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MATERIAL TECHNOLOGY LAB MANUAL

LIST OF EXPERIMENTS

1. Standard consistency of cement using Vicat`s apparatus.

2.A) Fineness of cement by Sieve analysis

B) Fineness modulus of coarse and fine aggregates.

3. Soundness of cement by Le-Chatelier`s apparatus.

4. Setting time of cement, initial and final of cement.

5. Compressive strength of cement.

6.A) Measurement of specific gravity of cement.

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8. Workability of cement concrete by (a) Slump test (b) Compaction factor test (c) Flowtable test.

9. Compressive strength of concrete by (a) Cube test, (b) Cylinder test

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11. Modules of rupture of concrete by flexure test.

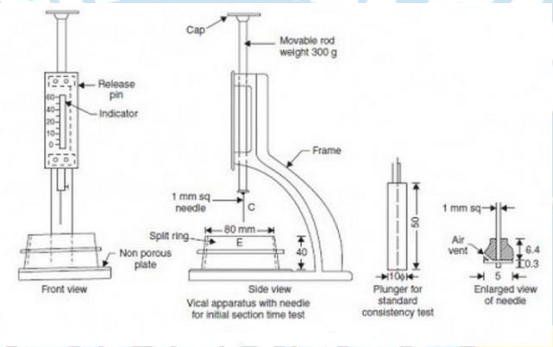
12.Bond strength between steel bar and concrete by pull-out test.

13.Non-destructive testing of concrete.

EXPERIMENT NO. 1

Aim:- To find the standard consistency of cement by using vicat apparatus.

Apparatus: - Vicat apparatus with vicat mould, vicat plunger and needles, gauging trowel, measuring jar,weighing balance, stop watch, rice plate, rubber glove and glass plate.



Theory :- The standard consistence of a cement paste is define as that consistency which will permit a vicat plunger having diameter 10 mm and length 50 mm to penetrate to a depth of 33-35 mm from the top of the mould. The apparatus is called vicat apparatus. This is used find out the percentage of water required to produce a cement paste of standard consistency of the cement paste is sometime called normal consistency (CPNC).

Procedure:-

1. Take about 500 gms. Of cement & Prepare a paste with a weighed quantity of water (up to 24% weight of cement) for first trial.
2. The paste is making with standard manner and filled into then vicat mould within 3-5 minutes.
3. Shake the mould to expel the air.
4. Put the mould on the vicat apparatus & brought the plunger down to tough the surface of the paste & quickly released allowing it to sink in to the paste by its own weight.
5. Take the reading on the indicator.
6. Similarly take the other reading by changing the % of water.
7. The minimum penetration of plunger is 33-35 mm from the top if exceed then our water cement ratio is incorrect.
8. Take the another sample for correct reading.

Precautions:-

1. Paste should be allowed for more than 3-5 minutes.
2. Mixture should not be made on the open surface or any rough surface because it absurd the water.
3. Take the reading accurately.
4. Used only fresh concrete.

Result:- The standard consistency of cement is determined.

EXPERIMENT NO. 2

Aim:-To determine the Fineness of cement by Sieve analysis

Materials Required:

- Cement sample
- Weighing balance
- Standard sieve set (sieve sizes – 90, 63, 45, 32, 22, 16, 12.5, and 9.5 micron)
- Sieve shaker
- Brush
- Tray
- Oven

Procedure:

1. Take a representative sample of cement weighing 100g (or as per the requirement of the standard).
2. Place the cement sample on a tray and dry it in an oven at a temperature of 100-110°C until it attains a constant weight. It may take 2-3 hours.
3. Take the dry sample out of the oven and allow it to cool to room temperature.
4. Weigh the dried sample and record the weight (W1).
5. Set up the sieve shaker and fix the sieve stack in it in the order of decreasing size of the sieves from top to bottom.
6. Pour the cement sample into the top sieve and place the lid on top of it.
7. Start the sieve shaker and allow it to operate for 10-15 minutes or until no further material passes through the sieves.
8. Weigh the residue left on each sieve and record the weights.
9. Calculate the percentage of cement retained on each sieve as follows:
   Percentage retained = (Weight of cement retained on the sieve/ Weight of the initial sample) x100
10. Calculate the cumulative percentage retained on each sieve by adding up the percentage retained on the current sieve to the percentage retained on the previous sieve.
11. Calculate the percentage of cement passing through each sieve as follows:

    Percentage passing = 100 - Percentage retained

12. Calculate the cumulative percentage passing on each sieve by adding up the percentage passing on the current sieve to the percentage passing on the previous sieve.
13. Plot a graph with cumulative percentage retained on the X-axis and sieve size on the Y-axis.
14. Determine the fineness modulus of the cement by summing up the cumulative percentage retained on each sieve and dividing it by 100.

Fineness modulus = (Cumulative percentage retained on all sieves / 100)

15. Report the fineness modulus of the cement as the average of three determinations.

Observations:

Table 1: Sieve Analysis of Cement

Sieve size (micron) Weight of cement retained (g) Percentage retained (%) Cumulative percentage retained (%) Percentage passing (%) Cumulative percentage passing (%)
90
63
45
32
22
16
12.5
9.5
Total

Calculations:

- Fineness modulus = (Cumulative percentage retained on all sieves / 100)

Precautions:

1. The sieve set should be cleaned and dried before use.
2. The sieve shaker should be properly calibrated before use.
3. The cement sample should be representative and should be thoroughly mixed before testing.
4. The sieving should be continued until no further material passes through the sieve.
5. The residue left on the sieve should be brushed carefully to avoid loss of cement particles.

Conclusion:

The sieve analysis of cement is an important test to determine the particle size distribution of cement. The fineness of cement affects its properties, such as strength, setting time, and workability. The fineness modulus is a measure of the fineness of cement and is calculated.

EXPERIMENT NO. 2(B)

Aim:- To determine the fineness modulus of fine aggregates and coarse aggregate.

Theory:

Fineness modulus is a numerical index used to know the mean size of particle in the total Quantity of aggregate. Fineness modulus is to grade the given aggregate for most economical mix and workability with less assumption of cement lower FM gives uneconomical mix and higher FM gives harsh mix. It is defined the average cumulative % retained by 100 was knownas fineness modulus

Apparatus:

Set of IS sieve, weighing balance, trays and mechanical sieve-shaker.

Fig. 6. Method of testing

Procedure:

1. Arrange the test services with larger openings at top and smaller openings at bottom andfinally below all keep a pan
2. Take 1 kg of sand in to a tray and break the lumps, if any in case of fine

aggregate and1kg of samples in the case of coarse aggregate and mixed aggregate.

3. Keep the sample in the top sieve and keep the total set in the top sieve and keep the totalSet in the shaker. Continue sieving for a period not less than 10 minutes.
4. Weigh the material retained on each sieve property.

Precautions:

Sample should be taken by quartering.

