# INDEX

**EXPERIMENT NO. 1**

# SPECIFIC GRAVITY OF CEMENT

**AIM** : To determine specific gravity of given sample of cement.

**THEORY:-** Specific gravity is normally defined as ratio between weight of a given volume of a substance and weight of an equal volume of water.

Since cement reacts with water, specific gravity of cement is determined indirectly using a liquid which does not react with water such as kerosene or naphta.

**EQUIPMENT:-** Specific gravity bottle and Electronic balance.

**MATERIALS:-** Kerosene free of water, distilled water, cement

**PROCEDURE:-**

1) Weigh the dry specific gravity bottle, **W1 gms**.
2) Fill the specific gravity bottle with distilled water up to the brim and weigh it, **W2 gms**.
3) Dry the specific gravity bottle and fill it with kerosene and weigh it, **W3 gms.**
4) Remove kerosene and introduce some quantity of cement( Approximately **1/3 of the volume of bottle**) into the bottle and weigh it, **W4 gms**
5) Fill the remaining part of bottle with kerosene and weigh it, **W5 gms**
6) Roll the bottle gently in inclined position until no further air bubbles rise to the surface.

**OBSERVATIONS:**

| Description | Trial – 1 | Trial - 2 | Trial - 3 |
|---|---|---|---|
| Weight of empty bottle ( W1) | | | |
| Weight of bottle + Water (W2) | | | |
| Weight of bottle + Kerosene (W3) | | | |
| Weight of bottle + Cement (W4) ( 1/3 volume of bottle) | | | |
| Weight of bottle +Kerosene + cement W5 | | | |
| Weight of Cement W6 = W5 – W1 | | | |
| Specific gravity of kerosene **Sk = (W3 – W1) / ( W2 – W1)** | | | |
| Specific gravity of cement : $S_c = \frac{(W4 - W1) * S_K}{(W3 - W1) - (W5 - W4)}$ | | | |

**RESULT :**

Specific gravity of Cement ( Average of Three Trails) :

**PRECAUTIONS:**

1. The Kerosene used should be free from water.
2. The specific gravity bottle should be held in a constant temperature water bath sufficiently long to ensure the same temperature before each weighing is made.
3. While introducing cement, care should be taken to avoid splashing and cement should not adhere to the inside of bottle above the liquid.

**DISCUSSIONS:**

1. Derive expression used for finding specific gravity of cement.

2. Why kerosene is used instead of water?

3. What is the purpose of conducting the test?

4. What is the density / specific gravity of following materials.

| | |
|---|---|
| Water | Kerosene |
| Gold | Steel |
| Silver | Concrete |
| Mercury | |

## EXPERIMENT NO. 2

## FINENESS OF CEMENT

**AIM**:- To determine fineness of cement by dry sieving as represented by the weight of the residue left on a standard 90 micron IS sieve confirming to IS : 460-1962 (Specifications for test sieves).

### PROCEDURE:

The procedure outlined in **I.S 4031 – 1968** is as under:

Break down any air set lumps in the cement samples with fingers.

Weigh accurately 100gms of cement and place it on a standard 90 micron IS sieve.

Sieve the sample continuously 15 minutes.

Weigh the residue left in the sieve and this weight shall not exceed the limit specified in the relevant standard specifications.

### METHOD OF SIEVING:

Holding the sieve in both hands, sieving shall be done with a gentle wrist motion, this will involve no danger of spilling the cement which shall be kept well spread out on the screen. More or less continuous rotation of sieve shall be carried out throughout the sieving.

The underside of the sieve shall be lightly brushed with a 25-40 mm bristle brush after every five minutes of sieving.

### OBSERVATIONS:

| Trail No. | Weight of Cement sieved (gm) | Weight of residue (gm) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

**RESULT :** Fineness of Cement ( Average of Three Trails) :

The limits specified in Relevant I.S. codes are as under:

| **Type** | **Code** | **Limits on Residue** |
|---|---|---|
| Ordinary Portland Cement | | 10% |
| Rapid Hardening Cement | | 10% |
| Low Heat Cement | | 10% |

**DISCUSSIONS:**

1) Define specific surface area of cement.

2) How does fine grinding affect time of set?

3) Fill in the blanks.
   i) Finer the grinding ______________________ is the size of cement particle.
   ii) Greater the fineness of grinding ____________________ rapid is the strength development and ______________ is the rate of heat generation.

4) Explain the disadvantages of too much fineness of cement.

5) How is fineness expressed?

6) In a fineness test by sieve analysis, the following values are obtained. Give your inferences.
   i) 6% ii) 10% iii)15%.

7) Why is rapid hardening cement more finely ground?

8) The following specifications are reproduced from I.S code, identify the types of cement. (O.P.C., R.H.C., L.H.C.)

| | I | II | III |
|---|---|---|---|
| a. Fineness % retained on 90 micron sieve | _ | 10 | 5 |
| b. Specific surface area by air Permeability $cm^2/gm$ | 3200 | 2250 | 3250 |

9) Of the two tests of determining fineness, explain, how one is better than the other?

10) What is the meaning of No.(9) sieve?

**MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY**
CIVIL ENGINEERING DEPARTMENT
**Structural Engineering Laboratory**

**EXPERIMENT NO. 3**

**NORMAL CONSISTENCY OF CEMENT**

**AIM:-** The object of the test is to determine the quantity of water required to produce a cement paste of standard consistency.

**APPARATUS:**

1) Vicat apparatus confirming to **IS 5513-1969**
2) Plunger 10 mm in dia.

**THEORY:**

The standard consistency of a cement paste is defined as that consistency which will permit the Vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould.

**PROCEDURE:**

The procedure outlined in **IS 4031 – 1968** is as under:

1) Prepare a paste of weighed quantity of cement (400 gms) with a weighed quantity of water taking care that the time of gauging is not less that 3 minutes and not more than 5 minutes and gauging shall be completed before any signs of setting occurs.The gauging time shall be counted from the time of adding water to the dry cement until commencing to fill the mould.

   **(The students are advised to begin with 400 gms. of cement and add 26% of water as first trial).**

2) Fill the Vicat mould with the paste, the mould resting on a non-porous gap plate. After completely filling the mould, smooth off the surface of the paste, making it level with the top of the mould. The mould may slightly be shaken to expel the air.

3) The mould together with the non-porous resting plate is then placed under the rod of the plunger.

4) Lower the plunger gently to touch the surface of the mould allowing it to sink into the paste. This operation should be carried out immediately after filing the mould.

5) Prepare trial pastes with various percentages of water (28%, 30%, 32%, etc.)
   Plot the graph with penetration on X-axis and percentage of water on Y-axis and obtain the normal consistency.

**OBSERVATIONS:**

| Trial No. | Percentage of Water | Penetration |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

**RESULT:** Obtain normal consistency from the graph. Normal consistency of given cement =

**DISCUSSIONS:**

1) How do you define normal consistency?

