MATERIAL TESTING LABORATORY MANUAL

Semester- 4th

Code- PCI4I201

Department of Civil Engineering

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LABORATORY RULES AND REGULATIONS

1. **General Rules**

a. Be alert and proceed with caution at all times in the laboratory.

b. Do not touch any equipment, other materials in the laboratory area until you are instructed to do so.

c. Do not operate machinery unless you have received instructions on their correct usage

d. Students are not allowed to do any load test on test frame, without supervision by the project supervisor.

e. Clear away the rubbish and clean up the work area and apparatusprovided for each experiment after use.

f. Clean up the machine after use.

g. Do not abuse the equipment and tools.

h. Any damage to equipment or apparatus must be reported immediately to the duty personnel.

i. Waste material should be disposed off properly.

j. Exercise extreme care when handling sharp-pointed or sharp-edged tools.

k. All accidents that occur in the laboratory must be reported.

l. Report all breakage, and tools and machines that are faulty.

m. Do not use tools that are blunt or in poor condition.

n. You must always concentrate/ focus on your work and know where the Emergency switch is located.

Experiment no.-1

SHAPE AND SIZE TEST FOR BRICK

AIM OF THE EXPERIMENT:-

To test the shape and size of the brick in laboratory.

THEORY AND SCOPE:-

Bricks are the most commonly used construction material. In this test randomly collected 20 bricks are staked along lengthwise, width wise and height wise and then those are measured to know the variation of sizes as per standard. Bricks are closely viewed to check if its edges are sharp and straight and uniform in shape. A good quality brick should have bright and uniform colour throughout.

For good quality bricks the result should be within the following permissible limits.

Length: 3680 mm to 3920 mm

Width: 1740 mm to 1860 mm

Height: 1740 mm to 1860 mm

APPARATUS REQUIRED:-

Measuring tape (steel tape)

MATERIALS REQUIRED:-

Bricks

PROCEDURE:-

- Collect randomly 20 number of bricks of standard size.
- Stack these bricks along lengthwise, measure the length of 20 bricks and note down its length.
- Stack along the width, measure the width of 20 bricks and note down the measurement.
- Stack along the height, measure the height and note down the measurement.

OBSERVATIONS AND CALCULATION:-

The measured length (M_l) of 20 bricks = -------- mm

The measured width (M_w) of 20 bricks = ---------- mm

The measured height(M_h) of 20 bricks = ---------- mm

Error Calculation:

(i) Length calculation

Measured length (M_l) if exceeds permissible limit take M_l = ----- mm

Permissible value (P_v) = 3920 mm

Error = $M_l - P_v$

% of error =[($M_l - P_v$)/ 3920] X 100 = --------%

(ii) Width calculation

Measured length (M_w) if exceeds permissible limit take M_w = ----- mm

Permissible value (P_v) = 1860 mm

Error = $M_w - P_v$

% of error = [($M_w - P_v$)/ 1860] X 100 = --------%

(iii) Height calculation

Measured length (M_h) if exceeds permissible limit take M_h = ----- mm

Permissible value (P_v) = 1860 mm

Error = $M_h - P_v$

% of error = [($M_h - P_v$)/ 1860] X 100 = --------%

RESULT:-

The measured length (M_l) is found to be ---- mm.

The measured width (M_w) is found to be ---- mm.

The measured height(M_h) found to be ---- mm.

CONCLUSION:-

The number of standard size brick is less or more due to randomly collected different size of bricks.

PRECAUTIONS:-

- The bricks should be collected of uniform size.
- The bricks should not fall down from the stack.

Experiment no.-2

WATER ABSORPTION TEST FOR BRICK

AIM OF THE EXPERIMENT:-

To test the water absorption of standard brick.

THEORY AND SCOPE:-

Bricks are made up of earthen components. Therefore when exposed to moisture tend to absorb but when this water content is evaporated from the brick, salt deposit appears on the surface of the brick giving a white layer. The absorption of water of a standard brick (190 mm X 90 mm X 90 mm) should be less than 16% by weight in 24 hrs.

APPARATUS REQUIRED:-

Weighing balance (sensitive to 0.1 gm), trowel, tray, oven, water bath

MATERIALS REQUIRED:-

Brick, cement, sand, water

PROCEDURE:-

- Take the sample of 3 bricks and dry these in the oven at a temperature of 110-115^{0}C for at least 48 hours. These are then allowed to cool in the oven with the oven switched off until they reach ambient room temperature and then each weighed on the weighing balance and the dry weight of sample is taken as W_1.
- Place each specimen in turn in the water bath allowing water freely to circulate on all sidesfor 24 hours.
- Remove all the specimens and allow to dry to saturated surface dried condition and weighed on the balance. The weighing should be completed within 2 minutes from their removal from the bath and the weight of the sample is taken as W_2.

OBSERVATIONS AND CALCULATION:-

Dry weight of brick (W_1) in Kg							
Weight of brick after immersing in water for 24 hrs (W_2) in Kg.							
Water absorption ($\frac{(W2-W1)}{W1}$) X 100 in Kg							
Average water absorption							

RESULT:-

The water absorption is found to be ----- %

CONCLUSION:-

Hence the water absorption value is within the permissible limit.

PRECAUTIONS:-

- The bricks should be collected of uniform size.
- The bricks should be fully immersed in water.

REFERENCE:

IS: 5454 – Method of sampling for clay building bricks.

IS: 1077 – Common burnt clay building bricks- Specification.

Experiment no.-3

COMPRESSIVE STRENGTH OF BRICK

AIM OF THE EXPERIMENT:-

To determine the compressive strength of bricks.

THEORY AND SCOPE:-

Bricks are the most commonly used building blocks used in construction works as masonry walls, paving bricks or in floorings where these are primarily subjected to compressive stresses. The strength of masonry wall is dependent uponthe basic strength of bricks as well as mortar. Therefore it is important to test the bricks for their compressive strength to assess the load carrying capacity of structural units constructed out of them. As per IS: 1077-1970, the minimum crushing strength of bricks is 3.5 N/mm^2 (50 kg/ cm^2) and bricks having compressive strength less than 5 N/mm^2 (50 kg/cm^2) are not used for structural works.

The common bricks are classified on the basis of their average compressive strength as given in the following table:

Class designation based on compressive strength	Average compressive strength not less than	
	N/mm^2	Kg/cm^2 (approx)
35	35	350
30	30	300
25	25	250
20	20	200
17.5	17.5	175
15	15	150
12.5	12.5	125
10	10	100
7.5	7.5	75
5	5	50
3.5	3.5	35

The compressive strength of any individual brick tested is not to fall below the minimum compressive strength specified for the corresponding class of bricks by more than 15 percent.