Careful sieving must be done to prevent any spilling of aggragate of aggregate

Graph: Draw a graph between IS sieve size (in log scale) and %passing. Specification: The following limits may be taken as guidance.

Fine sand : F.M—2.2—2.6

Medium sand : F.M—2.6—2.9

Coarse sand : F.M—2.9—3.2

Observations:

Weight of sample for fine aggregate=

Weight of sample for coarse aggregate=

Observation: Fine aggregate:

S.no.	IS sieve size	Wt. retained Gm	% retained	% passing	Cumulative % Retained
1	4.75mm				
2	2.36mm				
3	1.18mm				
4	600 μ				
5	300 μ				
6	150 μ				

Coarse aggregates:

S.no.	IS sieve size	Wt. retained Gm	% retained	% passing	Cumulative % Retained
1	80mm				
2	40mm				
3	20mm				
4	10mm				
5	4.75mm				
6	2.36mm				
7	1.18mm				
8	600 µ				
9	300 µ				
10	150 µ				

Result:

Fineness modulus of fine aggregate =

Fineness modulus of coarse aggregate=

EXPERIMENT NO. 3

Aim:-To determine Soundness of cement by Le-Chatelier`s apparatus.

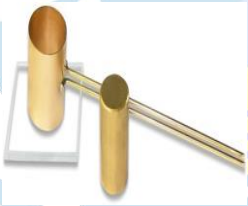
Theory:- It is very important that the cement after setting shall not undergo any appreciable change of volume. Certain cements have been found to undergo a large expansion after setting causing disruption of the set and hardened mass. This will cause serious difficulties for the durability of structures when such cement is used. The unsoundness in cement is due to the presence of excess of free 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 method and autoclave method.

In the soundness test a specimen of hardened cement paste is boiled for a fixed time so that any tendency to expand is speeded up and can be detected. Soundness means the ability to resist volume expansion.

Apparatus Required

Fig. 1: Le-Chateliers Apparatus

Le- Chatelier apparatus conforming to IS : 5514-1969



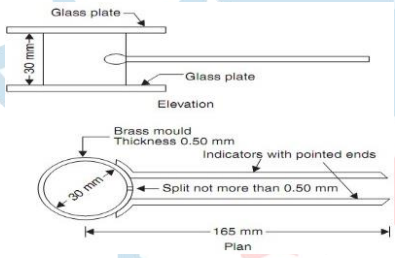


Fig. 2: Schematic of Le-Chateliers Apparatus

Consist of a small split cylinder of spring brass to other non-corrodible metal of 0.5mm thickness forming a mould of 30mm internal diameter and 30mm high. On either side of the split, two indicators are brazed suitably with pointed ends made of 2mm diameter brass wire in such a way that the distance of these ends to the centre of the cylinder is 165mm. The split cylinder will be kept between two glass plates. The temperature of the moulding room, dry materials and water shall be maintained at 27±2°C The relative humidity of the laboratory shall be 65 ± 5 percent. The moist closet or moist room shall be maintained at 27 ± 2°C and at a relative humidity of not less than 90 percent.

Fig. 3: Water bath

Water bath capable of containing immersed Le-Chatelier moulds with specimens and of raising their temperature from 27±2°C to boiling in 27±3 minutes.

Fig. 4: Vernier Calliper

Vernier Calliper should be able to measure upto 30 mm with least count of 0.1 mm

Fig. 5: Balance

On balance in use, the permissible variation at a load of 1000 g shall be ± 1.0 g. The permissible variation on new balance shall be one-half of this value. The sensibility reciprocal shall be not greater than twice the permissible variation.

Weights

The permissible variations on weights in use in weighing the cement shall be as prescribed in Table1.

Table 1 : Permissible Variations on Weights

Weight (g)	Permissible Variation on Weights inuse Plus or Minus(g)
500	0.35
300	0.30
250	0.25
200	0.20
100	0.15
50	0.10
20	0.05
10	0.04
5	0.03
2	0.02
1	0.01

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. [refer IS : 4031 (Part 4)-1988].
2. Cover the mould with another piece of lightly oiled glass sheet, place a small weight on this covering glass sheet and immediately submerge the whole assembly in water at a temperature of 27 ± 2°C and keep there for 24 hours.
3. Measure the distance separating the indicator points to the nearest 0.5 mm. Submerge the mould again in water at the temperature prescribed above.
4. Bring the water to boiling, with the mould kept submerged, in 25 to 30 minutes, and keep it boiling for three hours. Remove the mould from the water, allow it to cool and measure the distance between the indicator points.
5. The difference between these two measurements indicates the expansion of the cement. This must not exceed 10 mm for ordinary, rapid hardening and low heat Portland cements. If in case the expansion is more than 10 mm as tested above, the cement is said to be unsound.

Observation And Recording

Soundness/expansion of cement = L1-L2

L1=Measurement taken after 24 hours of immersion in water at a temp of 27± 2^0C

L2=Measurement taken after 3 hours of immersion in water at boiling temperature.

Calculate the mean of two values to the nearest 0.5 mm.

Discussions

1. In the event of cement failing to comply with the specified requirements, a further test should be madefrom another portion of the same sample in manner described above, but after aeration (done by spreading out to a depth of 75 mm and store it for 7 days in an atmosphere maintained at 27±2°C andrelative humidity of 50 to 80 percent).
2. Volume expansion in cement mortar or in cement concrete is caused by the presence of unburnt lime(CaO), dead burnt MgO and also $CaSO_4$.
3. By Le-chatelier method we can only find out presence of unburnt lime (CaO).
4. Presence of unburnt lime may develop cracks in the cement because of increase in volume.
5. Free lime (CaO) and Magnesia (MgO) are known to react with water very slowly and increase in volumeconsiderably, which result in cracking, distortion and disintegration.

EXPERIMENT NO. 4(A)

Aim:-To determine the initial setting time of cement.

Theory:

Initial setting time is the time when the paste starts losing its plasticity. And setting time is the timerequired for stiffening of cement paste to a defined consistency. It is the time taken for the cementpaste or cement concrete to harden sufficiently and attain the shape of the sculpt in which it is cast. In order that the concrete may be placed conveniently it is necessary that the initial setting time is not too quick and after is has been laid, hardening should be so that the structure can be made use of as early as possible. The initial set is a stage in the process of hardening after which any crack that may reappear will not unite.

Apparatus:

Vicat apparatus, vicat mould, needle, gauging, trowel, measuring jar, weighing balance, stopwatch, rice plate, rubber glove, nonporous glass plate.