2) What percentage of water should be used with this cement in preparation of 1:3 standard cements mortar cubes.

3) What items in the test procedure will affect the results of normal consistency determination?

4) What is the use of normal consistency?

**MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY**
CIVIL ENGINEERING DEPARTMENT
**Structural Engineering Laboratory**

**EXPERIMENT NO. 4**

## INITIAL SETTING TIME OF CEMENT

**AIM:-** To determine the initial setting time of cement.

**APPARATUS:** Vicat Apparatus confirming to IS 5313 – 1969, Stop Watch.

**PROCEDURE:** The procedure outlined by I.S 4031 – 1968 is as under:

### a) PREPARATION OF TEST BLOCK:

1) Prepare a neat cement paste by gauging the cement with 0.85 times the water required to give a paste of standard consistency. The paste shall be gauged in the manner described in normal consistency test. **(The students are advised to take 400 gms of cement and Normal consistency as 32%).**

   **Start a stopwatch at the instant when water is added to cement.**

2) Fill the Vicat mould with the cement paste, while it is resting on a glass plate.
3) Fill the mould completely and smooth off the surface of the paste making it level with the top of the mould.

Clean appliances shall be used for gauging. The temperature of water and that of test room at the time of gauging shall be within 27 ± 2$^{o}$C.

### b) DETERMINATION OF INITIAL SETTING TIME:

4) Place the test block confined in the mould and resting on the non porous plate, under the rod bearing the initial setting needle.

5) Lower the needle gently in contact with the surface of the test block and quickly release allowing it to penetrate in to the test block.

6) Repeat this procedure until the needle, when brought in contact with the test block and released as described above fails to pierce the block for 5 ± 0.5 mm measured from the bottom of the mould.

**The period elapsing between the time when water is added to the cement and the time at which needle fails to pierce the test block by 5 ± 0.5 mm shall be initial setting time.**

**OBSERVATIONS:**

| | | |
|---|---|---|
| Time when water is added | = | T1 |
| Time when needle fails to pierce the test block by 5 $\pm$ 0.5 mm | = | T2 |
| Initial setting time | = | T2 – T1 |
| | = | ________ Mins |

**RESULT:**

Compare your results with the standard values.
Discuss reasons for any variation.

**DISCUSSIONS:**

1) What causes the set of cement? What is the significance of time of setting?

2) What is the difference between “Setting” and “Hardening” of cement?

3) Define initial setting and final setting time of cement. What is the purpose of delaying the setting action?

4) What is the difference in needles used in determination of (i) Initial setting (ii) Final setting (iii) Normal consistency?

**MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY**
CIVIL ENGINEERING DEPARTMENT
**Structural Engineering Laboratory**

**EXPERIMENT NO. 5**

## COMPRESSIVE STRENGTH OF CEMENT

**AIM** :- To determine the strength of cement as represented by compressive strength tests on mortar cubes compacted by means of a standard vibration machine.

**APPARATUS:** Standard vibration machine, poking rod, cube moulds of 50 $cm^2$ face area.

**PROCEDURE:**

The procedure outlined by **I.S. 4031 – 1968** is as under:

1) Clean appliances shall be used for mixing and the temperature of water that of test room at the time when the above operations are being performed shall be 27 $\pm$ 2$^o$C.
2) Place on a nonporous plate, a mixture of cement and standard sand in the proportions of 1:3 by weight.

   Mix dry with a trowel for one minute and then with water until the mixture is of uniform color.
   The material for each cube shall be mixed separately and the quantity of cement, standard sand and water shall be as follows:

   | | |
   |---|---|
   | Cement | 200 g. |
   | Standard sand | 600 g. |
   | Water | (P/4 + 3.0) percent of combined weight of cement and sand. Where P is the percentage of water required to produce a paste of standard consistency. |

   The time of mixing shall in any event be not less than 3 min. And not more than 4 min.

3) In assembling the mould, oil should be applied at joints and inside surface should be treated with mould oil.

4) Place the assembled mould on the table of the vibration machine and firmly hold it in position by mean of a suitable clamp. Securely attach the hopper at the top of the mould. Immediately after mixing the mortar, place the mortar in the cube mould and prod with poking rod. The mortar shall be prodded 20 times in about 8 seconds to ensure elimination of entrapped air. Place the remaining quantity of mortar and prod again as specified for the first layer and then compact the mortar by vibration.

The period of vibration shall be of two minutes at 12000 vibrations per minute. At the end of vibration, remove the mould together with the base plate from the machine and finish the top surface with the blade of a trowel.

5) Keep the filled mould in atmosphere for 24 hours after completion of vibration. At the end of that period remove them from the mould sand immediately submerge in clean fresh water and keep these until taken out just prior to testing.

6) Test three cubes for compressive strength at the end of seven days of curing.

**The compressive strength shall be the average of the strength of three cubes for each period of curing.**

The cubes shall be tested on their sides without any packing between the cube and steel plates of the testing machine. The load shall be steadily applied from zero at rate of 350 $kg/cm^2/min$.

**OBSERVATIONS:**

**Time of curing : 7 days**

| Cube no. | Crushing load (kN) | Area ( sqmm) | Compressive Strength ( $N/mm^2$) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |

**RESULT:**

Compressive strength at 7 days ( Average of three Tests):

**DISSCUSSIONS:**

1) Which is the standard sand used for mortar cubes for cement strength test? Why should we use standard sand for this?

2) What is the purpose of conducting tests for compressive strength of cement?

3) What is the size of cube used in compressive strength?

4) The following specifications are reproduced from IS. Code. Identify types of cement (O.P.C., R.H.C, L.H.C.)s.

| Compressive strength (Kg/cm2) | I | II | III |
|---|---|---|---|
| at 3 days not less than | 100 | 275 | 160 |
| at 7 days not less than | 160 | - | 220 |
| at 1 day, not less than | - | 160 | - |

## EXPERIMENT NO. 6

## DENSITY OF CEMENT

**AIM** :- To determine the Density of cement..

**APPARATUS:** Specific Gravity Bottle of capacity 50 cc. and Electronic balance.

**PROCEDURE:**

The procedure outlined by **I.S. 4031 – 1968** is as under:

1) Clean appliances shall be used for mixing and the temperature of water that of test room at the time when the above operations are being performed shall be 27 $\pm$ 2$^{o}$C.
2) Take the empty weight of Specific gravity bottle, **W1 gms.**
3) Fill the Specific gravity bottle with Cement till its top and weigh it, **W2 gms.**
4) Take three Trails.