APPARATUS REQUIRED:-

Compression testing machine, Weighing balance (sensitive to 0.1 gm), trowel, tray, damp jute bags

MATERIALS REQUIRED:-

Bricks as per IS: 5454, cement, coarse sand of grade 3mm and down, water

PROCEDURE:-

- Take randomly 5 no.of bricks and measure its dimension.
- The bricks specimens are immersed in water at room temperature (25^0C to 29^0C) for 24 hours.
- Then remove the specimens and drain out any surplus moisture at room temperature.
- The frogs and all the voids in the bed face are filled with cement mortar 1:1 (1 cement, (1 clean coarse sand of grade 3mm and down).
- The bricks arestored under damp jute bags for 24 hours followed by immersion in clean water for 3 days.
- Then remove the bricks from the water.
- Test the sample by keeping the mortar filling face upwards and flat face horizontal in compression testing machine and note down the crushing load.

OBSERVATIONS AND CALCULATION:-

Compressive strength= $\frac{Maximum\ \ load\ at\ failure}{Average\ area\ of\ bed\ faces}$

Sl No.	Avg. Size of the specimen			Area of bed faces	Max^m load at failure	Compressive strength= $\frac{Maximum\ \ load\ at\ failure}{Average\ area\ of\ bed\ faces}$	Avg. Compressive strength
	L	B	H				

RESULT:-

The average compressive strength of bricks = ------ N/mm^2

CONCLUSION:-

The average compressive strength of bricks is within the permissible limit.

PRECAUTIONS:-

- The bricks should be collected of uniform size.

- The frog and all the void spaces are to be properly filed with cement mortar so as to give a plane surface for loading.
- After filling the frog and any other voids the bricks should be fully immersed in water.
- The testing sample should be placed with flat face horizontal and mortar face facing upwards and the load is to be applied centrally.

REFERENCE:

IS: 5454 – Method of sampling for clay building bricks.

IS: 1077 – Common burnt clay building bricks- Specification.

Experiment no.-4

FINENESS OF CEMENT

AIM OF THE EXPERIMENT:-

To determine the fineness of a cement sample by sieving through a 90-micron IS sieve. / The aim is to determine the fineness or surface area per gram of the cement by Blaine's air permeability method.

(I) Using 90 μ Sieve

THEORY AND SCOPE:-

The degree of fineness of cement is a measure of the mean size of the grains in cement. The rate of hydration and hydrolysis and consequent development of strength in cement mortar depends upon the fineness of cement. The finer cement has quicker action with water and gains early strength though its ultimate strength remains unaffected. However,the shrinkage and cracking of cement will increase with the fineness of cement.

APPARATUS REQUIRED:-

90 micron IS Sieve (conforming to IS: 460 part-I), pan, weighing balance (sensitive to 0.1 gm)

MATERIALS REQUIRED:-

Cement free from any air lump.

PROCEDURE:-

- Take 500 gm of cement (W_1) in a plate and weigh accurately and transfer it to a clean dry IS test sieve by breaking down of any air set lumps.
- Then sieve the cement with gentle wrist motion until most of the fine material passed through and the residue looked fairly clean.
- Take the weight of the residue as W_2.

Figure 1: 90 µ IS sieve

OBSERVATIONS AND CALCULATION:-

Mass of cement taken on IS sieve=500 gm

Mass of residue after sieving=gm

Fineness=(Mass of residue in gms/Mass of cement taken on IS sieve) percent

= (W_2/W_1) X 100

RESULT:-

Residue of cement is -------- percent.

CONCLUSION:-

The cement is suitable for use in construction as the fineness of the cement is less than 10%.

PRECAUTIONS:-

- Any air set lump in the sample should be broken down with fingers but it should not be rubbed on the sieve.
- The sieve must be cleaned thoroughly before starting the experiment.
- The care should be taken to ensure that no cement is spilled. After sieving all residue must be taken out carefully and weighed.

(II) Using Air Permeability apparatus

THEORY AND SCOPE:

Fineness of cement is also determined by air permeability method. For example, in this method a known volume of air is passed through the cement. The time is recorded and the specific surface is calculated by formula. Fineness is expressed in terms of specific surface of the cement (mm^2/gm). For Ordinary Portland Cement (all grades) specific surface is 225,000 mm^2/gm.

The fineness of cement is measured as specific surface. Finer cement offers a greater surface area for hydration and hence faster the development of strength (Fig. 2). Specific surface is expressed as the total surface area in square meters of all the cement particles in one kilogram of cement. The higher the specific surface is, the finer cement will be. Principle of air permeability method is in observing the time taken for fixed quantity of air to flow through compacted cement bed of specified dimension and porosity. Under standardized conditions the specific surface of the cement is proportional to $t^{0.5}$ where t is the time for given quantity of air to flow through compacted cement bed. The number and size range of individual pores in the specified bed are determined by the cement particle size distribution which also determine the time for the specified air flow.

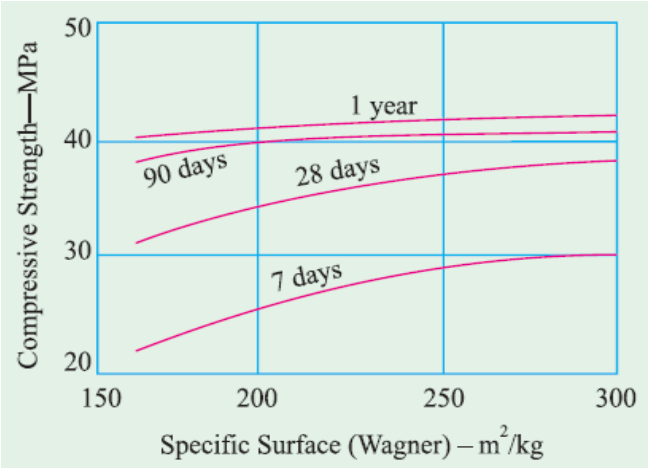

Figure 2: Graph of compressive strength vs specific surface of cement

Specific surface S is expressed as

$$S = \frac{\rho_0}{\rho} \times \frac{(1-e_0)}{(1-e)} \times \sqrt{\frac{e^2}{{e_0}^2}} \times \sqrt{\frac{0.1\eta_0}{0.1\eta}} \times \sqrt{\frac{t}{t_0}} \times S_0$$

Where e = porosity

ρ = density of the cement

ρ_0= density of standard cement

η_0= Air viscosity at the mean of three temperature for standard cement (Pa-s)

η= Air viscosity at the test temperature

t= Measure time for the cement under test

t_0= Mean of three times measured on standard cement

e_0= porosity of cement bed

e= porosity of reference cement bed

APPARATUS REQUIRED:-

Blain air permeability confirming to IS: 5516, Weighing balance, Timer

PROCEDURE: -

- Place the perforated disc on the ledge at the bottom of the cell and place on it a new filter paper disc. Place the weighed quantity of standard cement, W, in the cell taking care to avoid loss. Place a second new filter paper disc on the levelled cement. Insert the plunger and press it gently but the lower face of the cap is in contact with the cell. Slowly withdraw the plunger, rotate it through 90^0 and press once again. The bed is now compacted and ready for permeability test.
- Test is performed on the Blaine apparatus (see Fig.). It is practically manometer in the U-tube form. One arm of the manometer is provided at the top with conical socket to form an airtight fit with the conical surface of the cell. The same arm has four etched lines M_1 to M_4 and T-joint , which lead to an airtight stopcock beyond which is attached aspiration rubber bulb.
- Manometer is filled to the level of the lowest etched line with non-volatile, non-hygroscopic liquid of low viscosity and density.
- Insert the conical surface of the cell into the socket at the top of the manometer.
- Open the stopcock and with gentle aspiration raise the level of the manometer liquid to that of the highest etched line. Close the stopcock and the manometer liquid will begins to flow. Start the timer as the liquid reaches the second etched line and stop it when the liquid reaches the third etched line. Record the time, t and the temperature, T.
- The procedure repeats three times

- Calculate three values of the specific surface and mean of them.