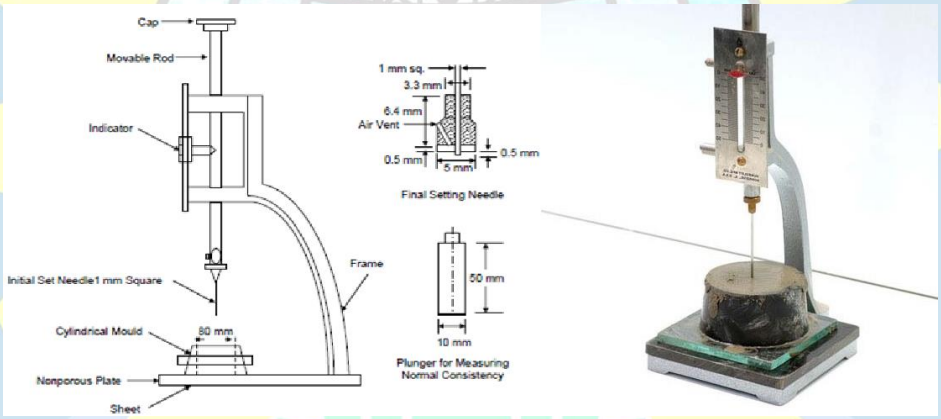


Fig. 3. Vicat apparatus with vicat mould

Procedure:

1. Prepared a neat cement paste by mixing with 85 water, P = standard consistency as foundbefore. The gauging is again kept between 3 to 5 minutes start the stop watch at the instantwhen the water is added to cement.
2. Filled the Vicat mould and smoothed the surface of the paste. Making level with the top ofthe mould.
3. Placed the test block in the mould resting on non-porous plate under the rod attached with the needle for initial setting time. Lowered the needle gently in contact with the surface of the test block. Quickly released allowing it to penetrate into the test block.
4. Repeated the procedure until the needle failed to pierce the block for about 5 mm measured from bottom of the mould for initial setting time test. The period elapsing between the time when water is added to the cement and the time at

which the needle fails to pierce the test block about 5 mm is the initial setting time.

Precautions:

1. Clean appliances shall be used for gauging.
2. Release the plunger gently.
3. The temperature of cement, water and that of test room, at the time when the above operations are being performed, shall be 27 ± 2 ºC.
4. For each repetition of the experiment fresh cement is to be taken.

Observation and Result:

Weight of cement taken = 400 gm

Weight of water taken = 0.85 × water obtained from standard consistency

1. No. of trials	1	2	3	4	5	6
2. Time taken (minutes)						
3. Initial reading (mm)						
4. Final reading (mm)						
5. Height not penetrated (mm)						

EXPERIMENT NO. 4(B)

Aim:-To Determine the final setting time of cement.

Theory:

Final setting time is that time period between the time water is added to cement and the time at which 1 mm needle makes an impression on the paste in the mould but 5 mm attachment does notmake any impression.

Apparatus:

Vicat apparatus, vicat mould, needle, trowel, measuring jar, weighing balance, stop watch, plate,rubber glove, nonporous glass plate.

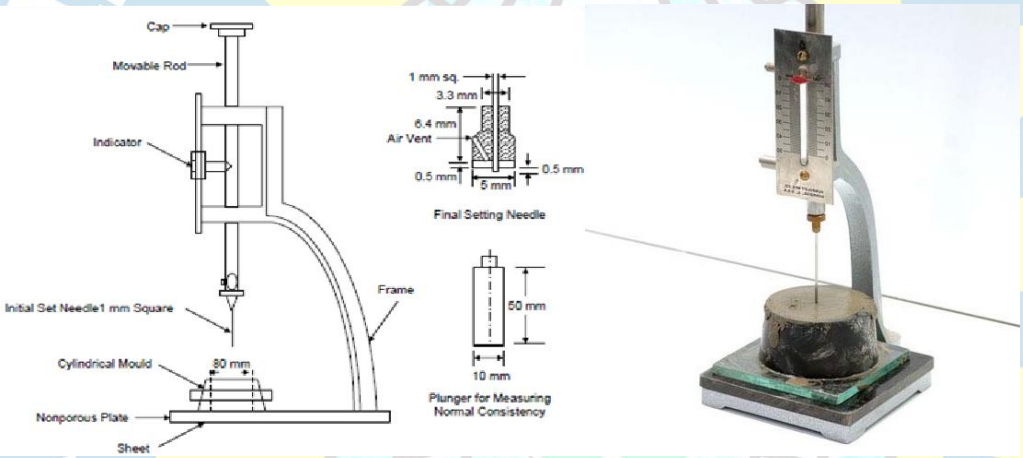


Fig. 4. Vicat apparatus with Vicat mould

Procedure:

1. Prepare a neat cement paste by mixing with 85 water, P = standard consistency as foundbefore. The gauging is kept between 3 to 5 minutes.
2. Start the stop watch at the instant when the water is added to cement.
3. Fill the Vicat mould and smooth the surface of the paste. Make level with the top of themould.
4. Place the test block in the mould resting on non-porous plate under the rod attached withthe needle for initial setting time.
5. Lower the needle with an annular attachment to get in contact with the surface of the testblock.
6. The cement is considered finally set when upon applying the final setting needle gently tothe surface of the test block; the needle makes an impression thereon, while the annular attachment fails to do so. Record this time.

Observation and Result:

Weight of cement taken = 400 gm

Weight of water taken = 0.85 × water obtained from standard consistency

1. No. of trials	1	2	3	4	5	6
2. Final reading time (minutes)						

EXPERIMENT NO. 5

Aim:- To determine the compressive strength of 1:3 cement and sand mortar cubes after 3 days and 7days curing.

Theory:

The compressive strength of cement is determined in order to verify whether the cement conforms to the above mentioned I.S code specifications and whether it will be able to develop the required compressive strength of concrete. According to the IS:269-1985, the ultimate compressive strength of cubes of cement and sand mortar in 1:3 proportion containing (P/4 + 3.5) % of water should beas follows:

After 3 days: Not less than 11.5 N/mm^2

After 7 days: Not less than 17.5 N/mm^2

Apparatus:

Universal testing machine or compressive testing machine, cube mould (7.16 cm side), vibrating machine, measuring cylinder trowels, non-porous plate and balance with weight box.

Fig. 5. Compressive Testing Machine

Procedure:

1. Taken the weight of the materials required. The material for each cube shall be mixed separately and quantities for one single cube are follows:
   cement = 185 gm, sand = 555 gm, water = (P/4+3.5) % of weight of cement and sand, where P is the % of water for standard consistency = 30%
2. Placed on a non-porous plate, the mixture of cement and sand in the proportion 1:3 by weight and mixed it dry with a trowel for one minute. Then mixed it with water until the mixture is of uniform color.
3. Placed the assembled mould in the table of vibrating machine and firmly put it in the position by means of suitable clamp.
4. Immediately after mixing the mortar filled the entire quantity of mortar in the mould andcompacted by vibration.
5. The period of vibrating should be ten minutes in the specific speed of 120 to 140 vibrationsper minutes.
6. Removed the mould from m/c and kept it at a temperature of 27±2° C in an

atmosphere ofat least 90% relative humidity for 24 hours after completion of vibrating.

7. At the end of that removed the cube from the mould and immediately submerged in cleanand fresh water and kept there until they are tussled.