**OBSERVATIONS:**

| S.No | Description | Trail -1 | Trail - 2 | Trail - 3 |
|---|---|---|---|---|
| 1 | Wt of Empty Bottle. W1 gms | | | |
| 2 | Wt of Bottle + Cement. W2 gms | | | |
| 3 | Volume of Bottle | 50 cc | 50 cc | 50 cc |
| 4 | Density of Cement = **( W2 – W1) / Vol .of Bottle. Kg/ m$^3$** | | | |

Density of Cement ( Average of three Trails) :

**EXPERIMENT NO. 7**

## SPECIFIC GRAVITY OF FINE AGGREGATE

**AIM:** To determine the specific gravity of fine aggregate (Less than 4.75mm) relevant code IS 2386 part III.

**THEORY:-** same as in coarse aggregate.

**APPARATUS:-**

i) Balance of capacity not less than 3 kgs readable and accurate to 0.5 gm and of such a type as to permit weighing of vessel containing aggregate and water.
ii) Ppycnometer
iii) A tray of area not less than 325 $cm^2$.
vi) A airtight container large enough to take sample.
v) Filter paper and funnel.

**DESCRIPTION OF APPARATUS**

A pycnometer is a glass jar of about one litre capacity having a metal conical screw top with a 6 mm. dia hold at its apex. The screw is water tight when screwed to the jar and if necessary a rubber or fibre washer is inserted in the joint.

**TEST PROCEDURE:**

The test procedure is listed in method III in the code, is as under.

1) A sample of about 300 g of fine aggregate finer than 4.75mm, shall be placed in the tray.
2) Take the empty weight of Pycnometer. **W1 gms**
3) The aggregate shall then be placed in the pycnometer which shall be filled with distilled water.
4) Any trapped air shall be eliminated by rotating the pycnometer on its side, the hole in the apex of the cone being covered with a finger.
5) The pycnometer shall be dried on the outside and weighed. **W2 gms**
6) The contents of the pycnometer shall be emptied into the tray, care being taken to ensure that all the aggregate is transformed.
7) The pycnometer shall be refilled with distilled water to the same level as before, dried on the outside and weighed. **W3 gms**

**Three samples shall be tested**

**OBSERVATIONS:**

| | **Sample I** | **Sample II** | **Sample III** |
|---|---|---|---|
| i) Weight of sample taken. W1 gms<br>ii) Wt of pycnometer + sample + water W2 gms<br>iii) Wt. of pyconometer + water W3 gms<br>iv) Specific Gravity = W1/ ( W1- (W2-W3)) | | | |

**CALCULATIONS**:

ii) Apparent specific gravity = $\dfrac{W1}{W1 - ( W2 - W3 )}$ =

**RESULT:-**

Specific Gravity of Fine aggregate ( Average of three trails) :

**PRECAUTIONS:-**

a) There should be no bubbles sticking to the surface of aggregate.
b) Aggregate should be handled carefully to avoid any loss during transferring from one unit to other.

**MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY**
CIVIL ENGINEERING DEPARTMENT
**Structural Engineering Laboratory**

**EXPERIMENT NO. 8**

## GRADING CURVES FOR FINE AND COARSE AGGREGATE

**AIM:-** To compare grading curves of given batch of aggregates with the specified curves and suggest necessary corrective measures.

**APPARATUS:** Gyratory sieve shaker, IS sieves of required sizes.

Necessary data; **I.S 2386 Part-I- 1963** has specified the following set of sieves for sieve analysis of aggregates.

**COARSE AGGREGATE:**

80mm, 63mm, 50 mm, **40mm**, 31.5m, 25mm **20mm**, 16mm, **12.5mm, 10mm**, 6.3mm, **4.75mm**,.

.

**I.S 383 -1970** has specified following ranges for various aggregates and various gradings.

**I. Single size grading of coarse aggregate of nominal size 20 mm.**

| I.S. Designation | Percentage passing through |
|---|---|
| 40mm | 100 |
| 20mm | 85-100 |
| 10mm | 0-20 |
| 4.75mm | 0-5 |

**II. Graded coarse aggregate of nominal size 20 mm**

| I.S. Designation | Percentage passing through |
|---|---|
| 40mm | 100 |
| 20mm | 95-100 |
| 10mm | 125-55 |
| 4.75mm | 0-5 |

III. **All in aggregate of 20mm nominal size**

| I.S Designation | Percentage passing through |
|---|---|
| 40mm | 100 |
| 20mm | 95-100 |
| 4.75mm | 30-50 |
| 600 microns | 10-25 |
| 150 microns | 0-6 |

**FINE AGGRGATES:**

**4.75mm**, 3.35mm, **2.36mm**, **1.18mm, 600 microns, 300microns, 150 microns, and 75 microns**

| I.S Designation | Percentage passing Grading Zone-1 | Grading Zone-2 | Grading Zone-3 |
|---|---|---|---|
| 10mm | 100 | 100 | 100 |
| 4.75mm | 90-100 | 90-100 | 90-100 |
| 2.36mm | 60-95 | 75-100 | 85-100 |
| 1.18 | 30-70 | 55-90 | 75-100 |
| 600 microns | 15-34 | 35-59 | 60-79 |
| 300 microns | 5-20 | 8-30 | 12-40 |
| 150 microns | 0-10 | 0-10 | 0-10 |

**I) Zone – I**

Coarse sands, suitable for rich mixes, For better workability the proportion of fine to coarse aggregate must be above 1:2

**II) Zone-II**

Medium sands, suitable for most concrete mixes. The normal fine to coarse aggregate ration is 1:2

**III) Zone –III**

Medium to fine sands, the ration of fine to coarse aggregate must be less than 1:2

**PROCEDURE:**

The procedure as per **I.S 2386 (Part-I) 1963** is as under:

a. The sample must be air dry before weighing and sieving. Care must also be taken to see that sieves are clean before use.
b. Weigh 5kg. of coarse aggregate and place into 40mm size sieve. Similarly weigh 1kg. of fine aggregate and place into 4.75mm size sieve.
c. Place the assembly of both the types of aggregate and sieve for 15minutes.
d. Weigh the material retained on each sieve and calculate percentage passing.
e. Plot the results of sieve analysis on a semi long graph with percentage passing on ordinate and sieve size as abscissa. Compare the results with the respective specified grading. Interpret the graph property and suggest measures to be taken to obtain proper grading.

Since the opening of sieves in a standard sieves are in the ratio of ½, a Logarithmic plot will show openings at constant spacing. Hence, instead of plotting the analysis on logarithmic scale, a scale could be chosen such that spacing on the adjacent sieves is approximately equal to 20% on the ordinate scale.