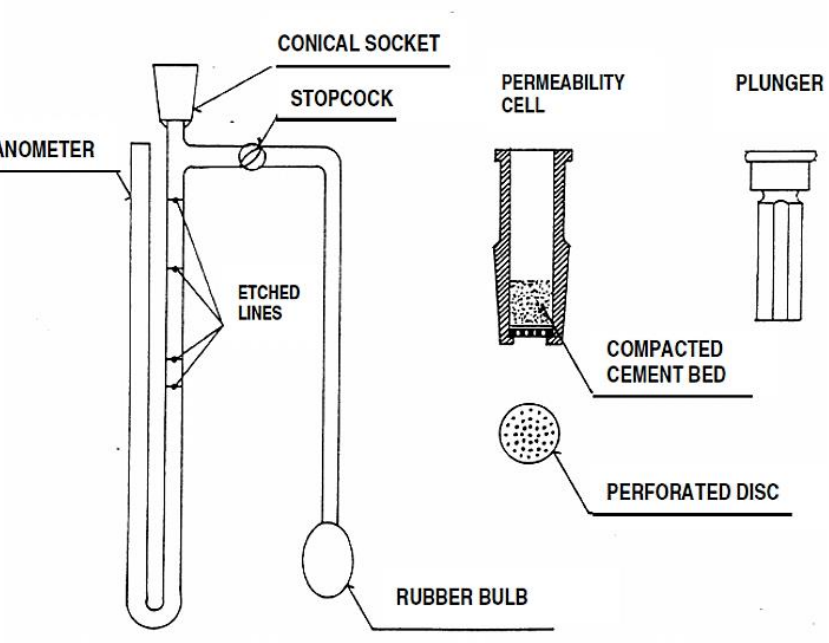

Figure 3: Blaine air permeability apparatus

OBSERVATIONS AND CALCULATION:-

Weight of cement required- ρ x v x (1-e) gm

Standard cement specific surface = S_0 (cm^2/gm)

Fineness S =

$$S = \frac{\rho_0}{\rho} \times \frac{(1-e_0)}{(1-e)} \times \sqrt{\frac{e^2}{{e_0}^2}} \times \sqrt{\frac{0.1\eta_0}{0.1\eta}} \times \sqrt{\frac{t}{t_0}} \times S_0$$

Where e = porosity

ρ = density of the cement

ρ_0= density of standard cement

η_0= Air viscosity at the mean of three temperature for standard cement (Pa-s)

η= Air viscosity at the test temperature

t= Measure time for the cement under test

t_0= Mean of three times measured on standard cement

e_0= porosity of cement bed

e= porosity of reference cement bed

RESULT:-

The specific surface of cement is ---------- mm^2/gm**.**

PRECAUTIONS:-

1. Take care to avoid loss when placing the weighed quantity of cememnt.
2. Take care when compact the cement by the plunger.
3. Carefully note down the reading.

REFERENCE:-

1. IS:460 (part-I)- Specification for test sieves
2. IS: 3535 (part-I)- Method of sampling hydraulic cement
3. IS: 4031 (part-I)- Method of physical test for hydraulic cement; Determination of fineness by dry sieving.
4. IS: 4031 (part-II)- Method of physical test for hydraulic cement; Determination of fineness by air permeability apparatus.

Experiment no.-5

STANDARD CONSISTENCY OF CEMENT

AIM OF THE EXPERIMENT:-

To determine the standard consistency of a given cement sample by Vicat apparatus.

THEORY AND SCOPE:-

The object of conducting this test is to find out the amount of water to be added to the cement to get a paste of normal consistency,i.e.,the paste of a certain standard solidity which is used to fix the quantity of water to be mixed in cement before performing tests for setting time, soundness and compressive strength.

APPARATUS REQUIRED:-

1. Vicat apparatus with plunger of 10 mm dia and 50 mm long, Vicatmould with glass plate. The vicat mould is of single piecetruncated conical form with internal dia 70 ± 5 mm at top, 80 ± 5 mm at the bottom and a height of 40 ± 2 mm.
2. Gaugingtrowel, measuring jar(100 ml),weighing balance of capacity 1 kg (sensitive up to 0.1 gm w),stop watch, non-porous plate, standard spatula.

MATERIALS REQUIRED:-

Cement free from any air lump, water

PROCEDURE:-

- For preparing one mould take 400 gm of cement passing 850-micron IS sieve and prepare a paste of cement with a weighed quantity of water (100 ml) taking care that the time of gauging is between 3 minutes to 5 minutes.The gauging time is counted from the time of adding water to the dry cement until commencing to fill the mould.
- Fill the vicat mould resting upon non-porous plate with this plate.After completely filling the mould, smooth off the surface of the paste by single movement of palm making it level with the top of the mould.The mould may be slightly shaken to expel air.
- Place the test block in mould with the non-porous resting plate under the rod attached with the plunger A.Lower the plunger gently to touch the surface of the test block and release it quickly,allowing it to sink into the paste.

- Prepare the trial pastes with varying percentages of water(firstly at an interval of 4%,that is of 24%,28%and 32%and then at an interval of 1%n and 0.25% between the percentage range determined by the previous test) and test as described above until the amount of water necessary for the standard consistency as defined is obtained.