Precautions:

1. Inside of the cube moulds should be oiled to prevent the mortar from adhering to the sidesof the mould.
2. Test three cubes for compressive strength at the periods mentioned under the relevantspecification.
3. Perform the standard consistency test of cement prior to this experiment.

Observation and Result:

Testing: Tested the cubes at the end of 3 days and 7 days.

Sl. No.	3 day strength		7 day strength	
	Load (kN)	Strength in N/mm^2	Load (kN)	Strength in N/mm^2

EXPERIMENT NO. 6

Aim:-To Determine of specific gravity of cement.

Theory:

The specific gravity of cement is the ratio of the weight of a given volume of substance to the weight of an equal volume of water. It is a number and denotes how many times a substance is heavy as water. To find the specific gravity of cement, it is required to find the weight of a certainvolume cement and the weight of an equal volume of water. As cement reacts with water its specific gravity is determined with reference to a non-reactive liquid like kerosene.

Apparatus: Le-Chatelier Flask (Specific gravity bottle), trowel, measuring jar, weighingbalance, plate, rubber glove.

Fig. 1. Le-Chatelier Flask

Procedure:

1. Clean and dry the specific gravity bottle and weigh it with the stopper (W_1).
2. Fill the specific gravity bottle with cement sample at least half of the bottle and weighwith stopper (W_2).
3. Fill the specific gravity bottle containing the cement, with kerosene (free of water)placing the stopper and weigh it (W_3).
4. While doing the above do not allow any air bubbles to remain in the specific gravitybottle.
5. After weighing the bottle, the bottle shall be cleaned and dried again.
6. Then fill it with fresh kerosene and weigh it with stopper (W_4).
7. Remove the kerosene from the bottle and fill it with full of water and weigh it withstopper (W_5).
8. All the above weighing should be done at the room temperature of 27 ^{0}C + 1^{0}C.

Observations:

Description of item	Trial 1	Trial 2	Trial 3
Weight of empty bottle W1 g			
Weight of bottle + Cement W2 g			
Weight of bottle + Cement + Kerosene W3 g			
Weight of bottle + Full Kerosene W4 g			
Weight of bottle + Full WaterW5 g			

Specific gravity of Kerosene $Sk = W_4 - W_1 / W_5 - W_1$……

Specific gravity of Cement $Sc = W_2 - W_1 / ((W4 - W1)-(W_3-W_2))*Sk$……

$Sc = (W_2 - W_1)* (W_4 - W1) / ((W_4 - W_1)-(W_3-W_2))*(W_5 - W_1)$……

Specific Gravity of cement = $\frac{(W2-W1)x(W4-W1)}{(W4-W1)x(W3-W2)x(W5-W1)}$

Note: Specific Gravity of kerosene =0.79

Precautions:

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

Result: Specific Gravity of Cement=

EXPERIMENT NO. 7

Aim:-To Determine of bulking of fine aggragate.

Theory:

When dry comes into contact with moisture, thin film is formed around the particles which causes them to get apart from each other. This will result in increasing volume of the sand. Thisphenomenon is known as bulking of sand. For this reason, if sand is measured by volume, bulking should be properly accounted.

Apparatus:

Weighing balance, weight box, mixing pan, measuring cylinder, rod for compaction.

Fig. 7. Weight box and rod for compaction**:** Bulking of sand

Procedure:

1. Taken 500 gm(W1) of sand passing through 1.18 mm sieve.
2. Kept the sample in an oven in a tray at a temperature of 100^{o}C-110^{o}C for 24±0.5 hours.3.
3. Cool the sand in air tight container and weight it(W2), water content of the sample is (W1-W2) ×100/W1 .
4. Taken out about 200 gm of sand and poured it into a pan.
5. Added 2% of water (by weight) and mixed well.
6. Poured the sand sample into a measuring cylinder.
7. Leveled the surface and read the volume in ml (h1).
8. Poured water into the measuring cylinder and completely inundated the sand and shakenit.
9. Leveled the surface and noted down the level in ml (h2).
10. Taken out the whole quantity of sand and continued the experiment by adding 2% water more each time and noted down the corresponding volume of sand until the dump sand volume starts decreasing.
11. Then (h1+h2) shows the bulking of the sample sand under test. Percentage of bulking = (h1-h2/h2) ×100 %

Precautions:

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

Observation and Result:

To draw the graph in between % of moisture added by weight along X-axis and % of increased volume along Y-axis. From the graph, the maximum % of bulking occurred to be picked, and % of water content at maximum bulking.

EXPERIMENT NO. 8

Aim:-To Determine workability of cement concrete by (a)slump test.

Equipment & Apparatus

1. Slum cone
2. Graduated cylinder
3. Balance
4. Vibrator
5. Vee bee apparatus
6. stop watch

Procedure:

1. Place the fresh concrete mix in the clean slump cone in four equal layers, tamping each layer 25 times with the tamping rod in a uniform manner the cross section. For the 2 nd and subsequent layers the rod should penetrate into
2. the under lying layers during such tamping. 3
3. Strike - off the top of concrete flush with the mould with a trowel so that it is exactly filled.
4. Remove the metallic cone by raising it slowly and carefully in a vertical direction. As soon as the concrete settlement stop measure the subsidence of concrete in mm.