**OBSERVATION:**

**Coarse Aggregate**

| I.S Designation | Weight Retained | Percentage Passing |
|---|---|---|
| 40mm | | |
| 20mm | | |
| 12.5mm | | |
| 10mm | | |
| 4.75mm | | |
| 2.36 mm | | |
| 1.18mm | | |
| 600 microns | | |
| 300 microns | | |
| 150 microns | | |
| 75 microns | | |

**Fine Aggregate**

| I.S Designation | Weight Retained | Percentage Passing |
|---|---|---|
| 4.75mm | | |
| 3.35mm | | |
| 2.36mm | | |
| 1.18mm | | |
| 600 microns | | |
| 300 microns | | |
| 150 microns | | |
| 75 microns | | |

**RESULTS:**

Plot grading curves. On the same graph plot respective specified grading curve

**DISCUSSIONS:**

1) Define the following terms:

   a) Coarse Aggregate

   b) Fie Aggregate

   c) All in Aggregate

   d) Segregation

   e) Harshness.

2) What is the difference between

   a) Continuous graded, poor graded and gap graded aggregate.

   b) Single sized and well-graded aggregate

   c) Rich mix and lean mix.

   d) 20 mm size particle and 20mm size aggregate.

   e) Finer grading and coarser grading.

3) Plot the following curves of specified grading as per I.S 383 (Refer notes)

   1) All in aggregate 20mm size
   2) Fine aggregate zone –I
   3) Fine aggregate zone-II
   4) Fine aggregate Zone-III
   5) Single sized aggregate 20mm
   6) Graded coarse aggregate 20mm

4) Plot the grading curve of coarse and fine aggregate you have tested.
Does the coarse aggregate fall within prescribed limit?
State to which zone does fine aggregate belong.

5) Fill in the blanks:

a) One micron is __________ of a mm.
b) Aggregate is classified as single size aggregate when it contains __________
c) Graded aggregate is one which contains _________-
d) If particles of one size are missing the grading is known as __________
e) Sieve sizes for 20mm single size aggregate are__________
f) Sieve sizes for 20mm graded coarse aggregate are ___________
g) Sieve sizes for zone-II sand are ______________
h) Grading of aggregate must be considered from the point of view of following requirements.
i) ________________________
ii) _________________________
iii) _________________________

**EXPERIMENT NO. 9**

## FINENESS MODULUS OF FINE AND COARSE AGGREGATE

**AIM:-** To determine the fineness modulus of given batch of fine and coarse aggregate.

**EQUIPMENT:** Gyratory sieve shaker, I. S. Sieves

For fine aggregate (Sieves of 20mm dia. frame) micron, 300 micron, 600 micron, 1.18mm, 2.36 mm, 4.75mm, 10mm

For coarse aggregate (Sieves of 30mm dia. Frame ) 4.75mm, 10mm, 20mm, 40mm.

**PROCEDURE:**

1) Make a set of required sieves for fine and coarse aggregates. Place the assembly in Gyratory sieve shaker.

2) For fine aggregate weigh 1 kg and place it in 4.75mm
For coarse aggregate weigh5kg. and place in 80mm sieve.

3) Turn on the sieve shaker and run it for 15 minutes.

4) Weigh the weight of material retained on each sieve and enter in the given table.

5) The fineness modules is given by the sum of cumulative percent weigh retained divided by 100.

6) The standard values are

| | | | |
|---|---|---|---|
| Fine sand | 2.2 | - | 2.6 |
| Medium sand | 2.6 | - | 2.9 |
| Coarse sand | 2.9 | - | 3.2 |
| Coarse aggregate | 6 | - | 8 |

## OBSERVATIONS:

**Fine aggregate:**

| I.S Sieve size | Weight retained gms | % wt retained | Cumulative % of weight retained |
|---|---|---|---|
| 4.75 mm | | | |
| 2.36mm | | | |
| 1.18mm | | | |
| 600 microns | | | |
| 300microns | | | |
| 150 microns | | | |
| 75 microns | | | |
| | | | Total T = |

**Fineness modules = T / 100 = _____________**

**Coarse aggregate:**

| I.S Sieve size | Weight retained gms | % wt retained | Cumulative % retained |
|---|---|---|---|
| 40 mm | | | |
| 20 mm | | | |
| 12.5 mm | | | |
| 10 mm | | | |
| 4.75 mm | | | |
| 2.36 mm | | | |
| 1.18 mm | | | |
| 600 microns | | | |
| 300microns | | | |
| 150 microns | | | |
| 75 microns | | | |
| | | | Total T = |

**Fineness modules = T / 100 = ___________**

**RESULT:** Fineness modulus of fine aggregate is __________________________
Fineness modulus of coarse aggregate is ________________________

**DISCUSSIONS:**

1) Define fineness modulus of aggregate. What is its significance?

2) Following are the results of sieve analysis of fine aggregate. Calculate the Fineness modulus. State which aggregate is coarse.

3) How do you distinguish a fine aggregate with a coarse aggregate?

4) What is flakiness and elongation index?

**EXPERIMENT NO. 10**

## BULKING OF FINE AGGREGATE

**AIM:** To determine percentage bulking and necessary adjustment of bulking of the aggregate.

**APPARATUS:** 250 cc. graduated jar, steel or glass rod as poker, tray, balance and weight.

**PROCEDURE:**

The following is the procedure suggested by I.S. 2386 part –III 1963.

1) Take 250cc of fine dry sand and find its weight.

2) Add 2% water and mix thoroughly.

3) Pour the damp sand in the cylinder till it reaches 200 ml mark.

4) Then fill the cylinder with water and stir it well. It will be seen that sand surface is now below its original level. Suppose the surface is at the mark Y ml.
5) The bulking factor = 200/ Y
   Percentage of bulking = $\frac{(200 - Y)}{Y} \times 100$
6) Repeat the same procedure with various moisture contents 4, 8, 12, 16 and 20. Plot a graph between percentage of moisture (on abscissa) and percentage of bulking on ordinate. Determine the percentage of moisture content of max. bulking.

**OBSERVATION:**

**Fine Sand:**

| % of moisture | % of bulking |
|---|---|
| 2 | |
| 4 | |
| 6 | |
| 8 | |
| 10 | |
| 12 | |
| 14 | |

**RESULT:**

Maximum % age of Bulking is ___________________

Percentage of moisture content for max. bulking is : __________ ( Optimum Moisture content)

For a batch requiring 100 litres of dry sand, if damp sand with percentage of moisture (as calculated above for max. bulking) is supplied, then quantity of additional material required is as under.

**DISCUSSION:**

1) Define bulking of sand. Why does sand bulk?

2) What will be the effect on bulking if the percentage of moisture is
   (i) 25%   (ii) 15%   (iii) 5%

3) If the volume of dry sand is 70 litres, what is the actual volume of bulked sand that should be added to concrete mix if.

