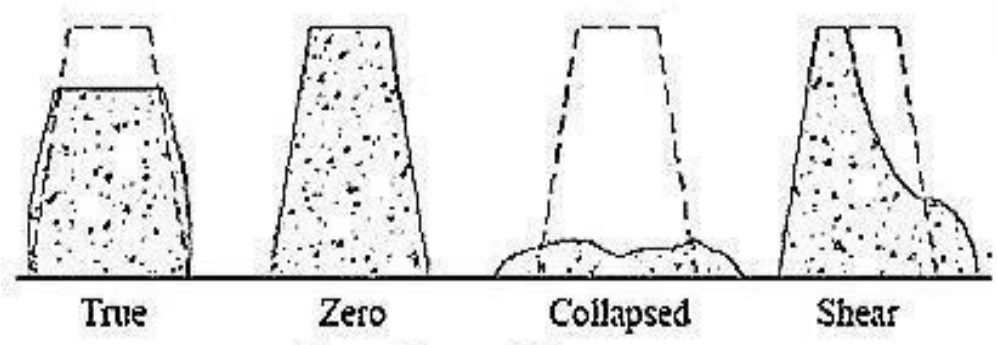
THEORY: Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It is suitable for medium workability concrete. Unsupported concrete, when it is fresh, will flow to the sides and a sinking in height will take place. This vertical settlement is called slump. Slump is a measure of workability. There are four types of slump-

i. ***True slump*** refers to general drop of the concrete mass evenly all around without disintegration.

ii. ***Zero slump*** concrete is defined in the same document, as concrete of stiff or extremely dry consistency showing no measurable slump after removal of the slump cone.

iii. ***Collapse slump*** indicates that concrete mix is too wet and the mix is regarded as harsh and lean.

iv. ***Shear slump*** indicates that the concrete lacks cohesion. It may undergo segregation and bleeding and thus is undesirable for the durability of concrete.



Four Types of Slump

Perform the test for w/c ratio of 0.6, 0.7 and 0.8. For each mix take 2.5 Kg. Cement, 5 Kg., FA and 10 Kg. C.A. (1:2:4).

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.

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.

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

RESULT : The slump of concrete …… mm indicate **very low /Low/ Medium/ High** Degree of workability

Recommended workability value

Degree of workability	Slump (in mm)
Very low	0 - 25
Low	25 – 50
Medium	50 – 100
High	100 - 150