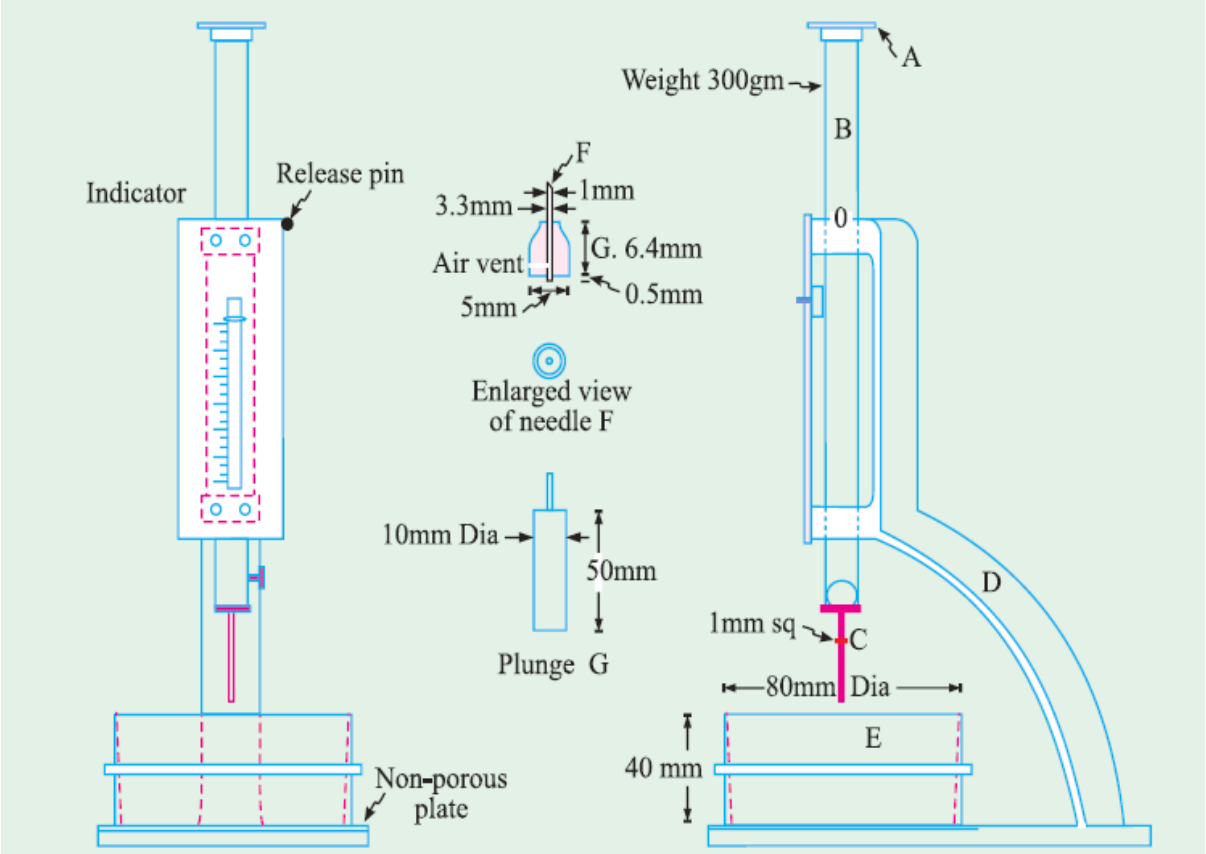

Figure: Schematic diagram of Vicat's apparatus

OBSERVATIONS AND CALCULATIONS:-

Sl No.	Mass of cement sample (gm)	Quantity of water added (ml)	% of water added	Unpenetrated depth, mm	Remarks

RESULT:-

Standard consistency of cement is found to be at ------- % of water.

CONCLUSION:-

Hence the percentage of water required to produce a cement paste of standard consistency is ---------- by weight of cement.

PRECAUTIONS:-

- The experiment should be conducted at a temperature of 27±2ºC and humidity of 90%.
- After a half minute from the instant of adding water,it should be thoroughly mixed with fingers for at least one minute. A ball of this paste is prepared and then it is pressed into the test mould,mounted on the non-porous plate.
- The plunger should be released quickly without pressure or jerk,after the rod is brought down to touch the surface of the test block.
- For each repetition of the experiment fresh cement is to be taken.
- Plunger should be cleaned during every repetition andmake sure that it moves freely.

REFERENCE:-

1. IS: 4031 (Part-IV) Determination of consistency of standard cement paste.
2. IS: 5513 – Specification for vicat's apparatus
3. IS: 3535 (part-I)- Method of sampling hydraulic cement

Experiment no.-6

SETTING TIME OF CEMENT

AIM OF THE EXPERIMENT:-

To determine the initial and final setting time of a given cement sample by Vicat apparatus.

THEORY AND SCOPE:-

In order that the concrete may be placed in position conveniently, it is necessary that the initial setting time of cement is not too quick and after it has been laid hardening should be rapid 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 cracks that may appear will not re-unite. The concrete is said to be finally set when it has obtained sufficient strength and hardness.

Therefore certain limits for initial and final setting times have to be specified.

APPARATUS EQUIRED:-

1. Vicat apparatus with needle for the initial setting time and annular collar for final setting time, Vicat mould with glass plate. The vicat mould is of single piece truncated conical form with internal dia 70 ± 5 mm at top, 80 ± 5 mm at the bottom and a height of 40 ± 2 mm.
2. Gauging trowel, measuring jar (100 ml), weighing balance of capacity 1 kg (sensitive up to 0.1 gm w), stop watch, non-porous plate, standard spatula.

MATERIALS REQUIRED:-

Cement free from any air lump, water

PROCEDURE:-

Preparation of Test Block :

- Prepare a neat cement paste by gauging the cement with 0.85P water, where P= standard consistency as found.The gauging time is kept between 3 to 5 minutes.Start the stop watch at the instant when the water is added to the cement.
- Fill the Vicat mould and smooth off the surface of the paste making it level with the top of the mould.The cement block thus prepared is known as test block.

Determination of Initial Setting Time:

- For the determination of initial setting time,place the test block confined in the mould and resting on non-porous plate under the rod attached with the needle B,lower the needle gently in contact with the surface of the test block and release quickly,allowing it to penetrate into the test block.
- Repeat this procedure until the needle fails to pierce the block for about 5 mm measured from the bottom of the mould.The period elapsed between the time when water is added to the cement and the time at which the needle fails to pierce the test block by about 5 mm is the initial setting time.

Determination of Final Setting Time:

- For the determination of final setting time replace the needle B of the Vicat apparatus by the needle with an annular attachment C.The cement is considered finally set when,upon applying the needle C gently to the surface of the test block,the needle makes an impression thereon,while the attachment fails to do so.