   (i) Bulking of sand is 20%

   (ii) Bulking of sand is 30%

4) In the problem above, if only 70 litres of bulked sand is added to concrete, then what will be the actual volume of dry sand added if

   (i) Bulking of sand is 20%

   (ii) Bulking of sand is 30%

The following are the values of bulking of sand for various moisture contents for a typical sand.

| Moisture | Percentage bulking | | |
|---|---|---|---|
| Percent | Fine Sand | Medium Sand | Coarse Sand |
| 1 | 16 | 8 | 6 |
| 2 | 20 | 16 | 12 |
| 3 | 32 | 22 | 15 |
| 4 | 36 | 27 | 17 |
| 5 | 38 | 29 | 18 |
| 6 | 37 | 28 | 18 |
| 8 | 35 | 26 | 16 |
| 10 | 32 | 22 | 12 |
| 12 | 28 | 19 | 8 |
| 15 | 22 | 12 | 2 |
| 17 | 18 | 7 | 0 |
| 20 | 0 | 0 | 0 |

i) Plot the values with percentage of moisture on X-axis and ordinate being percentage bulking for fine, medium and coarse sand on the same graph.

ii) Plot similar graph for the values obtained in your test for fine sand and coarse sand.

iii) Discuses the relative bulking tendencies of fine and coarse sand in plot (i) and plot (ii) separately.

**EXPERIMENT NO. 11**

## BULK DENSITY OF AGGREGATE

**AIM :** To determine bulk density of coarse and fine aggregate
Relevant code**: I.S. 2386 Part III Page No. 12 & 13.**

**THEORY :**

The bulk density is the weight of material in a given volume measured in kg/ liter of the aggregate which is filled loose in container, it is called loose bulk density and if the aggregate is compacted, it is called rodded bulk density.

The bulk density of an aggregate is affected by the following.

i) Amount of effort used to fill the container.
ii) size distribution
iii) shape (angular & flaky shaped under the bulk density)
iv) specific Gravity.

Loose bulk density is used to convert the quantity of aggregate by weight to quantities by volume when volume batching is done.

Rodded bulk density is used to detect changes in grading and shape while comparison has to be done.

**APPARATUS:**

1. A balance sensitive to 0.5 percent of weight of sample to be weighed,
2. Cylindrical metal measures with capacities as under.

| Size of Particles | Nominal Capacity (liter) | Inside Dia (mm) | Inside Height (mm) | Thickness of metal (mm) |
|---|---|---|---|---|
| 4.75mm | 3 | 150 | 170 | 3.15 |
| 4.75 to 40 mm | 15 | 250 | 300 | 4.00 |

3. Tamping Rod: A straight metal tamping rod of cylindrical cross section 16mm in dia and 600mm long rounded at end.

**PROCEDURE:**

The test shall be conducted on dry specimen. The procedure given in code is as under:

**RODDED BULK DENSITY:**

1) The measure shall be filled about one third full with thoroughly mixed aggregate and tamped with 25 strokes of the rounded end of tamping rod.

2) Repeat the same procedure after filling measure 2/3$^{rd}$ full.

3) The measure shall finally be filled to overflowing, tamping 25 times and surplus aggregate shall be struck off using tamping rod as straight edge.

4) The net weight of aggregate shall be determined and true bulk density calculated in kg/ litre.

**LOOSE BULK DENSITY:**

1) The measure shall be filled to overflowing by means of a shovel or scoop, the aggregate being discharged from a height not exceeding 5 cm above top of measure.

2) Care shall be taken to prevent, as far as possible segregation of the particle sizes of which the sample is comprised.

3) The surface of the aggregate shall then be leveled with a straight edge.

4) The net weight of aggregate in the measure shall then be determined and bulk density calculated in kg/litre.

5) The above procedure of rodded bulk weight and loose bulk weight should be used for following samples.
    a) 20 mm graded angular aggregate.
    b) 20 mm single size and angular aggregate.
    c) 20mm fine aggregate.

**OBSERVATIONS AND CALCULATIONS:**

**RODDED BULK DENSITY OF FINE AGGREGATES:**

| | Trail -1 | Trail - 2 | Trail -3 |
|---|---|---|---|
| _Empty Weight of Container, W1 kg | | | |
| Wt. of Container + Material. W2 kg | | | |
| Volume, m3 | | | |
| Density. Kg/m3 | | | |

Average Rodded Density of Fine Aggregates: _______________

**LOOSE BULK DENSITY OF FINE AGGREGATES:**

| | Trail -1 | Trail - 2 | Trail -3 |
|---|---|---|---|
| _Empty Weight of Container, W1 kg | | | |
| Wt. of Container + Material. W2 kg | | | |
| Volume, m3 | | | |
| Density. Kg/m3 | | | |

Average Loose Density of Fine Aggregates: _______________

## RODDED BULK DENSITY OF COARSE AGGREGATES:

| | Trail -1 | Trail - 2 | Trail -3 |
|---|---|---|---|
| _Empty Weight of Container, W1 kg | | | |
| Wt. of Container + Material. W2 kg | | | |
| Volume, m3 | | | |
| Density. Kg/m3 | | | |

Average Rodded Density of coarse Aggregates: _______________

## LOOSE BULK DENSITY OF COARSE AGGREGATES:

| | Trail -1 | Trail - 2 | Trail -3 |
|---|---|---|---|
| _Empty Weight of Container, W1 kg | | | |
| Wt. of Container + Material. W2 kg | | | |
| Volume, m3 | | | |
| Density. Kg/m3 | | | |

Average Loose Density of Coarse Aggregates: _______________

**MUFFAKHAM JAH COLLEGE OF ENGINEERING AND TECHNOLOGY**
CIVIL ENGINEERING DEPARTMENT
**Structural Engineering Laboratory**

**EXPERIMENT NO. 12**

# WORKABILITY OF CONCRETE BY SLUMP TEST

**AIM :** To determine workability of concrete by slump test.

**THEORY :** The term workability can be defined in two ways:

1. "It is that property of freshly mixed concrete which determines the ease and homogeneity with which it can be mixed, placed, compacted and finished". This definition is adopted in I.S 6461.

2. "It is the property of concrete which determines the amount of useful internal work necessary to produce complete compaction.

   This definition is adopted in I.S 1199.

   Thus workability is a term which possesses three different properties.