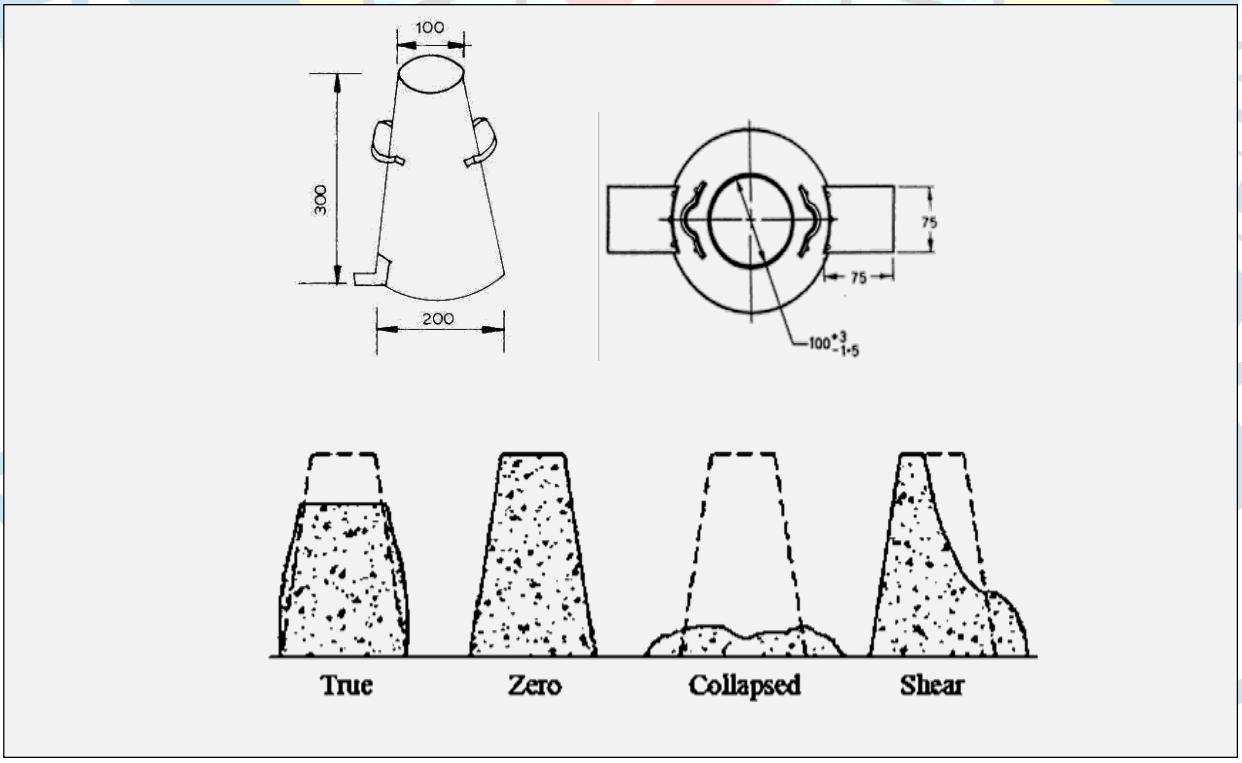


TABLE 1

Sl no	Degree of Workability	Slump (mm)	Compaction Factor	Situation
1.	Very Low	0-25	0.78	Roads vibrated by power operated machines. Concrete may be compacted with hand
2.	Low	25-50	0.85	Road vibrated by hand operated machine For more workability mix concrete may be manually compacted in road using rounded Or irregular shapes. Mass concrete Foundations without vibration or lightly Reinforced sections with vibrations.
3.	Medium	50-100	0.95	For less workable concrete's, manually Compacted flat slabs using crushed Aggregate. Normal reinforced concrete Manually compacted and highly reinforced Section with vibration.
4.	High	100-175	0.95	For section with congested reinforcement. Not normally suitable for vibration.

Safety & Precautions:

1. Use hand gloves, safety shoes & apron at the time of test.
2. After test switch off the machine.

3. Keep all the exposed metal parts greased.
4. Keep the guide rods firmly fixed to the base & top plate.
5. Equipment should be cleaned thoroughly before testing & after testing.

Result:

Slump = mm

(B)Compaction Factor test

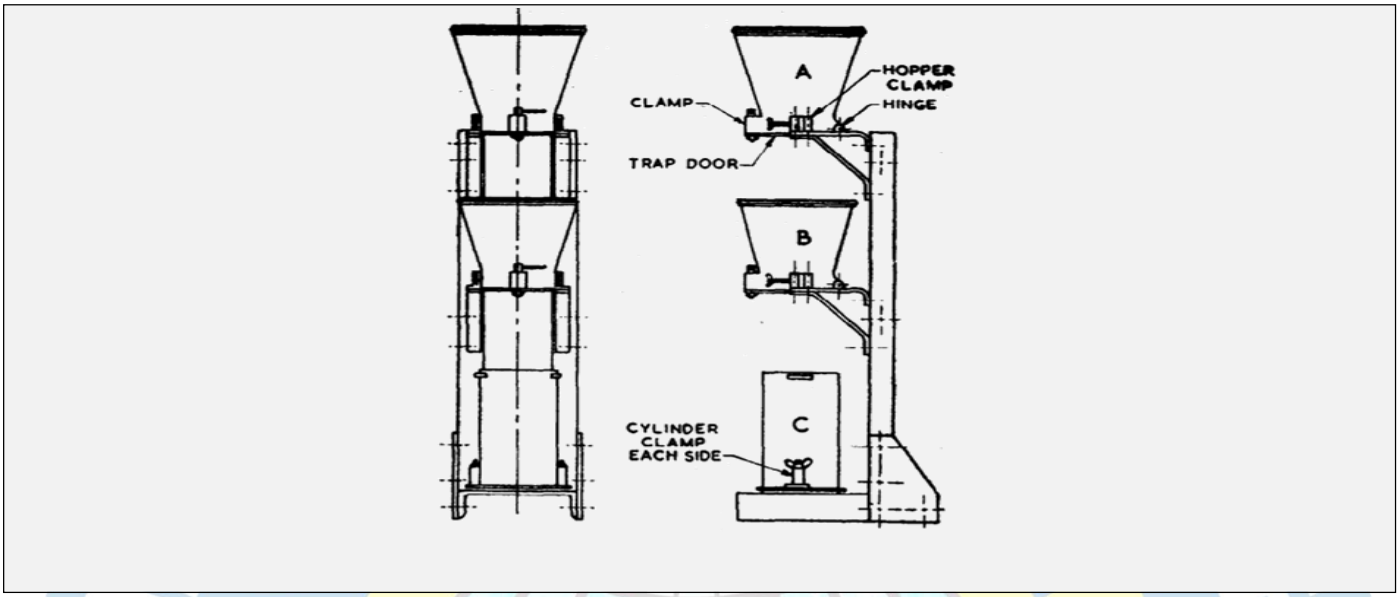
Aim: To assess the workability of given concrete mix by compaction factor test.

Equipment & Apparatus

1. Compaction factor apparatus
2. Graduated cylinder
3. Balance
4. Vibrator
5. Vee-Bee apparatus
6. stop watch
7. spatula
8. Trowel
9. Tamping rod

Procedure:

1. Keep the compaction factor apparatus on a level ground and clean the inner surface of thehopper and cylinder. Fasten the hopper trap door.
2. Weigh the empty cylinder accurately (W1). Fix the cylinder on the base with fly – nut and bolt in such a way that central axes of the hoppers and cylinder lie in one vertical line.
3. Fill the freshly mixed concrete in the upper hopper gently and carefully with a hand scoop without any compacting effort. After 2 minutes release the trap door so that the concrete may fall in to the lower hopper bringing concrete to some degree of compaction.
4. Immediately after the concrete has come to rest in this hopper open its trap door andallow the concrete to fall into the cylinder.
5. Remove the excess concrete above the top of the cylinder by a pair of trowels with blades kept horizontal. Clean the cylinder from all the sides properly and weigh it to find the weigh of this partially compacted concrete (W2).
6. Refill the cylinder with the same sample of concrete in approximately 5 cm thick lawyers using mechanical vibration so as to expel all the air in it order to obtain full compaction. Level up the top and weigh this cylinder to get the weight of fully compacted concrete (W3}.