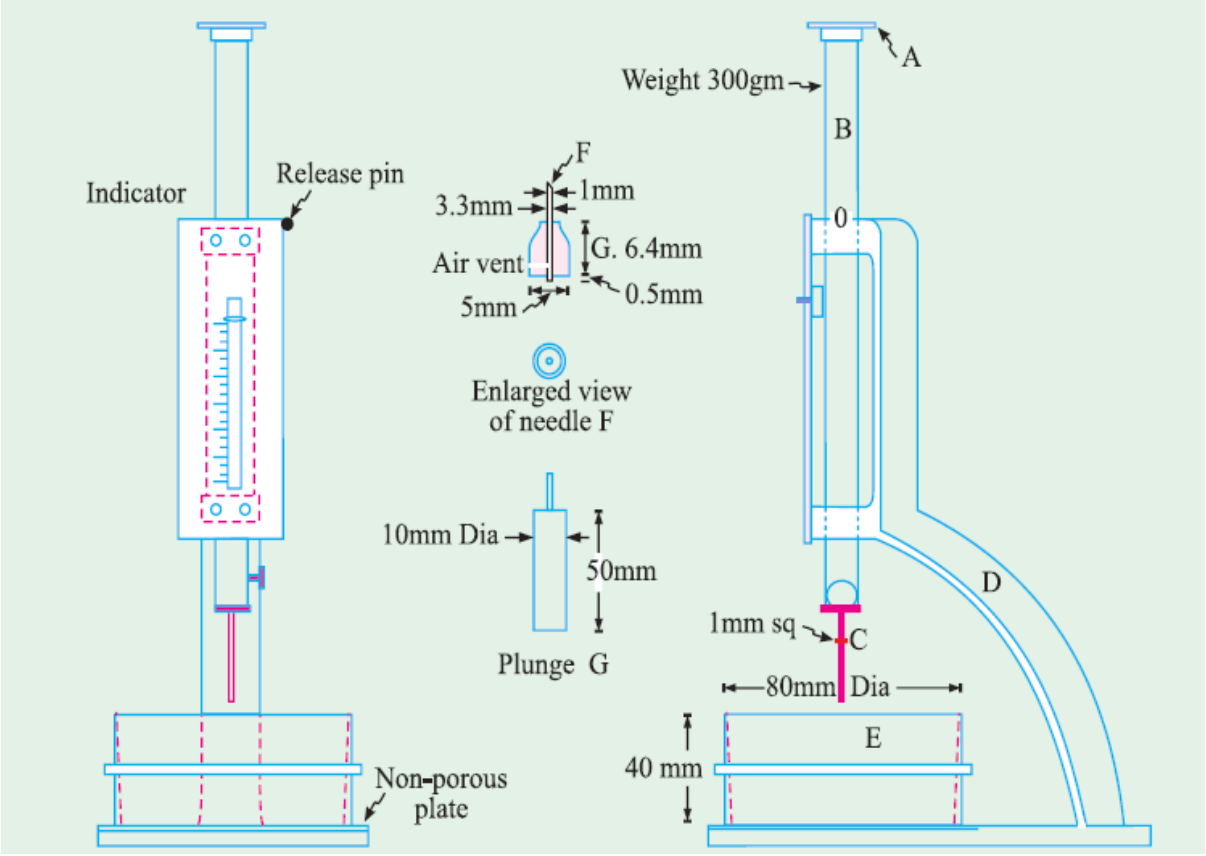

Figure: Schematic diagram of Vicat's apparatus

OBSERVATIONS AND CALCULATIONS:-

1.Time in minutes						
2.Initial reading						
3.Final reading						
4.Height not penetrated,mm						

RESULT:-

Initial setting time of cement and final setting time are found to be------ minute and -------- minute respectively.

CONCLUSION:-

As the cement used was Portland-pozzolana-cement the setting time found from the experiment is greater than the setting time of ordinary Portland cement i.e.

Initial setting time – ----------minutes.

Final setting time - ----------minutes or hours.

PRECAUTIONS:-

- The experiment should be conducted at a room temperature of 27±2ºC and at a relative humidity of 90 percent.
- After a half minute from the instant of adding water, it should be thoroughly mixed with fingers for at least one minute.A ball of this paste is prepared and then it is pressed into the test mould,mounted on the non-porous plate.
- The plunger should be released quickly without pressure or jerk,after the rod is brought down to touch the surface of the test block.
- For each repetition of the experiment fresh cement is to be taken.
- Plunger should be cleaned during every repetition and make sure that it moves freely and there are no vibrations.

REFERENCE:

1. IS: 4031 (Part- IV) -1988- Determination of consistency of standard cement paste.
2. IS : 4031 Part V) – 1988
3. IS : 5513-1976- Specification for vicat's apparatus

Experiment no.-7

SPECIFIC GRAVITY OF CEMENT

AIM OF THE EXPERIMENT:-

To determine the specific gravity of a cement sample using

(a) specific gravity bottle.
(b) Le-Chatelier Flask

THEORY AND SCOPE:-

Specific gravity is normally defined as the ratio between the mass of a given volume of material and mass of equal volume of water. One of the methods of determining the specific gravity of cement is by the use of a liquid such as water free kerosene which doesn't react with cement. A specific gravity bottle may be employed or standard Le- chartiliers flask may be used.

APPARATUS REQUIRED:-

(a) Weighing balance, specific gravity bottle
(b) Le-Chatelier Flask

MATERIALS REQUIRED:-

Cement free from any air lump, kerosene free from water

PROCEDURE:-

(I) <u>Using Specific gravity bottle</u>

- Weigh a clean and dry specific gravity bottle with its stopper, take reading as W_1.
- Add water to the graduated mark of bottleflask and weigh it with stopper (W_2).
- Empty thebottlelask, clean it and refills with clean kerosene (polar liquid)upto the graduated mark and weigh it with stopper (W_3).
- Take out half volume of kerosene, add sample of cement up to it reaches the graduation mark and mix thoroughly to remove entrapped air, weigh with its stopper (W_4).
- Empty the bottle, add sample of cement (about 50 gm) and weigh with stopper (W_5).

Figure: Specific gravity bottle

OBSERVATIONS AND CALCULATION:-

Specific gravity of kerosene = $\frac{(W3-W1)}{(W2-W1)}$

Specific gravity of cement =

$$\frac{W5(W3-W1)}{(W5+W3-W4)-(W2-W1)}$$

Where W_1 = Weight of the empty bottle

W_2 = Weight of the bottle + weight of water

W_3 = Weight of the bottle + weight of kerosene

W_4 = Weight of the bottle+ weight of kerosene + weight ofcement

W_5 =Weight of cement

(II) <u>Using Le-Chatelier Flask</u>

The dried Le-chatelier flask is taken and the kerosene is filled to a point on the stem between zero and one ml.

(ii) The inside of the flask is dried above the level of the liquid.

(iii) The flask is immersed in a constant temperature water bath maintained at room temperature for sufficient time.

(iv)The level of the kerosene oil in the flask is recorded as initial reading.

(v) Introduce about 60 gms of cement into the flask so that the level of kerosene rises to about say 22 ml mark. Splashing should be avoided and cement should not be to allowed to adhere to the sides of the flask above the liquid.

(vi)The glass nipple is inserted into the flask and it is rolled gently in an inclined position to free the cement from air until no further air bubble rises to the surface of the liquid.

(vii) The flask is kept again in Constant temperature water both and note down the new liquid level as final reading.

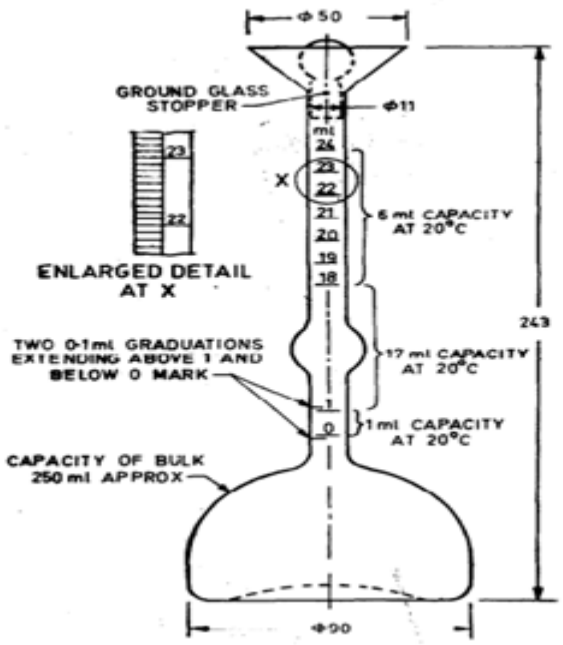

Figure: Le- Chatelier Flask

OBSERVATION AND CALCULATIONS:-

(a) Air temperature = ----^{0}c

(b) Weight of cement used = ---gms

(c) Initial reading of flask = ---mls

(d) Final reading of flask = ----mls

(e) Volume of cement particles (d-c) = ----mls

(f) Weight of equal volume of water = ------gms

Specific gravity = $Weight\ of\ cement\ of\ given\ volume/Weight\ of\ equal\ volume\ of\ water$

RESULT:-

Specific gravity of the given amount of cement is ----------.