   **Compatibility** or the ease with which concrete can be compacted & air voids removed.
   **Mobility** or the ease with which concrete can flow into moulds around steel & be remoulded.
   **Stability** or the ability of concrete to remain a stable coherent homogeneous mass during handling & vibration, without the constituents segregating. No one test gives complete guidance on the degree to which these properties are developed in a mix.
   **The slump test** indicates the consistency of cement concrete. The measure of workability is the slump observed after the subsidence of concrete mix. It is basically a field test which determines essentially the consistency or wetness of the mix. It was developed by Chapman in the United States in 1913. This is the simplest test & most commonly employed in on-site testing. The test is not very accurate particularly with drier, leaner mixes, but it represents a useful means of comparing workability of different batches of concrete

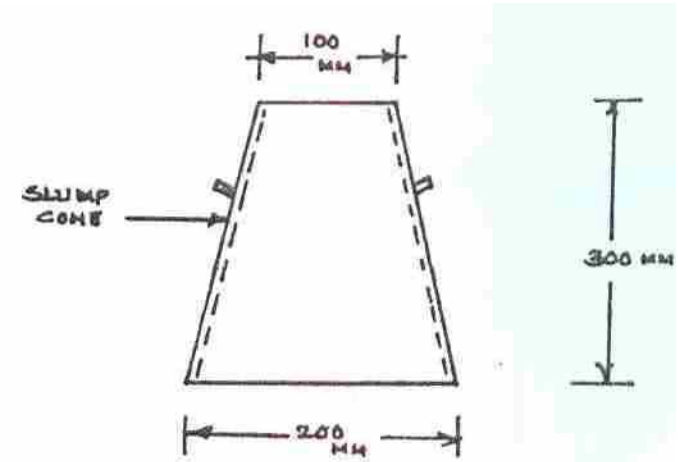
   **There are three types of slumps.**


Types of slump

**APPARATUS USED:**

**Slump cone, tamping rods, weighing balance, trowel, scale and iron pan.**

**DESCRIPTION OF APPARATUS:**




**Slump Cone:**

It is a hollow frustum of a cone with the following internal dimensions.

| | |
|---|---|
| Bottom dia | 20cm |
| Top dia | 10cm |
| Height | 30cm |

The mould is made of metal sheet of 1.6mm thickness, with smooth internal surfaces. It is provided with suitable foot pieces and handles to facilitate lifting.

**Tamping rod:**

The tamping rod used is of steel 16mm dia & 0.6 m long and rounded at one end to a hemispherical tip.

**PROCEDURE:**

The procedure as per I.S 1199 is an under:

The Internal surface of the mould shall be thoroughly freed from superfluous moisture and any set concrete before commencing the test.

The mould shall be placed on a smooth rigid horizontal surface and must be held firmly in positing while it is being filled.

The mould shall be filled in four-layers each approximately one quarter of the height of the mould. Each layer should be tamped with 25 strokes of the rounded end of the tamping rod. The strokes shall be distributed in uniform manner over the cross section of the mould and for the second & subsequent layers shall penetrate into the underlying layers. The bottom layer shall be tapped throughout its depth.

After the top layer has been rodded, the concrete shall be struck off level with a trowel of the tamping rod so that the mould is exactly filled.

Any mortar which may have leaked out between the mould and the base plate shall be cleaned way.

The mould shall be removed from the concrete immediately by raising it slowly & carefully in a vertical direction. This allows the concrete to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of the specimen being tested.

**OBSERVATION:**

| Particulars | I | II | III |
|---|---|---|---|
| Cement | | | |
| C.A | | | |
| F.A | | | |
| W/c ratio | | | |
| Water added | | | |
| Type of slump | | | |
| Workability cm | | | |

**CONCLUSIONS :**

______________________________________

______________________________________

**PRECAUTIONS:**

1. The stroke must be uniform.

2. The cone should be lifted up carefully without disturbing concrete.

3. The slump test should not be conducted when there are vibrations all around.

**DISCUSSIONS:**

1. Define workability of concrete.

2. What are the factors that influence workability?

3. What properties are measured by
   a) Slump cone test

   b) Compaction factor test

   c) Vee Bee test

4. Is it possible to have workability but low slump or low workability and high slump?

5. Draw neat sketches of the apparatus used in slump test & compaction factor test.

**EXPERIMENT NO. 13**

## WORKABILITY OF CONCRETE BY COMPACTION FACTOR TEST

**AIM :** To determine workability of concrete by compaction factor test.

**THEORY :** I.S. 1199 defines workability as under:

"It is the property of concrete which determines the amount of useful internal work necessary to produce complete compaction".

Workability is, however a composite property. The different methods of measuring workability measure one particular aspect of that property. The compaction factor test measures degree of compaction for a certain amount of work done.

Suggested ranges of values of workability of concrete according to I.S. 1199 are as under:

| Degree of workability | Placing condition | Value of workability C.F |
|---|---|---|
| Very low | Concreting of shallow sections with vibrations | 0.75 – 0.80 |
| Low | Concreting of lightly reinforced sections with vibrations | 0.80 -0.856 |
| Medium | Concreting of lightly reinforced sections without vibration or heavily reinforced section with vibration | 0.85 – 0.92 |
| High | Concreting of heavily reinforced sections without vibration | Above 0.92 |

The compaction factor test was developed by Glanville and others in Britain in 1947 and is a more sensitive method of determining the workability of drier concrete. It measures the degree of compaction induced by a standard amount of work, and compares the density of this compacted sample against a fully compacted sample.

The method tends to be accurate for very wet, rich, mixes, and for extremely dry lean mixes, however, it provides a yardstick for continuous production of a mix.

The compaction factor test apparatus consists of tow conical hoppers mounted vertically above cylindrical mould. The internal dimensions are as under:

| | Top dia | Bottom dia | Height |
|---|---|---|---|
| **Upper hopper** | 25 cm | 12.5 cm | 22.5 cm |
| **Lower hopper** | 22.5 cm | 12.5cm | 22.5cm |

The dimensions of cylinder are 15cm dia & 30 cm height.

The distance between bottom of upper hopper and top of lower hopper is 20cm similarly the distance between bottom of lower hopper and top of cylinder is 20cm. The lower ends of hopper are fitted with quick release flap doors. The hopper and cylinder are rigid in construction and rigidly mounted on the frame.

**PROCEDURE:**

1. Grease the inner surface of the hopper & cylinder.
2. Fasten the hopper door.
3. Weigh the empty cylinder accurately W1 kg.
4. Fill the freshly mixed concrete in upper hopper gently with trowel without compacting.
5. Releases the trap door so that the concrete may fall into the lower Hooper bringing the concrete into standard compaction.
6. Immediately after the concrete comes to rest, open the trapdoor of the lower hopper and allow the concrete to fall into the cylinder bringing the concrete into standard compaction.
7. Remove the excess of concrete above the top of the cylinder by a trowel.
8. Clean the cylinder for all sides properly. Find the weight of partially compacted concrete thus filled in cylinder W2 kg.

9. Refill the cylinder with the same sample of concrete in approximately 5cm layers, vibrating each layer so as to expel all the air and to obtain full compaction of concrete.

10. Level up the mix and weigh the cylinder filled with fully compacted concrete w3kg.

**OBSERVATIONS:**

| | I | II | III |
|---|---|---|---|
| Wt. of cylinder (W1) | | | |
| Wt. of cylinder + Fallen concrete (W2) | | | |
| Wt. of cylinder + fully compacted concrete (W3) | | | |
| Wt. of loose concrete (W2- W1) = W4 | | | |
| Wt. of fully compacted concrete (W3-W1) = W5 | | | |
| Compaction factor W4/W5 | | | |
| Proportion of sample & w/c ratio | | | |

**CONCLUSIONS:**

**PRECAUTIONS:**

The top hopper must be filled gently.