Compaction factor test

Observations and Calculations:

Note: The proportion of various in gradients in the concrete mix are, cement, sand, coarseaggregate, water and admixtures, if any.

$$\text{Compaction factor (CF)} = \frac{W2 - W1}{W3 - W1}$$

Safety & Precautions:

1. Use hand gloves, safety shoes & apron at the time of test.
2. After test switch off the machine.
3. Keep all the exposed metal parts greased.
4. Keep the guide rods firmly fixed to the base & top plate.
5. Equipment should be cleaned thoroughly before testing & after testing.

Result:

Compaction factor of concrete=

(C)Flow table test of concrete

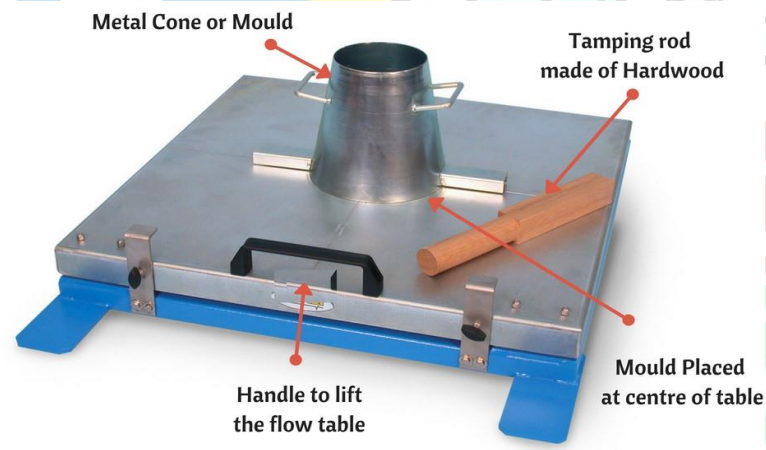
Aim: To assess the workability of given concrete mix by flow table test.

As the name suggests, in this test the workability of concrete is determined by examining the flowing property of concrete. Flow table test of concrete also determines the Quality of Concrete concerning its consistency, cohesiveness and the proneness to segregation. As there are two methods to find the flow value of concrete which one is outdated. Here we are explaining the new method of flow table test.

Apparatus

Flow table made of metal having thickness 1.5mm and dimensions 750mmx 750mm, tamping rod made of hardwood, Scoop, Centimeter Scale, Metal Cone or mould (Lower Dia = 20cm, upper Dia = 13 cm, Height of Cone = 20cm). The middle portion of flow table is marked with a concentric circle of dia 200mm to place a metal cone on it. A lift handle

The more details about Flow table is depicted in the below image go through it if required



Flow Table Test of Concrete

Procedure :

1. Prepare concrete as per mix design and place the flow table on a horizontal surface.
2. Clean the dust or other gritty material on Flow table and Sprinkle a hand of water on it.
3. Now place the metal cone at the middle portion of the flow table and stand on it.
4. Pour the freshly mixed concrete in the mould comprising two layers; each layer should be tamped with tamping rod for 25times. After tamping the last layer, the overflowed concrete on the cone is struck off using a trowel.
5. Slowly, lift the mould vertically up & let concrete stand on its own without any support.
6. The flow table is raised at the height of 12.5mm and dropped. The same is repeated for 15times in 15secs.

7. Measure the spread of concrete in Diameter using centimetre scale horizontally and vertically. The arithmetic mean of the two diameters shall be the measurement of flow in millimetres.

Calculations: $= \frac{D1+D2}{2}$

EXPERIMENT NO. 9

Aim:-To Determine compressive strength of concrete by (a)cube test.

Apparatus: Moulds for the test cubes, tamping rod, metallic sheet, Compressive testing machine

Material: Cement, sand, aggregate and water, grease

Procedure:

Compressive testing machine

1. Calculate the material required for preparing the concrete of given proportions
2. Mix them thoroughly in mechanical mixer until uniform colour of concrete isobtained
3. Pour concrete in the lightly greased cube moulds.
4. Fill concrete in two layers each of approximately 75 mm and ramming eachlayer with 35 blows evenly distributed over the surface of layer.
5. Struck off concrete flush with the top of the moulds.
6. Level the concrete at the top of the mould by means of trowel and give properidentification mark of the specimen.
7. Immediately after being made, they should be covered with wet mats.
8. Specimens are removed from the moulds after 24hrs and cured in water. Keepit for curing up to 28 days.

Testing of concrete cubes:

1. Take the cube out of water at the end of three days with dry cloth. Measure the dimensions of the surface in which the load is to be applied. Let be 'L' and 'B' respectively.
2. Place the cube in compressive testing machine and apply the load uniformly atthe rate of 35N/mm2.
3. Note the load at which the cube fails. Let it be 'P'. Also note the type

offailure and appearance cracks

4. Calculate the compressive strength of the cube by using formula P/A. WhereA is the area of loaded surface (i.e. L×B).
5. Repeat the same procedure (steps 9 to 12) for other two cubes.
6. Repeat the whole procedure (Step 9 to 13) to find the compressive strength of the cube at the end of 7 days and 28 days.

Observation

(a) For 3 days strength:

Sl. No.	Length (in mm)	Breadth (in mm)	Load (in N)	compressive strength in N/mm^2	Remark
1					
2					
3					

Average =

(b) For 7 days strength:

Sl. No.	Length (in mm)	Breadth (in mm)	Load (in N)	compressive strength in N/mm^2	Remark
1					
2					
3					

Average =

(c) For 28 days strength:

Sl. No.	Length (in mm)	Breadth (in mm)	Load (in N)	compressive strength in N/mm^2	Remark
1					
2					
3					

Average =

Results:

The type and grade of concrete :

The compressive strength of cement at the end of

i) 3 days :_____. N/mm^2.

ii) 7 days :_____. N/mm^2.

iii) 28 days :_____. N/mm^2.

(b)Cylinder test

Aim:-To Determine compressive strength of concrete by (b)Cylinder test

Apparatus: Moulds for the test cubes, tamping rod, metallic sheet, Compressive testing machine

Material: Cement, sand, aggregate and water, grease

Procedure

1. The concrete cylinder is cast for standard size and allowed to cure for 28 days. Three specimens of the same dimension are cast for testing.
2. Takeout the specimen from the curing tank.
3. Wipe out the excess water from the surface of the specimen.
4. Place the specimen vertically on the platform of compression testing machine. Uniform load application and distribution is facilitated by having pad caps at the ends of the cylinders.
5. Before starting to apply the load, make it sure that the loading platforms touch the top of the cylinder.
6. Apply the load continuously and uniformly without shock at the rate of 31.5 kN/min. And continue the loading until the specimen fails.
7. Record the maximum load taken.
8. The test is repeated for the remaining two specimens.

Sr. No.	Age of Specimen	Identification Mark	Dia of Specimen (mm)	Depth (mm)	Maximum Load (N)	Tensile Strength(MPa)	Average Tensile Strength (MPa)
1	7 Days						
2							
3							
4	28 Days						
5							
6							

EXPERIMENT NO. 9

Aim:-To Determine indirect strength of concrete-split cylinder test.