CONCLUSION:-

The cement is suitable for use in construction as the specific gravity of the cement is found to be ----------.

PRECAUTIONS:-

- Kerosene which is to be used should be free from water.
- The flask should be dried properly.
- Care should be taken while putting the cement inside the flask so that no cement particles get stick to the inner wall of the stem of the flask.
- The initial reading and final reading in the flask should be taken at the eye level.

Experiment no.-8

SOUNDNESS TEST OF CEMENT

AIM OF THE EXPERIMENT: To verify the soundness of cement by Le- Chetelier apparatus method.

THEORY AND SCOPE:-

Cement is said to be nif it does not undergo significant volume change during hardening process and it is presumed to be unsound, when the percentage of free time and magnesia is more than that specified. However, the unsoundness may be reduced by limiting the magnesia content to less than 0.5 percent, by allowing the cement to aerate for several days and though proper mixing.

There are two methods by which the soundness of cement can be determined namely (1) Le-Chetelier method and (2) Auto clave method. In Le-Chetelier test, the expansion in cement should not be more than 10mm according to: 269. However, it may be noted that expansion due to the presence of free lime only is mostly reflected in Le-Chetelier's test.

In this method, the field condition of exposure of cement to natural weathering agent is stimulated by accelerated hydration due to boiling of the specimen in water in the laboratory.

APPARATUS REQUIRED :

1. Le-chetelier apparatus
2. Glass plates -2 no's
3. Load weight
4. Trowel
5. Thermometer
6. Measuring cylinder
7. Enamel tray
8. Weighing balance
9. Water bath
10. Stop watch

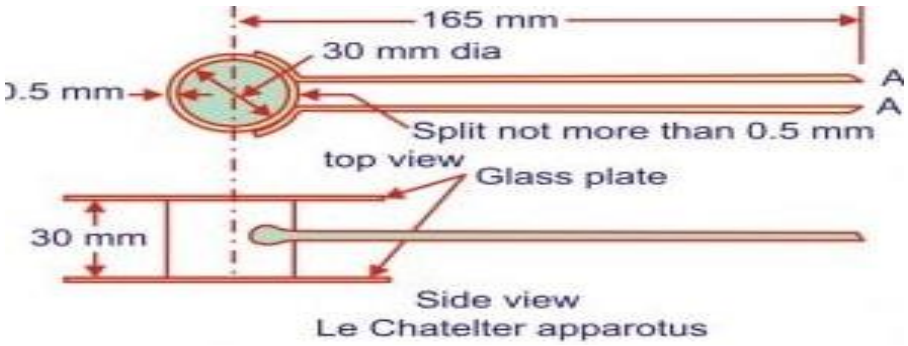

Figure: Le-Chatelier apparatus

MATERIAL REQUIRED:-

1. Ordinary Portland cement of around 50gms. The sample is to be taken in accordance with the requirements of 1S:3535 and the representative sample of the cement selected is to be thoroughly mixed before testing.
2. Portable or distilled water.

PROCEDURE:

- About 50gm (W) of cement of known normal consistency (P) is weighted for each mould.
- The amount of water equal to 0.78P * W measured with the help of measuring cylinder (where P &W are as defined above)
- The cement sample and water are mixed properly to form a paste.
- The brass spilt cylinder mould is placed one glass plate and the above cement paste is filled up in it.
- Care is taken to keep the edge of the mould gently together, while filling the cement paste is the mould.
- The split cylinder with sample is covered with another piece of glass plate and the lead weight is placed over it.
- The above assembly is submerged in fresh and clean water maintained at a temperature of 27#2”C and kept it there for 24 hours.
- After curing, the distance separating the indicator points is accurately measured in mm.
- Again, the mould is submerged in water at the same above prescribed temperature in a water container or water bath.
- The water in the water bath is allowed to boil for 3 hours with the mould kept submerged in it by raising the temperature to boiling point in about 25 to 30 mintutes.
- Then the mould is removed from water, allowed to cool in natural manner and the distance between the indicator points is masured.
- The difference between the two measurements represents the Le- chetelier expansion of cement on hydration.

PRECAUTIONS:

1. Weighing of the cement and measurement of the water is to be done accurately.
2. The edge of the split cylinder mould is to be kept together gently while filling it with the cement paste.
3. Gauging time 3-5 minutes is to be maintained from addition of water to the cement till the mould is filled up.
4. Mould is to be handled carefully while conducting the test ; otherwise the dimension of the specimen may change due to disturbance of the gap between the two jaws.
5. The temperature of water in the bath is to be correctly maintained.

OBSERVATION AND CALCLATION:-

Sl No.	Particular Of specimen	Specimen No.		
1	Weight of the cement sample (W)			
2	Normal consistency of the sample cement (P)			
3	Amount of water added to the sample = 0.78PX W			
4	Time at which the sample is put in water at 27 ± 2^0C			
5	Time when water is brought to the boiling point			
6	Distance between the pointer ends before heating (D_1) mm			
7	Time of boiling			
8	Distance between the pointer ends after heating (D_2) mm			
9	Difference (D_2- D_1) in mm			

RESULT:-

Average value of Le- Chatelier expansion of the cement has been found to be _____ mm.

CONCLUSION:-

DISCUSSION:-

The expansion of the cement as measured by Le-Chetelier apparatus is not to be more than 10mm for ordinary port land cement , rapid hardening cement,low heat port land cement and blast furnace slag cement.

REFERENCE:-

1) I.S:4031 – Method of physical test for hydraulic cement – (Part - III) Determination of soundness of cement.

Experiment no.-9

COMPRESSIVE STRENGTH OF CEMENT MORTAR

AIM OF THE EXPERIMENT:-

To determine the compressive strength of 1:3cement sand mortar cubes after 7 days and 28 days of curing.

THEORY AND SCOPE:-

The compressive strength of cement mortar determined in order to verify whether the cement confirms to IS specification(IS:269-1976) and whether it will be able to develop the required compressive strength of concrete.

According to IS application the ultimate compressive strength of cubes of cement sand mortar of the ratio 1:3,containing ($\frac{P}{4}$+3.0) percent of water where, p is the normal consistency of cement. The fine aggregate used in the preparation of the mortar is standard sand (Ennore sand), washed, cleaned and dried at 100 ^{0}C to 110 ^{0}C & cooled. This test can be considered as a final check on the quality of cement and can be calculated by measurement of applied load on the contact area of the cube. Ordinary Portland cement should have minimum compressive strength of 16 Mpa, 22 Mpa and 33 Mpa at 3, 7 and 28 days respectively. 28 days of compressive strength of cement is referred to as grade of cement (without mention of the unit Mpa) i.e. cement of 33, 43 or 53 grade.