The mix should not be pressed or compacted in hopper.

If concrete in hopper does not fall through when the flap is released, it should be freed by passing a metal rod.

**EXPERIMENT NO. 14**

## WORKABILITY OF CONCRETE BY VEE BEE CONSISTOMETER TEST

**AIM:** To determine workability of freshly mixed concrete by use of Vee-Bee consistometer..

**APPARATUS:**

Vee-Bee consistometer (I.S 1199-59) consists of a vibrating table resting on elastic support, a cylindrical container and a sheet metal slump cone ,a standard iron rod weighing balance, trowels.

The vibration table 380 mm long and 260 mm wide is supported on rubber shock absorbers at a height of about 305 mm above the floor level. Under the table is mounted an electrically operated vibrometer. The assembly is mounted on a base that rests on three rubber feet.

The sheet metal slump cone open at both ends is placed in cylindrical container that is mounted on the vibration table by means of wingnuts. The cone is 300mm high with its bottom & top diameters as 200mm & 100mm respectively.

A swivel arm holder is fixed to the base & into it is telescoped another swivel arm with funnel & guide sleeve. The swivel arm can be detached from the vibrating table. A graduated rod, to the one end of which a transparent disc can be screwed is fixed to the swivel arm through the guide sleeve. The divisions on the scale on the rod record the slump of concrete cone in the cylindrical container.

The standard iron rod is 20mm in dia & 500 mm in length.

**THEORY:**

Developed in Sweden by V. Bahrner in 1940, this is a remoulding test in which the time taken to transform by means of vibrations a standard cone of concrete to a compacted flat cylindrical mass is recorded. The measures required in remoulding and gives an indication of mobility & to some extent of the compatibility of freshly mixed concrete. The method is most suitable for dry mix., but does not give reliable results for concrete mixes of max aggregate size in excess of 20mm. The method is inaccurate for highly workable mix.

**PROCEDURE:**

1. Carry out the ordinary slump test by keeping the cone inside the cylinder itself.

2. The metal disc with sliding rod is to be used to measure the slump. Read the scale on the rod to give the slump.

3. Remove the slump cone from the cylinder and start the vibrator and simultaneously start the stopwatch.

4. Note the time required for concrete to take a horizontal surface. This can be done by seeing through the plastic disc.

**OBSERVATIONS:**

| Sno | Particulars | I | II | III |
|---|---|---|---|---|
| 1 | Initial reading on graduated rod (a) | | | |
| 2 | Final reading on the graduated rod (b) | | | |
| 3 | Slump (b-a) mm | | | |
| 4 | Time for complete remoulding seconds. | | | |

**RESULT:**

The consistency of concrete is:

**PRECAUTIONS:**

1. Oil the inside surface of cylinder.

2. Remove slump cone carefully without disturbing the form from the cylinder before starting the vibration.

3. Stop the vibration as soon as horizontal surface is formed.

## EXPERIMENT NO. 15

## COMPRESSIVE STRENGTH OF CONCRETE

**AIM**: To determine compressive strength of concrete of by conducting cube tests.

**APPARATUS**:

3 No. Cube moulds 150mm in size.

**EQUIPMENT:** Weighing balance, mixer, and 2000 KN compression testing machine.

**THEORY:**

Concrete is primarily strong in compression, and in actual construction it is used basically for the compressive strength. The strength in compression has a definite relationship with all the other properties of concrete. These properties are improved with improvement in compressive strength.

For determining compressive strength of concrete, cubes & cylinders are used. Grades of concrete as per IS 456 are based upon cube strength. Thus the characteristic strength of concrete is defined as that strength of 150mm cube, cured for 28 days, below which not more than 5% of the test results will fall.

The cylinder strength forms the basis for defining compressive strength in some other codes such as ACI 318. The cylinder strength is approximately 0.8 times, the cube strength. The reduction in value of strength is due to height to lateral dimension effect.

**DESCRIPTION OF APPARATUS**:

a) Cube moulds :- size 150mm x 150mm x 150mm
made of steel or cast iron.
b) Tamping rod :- 16mm dia, 650 mm in length
bullet pointed at lower end.

**PROCEDURE:**-

**Casting:**

1. Mix the concrete ingredients thoroughly in the mixer until uniform colour is obtained.

2. Pour concrete in the moulds oiled with medium viscosity oil. Fill concrete in two layers each of approximately 75 mm and ramming each layer with 25 blows evenly distributed over the surface of layers.

3. Fill cylinder mould in 4 layers each of approximately 75 mm and ramming each layer with 25 evenly distributed blows.

4. Trowel off concrete flush with top of mould.

**Curing:**

1. Specimens are removed from the mould after 24 hours and cured in water for 28 days.

2. After 24 hours of casting, the cylindrical specimens are capped with neat cement paste of 35% water content. After another 24 hours, they are immersed in water for final curing.

**Testing:**

1. Measure size of the specimen to the nearest 0.2mm. The length of cylinder is measured to nearest 2 mm.

2. Place specimen centrally in the compression testing machine. Apply load continuously, uniformly and without shock at rate of 14 $N/mm^2/min$.

3. Record the max. load carried by each specimen. Also note the type of failure and appearance of crack.

**OBSERVATIONS:-**

| Type | Particular | Specimen | | | Average Strength, $N/mm^2$ |
|---|---|---|---|---|---|
| | | I | II | III | |
| Cube | Area of Cross section | | | | |
| | Crushing load KN | | | | |
| | Crushing Strength $N/m^2$ | | | | |

**RESULTS:-**

**Cube Strength: -** =

**DISCUSSIONS:-**

1. What is the minimum compressive strength of O.P.C at 7 days curing?
2. Why cube strength is is greater than the cylinder strength. What is the relationship?
3. How does the strength of concrete get affected by the rate of loading?
4. What is meant by M20 concrete?
5. Define characteristic compressive strength of concrete?
6. What is the relationship between Target mean strength and characteristic compressive strength?

7. What is the expression given in code to find out strength on any day? Using that expression determine strength of M20 concrete after 3 days, 7 days, 14 days and 21 days.

**<u>ADDITIONAL QUESTIONS</u>:-**

1. You have tested concrete of same batch and cured for same no of days. But each cube has different strength. Explain the variations?