APPARATUS:

1. Compression testing machine
2. tamping rods
3. weighing device
4. Tools and containers for mixing
5. Tamper

REFERENCE CODE:

1. IS:456:2000 code of practice for plain and reinforced concrete
2. IS:5816:1999 Method of test for split tensile strength of concrete

THEORY:

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack.

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. Centre one of the plywood strips along the centre 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 cantered over the plywood strip.
13. Place a second plywood strip lengthwise on the cylinder, cantered on the lines marked on the ends of the cylinder. Apply the load continuously and without shock, at a constant rate within, the range of 689 to 1380 kPa/min splitting tensile stress until failure of the specimen
14. Record the maximum applied load indicated by the testing machine at failure. Note the type of failure and appearance of fracture

OBSERVATION AND CALCULATION:

1) Mix proportion =……..
2) Date of casting=…….
3) Date of Testing=…….
4) Age of concrete=…….

Trail No	Wt. of specimen kg	Diameter of specimen mm	Length of Specimen mm	Failure load P mm	Split tensile strength
1					
2					

Calculate the splitting tensile strength of the specimen as follows:

$$T = \frac{2P}{\Pi DL}$$

where

D: diameter

L : Length, m

P : maximum applied load indicated by testing machine,kN

T : splitting tensile strength,

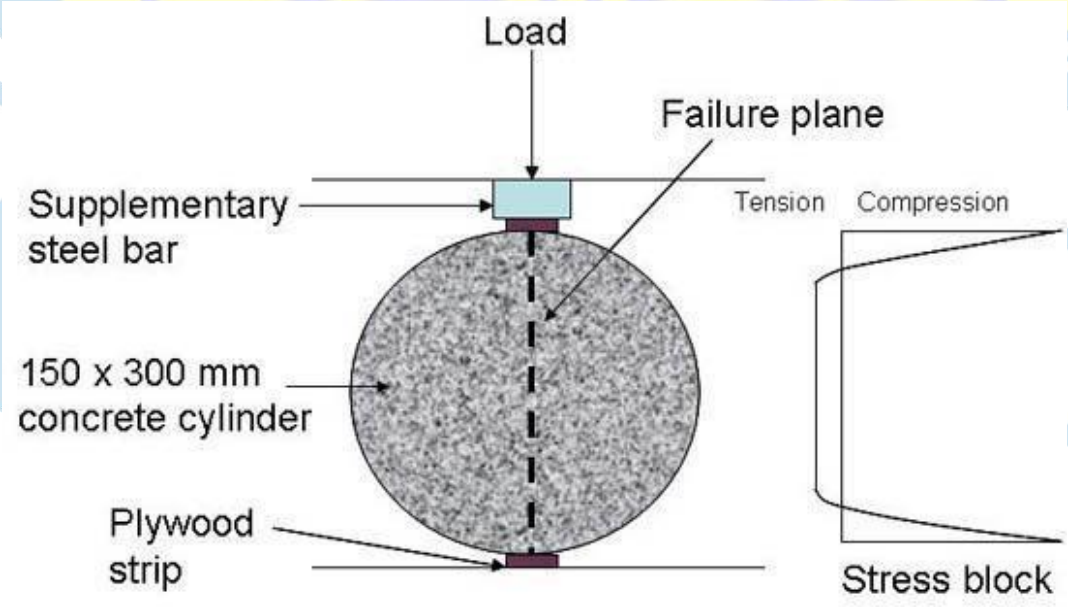


Fig.: Loading Arrangement for Determining Split Tensile Strength

RESULT:

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 ……..

EXPERIMENT NO. 10

Aim:-To Determine modulus of rupture of concrete by flexural test.

Theory:

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam to resist failure in bending. It is measured by loading 150 x 150 mm concrete beams with a span length of 700 mm. This test is performed by three point loading experiment. The Third point loading test applies the forces at the 1/3 and 2/3 points equally from the top side by distributing a single centred force through a steel beam to two points rather than one. The beam is supported at two points from below near the ends. The bending moment is lower in a third point test than in a centre point test. Highway designer use a theory based on flexural strength for design of pavements. However, there is very limited use of flexural testing for structural concrete. Figure 9 shows a typical test arrangement for flexural strength test.

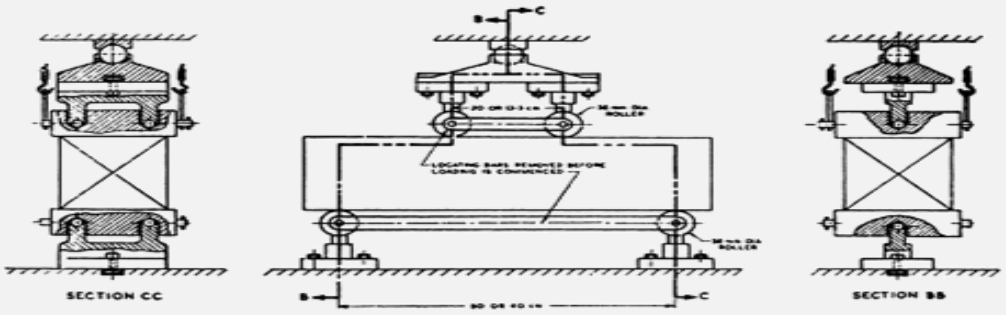


Figure 9: Arrangement for loading of flexure test specimen

Flexural strength tests are extremely sensitive to specimen preparation, handling, and curing procedure. Beams are very heavy and can be damaged when handled and transported from the jobsite to the lab. Allowing a beam to dry will yield lower strengths. The beams must be cured in a standard manner, and should be tested while wet. Meeting all these requirements on a job site is extremely difficult and hence often results in unreliable and generally low MR values. A short period of drying can produce a sharp drop in flexural strength.

Apparatus: Flexural testing beam moulds, tamping rod, metallic sheet, universal testing machine.

Material: Cement, sand, aggregate and water, grease

Procedure:

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

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

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

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

5. Mould: The 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

orother 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 loadingdevice. No packing shall be used between the bearing surfaces of the specimenand 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.

Observation

- Length of Specimen (*l*) :_____mm
- Width of the specimen (*b*) :_____mm
- Depth of the specimen (*d*) :_____mm

Sl. No.	Age of specimen	Maximum load (P) in N	Position of Fracture (*a*) in mm*	Modulus of rupture (f_b)** (MPa)
	7 days			
	28 days			

* '*a*' equals the distance between the line of fracture and the nearer support, measured onthe centre line of the tensile side of the specimen.