APPARATUS REQUIRED:-

Cube moulds- 7.06 cm size (9 no.s), Vibrating machine, Enamel trough, Measuring cylinder- 100 ml/ 200 ml capacity, Trowels, Nonporous plates, Weighing balance of accuracy 0.02 gm,Grease/ lubricating oil, compression testing machine.

MATERIALS REQUIRED:-

Cement, water

PROCEDURE:-

A) Preparation of mortar for the cubes:

- The interior surface of the cube moulds are oiled.

- Calculate the material required. The material for each cube shall be mixed separately and the quantity of cement and standard sand shall be as follows

  Cement =200gm

  Standard sand =600gm

- The mixture of cement and standard sand in the proportion of 1:3 by mass, on a nonporous plate or china dish, was placed, mixed (when dry) with a trowel for one minute was of uniform colour. Percentage of water was used ($\frac{P}{4}$+3.0) and time of gauging about 3-4 minutes.
- The assembled mould was placed on the table of the vibrating machine and it was firmly held in position with clamps.
- Immediately after mixing the mortar, the entire quantity of mortar was filled in the cube mould and compacted by Vibrating machine. The period of vibration shall be 2 minutes at the specified speed of 12000±400 cycles per minute.
- The mould was removed from the machine and it was kept at a temperature of 27±2ºC on an atmosphere at least 90% relative humidity for 24 hrs after completion of vibration.
- After 24 hrs, the cube was removed from the mould and immediately after submerged in clean and fresh water and kept there until taken out just prior to breaking. The water in which the cubes are submerged, shall be renewed after 7 days and be maintained at temperature of 27±2ºC.The cubes were kept wet till they are placed in machine for testing.

B) Testing

- The test cube is placed on the platform of compression testing machine (by keeping any of its transverse surfaces horizontal) co- axially without any packing between the cube and the steel platens of the testing machine.

- The test cube at a particular age is tested and the corresponding readings are recorded.

Figure: Compressing testing machine

OBSERVATIONS AND CALCULATIONS:-

Sl no.	7 days strength			28 days strength		
	Area of specimen (A) mm^2	Load (KN)	Strength (N/mm^2)	Area of specimen (A) mm^2	Load(KN)	Strength (N/mm^2)

RESULT:-

The compressive strength of cement is found as follows:

1. At 7 days →------- N/mm^2.
2. At 28 days →-------- N/mm^2.

CONCLUSION:-

(Comment on the result by comparing with specification of cement)

Referring to the specification of cement, the test result indicates that the cement satisfies / does not satisfy the requirements of strength development at ages of ---------- and ---------- days.

PRECAUTIONS:-

- The mortar shall not be compressed to moulds with hand.
- The results which fall outside of the average results should be neglected on either side.
- The cube should be tested on their and not on their faces.
- The inside of the cube mould should be boiled to prevent the mortar from adhering on the sides o mould.
- The size of sand particle should be such that not more than 10 percentage by weight shall pass a 60-micron IS Sieve and shall completely pass through a 85-micron IS Sieve.
- The time of wet mixing shall not be more than 3 minutes.If the time of mixing exceeds 4 minutes to being a uniform colour.The mixture shall be rejected and fresh mortar should prepared.
- The cubes shall not be allowed to dry until they are broken.

REFERENCE:-

1. IS:4031 (Part-VI)- Method of physical tests for hydraulic cement; determination of compressive strength.
2. IS: 650- Specification of standard sand for testing of cement.

Experiment no.-10

FINENESS MODULUS AND GRAIN SIZE DISTRIBUTION OF FINE AGGREGATE

AIM OF THE EXPERIMENT:-

To determine fineness modulus and grain size distribution of fine aggregate**.**

APPARATUS REQUIRED:-

Indian standard test sieves(4.75mm,2.36mm,1.18mm,600μm,300μm,150μm) ,weighing balance,sieve shaker,trays,drying oven

MATERIALS REQUIRED:-

Fine aggregate

THEORY AND SCOPE:-

The size of the fine aggregate is limited to maximum of4.75mm gauge beyond which it is known as coarse aggregate. Sand as fine aggregate for concrete or mortar is required to be well graded on the principle that the smaller particle shall fill the voids between larger particles leaving minimum voids that are supposed to be filled up by the cement particle in the resulting mass.

For normal structural purpose, the grading shall be within the limits specified in IS:383: 1970. Standard grading zones or limits of percentages passing different sieves are specified for proper grading of sand into grading zones I, II, III, IV as shown in the following table.

Table 1: Grading limits of fine aggregate IS: 383- 1970

		Percentage passing by weight for		
I.S. Sieve Designation	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

In order to ensure the presence of all sizes of particles, the property of aggregate called fineness modulus is defined. The fineness modulus represents the massed average size of the sieve on which the material is retained, the sieve being counted from the finest. The following limits on fineness modulus may be taken as guidance.

Sl No.	Sand type	Range
1	Fine sand	2.2 to 2.6
2	Medium sand	2.6 to 2.9
3	Coarse sand	2.9 to 3.2

PROCEDURE:-

- Take 1kg of fine aggregate from a laboratory sample.Care shall be taken to ensure that the sieves are clean before use.
- Carry out sieving by using sieve shaker. Shake each in order4.75mm,2.36mm,1.18mm,600μm,300μm,150μm over a clean tray for a period 2minutes Shaking.
- 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.
- 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.
- Find the mass of aggregate retained on each sieve taken in order.

Figure: Indian standard sieves

OBSERVATIONS AND CALCULATIONS:-

Sl No.	IS sieve size	mass retained(gm)	percentage retained(gm)	percentage passing	cumulaive percentage retained
1					
2					
3					
4					
5					
6					
7					
					∑=

Fineness Modulus of fine aggregate=$\frac{\sum Sum\ of\ cumulative\ percentage\ retained\ on\ sieves}{100}$

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 belongs to Grading Zones I / II / III / IV.

iii. Particle size distribution or grading curve is plotted between the cumulative percentages finer or passing vs. Particle size or sieve size on a semi-logarithimic scale.

CONCLUSION:-

The experiment has an important bearing on the on the concrete mix. From the result of sieve analysis one is able to proportion the fine and coarse aggregate in order to get combine mix of required gradation.

PRECAUTIONS:-

1. Material is not to be forced through the sieve by hand pressure but light brushing with a soft brush on the underside of the sieve may be used to clear the sieve openings.
2. There should be no loss of material or fines during the process of weighing, sieving or transferring and the total weight on the sieves and bottom pan should tally with the sample weight taken.

REFERENCE:-

1. IS: 383- Specification for coarse and fine aggregate from natural sources for concrete.
2. IS: 2386-(Part-1) Method of test for aggregates for concrete, particle size and shape.

Experiment no.-11

GRAIN SIZE DISTRIBUTION OF COARSE AGGREGATE

AIM OF THE EXPERIMENT:-

To determine grain size distribution and fineness modulus of coarse aggregate.

APPARATUS REQUIRED:-

Indian standard test sieves 80mm,40mm,20mm,10mm and 4.75mm(refer 460-1978),weighing balance, sieve shaker,trays,drying oven.