2. How is this variation in strength taken care of?

3. What is standard deviations?

4. Why is probability concept used in defining strength of cement?

**EXPERIMENT NO. 16**

## FLEXURAL STRENGTH

**AIM:**- To determine modulus of rupture of concrete.

**APPARATUS**:- Prism mould 100 X 100 X 400 mm (3 No.), Tamping bars, trowels, Hand scoop

**EQUIPEMENT:**- Weighing balance, mixer, 200 KN compression testing machine.

**THEORY:-** Modulus of rupture defined as the max. tensile stress reached in the bottom fiber of the test beam.

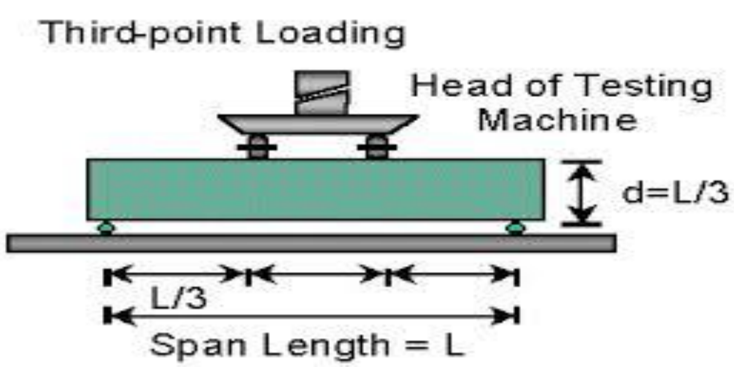
The test tensile stress of concrete can be determined:

i) Directly by conducting flexure test on beam.
ii) Indirectly by split tensile strength test.

The direct test is conducted by third point loading.

Let

$\sigma$ = Modulus of rupture




W = Load applied

L = Effective span

d = Depth of beam

If fracture occurs within middle third of span,

$$\sigma = WL/bd^2$$

If failure occurs outside the middle third,

$$\sigma = 3WL/bd^2$$

If failure point falls outside the middle third by more than 5% of span, the results shall be discarded.

While the compressive strength is the most important property of concrete, the knowledge of tensile strength helps in estimating loads under which cracking may develop.

**PROCEDURE:**-

**Casting and Curing:**

The procedure for making and curing the beams is identical to that of cubes except that a minimum of 175 tamps is required for each 50 mm layer of 150 mm.

**Testing:**

1. The specimen is placed in the testing machine such that the load shall be applied to the uppermost surface as cast in the mould along two lines spaced 20 cm apart.
2. The load is applied carefully without shock and at a rate of 400Kg/min.
3. The observations are recorded.

**OBSERVATIONS**:-

| **Description** | | **Specimen** | | |
|---|---|---|---|---|
| | | **I** | **II** | **III** |
| Date of casting | | | | |
| Date of testing | | | | |
| Age of testing | | | | |
| Measurements | L mm | | | |
| | B mm | | | |
| | D mm | | | |
| Volume L X B X D | | | | |
| Wt. of beam W | | | | |
| Unit wt. W/V | | | | |
| Breaking load | | | | |
| Modulus of Rupture = N/mm2 | | | | |

Average modulus of rupture = ________$N/mm^2$

**CONCLUSIONS**:-

Average modulus of rupture:

Relation between modulus of rupture and split tensile strength:

Relation between compressive strength and modulus of rupture:

**DISCUSSIONS:**

1. What is meant by split tensile strength of concrete? Explain the expression used to determine it and draw relevant graph.

2. What is meant by modulus of rupture? What is the expression suggested to find the modulus of rupture?

3. When are the results related to modulus of rupture discarded?

4. What is the relationship between modulus of rupture and split tensile strength?

5. What is the relationship between tensile strength and compressive strength of concrete?

**EXPERIMENT NO. 17**

## SPLIT TENSILE STRENGTH

**AIM**:- To determine the split tensile strength of concrete of given mix proportions.

**APPARATUS REQUIRED**:-

Compression testing machine, packing strips of plywood conforming to IS 303 – 1970. Cylinder moulds 150 mm dia X 300 mm height. Weighing machine, mixer, tamping rod.

**THEORY**:-

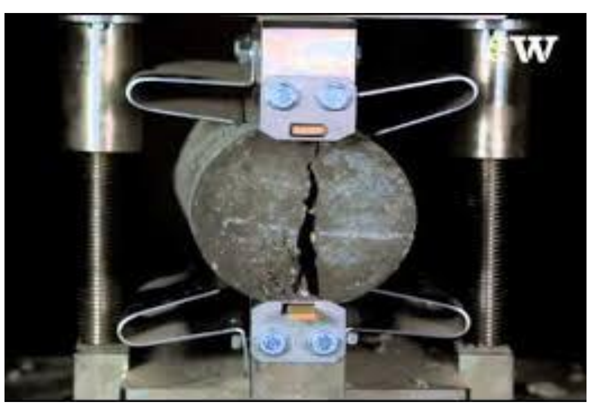
Though concrete is not expected to resist direct tension, the determination of tensile strength of concrete is necessary to determine the load at which the concrete member may crack, since cracking is a tensile failure.

The split test is an indirect method of determining tensile strength of concrete. The test consists of applying a compressive live load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens. Due to compressive loading, a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter.

The magnitude of the tensile stress $\sigma_{sp}$ is given by:

$$\sigma_{sp} = 2P/\pi Dl.$$
$$= 0.637\ P/Dl$$

Where
P = applied load
D = diameter of cylinder
l = length of cylinder



**PROCEDURE**:-

1. Using normal mix M20 (1:1.5:3) with water cement of ratio of 0.6..
2. In mixing by hands, cement and fine aggregate shall be first mixed dry to uniform colour and then coarse aggregate is added and mixed until coarse aggregate is uniformly distributed throughout the batch. Now water shall be added and ingredients are mixed until resulting concrete is uniform in colour. Mix at least for 2 min.

3. Pour concrete in moulds oiled with medium viscosity oil. Fill cylinder moulds in four layers each of approximately 75 mm and ram each layer more than 25 times with evenly distributed strokes. Remove surplus concrete from top of moulds with the help of a trowel. Remove the specimen from moulds after 24 hours and immerse them in water for final curing.

4. Before testing, determine diameter, length of specimen to nearest 0.2mm center one of plywood strip along the center of lower platen. Place the specimen on the plywood strip. The second plywood strip similarly placed on the top of the cylinder.

5. The load is applied without shock until failure occurs. Note the appearance of concrete and any unusual features in the type of failure.

Compute splitting strength of specimen to nearest 0.05 $N/mm^2$

| **Specimen No.** | **1** | **2** | **3** |
|---|---|---|---|
| Date of test | | | |
| Age of test | | | |
| Weight of specimen(Kg) | | | |
| Max load P kg. | | | |
| Dia of specimen mm | | | |
| Length of specimen mm | | | |
| Split Tensile strength $N/mm^2$ | | | |

**PRECAUTIONS**:

1. The mould and base plate should be oiled lightly, before use.
2. The specimen should be made and cured as per IS 515 1959
3. The cylinders should be placed in testing machine centrally.
4. The load should be applied without shock.

**RESULTS**:

Split tensile strength of Concrete is :