** When *a*> 200 mm for a 150 mm specimen, the flexural strength of the specimen expressed as the modulus of rupture, f_b, is calculated from:

$$ff_b = \frac{P \times l}{a \times d^2}$$

But, if 200> *a*> 170 mm for a 150 mm specimen f_b, is calculated from:

$$ff_b = \frac{P \times l}{b \times d^2}$$

Results:

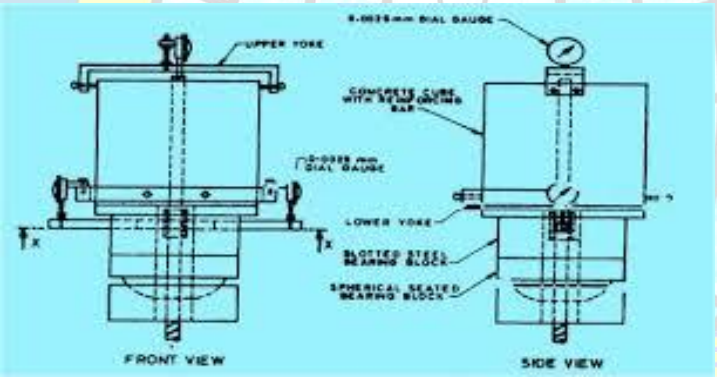
- The average 7 days modulus of rupture of concrete sample is :_MPa
- The average 28 days modulus of rupture of concrete sample is :_MPa

EXPERIMENT NO. 11

Aim:- To determine the bond strength between steel bars and concrete by pull-out test.

Apparatus

- Beam mould (100 mm x 150 mm x 1830 mm)
- Cylinder mould (dia = 150 mm & height = 300 mm)
- Aligning stand
- 50 KN (5 tons) transverse testing machine or a loading reaction frame
- 100 KN (10 tons) universal testing machine with pullout test arrangement
- Dial gauges
- Tamping bar
- Trowels
- Graduated jar
- Platform weighing balance
- Concrete mixer
- Table vibrator



APPARATUS FOR BOND STRENGTH TEST

Procedure

1. Prepare 1:2:4 concrete mix and having water cement ratio equal to 0.6. for this take 17 kg cement, 34 kg sand, 68 kg coarse aggregate and 10.2 kg of water.
2. Cast the concrete beam of size 100 m x 150 mm x 1830 mm. using two 10 mm bars having an effective cover of 12.5 mm and overlapping of 200 mm in the middle. The four pieces of bars will have hooks at one end only. Cast three cubes along with the beam for finding crushing strength of concrete.
3. Cast three cylinders upto a height of 200 mm with a 10 mm dia rod placed at the centre of cylinder.
4. Remove the specimens from the moulds after 24 hours and put them in water. Test the beam after 27 days of wet curing applying the load gradually on 50 KN transverse testing machine or on a loading reactions frame. Test the three cubes in compression.

5. Perform the pull out test on 100 KN universal testing machine using pull out test attachment at 28 days age.
6. Attach a dial gauge for finding out the slip between steel and concrete and plot the curve between load and slip.
7. Note the load at 0.125 mm slip and at bond failure.

Observation & Calculation

Record observations in the table as given below.

R.C. Beam Test

Load at first crack (N)

Ultimate load at bond failure, **P** (N)

Maximum B.M. at first crack (Nm)

Maximum B.M. at failure (Nm)

Actual effective depth (mm)

Crushing Strength of concrete (N/mm^2)

Ultimate bond stress

Calculate ultimate bond using the following formula

$$\sigma_{bu} = P_b / (\pi \times d \times l)$$

where,

σ = ultimate bond stress

P_b = Bond failure load

d = dia of bar

l = length of bar (in this case it is 200 mm)

Pull Out Test

Load at 0.125 mm slip (P_1)

Load at bond failure (P_2)

Average bond strength at 0.125 mm slip (N/mm^2)

Average bond strength at failure (N/mm^2)

Average bond strength at 0.125 mm slip = P_1 / (π*d*l)

Average bond strength at failure = P_2 / (π*d*l)

EXPERIMENT NO. 12

Aim:- To determine the non destructive testing of concrete

APPARATUS:

1. Rebound Hammer instrument.
2. Abrasive Stone

PROCEDURE:

Hold the instrument firmly so that the plunger is perpendicular to the test surface. Gradually push the instrument toward the test surface until the hammer impacts. After impact, maintain pressure on the instrument and if necessary depress the button on the side of the instrument to lock the plunger in its retracted position. Read the rebound number on the scale to the nearest whole number and record the rebound number. Take ten readings from each test area. No two impact tests shall be closer together than 25 mm (1 in). Examine the impression made on the surface after impact, and if the impact crushes or breaks through a near-surface air void, disregard the reading and take another reading.

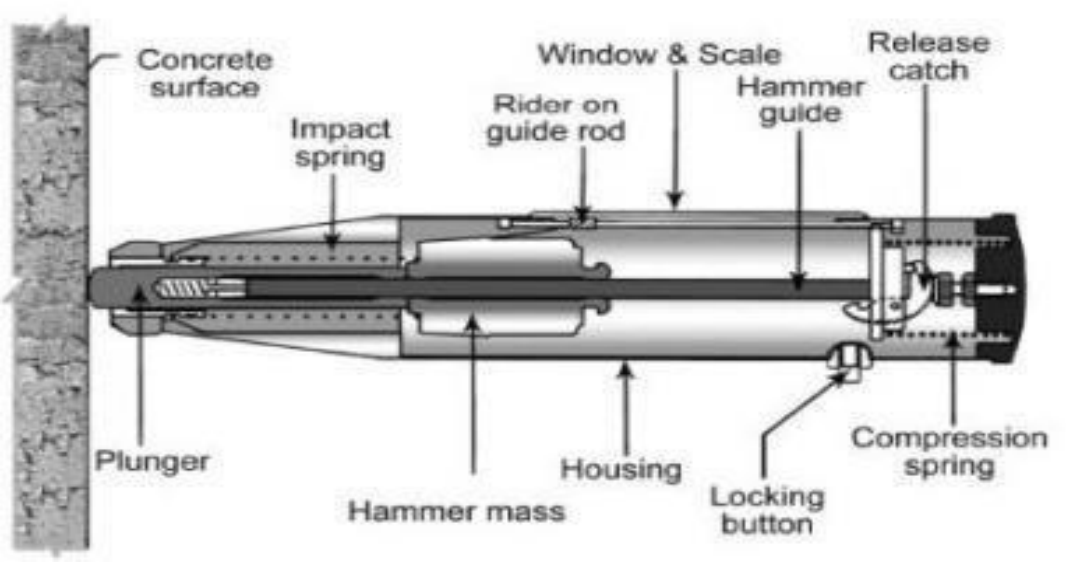


Fig.: Rebound Hammer

READING YOUR RESULTS:

Make at least ten readings from a concrete surface and discard the highest and lowest rebound numbers. Average the remaining eight numbers. If desired, take a few test readings before you complete your series of ten regular tests. Use the average rebound number to estimate the strength of the concrete. Compare your

average rebound number to the chart shown on your Concrete Rebound Hammer.

Average Rebound Number	Quality of Concrete
>40	Very good hard layer
30 to 40	Good layer
20 to 30	Fair
<20	Poor concrete

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