MATERIALS REQUIRED:-

Coarse aggregate

THEORY AND SCOPE:-

Aggregate larger than 4.75 mm IS sieve is called coarse aggregate. When the aggregate contains different sizes of particles in suitable proportion, it is called a graded aggregate. This graded aggregate improves the workability of concrete.

Sieve analysis of aggregates is done to determine the proportions smaller than the different sizes of particles and is given in terms of percentage of total aggregates passing through each sieve size. The results are plotted on a graph with ordinates showing percentage of aggregate passing or finer than a particular size while the abscissa shows the sieve size on logarithimic scale and the resulting curve is known as grading curve/ gradation curve.

In order to ensure the presence of all sizes of particles, the property of aggregate called fineness modulus is defined. The fineness modulus represents the massed average size of the sieve on which the material is retained, the sieve being counted from the finest.

PROCEDURE:-

- The sample is brought to an air dry condition either by drying at room temperature or by heating at a temperature of 100^0C t0 110^0C and cooled.
- The air dried sample of course aggregate is then weighed accurately.
- The sample of aggregate is sieved successively on the appropriate sieves starting with the largest in order 80mm,40mm,20mm,10mm and 4.75mm over a clean tray for a period 2minutes Shaking.

- 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.
- 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.
- Lumps of fine material, if present, is to be broken by gentle pressure with fingers against the side of the sieve.
- Find the mass of aggregate retained on each sieve taken in order.

Figure: Indian standard sieves

Table 2: Grading limit for coarse aggregate IS:383- 1970

OBSERVATION AND CALCULATION:-

Sl No	IS sieve size	Mass retained(gm)	Percentage retained	Percentage passing	Cumulaive percentage retained
1					
2					
3					
4					
5					
					∑=

CALCULATION:-

Fineness Modulus coarse aggregate=$\frac{\sum Cummulative\ percentage\ retained+500}{100}$

RESULT:-

i. The given sample of aggregate confirms to grading requirements of single size/ graded aggregate of nominal size-------.

ii. A particle size distribution curve or grading curve is plotted with ordinate showing percentage of aggregate passing or finer and the abscissa showing the sieve size on logarithmic scale i.e. a semi log plot. The grading curve indicates whether the grading of a given sample of aggregate is too coarse, too fine or deficient in a particular size. Thus

   (a) If the actual grading curve is lower than the specified grading curve, the aggregate is coarser indicating the possibility of segregation of the mix.

   (b) If the actual grading curve lies well above the specified grading curve, the aggregate is finer indicating greater water requirement.

   (c) If the grading curve is steeper than the specified grading curve, it indicates the excess a middle size particles and may lead to harsh mix.

   (d) If

iii. A comparison of this curve is made with the standard curve for single size and graded coarse aggregate.

CONCLUSION:-

The experiment has an important bearing on the concrete mix.From the result of sieve analysis one is able to proportion the fine and coarse aggregate in order to get combine mix of required gradation.

REFERENCE:-

1. IS: 2386-(Part-1) Method of test for aggregates for concrete, particle size and shape.
2. IS: 383- Specification for coarse and fine aggregate from natural sources for concrete.
3. IS: 460- IS specification for test sieves.

Experiment no.-12

CRUSHING VALUE OF COARSE AGGREGATE

AIM OF THE EXPERIMENT:-

To determine the crushing value of coarse aggregate.

APPARATUS REQUIRED:-

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

MATERIALS REQUIRED:-

Course aggregate

THEORY AND SCOPE:-

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

Figure: Crushing test apparatus

PROCEDURE:-

- The material for the standard test shall consist of aggregate passing 12.5 mm IS sieve and retained on 10 mm IS sieve, and shall be thoroughly separated on these sieves before testing.
- The aggregate shall be tested in surface dry condition. If dried by heating, the period of drying shall not exceed 4 hours, the temperature shall be 100 to 110^0C and the aggregate shall be cooled to room temperature before testing.
- The cylinder shall be filled with 3 layers of approximately equal depth, each layer being tamped 25 times with the rounded end of tamping rod and finally levelled off using the tamping rod as a straight edge.
- The weight of material comprising the test sample shall be determined (weight A) and the same weight of sample can be taken for the repeat test.
- The apparatus with the test sample and plunger in position, shall then be placed between the platens of testing machine and loaded at as uniform rate as possible so that the total load is reached in 10 minutes.
- The load shall be released and whole of the material removed from the cylinder and sieved on a 2.36 mm IS sieve for the standard test. The fraction passing the sieve shall be weighed (weight B)

OBSERVATION AND CALCULATION:-

The ratio of the weight of fines formed to the total sample weight in each test shall be expressed as a percentage, the result being recorded to the first decimal place

Aggregate crushing value = $\frac{B}{A}$ X 100

A = Weight in gm of saturated surface dry sample.

B = Weight in gm of fraction passing through

appropriate sieves.

RESULT/ CONCLUSION:-

i. The aggregate crushing value of given sample of coarse aggregate is …….. %

ii. The aggregate crushing 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.

REFERENCE:-

1. IS : 2386 (Part IV) – 1963
2. IS: 383- Specification for coarse and fine aggregate from natural sources for concrete.

Experiment no.-13

TENSILE STRENGTH OF STEEL

AIM OF THE EXPERIMENT:-

To determine the tensile strength of steel by using UTM and the percentage of elongation of steel.

THEORY AND SCOPE:-

Ultimate load is taken by the material before failure is known as failure load stress and corresponding to this is known as tensile strength. It is indicated that the maximum stress-strain curve and in general indicates when cracking occurs.

Its value does not depend on the size of the test specimen. However, dependent on the preparation of specimen, temp., test environment and material.

Various tensile strength are-

(a) Yield strength:

The stress at which elastic deformation changes to plastic deformation causing it to deform permanently.

(b) Ultimate strength:

The maximum strength that the material can withstand when subjected to tension or compression or shear.It is the maximum stress strain curve.

(c) Breaking strength:

The stress corresponding to the point of rupture on the stress-strain curve.

(d) Proof stress:

The stress corresponding to 0.002 strain

Factor of safety=ultimate stress/working stress

Tensile strength > Yield strength

Grade of steel	Fe415	Fe500	Fe550
Proof stress(N/mm^2)	415	500	550
Minimum tensile strength(N/mm^2)	485	545	585
% of elongation reqd.(minimum)	14.5	12.5	8

APPARATUS REQUIRED:-

Universal Testing Machine

MATERIALS REQUIRED:-

Steel rod of 10 mm diameter.

OBSERVATION AND CALCULATION:-

Sample	Initial length	Final length	Ultimate load	% of elongation
10ϕ				
10ϕ				

CALCULATION:-

For tensile strength:

Maximum load taken by 10 mm ϕ for 1st sample= KN

Area of c/s= ------mm^2

Tensile strength=(Max^m load taken by the sample)/7Area of specimen

=------- N/mm^2

CONCLUSION:-

The 1st sample was failed/passedin tensile strength and.So the rod was successfully passed/failed through tensile strength test and % of elongation was found to be --------%.